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IDIMT-2015
Information Technology and Society Interaction and Interdependence

23nd Interdisciplinary Information Management Talks

The 23nd annual IDIMT conference is continuing in its tradition as an interdisciplinary forum for multi-disciplinary, multi-national, and future-oriented research. It deals with current and future challenges caused by Information and Communication Technologies (ICT) which structure and modify our environment, our society and economics. We interact with ICT in multiple ways; the interdependence between Society and Technology is increasing. This leads to a permanent transformations of business processes which are also reflected in changes in everyday life.
This year's conference covers several areas of profound ICT impact: health care, social media, business models, smart cars and smart homes, and overarching ethical issues.
In addition to having accepted 13 invited papers we have also accepted, based on a blind review process, 45 submitted papers. The authors come from 12 different countries: Austria, Croatia, Czech Republic, Denmark, Germany, Greece, Italy, Lybia, Luxembourg, Slovakia, Slovenia, and Switzerland.

The papers have been organized into the following themes:

- Information and Computer Ethics
- Resilience of Societies
- Health-Data Processing: Socio-technical Aspects
- Smart-home Security
- Social Media for Information Management
- Wisdom of Crowds
- Autonomous Systems and Vehicles
- ICT's Impact on Economy and Society
- Open Innovation and new e-Business Models
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9 783990 333952
ISBN 978-3-99033-395-2
www.trauner.at

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Doucek ■ Chroust ■ Oškrdal (Editors) IDIMT-2015

Band 44

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Oškrdal Václav (Editors)

IDIMT-2015
Information Technology and Society Interaction and Interdependence

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Schriftenreihe Informatik
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Impressum

Schriftenreihe Informatik

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(Editors)
IDIMT-2015
Information Technology and Society – Interaction and Interdependence
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This publication was partially supported by the University of Economics, Prague VSE F4/22/2015(409015) and Česká spořitelna, a.s.

The Conference IDIMT-2015
took place September 9-11, 2015
in Poděbrady, Czech Republic

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Herstellung: Kern:
Johannes-Kepler-Universität Linz,
4040 Linz, Österreich/Austria

Umschlag:
TRAUNER Druck GmbH & Co KG,
4020 Linz, Köglstraße 14,
Österreich/Austria

ISBN 978-3-99033-395-2
www.trauner.at

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Welcome to IDIMT 2015!

A hearty welcome to the 23rd IDIMT Conference!

Looking back over the long history of IDIMT conferences we can notice improvements having taken place from one conference to the next. This year we are proud that for the first time we had had such a large submission of papers that we had to split the programme in 2 parallel streams in order to provide sufficient common discussion time at the end of each session.

The overall orientation of our conferences has not changed: it deals with current and upcoming challenges in a world living from and dependent on Information and Communication Technology, however, each year we can observe slight variations in interest and direction:

This year's emphasis is on ICT's impact on health care, on home security, and social media, and the resilience of systems. ICT influence on business receives the expected attention. As an overarching topic we want to discuss ethical issues. Hence the title of this year's conference:

"Information Technology and Society - Interaction and Interdependence"

Christian's Loesch lecture always offers an often surprising view on the new developments in technology, and also its limits.

And we should not forget the afternoon/evening excursion which is always perfectly organized by Petr Doucek!

A look into the audience shows me the familiar faces of participants who loyally return year after year. We are a big family! This friendly atmosphere and the ample discussion time are one of IDIMT's greatest assets.

Looking back at the previous 22 conferences (we started in 1993!) we can observe a common shift of discussion from technology (especially software) to 'softer topics'. More and more the papers as well as discussions are concerned with the impacts and consequences (both positive and negative) of ICT on business, humans and society.

This year's conference will have more and a greater diversity of topics and issues. The resulting sessions are:

- Social Media for Information Management
- The Wisdom of Crowds
- hDATA Processing: Socio-technical Aspects of Health
- Resilience 2.0: ICT for Resilience of Societies
- Smart-home Security
- Smart Vehicles: Societal, Economic and Technical Issues
- ICT and its impacts on Economy and Society
- Do We Need Information and Computer Ethics?
- Open innovation and new e-business models
- eSourcing and eProcurement
- Corporate performance management
- Academic and Business Co-operation

In my opinion the IDIMT-conferences act as a regional indicator of current trends in ICT. The headings of the individual sessions and the number of accepted papers reflect the current interest of participants.

Employing a blind review process we have accepted 45 out of 67 submitted papers plus 13 invited papers, giving an acceptance rate of 67%. The authors come from 12 different countries: Austria, Croatia, Czech Republic, Denmark, Germany, Greece, Italy, Libya, Luxembourg, Slovakia, Slovenia and Switzerland.

Each session is organized by a Session Chairperson. Traditionally a session starts with a keynote, the other papers providing additional points of view. The papers are followed by intense discussions. We believe that the intense discussions are one of the attractions of the IDIMT-Conferences, due to the interdisciplinary exchange of thoughts.

The preparation and realization of IDIMT 2015 would not have been possible without the support of many organizations and persons. Therefore we would like to thank:

- the University of Economics, Prague Internal Grant Agency (IGA) for Project VSE F4/21/2015 (409015),
- the University of Economics Prague and the Johannes Kepler University Linz, which as partner universities provide the organizational infrastructure.

Our further thanks go to:

- Petr Doucek for chairing the Organizing Committee, finding a new, attractive location for the conference and organizing a greatly appreciated evening event,

- Antonín Pavlíček for organizing the program, the reviews, keeping contact with all involved speakers, especially reminding the authors,
- Václav Oškrdal who took over the work of arranging and assembling the selected papers into the proceedings,
- Lea Nedomová, Conference Secretary, for her support in performing all the other necessary administrative jobs,
- all Keynote Speakers, speakers and contributors of papers,
- all Session Chairpersons for establishing contacts and soliciting contributors,
- all reviewers providing critical remarks for improving the papers,
- the Trauner Verlag for acting as the publisher of our conference, and
- all other unnamed persons contributing to the success of this conference.

Looking forward to a successful and interesting conference!

Gerhard Chroust, July 2015

We want to thank all reviewers of the IDITM 2015 Conference:

Klára Antlová
Georg Aumayr
Lucie Böhmová
Alena Buchalcevová
Jan Čapek
Radim Čermák
Gerhard Chroust
Radoslav Delina
Petr Doucek
Jakub Fischer
Gudrun Haider
Jana Hančlová
Christian Kloyber
Bohumil Král
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SESSION A: RESILIENCE 2.0: ICT FOR RESILIENCE OF SOCIETIES

RESILIENCE 2.0: ICT FOR RESILIENCE OF SYSTEMS

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Keywords

Disaster Management, vulnerability, Phases, fragile, antifragile, Intervention

Abstract

Due to many factors (larger population, more dependency on technology, more interference with the natural systems and balances, resulting changes in climate, ...) the number and the severity of disasters seem to grow, exaggerated additionally by the media coverage. Consequently disaster prevention and Disaster Management also have to be given increased attention. The ultimate goal of Disaster Management is survival of the affected population in the case of disaster.

With respect to a disaster-caused behavior we try to transform a system in such a way that instead of being fragile (losing its functionality due to the disaster) it will become resilient (having the capacity ... to bounce back to dynamic stability after a disturbance), or even antifragile (being able to "learns" to improve disaster resilience).

Resilience 2.0 identifies a new paradigm: modern Information and Communication Technologies (ICT) are employed as a basis for resilience of a system. ICT provide the basis for quick, effective, and efficient reaction to disasters. Only the coordinated intra- and interphase use of ICT promises sufficient success and can bring resilience to currently still fragile systems. ICT Support for the Response/Intervention Phase is considerably different from classical ICT-application due to high time and performance pressure, physical and psychological stress on personell, potentially damaged ICT-platforms and communication infrastructure, unknown and/or adverse natural environment, etc.

1. Motivation

Diverse Disasters often endanger the foundations of our society. This seems to be the case at present as result of observing media coverage. They seem to happen occur more frequently often and more devastatingly". Observing the various media one gradually gets the impression that this is the situation today. Several facts contribute to this feeling:

- We receive much prompter and more detailed information concerning distant disasters. Many media reports wallow in the details of disasters ("bad news are good news").

- Human activities increasingly impact the environment often in an adverse way - many disasters are triggered by human activity, be it by changes to the environment, be it by reducing safety margins for the sake of so-called of efficiency,
- An increasing number of humans live in areas which were originally avoided.
- The Western World often has the false belief that technology can prevent any kind of risk. This has made us become less tolerant when being confronted with natural disasters etc.

We have to recognize that the basic and ultimate goal is survival of the affected population in an acceptable way in the case of disaster. Nature is an experienced and creative teacher with respect to survival of a species. One of the experiences is that considerable attention has to be given to the preparation of response to future disasters in order to avoid the worst possible consequences and improve the chances for survival.

2. Background

2.1. What constitutes a Disaster?

Disasters result from a unfortunate combination of 3 major factors (Khan et al. ,2008), fig. 1:

hazard "a dangerous condition or event, that threat or have the potential for causing injury to life or damage property or the Environment"

vulnerability "the extent to which a community, structure, services or geographic area is likely to be damaged or disrupted by the impact of a particular hazard, on account of their nature, construction and proximity to hazardous terrains or a disaster prone area."

capacity "resources, means and strengths which exist in household and communities which enable them to cope with, withstand, prepare for, prevent, mitigate or quickly recover from a disaster"

Figure 1: Factors contributing to a disasters

A further difficulty is the highly different time-behavior of disasters, from abruptly starting without any warning (e.g. comets, ’d’ and ’i’ in fig. 2) to slow on-set disasters where it is difficult to pinpoint the point-of-no-return where a normal situation gradually turns into a disaster (e.g. global warming or floods, ’a’, ’c’ and ’e’ in fig. 2). These variants are shown in fig. 2 (Mrotzek and Ossimitz, 2008; Mrotzek, 2009), where grey indicates the ’acceptable domain’.

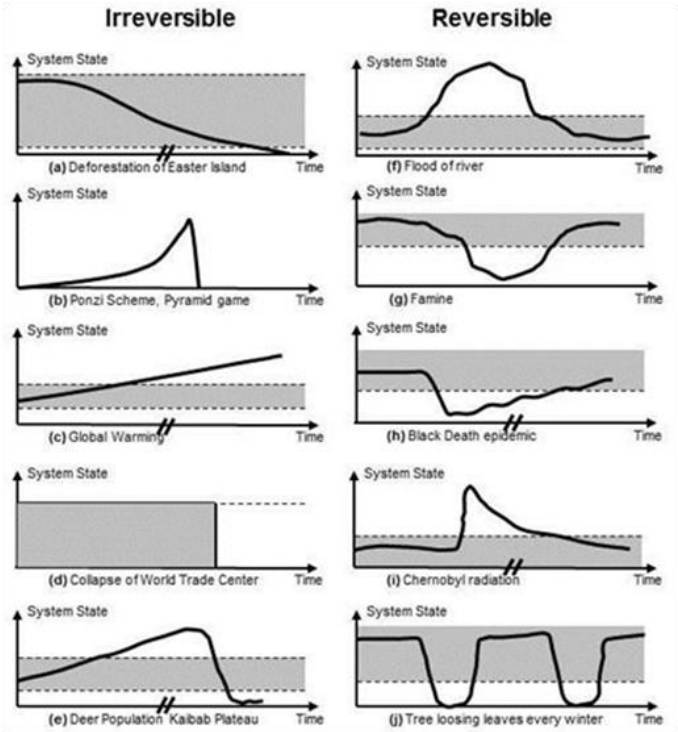

Figure 2: Catastrophes, time behavior

2.2. Phases of Disaster Management

One can identify several phases of Disaster Management, but the classifications, the demarcations between the phases, their names and the comprised activities are not uniformly defined yet, see Tierney et al. (2001); Khan et al. (2008); McEntire (2007); INSARAG (ed.) (2012). One can hope that the standard ISO 22320 (Lazarte, 2013; ISO, 2011a) will bring some uniformity.

The Disaster Impact is the pivot point, although even there a definition might be difficult when we talk about slow-onset disasters, see fig. 2.

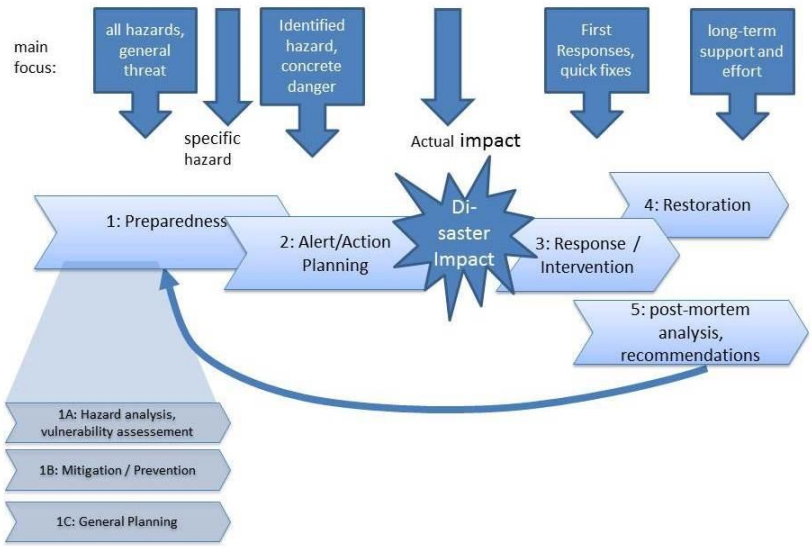

Figure 3: Disaster Phases and corresponding response processes

Figure 3 shows the phases of Disaster Management together with the main foci on top.

1. **Preparedness** This encompasses all activities which are undertaken before any specific hazard becomes threatening (IFRC (ed.), 2007b,a; McEntire, 2007; Tierney et al., 2001). Three different areas have to be considered:

   1A: Hazard, vulnerability and risk assessment: Based on existing data the risks faced by a region/society must be analyzed based on the identification of hazards, analyzing the vulnerabilities and the capabilities. (IFRC (ed.), 2007b)

   1B: Mitigation/prevention: This encompasses any activity that reduces either the chance of a hazard taking place or a hazard turning into disaster.

   1C: General Planning: Anticipatory measures and actions, action plans, listing and provisioning necessary resources and equipment, organizing training, etc. for all anticipated hazards. This includes, in the line of resilience, plans for the restoration phase.

2. **Alert / Action Planning:** plans or preparations are made how to react, to save lives or property, and decide how the rescue service operations coordinated and executed. This phase covers implementation/operation, refreshing of training, issuing early warnings capacity building so the population will react appropriately when an early warning is issued.
3. **Response/Intervention:** is primarily concerned with rescuing people and bringing the system into a temporarily stable state (’quick fixes’) - in most cases with external help. This phase is the implementation of the action plans conceived in Phase 2 .
4. **Recovery/Restauration**: The often long-lasting Restoration Phase intends to bring the system into a long-term acceptable state (Chroust et al., 2015) considering reducing vulnerability and improving maintainability. It includes actions that assist a community to return to a sense of normality after a disaster.
5. **Post-mortem Analysis and Recommendations** is the path to future improvement by collecting, analyzing and aggregating lessons learnt, and making recommendations for the system in general and for Phase 1 in particular.

2.3. Classifying system vulnerability with respect to disasters

Systems show different behavior with respect to actual disasters (fig. 4).

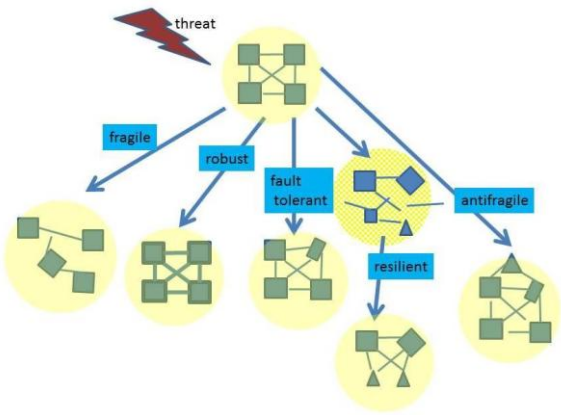

Figure 4: Classes of vulnerability

fragile: the system breaks/becomes non-existent for the future.

fault tolerant: for a limited set of pre-defines hazards (’faults’) the system is able to cope with or handle the disturbance successfully.

resilient: the system, when damaged, is able to be brought into an acceptable state, most likely not the same as before (fig. 5).

robust: the system is unchanged and remains unchanged, it is basically not affected

antifragile: the system is not only resilient but additionally "learns" to better counter a similar disturbance in the future, possibly becoming fault tolerant or even robust (Taleb, 2012).

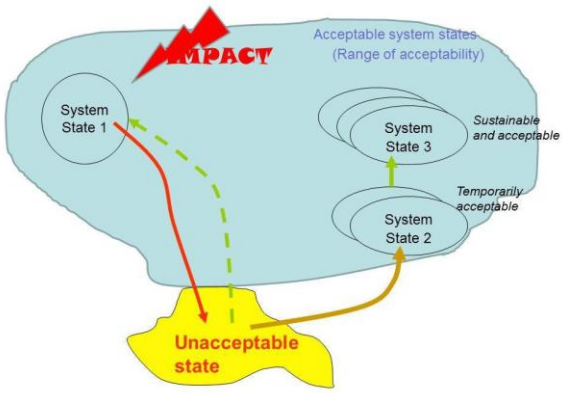

Figure 5: State transition: unacceptable/acceptable

Caveat:

Above classification is very simplistic and idealistic, since a system may react in completely different ways to different types of hazards and threats. Additionally the duration of achieving an acceptable state can vary from hours to years. Finally the definitions strongly depend on the definition of the system boundary: A house itself might be rather fragile with respect to fire, but if we consider the city's fire brigade as a part of the threatened system, then it can be classified as fault tolerant or resilient, see fig. 6.

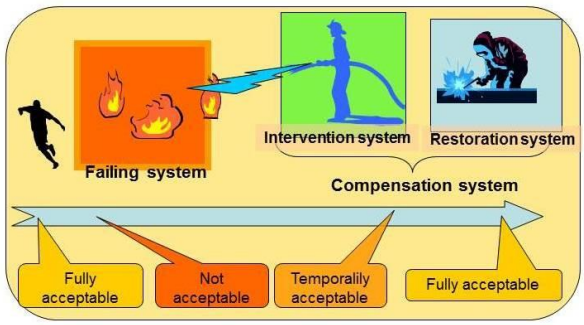

Figure 6: Intervention and Restoration System

3. Resilience

3.1. Vulnerability and Resilience

In Francois (2004, p. 504) resilience is defined as "The capacity of an adapting and/or evolving system to bounce back to dynamic stability after a disturbance. In a more general meaning, resilience includes the system's ability to create new conditions of fitness for itself whenever necessary". Holling (1986) adds: The size of the stability domain of residence, the strength of repulsive forces at the boundary, and the resistance of the domain to contractions are all distinct

measures of resilience". [A system] has "the ability ... to absorb changes of state variables, driving variables, and parameters, and still persist"

Comparing the 5 types of vulnerability we may say:

- *fragility* is to be avoided at all means.
- *fault tolerance* is not sufficient in all those cases, where one does not have a full control over the environment, because hitherto not identified hazard will not be taken care of.
- *robustness* might be too difficult to achieve due to the cost and effort for the current system. Additionally maintenance and evolution of such a system might become too difficult.
- *antifragility* might require too many/complex additional system components or overhead for the learning effect.
- *resilience* over a wide (and even not fully known) range of possible hazards is a highly desirable property of a system and therefore the most worthwhile objective of system design with respect to Disaster Management (Brose, 2015). Resilience, however, like many desirable aspects of Disaster Management, does not come free: it entails cost and effort and needs preparation *before* a disaster strikes.

3.2. Resilience 2.0 and ICT Support

Like so many other human enterprises Disaster Management can profit from the application of Information and Communication Technologies, see Svata (2012); Asimakopoulou and Bessis (2010), McEntire (2007, chapter 11).

Resilience 2.0 identifies this new paradigm: modern Information and Communication Technologies (ICT) is used as a basis and even a precondition for resilience of a system and provides quick, effective, efficient and sustainable Disaster Management.

In the sequel we list for the different phases of Disaster Managements the essential activities as discussed in ISO (2011b), INSARAG (ed.) (2012); Haddow and Haddow (2008). All phases can be supported - sometimes even automated by use of ICT. Most of these technologies are also used in every-day business. A few modern technologies which are specifically helpful to Disaster Management are discussed in the following table.

	Disaster Phases, key activities and ICT
(sub)phase	key activity
1A: Hazard, vulnerability and risk assessment:	•recording of status-quo-ante (maps, photos, digitalization of environments, buildings, etc.) digitalizing of documentation mark objects for worthwhile safekeeping and record their context back-up documents etc.
1B: Mitigation / Prevention	identification, analysis and cataloguing hazards per hazard: mitigation and/or prevention options creating emergency plans and scenarios Prepare restauration documentation (maps, documents, pictures, ...)

1.C: Planning	establish collaborative networks get Early Warning system(s) and Alert System(s) into stand-by mode select appropriate processes and emergency best practices (Chroust and Aumayr, 2014) establish inventory of necessary resources (personnel, goods) definition and simulation of logistics during the Response Phase select specific disaster scenarios (use Virtual and Augmented Reality) prepare text for News Media
2.Alert / Action Planning	Collect data about the impeding hazard (including social media) prepare and issue early warnings and evacuation plans National Governors Assoc. (3014), logistic plans, simulation of impacts and its evolution prepare text for News Media statements contact relevant response organizations set up Project and Process Management (Haider et al., 2014)
3.Response / Intervention	evaluate amount and location of damage/casualties etc. (sensor data?) scenario descriptions, site-map creation bring in first responders consider secondary (chained) disasters execute evacuation (if necessary/feasible) electronically detect/locate victims and helpers (robots!) establish communication between all involved people aggregating localized information including social media into situational maps (Virtual Reality) finding and re-connect missing persons (families, children)
4. Recovery / Restauration	strategic decisions (what can/should/must be restored) evaluate cultural values (trade-offs) interpret and evaluate historical construction and lay-out plans
5. Post-mortem Analysis :	tallying the losses, SWOT-analysis statistical correlations AI-governed re-play of events derive improvements and recommendations

For the activities/tasks required in the various phases as sketched above, various tools are especially useful. In the following table we indicate in which of the phases certain tools are of prominent

importance, admitting that each tool would to some extent be useful in all phases. Obviously different types of disasters also different tools.

Tools Phases ->	1A	1B	1C	2	3	4	5
Big Data	x	x	x			x	x
Computer animation, Simulation	x	x	x	x	x	x	x
Crowd Sourcing		x			x		
Crowd Tasking				x	x	x	
Early Warning Systems			x	x	x		
Electronic opinion surveys	x		x	x			x
Geoposition System (GPS), Google Earth, satellite photography		x	x	x	x	x	
Multivariate Statistics	x	x	x				x
Process Management Tools					x		
Project Management Tools					x		
Robotic, teleguidance				x	x		
Sensor technology				x	x		
Social Media		x		x	x	x	
Virtual Reality	x	x	x	x	x	x	x

4. Complications for ICT during Response/Intervention (Phase 3)

Except for Phase 3 the use of ICT for Disaster Management will not be much different from classical applications, see the activities listed in section 3.2. Application and use of ICT in Phase 3 (Response/Intervention), however, encounters considerable additional problems. The difficulties result from the circumstances and the environment of responding to a disaster. In a nutshell these extraordinary difficulties stem from: high priority of life savings actions, often for the sake of preempting other important

tasks, time and performance pressure, physical and psychological stress on personnel, damaged ICT infrastructure, unknown and/or adverse natural environment, etc.

Performance Pressure:

- time pressure/preemption of tasks and procedures due to the priority of saving human lives
- incomplete and often misleading information for planning

ICT infrastructure:

- special precautions have to be taken to overcome damages to the ICT-infrastructures itself: destroyed/damaged computer equipment, land lines and WLAN connections,
- electrical power supply might be severely damaged or not-existent (black-out)
- overload of WLAN capacity due to high-volume usage (social media!)

Communication:

- Communication equipment might be damaged, out of order or reduced in its capacity
- Social Media interactions by mobile phones and internet connectivity might overload the available channels blocking disaster-relevant messages
- Communication between helpers from different countries and cultures will add problems of understanding
- agitation and stress might degrade the quality of observations and messages.

Personnel:

- psychological stress situations of all helpers (Bundesamt f. Bevölkerungsschutz und Katastrophenhilfe, 2011)
- regular personnel might be incapacitated themselves or busy helping their own family and therefore not be available
- volunteers will probably be not sufficiently trained for operating complex ICT-equipment
- Outside helpers will come from different regions, language groups, ethnicity and cultures creating problems in communication and cooperation

Location and Environment:

- interventions must take place in unknown, often adverse locations,
- streets, tunnels, bridges are possibly damaged by unexpected events (land slides, ...)
- local political restrictions, censuring etc. hamper actions

5. Summary

Resilience of systems is a highly desirable goal. In this paper we discussed the use of ICT to create/improve resilience of many of the systems our society depends on. For each Phase different types of ICT are most appropriate and promise the highest return on investment. Only the coordinated use of ICT in all 5 Phases promises sufficient success and the change to turn many of our now still fragile systems into resilient systems. This aim requires investment with respect to funds and creative thinking and is a long range project. ICT can very successfully and convincingly improve Disaster Management and sometimes will make the difference between a fragile system and a resilient system.

We also discussed that ICT itself is vulnerable to the imponderabilities of a disaster impact. This requires a recursive application of many of the Best Practices we listed to the ICT systems themselves.

We hope that this paper will trigger an interdisciplinary discussion, perhaps exhibiting new approaches and new methods and improve the situation for humans affected by a disaster.

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A METHODOLOGY TO ANALYZE INTEROPERABILITY IN CRISIS AND DISASTER MANAGEMENT

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Keywords

Interoperability, inventory, key indicator, efficiency, crisis and disaster management

Abstract

Interoperability of stakeholders is an imperative requirement of nowadays crisis and disaster management. Within the European Commission funded FP7 project EPISECC a concept of a common information space is developed in order to assist in the improvement of the European crisis and disaster management. A basis of the development of such an information space is the profound analysis of the management of past disasters with specific focus on interoperability and efficiency of applied processes. In order to perform such an analysis an inventory on the management of selected past disasters was developed. The information for the inventory is obtained by systematic expert interviews using online questionnaires. Multiple crisis and disaster managers that are active nationally, internationally or on both levels are interviewed in order to obtain the required information. The methodology behind this inventory is described in frame of this paper.

1. Introduction

More than in other societal affairs, “resilience of societies” has obtained a special validity in disaster management. Albeit definitions differ along heterogeneous interpretations, the capacity of a society to get over the impact of a natural or a human-induced hazardous event builds the essence. Frequently, the availability of disaster management agencies to establish synchronised response and recovery procedures might be decisive for harmonised efforts and bundled resources (Iannella, 2007). A seamless and robust information exchange has been considered as vital for coordinating disasters relief efforts including various actors at different institutional stages in an efficient way. Evidence highlighting the role of information was provided by the World Disaster Report (2005) which stated “information alone can save lives.”

Indeed, in certain circumstances, when time is tight and decisions are urgently required, processes of disseminating information wherever required in a way that it can be understood are critical success factors for ensuring the security of citizens and maintaining the resilience of the society.

As elaborated by Sagun (2009), two major channels of information flow have been considered as pertinent for managing a disaster

(a) intra-organisational – within an organisation and

(b) inter-organisational – between various organisations.

Considering the citizens’ communication needs, there is the obligation to establish a bidirectional information exchange, in fact from people to organisations and from organisations to people. From an organisational view, communication results from the necessity to prepare and coordinate the deployment of resources. However, during disastrous events the communication and information exchange capabilities are often compromised or destroyed, either by the catastrophe itself or due to events and effects in its aftermath, like overload and congestion. In such situations, it is absolutely essential to compensate intermitted information flow by reconditioning reliable communication rapidly. Although, maintaining an intact information and communication technology (ICT) infrastructure during an event is challenging by itself, the interoperability between systems of the different actors involved poses an added crucial point (Weiser, 2007). Frequently, a lack of information inhibits the capability of responsible agencies to respond appropriately resulting in

inconsistencies of measures, redundancies in the deployment of resources and gaps in the situational awareness. Access to information, communication with other rescuers and stakeholders as well as the availability of resources are key factors to minimize damage and loss of life. Multiple challenges have to be encompassed: language and cultural barriers, know-how levels, organisational and especially technical barriers e.g. in voice and data communication as well as in automated data exchange.

Special attention to interoperability, understood as the ability to exchange information between different systems (Delprato et al., 2014), has been paid by the ESENet Project, where an assessment of the different interoperability layers, and of the interoperability during certain events was provided (ESENet, 2014).

The project EPISECC is aiming at developing a concept of a common "European Information Space". This information space is dedicated to become the key element in a future integrated pan-European crisis and disaster response capacity. Besides the development of a common Taxonomy and an ontology model, aimed at addressing the Semantic Interoperability issue, EPISECC will focus on the establishment of Interoperability at Physical (i.e. network) and Syntactical (i.e. automated information exchange) levels. One of the main purposes of the developed inventory, is to allow analysis of interoperability at all levels.

2. Methodology

2.1. The data model

A mandatory pre-requirement for the development of a pan European information space is a profound analysis of past disaster responses with focus on interoperability and efficiency solutions and issues of disaster management. For this purpose an inventory was developed within EPISECC. The general concept, structure and ideas of the 'Architecture of integrated Information Systems' (ARIS) served as starting point for the development of the data model of the inventory (Scheer, 2002). In general terms, the structure of the EPISECC data model consists of main areas, such as data, processes, tools and business models (Huebner, et al., 2015). In addition to these, additional areas of information such as initiator, actor or disaster groups were included in the EPISECC data model. The areas of information were assigned to the four overarching main information units which are Interoperability, Disaster, Organisation and Crisis and Disaster Management Cycle.

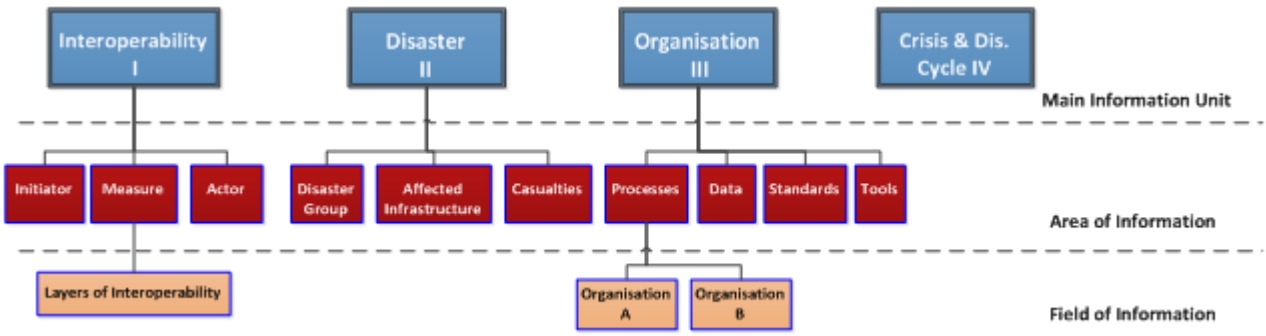

Figure 1: Levels of information of the EPISECC data model

On a lower level, each area of information is subdivided in multiple fields of information such as data type or data language in case of the area of information "data". The whole structure of the different levels of information is called template in the EPISECC project. The template can be

considered as the taxonomy of the included fields of information. The data model encompasses in addition to the taxonomy the logic combination of the different fields of information.

The data model is the starting point for analysing the management of past critical disasters. The method of finding relevant information for the inventory of EPISECC goes from the data model over identifying relevant questions together with selected stakeholders being active in disaster management, the development of an online questionnaire up to final interviews of crisis managers with focus on the strategic level in order to identify and analyse relevant information on the management of past disasters (see Figure 2**Chyba! Nenalezen zdroj odkazů.**). In the following hapters this process is discussed in detail.

2.2. Identification of questions

After having developed the data model, questions being relevant for the inventory were collected from stakeholders such as the Austrian Red Cross or the German Federal Agency for Technical Relief (THW). For this purpose stakeholders were asked to provide questions on missing relevant information related to disaster management with focus on the response phase on one hand and interoperability and efficiency on the other. The arising so called pre-questions were aimed at showing what the users would like to have answered by the inventory. The result of the interviews on these pre- questions showed the broad scale of interests of stakeholders in such an inventory on the management of past disasters.

The project team considered all pre-questions suggested by stakeholders as a priori relevant. Nevertheless, it was necessary to restrict the number of questions based on their relevance for EPISECC. Using a specifically designed ranking process, the project team selected 29 questions out of a total sample of about 140 to be implemented in the questionnaire. The ranking process was designed in order to highlight the questions which were more relevant from the perspective of interoperability and efficiency in disaster response. The questions being most representative from this perspective are shown in Table 1.

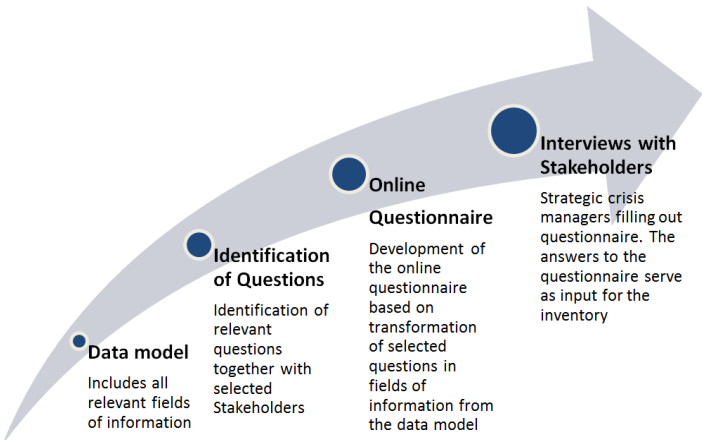

Figure 2: Method for data gathering for the inventory

Questions for the EPISECC inventory
What information/data were exchanged in a specific country during a specific type of disaster? How many sources for information were used? How were information saved and exchanged?
How fast could alternative solutions after the collapse of communication tools be provided?
Who alerts partner emergency services? How long time does it take?
Overcoming of language barriers: e.g. how was the collaboration between local and international

operational commanding units working?
Which information should be available at which level at which time in each country? Similar information available in country A and B are needed at what level in country A and what level in country B?
How can the communication with another country be realised? Are frequencies provided and predefined radio channels?

Table 1: Examples of selected questions to be implemented in the EPISECC inventory

2.3. Transformation of questions in fields of information of the data model

Generic questions such as those shown in Table 1 would, in case they are answered directly, trigger narrative answers being only comparable to a limited degree making therefore systematic analysis and quantifiable answers hardly achievable. In order to overcome these limitations, the generic questions asked by the selected stakeholders need to be transformed applying the process described in chapter 2.3 to information elements that can be implemented in the online questionnaire. For this purpose we applied a step by step process. A simplified version of this process is shown in Table 2:

First step	To identify key terms (typically substantives and verbs) in the questions
Second step	What key terms from the questions are missing in the data model of the inventory? Identify a place for the additional key terms (corresponding to fields of information) in data model
Third step	Recompose the questions using all necessary fields of information

Table 2: Simplified process for transformation of question

To give an example, the transformation process of the first question of Table 1 is shown in Table 3:

Selected Question	What data of a specific data type were exchanged in a specific country during a specific disaster?
Key Terms	Data, data type, exchanged (synonym for interoperability, fields of information selected: initiator, actor, measure), country (synonym for spatial scope), disaster (selected fields of information: disaster generic group, disastergroup, disaster main type, disaster sub type, start, end)
Missing key terms	Identification number of the disaster
Transformed questions on fields of informations of the data model	Identify disaster (generic group, group, main type, sub type, start, end, identification number) Identify the initiator of the data transmission (e.g. name, stakeholder type, type of responsibility, acting as focal point) Identify the actor (recipient) of the data transmission (see above) Identify layer of interoperability (necessary?) Identify data (data resource name, content, type, language) Identify spatial scope

Table 3: Example of a transformation process of a generic question

2.4. The inventory database

EPISECC uses the expert system Emikat as basis for its inventory. Emikat is a product of AIT Austrian Institute of Technology GmbH and is currently operational in several customer and research based projects since 2001. Originally, Emikat has been developed to model emission inventory related entities and processes. That's where its German name Emissions Kataster

(emission cadaster) originates from. Emikat is able to model different kinds of scenarios and automatically derive its implications in terms of emissions. On the technical level Emikat is a typical "Client-Server" solution as can be seen in Figure 3Figure 1. The Java-based Web Start client can be downloaded from the Emikat website (http://www.emikat.at). It uses encrypted Simple Object Access Protocol (SOAP) web services technology to communicate with the servers which are hosted by AIT in Austria. Emikat is designed to administrate multiple customers in parallel. This approach allows multiple customers to share infrastructure and parts of their data but maintain separated working spaces to keep their critical business data. AIT will reuse administrative data and basic application modules and provide dedicated workspaces and user accounts for the EPISECC project.

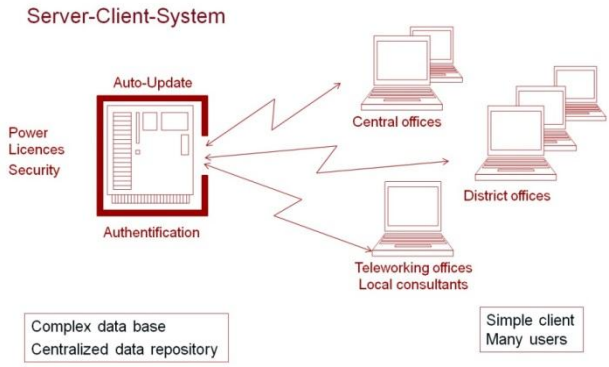

Figure 3: Emikat Client-Server Structure

3. Analyses of the information obtained from stakeholders

3.1. Interface to stakeholders – the questionnaire

To receive the necessary input for the inventory database a questionnaire has been created. The questionnaire is addressed to different type of respondents from crisis and disaster management, such as the Bavarian Red Cross. The questions are grouped in different sections, according to their topic / focus (e.g. information on the organisation, on the disaster, on the adopted interoperability processes and measures, and so on). In Figure 4 we show as an example the page with questions related to disasters from the EPISECC questionnaire.

3.2. Implemented key indicator on interoperability

Key indicators (KI), which are dedicated to replace intuitive opinions by verifiable data, are used in addition to the quantifiable and therefore comparable answers to the transformed questions, and add a few representative metrics to the overall analysis. These key indicators are calculated by specific mathematical formulas. Answers from the questionnaires serve as input for these equations. As stated in (Engelbach, et al., 2014) these indicators can be absolute values or ratios. To find suitable key indicators on aspects of crisis and disaster management such as interoperability and efficiency a literature review was performed. Several indicators from literature are integrated in EPISECC such as the Delivery Data Reliability Index from (Santarelli, Abidi, Regattieri, & Klumpp, 2013) or the Process Cost Indicator (Davidson, 2006).

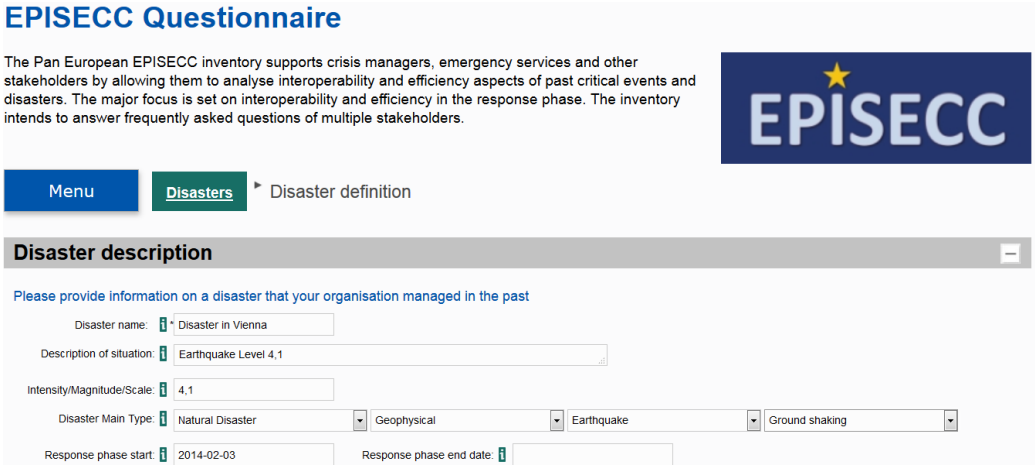

Figure 4: Example of a page of the EPISECC questionnaire

Although multiple publications on interoperability exist, we did not identify literature containing a key indicator for interoperability in crisis management suitable for our purposes. Therefore the following indicator has been established:

$$KI_{Int} = [0{,}5 \cdot (1 - T_{suc}) + 0{,}5 \cdot (1 - T_c)] \cdot \left[\frac{D_{Tr-is}}{D_{Tr-id}} \cdot \frac{D_{Us-is}}{D_{Us-id}}\right] \quad (1)$$

where:

KI_{Int}	Key Indicator for Interoperability (Value between 0 and 1, 0 = Worst Case, 1 = Best Case)
T_{suc}	Normalised Time for setting up an information exchange channel, e.g. a frequency channel for communication (Value 0 ideal case = no time for setting up channel, value 1 worst case = worst case time to set up channel, depending on expectation of stakeholder)
T_c	Normalised Time for exchanging or provision of information (Value 0 ideal case = no time needed for the process of information exchange (ideal, not possible, the shorter, the better), value 1 worst case = worst case time for exchanging information, depending on expectation of stakeholder)
D_{Tr-is}	Data transmitted real status (is); (Value 100 best case = all required data transmitted, value 0 worst case = worst case, no required data transmitted)
D_{Tr-id}	Data transmitted ideal (id); always 100 (100%), all expected data transmitted
D_{Us-is}	Data understood real status (is); (Value 100 best case = all data transmitted understood, value 0 worst case = worst case, no required data understood)
D_{Us-id}	Data understood ideal (id); always 100 (100%), all expected data understood

The indicator is based on several assumptions, e.g. giving the time to set up an information exchange channel the same weight as the time to exchange the information can be seen as first approach. Future experiences might allow using more specific weighting factors, for instance weighting factors depending on type of disasters (slow or fast onset). In addition, the indicator could be sharpened by including additional impact factors such as time requested to identify a communication counterpart. However, the four imperative factors of communication, i.e. time to set up a communication channel, time requested to communicate, amount of data transmitted as well amount of data understood are already included.

4. Outlook

Currently the EPISECC questionnaire is finalised and the evaluation of the first interviews of stakeholders is performed, analysis is ongoing and software implementation is finalised. During the next few months further interviews will be performed with multiple stakeholders that are nationally and/or internationally engaged in the crisis and disaster management community. The interviews will encompass a large scale of crisis managers such as experts from United Nations as well as from the European Union and Member States. In case of recommendations from the experts some adaptations of the inventory's architecture will be implemented in order to enhance acceptance of the inventory by stakeholders. The focus of the interviews is set on strategic operations in the response phase of the crisis and disaster management cycle (Lumbroso 2007). The content of the inventory is supporting the development of the common information space due to the identification of both best practices as well as shortcomings related to interoperability and efficiency of applied crisis management processes.

The inventory also offers the possibility to provide responses to specific questions posed by stakeholders in crisis management. The large number of possible combinations of the fields of information of the questionnaire allows achieving new knowledge in the domain. The EPISECC inventory allows also the implementation of additional key indicators. The interoperability key indicator presented in chapter 3.2 is a new developed measure from EPISECC and might be extended by additional indices in case of necessity.

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AN ONTOLOGICAL APPROACH TO RISK MITIGATION OF LONG LASTING SOCIAL CRISIS INCIDENTS THROUGH COMMUNICATION

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Keywords

Ontologies, Long Lasting Social Crisis Incidents, Ontological Model, Domain Entities, Communication, Risk Mitigation

Abstract

Managing effectively social crisis incidents, that are triggered by natural or man-made disasters and influence the operation and the availability of the critical infrastructure i.e. electricity, water supply transportation and telecommunications, is a complex task to deal with, due to the presence of multiple domain entities which are involved in such circumstances. An efficient path that can be followed in order to mitigate the risk of potential human and financial losses, caused by a social crisis incident, is the creation of a communication model that can be interpreted by all the involved experts. Ontological models incorporate common glossaries and are suitable tools for achieving effective communication among all Domain Entities. The current paper deals with the creation of an Ontological approach for managing social crisis incidents. The delineated framework includes multiple interdisciplinary Ontological Entities in order to be clearly understood by all the experts who formulate crisis management strategies. The main advantageous elements of this contribution are its flexibility, which is ensured by the unlimited number and independent ranking order of the Ontological Entities, as well as the adoption of mathematical tools that measure the impact of each Entity on the decision - making process in order to face social crises. The model also estimates the time required to restore Critical Infrastructure in such situations and mitigate in this way the risk of an extended social crisis. The decision about this timeframe is made through the study and analysis of past data regarding similar emergency situations.

1. Introduction

"Communication" has been thoroughly analyzed over the years from various scientific aspects. It is considered to be a core element of human behavior and a crucial factor which influences the development of global civilization. Communication is mainly realized by means of information transmission among people. People share information, influence others, establish relationships, form ordered units and act in concert. That is why "communication scientists consider the process of communication one of the important foundations of human society" (Ren and Zhai, 2014).

In the modern era, communication is mainly achieved through the adoption of Information and Communication Technologies. For this reason, throughout the recent decades, communication and information modeling have been oriented to the illustration of objects, which are called Entities, as well as their relationships and information transmission among these objects. The relationship between Entities and their information representation has become the forefront of Ontologies and information modeling, because conceptual models (Ceusters & Smith, 2010) have become critical in encoding human understanding of information (Smith et al., 2006).

There are various definitions for ontologies but perhaps the most cited one is "a formal, explicit specification of a shared conceptualization" (Uschold & Gruninger, 2004). Agarwal (2005) includes the term Communication by stating that "an ontology is the manifestation of a shared understanding of a domain that is agreed between a number of agents and such agreement facilitates accurate and effective communications of meaning, which in turn leads to other benefits such as inter-operability, reuse and sharing". Under this assumption, it can be realized that effective communication towards decision - making, requires not only the formulation of conceptual models, but also, the support of such models by mathematical formulas that stabilize their validity, provide the possibility of measuring the importance of all involved Entities and enable the flexibility, balance and reusability of the model by adding or ignoring some of the Entities.

Furthermore, other researchers underline the need for adopting Risk Management policies when proposing Social Crisis Management strategies, meaning strategies that involve detailed preparedness, response and recovery plans aimed for reacting to hazards that threaten the operation of the Critical Infrastructures, the lives of the citizens and public and private properties. More precisely, (Rougier et al (2013) claim that "if we are to minimize loss of life, economic losses, and disruption from natural hazards, there is an imperative for scientists to provide informed assessments of risk, enabling risk managers to reduce social impacts significantly, to conserve economic assets and to save lives"

Based on the above analyzed literature, the current paper aims to propose a new theoretical Ontological framework, which pinpoints the impact of multiple domain ontologies from the Social Crisis Management research field, on the Ontological Entity entitled "Communication", which in its turn influences the Risk Mitigation Ontological Entity (Figure2) of long-lasting social crisis incidents. The model is proposed as a flexible ontological strategic plan towards the timely restoration of Critical Infrastructure in social crisis incidents. The framework is currently presented in its initial form. The model's detailed formulation according to a knowledge representation language, such as the Web Ontology Language (OWL), is beyond the scope of the present article since it is still under research and development by our research team.

2. Problem Definition – Communication, Ontologies, Decision Making and Risk Mitigation of Long Lasting Social Crisis Incidents

Many scientists indicate the necessity of utilizing common languages during unexpected events, such as crisis incidents. They precisely state that "glossaries and vocabularies play a significant role in emergency management due to the importance of clear communication during disaster response" and that "the importance of having a common understanding within the disaster management field has been recognized" (Grolinger et al., 2011). Mattioli et al. (2007) indicate that "responding to a Disaster, an Incident, a Crisis, or an Emergency (such event is called in the sequel a DICE) in a timely and effective manner can reduce deaths and injuries, contain secondary effects, and reduce the resulting economic losses and social disruption". Moreover, Shen et al. (2012), underline that "decision-making in crisis management requires high effectiveness but carries large

risk. Therefore, we need specialized theories and approaches to support emergency decision-making".

However, after studying the most widely publicized and worldwide indexed research articles in journals and scientific monographs, it was concluded that no standard, flexible and expandable ontological models have been developed regarding effective communication and its influence on the decision making process in order to achieve efficient and early response to unexpected events, thus mitigating the risk of experiencing highly extended social emergency events.

The currently proposed model, aims to contribute to the ontological approach to decision-making during social crisis incidents, by mitigating the risk of a prolonged emergency situation. The idea behind the construction of the new approach is the presence of various ontological entities which efficiently and timely communicate among themselves in order to mitigate the risk of an extended social crisis. The aforementioned Ontological Entities influence timely and effective Communication which, in its turn, helps Crisis Management experts in making decisions towards, a) Risk Mitigation of extended social emergency events, b) estimation of the time required to restore Critical Infrastructure based on historical data of similar, past social emergency situations. Communication is relevant to all phases of an emergency incident that is, Pre-Crisis, During Crisis and Post-Crisis.

3. Description of the Proposed Ontological Framework

The new method, considers as Ontological Entities all the involved Factors that interact with the main Ontology, which is "Communication". In its turn, Communication affects another Ontology, meaning Risk Mitigation of delayed recovery of Critical Infrastructure. The idea is to mitigate the risk of a prolonged crisis incident in order to reduce or even eliminate loss of lives as well as immense economic damage. The currently proposed Ontological Framework should include a Risk Mitigation policy with respect to the protection of human lives and to the avoidance of uncontrolled unwanted economic losses due to extended disoperation of Critical Infrastructures. Apart from the interaction of Ontologies from various domains, the model is aimed to differentiate from existing emergency management ontological models. Kruchten et al. (2007), propose a conceptual model of disaster affecting infrastructures (Figure1). Despite the obvious inclusion of the most important Ontological Entities, still the model's functionality lacks flexibility and expandability.

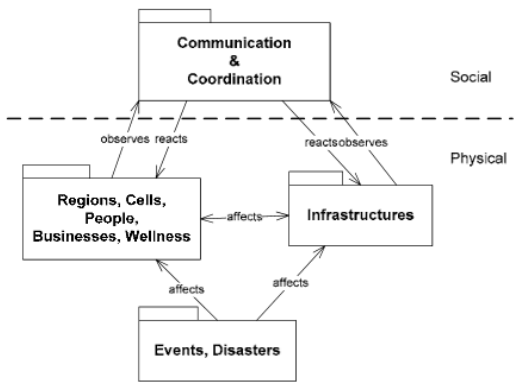

Figure1 Four Packages of the Conceptual Model (Kruchten, et al. , 2007)

In order to avoid the utilization of a limited number of Ontologies, the currently developed Ontological Framework is aimed to support the participation of multiple Domain Ontologies, the number of which is determined according to the social crisis situation. The domain expert, is able to

add new or remove unwanted Domain Ontologies. As it has been mentioned, the specific Domain Ontologies act as Factors that influence the timely and efficient Communication among the involved Units. Communication, is an Ontological Entity which in its turn affects the final Ontological Entity, that is, Risk Mitigation Regarding Timely Restoration of Critical Infrastructures. The model's flexibility is ensured by the support of mathematical methods that indicate firstly non-arbitrary weights values that is, the Rank Order Centroid Method for precise weight assignment, and, secondly, impact and probability of occurrence of each Factor/Ontological Entity that is, the formula that defines the Risk Magnitude. The proposed Ontological framework includes 4 Ontological Layers. Each Layer includes the following Entities:

LAYER 1: *Upper Ontology*: The Upper-Ontology indicates an Entity such as Government, Ministry, Public Organization and many more entities of a similar extent. It is considered to be the Domain Ontology of the highest level.

Ontologies that Interact with and Are Parts of the Upper Ontology: The specific Domain Ontologies are active Entities of the Model, and their presence influence Communication and the overall Risk Mitigation of any type of disaster caused by extended disoperation of Critical Infrastructures. The framework is independent of the number of involved Domain Ontologies and their importance. Domain Ontologies interact with and are parts of the Domain Upper Ontology (Figure 2). The Ontological Entities influence and are influenced by the Ontological Entity "Communication". They also influence the Ontologies of Layers 3 and 4. The specific layer can include an unlimited number of Ontological Entities which enhances the flexibility of the described contribution.

LAYER 2: *Communication Ontology*: Communication is considered to be the "Core" Ontological Entity of the currently developed model. It influences the Ontological Entities of the first Ontological Layer and also the *Risk Mitigation* Ontology which is included in the third Ontological Layer. It also influences the estimation of an approximate timeframe during which the size of a similar past crisis incident can be reduced.

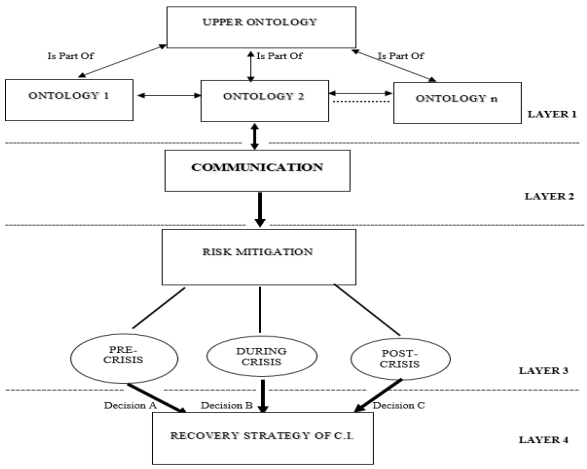

Figure 2 The Ontological Framework for Facing Social Crisis Incidents

LAYER 3: *Risk Mitigation Ontology*: Risk Mitigation is performed in terms of timely restoration or recovery of the Critical Infrastructures in order to prevent loss of lives and financial damages.

LAYER 4: *Recovery Strategy of C.I. Ontology*: The strategic policy towards bringing back to life Critical Infrastructure considers a specific timeframe within which reduction of past disasters size can be achieved. The concept is to recover infrastructures within a shorter period of time than in historical crisis events. Time estimation is performed by considering the analyzed risk strategy.

4. Risk Mitigation and Time Estimation for Social Crisis Incidents through the Analysis of Ontological Entities/Factors

The current work includes the introduction and presentation of a new contribution to the Crisis Management research area, entitled as *Communication Recovery Index (COMRI).* This paper focuses especially on social crisis incidents. Yet, the specific index can be implemented to several crisis situations, even those which affect the operation of enterprises. However, for such incidents another ontological communication model has to be formulated, and this is beyond the scope of the present work. The estimation of the specific index is based on the *Composite Risk Index* (Turner, 2011*),* which is calculated according to the following formula:

$$\text{COMPOSITE RISK INDEX} = \text{IMPACT OF RISK EVENT} \times \text{PROBABILITY OF OCCURENCE} \quad (1)$$

Borghesi & Gaudenzi, (2013) mention that "Risk is characterized by two basic features:

- the severity of the possible adverse consequences
- the likelihood (probability) of occurrence of each consequence".

According to the Composite Risk Index theory, the Impact is marked on a scale from 1 to 5, where 1 is the minimum impact value and 5 is the maximum impact value. Moreover, the probability of occurrence is marked on a similar, 1-5 scale. As a result, it can be easily realized that the minimum value of the Composite Risk Index is 1 and the maximum value is 25.

Considering the Composite Risk Index methodology, the derived equation for estimating the Communication Recovery Index (COMRI) value for each one of the factors/ontological entities of Layer 2 is the following:

$$\text{COMRI} = W \times P \quad (2)$$

where, W = Weight of Factor (Ontological Entity) and P = Probability of Occurrence or Presence. According to the proposed ontological framework, since multiple Ontological Entities participate as Factors that influence Timely Communication and consequently the Timely Restoration of Critical Infrastructures, the final RI value is calculated according to the following equation:

$$\text{COMRI} = \sum_{i=1}^{n} (W_i \times P_i) \quad (3)$$

The differentiation of the newly proposed Risk Analysis approach is that the Weight Values of the Factors (Ontological Entities) are not assigned according to a 1 – 5 scale, but according to the ranking order of each Factor. In other words the final weight value of each factor is based on its importance and finally according to the number of the involved factors. The selected approach is the Rank Order Centroid (ROC) approach and it is analyzed in the following paragraph.

The probability of occurrence (P) for each of the involved Ontological Entities is based on the 1-5 level scale, and it is determined by:

- Experience of the Domain expert
- Historical data of crisis and emergency incidents regarding a specific geographical area.

Finally, the proposed Ontological Framework provides the domain experts with the possibility of estimating an approximate Time Deviation (TD) regarding the recovery of Critical Infrastructures. The demanded input is a Recovery Time (RT), which is provided as an input value from crisis

management databases. This means that if the RT value is known from similar historical crisis events, the calculation of the Time Deviation is provided by the following formula:

$$TD = RT \times \frac{COMRI}{100} \quad (4)$$

The proposed by the Framework strategy considers a reduction in the maximum estimated timeframe according to which the Critical Infrastructures should be recovered. As a consequence, the Total Recovery Time (TRT) of the examined scenario, is estimated as follows:

$$TRT = RT - TD \quad (5)$$

4.1. Assigning Non-Arbitrary Weight Values to Each Ontological Entity/Factor with the Rank Order Centroid (ROC) Method

The term "Rank Order Centroid" was generated by Barron & Barrett (1996). The idea is to convert ranks (first, second, third, fourth) into values that are normalized on a 0.0 to 1.0 interval scale. The primary reason for selecting the ROC approach is that it is a simple way of giving weight to a number of items ranked according to their importance. The decision makers can usually rank items much more easily than give weight to them (Bagla et al., 2011). This method takes those ranks as inputs and converts them to weights for each of the items, according to the following formula:

$$Wi = \frac{1}{m} \times \sum_{n=1}^{m} \frac{1}{n} \quad (6)$$

where W_i is the Weight Value of the i^{th} item, and m denotes the number of items (factors). For example, if there are 4 items, the item ranked first will be weighted (1 + 1/2 + 1/3 + 1/4) / 4 = 0.521, the second will be weighted (1/2 + 1/3 + 1/4) / 4 = 0.271, the third (1/3 + 1/4) / 4 = 0.146, and the last (1/4) / 4 = 0.062.

In order to adjust the values to the needs of the currently developed model, the values are normalized on a 0 to 10 scale. As a consequence, the Maximum value of COMRI will be 50, since the maximum value of Weight is 10, in the occasion when only 1 ontological entity is considered in the social crisis scenario, and the Maximum Probability of Occurrence is 5, which means that the presence of the specific entity is highly possible. As a result, the above mentioned 1-5 scale for the Probability of Occurrence, implemented along with the ROC approach for the weight assignment of the ontological factors, prohibits negative or zero values regarding the Total Recovery Time (TRT) in Eq. 5.

4.2. Practical Example

Crisis Scenario: After a severe earthquake, a provision of electricity is interrupted. **Upper-Ontology Involved**: Public Coordination. **2 Domain Ontologies**: Management of ICT Infrastructure, Crisis Management. **Core Ontology**: Communication

The Ontologies should be ranked according to their importance. The corresponding weight values are depicted in Table 1:

Ranking Order	Ontologies	Weight Value	P Value
1	COMMUNICATION (Timely)	5,21	2
2	PUBLIC COORDINATION	2,71	5
3	MANAGEMENT OF ICT INFRASTRUCTURE	1,46	2
4	CRISIS MANAGEMENT	0,62	4

Table 1 Ranking Order, Weight Assignment and Probability for the Involved Ontological Entities

The Communication Recovery Index is calculated as follows:

$\mathrm{COMRI} = \sum_{i=1}^{4}(W_i \times P_i)$ = (5,21 × 2) + (2,71×5) + (1,46×2) + (0,62×4) = 10,42+ 13,55+2,92 + 2,48= 29,37. If we assume that according to similar past crisis events the restoration was implemented in 2 hours (RT = 2 Hours), then the expected Time Deviation will be calculated in the following way:

$\mathrm{TD} = \mathrm{RT} \times \frac{\mathrm{COMRI}}{100} = 2 \times \frac{29{,}37}{100} = 0{,}58$ Hours and TRT = 2 - 0,58 = 1,42 Hours

The derived TRT value indicates that the maximum timeframe within which CIs should be recovered in order to achieve limited damage, in comparison to the previous disasters, is 1,42 Hours.

5. Conclusions – Future Work

An initial theoretical framework based on Ontologies and Efficient Communication for implementing effective social crisis management strategies, is delineated in the current paper. The presented model is divided into four Ontological Layers that is, the Upper Ontology and Domain Ontologies, Communication Ontology, Risk Mitigation Ontology, regarding timely restoration of Critical Infrastructures, and Recovery Strategy Ontology. The Ontologies of the first Layer influence and are influenced by Communication which, in its turn, affects the Risk Management and the final decision making strategy regarding the timely restoration of infrastructures. The model's main advantage is that for flexibility and expandability reasons an unlimited number of Domain Ontologies is permitted, depending on the crisis situation. The impact (weight values) of the Ontological Entities on efficient recovery policy is estimated according to a simple and accurate mathematical method that is, the Rank Order Centroid. The model aims to prevent loss of human lives and huge economic disasters through the reduction of the duration of a future crisis event. For implementing the current model, analysis of duration of past social crisis events is demanded. Future research regarding the present contribution includes, firstly, the creation of a detailed Ontology Schema based on the Web Ontology Language (OWL), consisting of Individuals, Properties and Classes, and, secondly, the creation of a software user interface which will support the automatic estimation of the desired results according to the corresponding social crisis scenario.

6. Acknowledgement

This paper was supported by the SGS 21079 research project of the Technical University of Liberec "New possibilities of advanced information and communication technologies in solving of uncommon situation".

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ENGAGING END-USERS IN THE DEVELOPMENT OF SMARTPHONE APPLICATIONS FOR EMERGENCY SERVICES

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Keywords

Participatory design, user engagement, Cognitive Walkthrough, smartphone applications

Abstract

The objective of the project Public Safety Net (PS.NET) is to assess the potential of commercial networks for emergency services. Cognitive Walkthroughs were used to involve end-users in the development of smartphone applications for emergency services. Four use cases were discussed in order to establish their usefulness and usability from a users' perspective. In general, great potential was seen in complementing the means of communication already used by an organisation with commercial networks. However, the discussion of specific use cases showed differences in the needs among emergency organisations (police, volunteer fire brigades, ambulance services). Data protection and privacy issues were a major concern for the staff of emergency services. This paper presents the results of the discussed use cases in detail.

1. Introduction

In Austria, emergency services (ambulance services, fire brigade, and police) in general use radio networks as a tool to communicate with their staff in the field. In certain situations, the additional use of commercial networks could be a further asset for these organisations – e.g. to alert volunteers, to submit broadband data or as fall-back solution.

The objective of the project Public Safety Net (PS.NET)[1] is to assess the potential of commercial networks for emergency services. Core of the project is the development of smartphone applications for selected use cases[2], namely:

[1] The project is funded by the Austrian security research programme KIRAS of the Federal Ministry for Transport, Innovation and Technology (bmvit).

[2] The uses cases are based on the results of a needs analysis in which users were involved.

- The alert of (volunteer) members of an emergency service;
- The determination of the positions of staff;
- The collection of broadband data on a current situation on the ground, and
- The integration of broadband data into the common operational picture.

During the development process of these applications, the project PS.NET puts a special focus on the engagement of potential users. Their involvement is to ensure that the developed technologies are well adapted to their needs. Therefore, Cognitive Walkthroughs with staff from emergency services were conducted.

This paper describes the methodology used for the Cognitive Walkthroughs, presents the results and discusses their implications for the further project development.

2. Methodological Approach

The importance of end-user involvement is increasing in various fields; this is especially true for the development of new technologies. Participatory approaches not only support the empowerment of end-users but also lead to a better acceptance of results. In PS.NET as well, the usefulness and usability of the PS.NET applications depends on the engagement and participation of their end-users. Thus, the project uses a bottom-up approach to make sure that the developed technologies meet the requirements and needs of end-user organisations, increasing the probability of the applications' implementation as much as possible.

End-users were involved by means of the *Cognitive Walkthrough* method. Cognitive Walkthroughs are a well-established qualitative methodology in the design and testing of software. In general, users are confronted with a specific scenario during Cognitive Walkthroughs and asked to perform certain tasks linked to it (Nielsen, 1994). While they perform these tasks, the participants are observed and their behaviour is documented. The results of the analysis finally feed back into the design process of the tested software (Colbert, 2001).

In the PS.NET project, the functionalities of the applications designed for the four before-mentioned use cases were discussed in Cognitive Walkthroughs with nine persons from different emergency services (in group and individual settings). This happened at an early stage of the development process where paper mock-ups or pilot versions were only partly available. Therefore the Cognitive Walkthrough methodology was adapted and the focus was laid on the communication processes linked to the main functionalities of the applications.

The Cognitive Walkthroughs were to answer the following questions:

- Which benefits could arise for emergency services using the proposed applications? How could the proposed applications be improved?
- Which differences between public safety organisations can be observed with regard to possible benefits and improvements?

After a short presentation on the project's main objectives the four use cases were presented. To give an example of the use case 'alert of (volunteer) members of an emergency service': In a first step, the participants were asked how their organisations' staff is currently being alerted. In a second step the applications developed within PS.NET for alerting (voluntary) staff of emergency services were presented, followed by a discussion of advantages, disadvantages and possible improvements. Graphs and screenshots of the applications being developed gave the participants a

better understanding of the functionalities. Feedback and recommendations were visualized on a pin-board. In addition, each participant answered a questionnaire after the discussion of each use case. This procedure – discussing the currently established approach of an organisation to deal with a specific use case, presenting the PS.NET application for this use case, discussing the application with the participants, and collecting written feedback – was repeated for each of the other use cases.

The final part of the Cognitive Walkthroughs was a SWOT-Analysis. This analysis was used to sum up the previous discussions and to identify general strengths, weaknesses, opportunities and threats of the PS.NET technology from the emergency services' perspective.

2.1. Pre-Test and adaptions in the methodology

The first Cognitive Walkthrough took place in a group setting and was used to pre-test the method. In the pre-test the four use cases were embedded in a flood scenario to gain a better understanding of the applications' advantages during a disaster relief operation. It became clear that this scenario rather confused the participants instead of inspiring them to think of possible situations where the application of the proposed technologies could be helpful. It also turned out to be important to focus not exclusively on disaster relief operations but to also to include the daily work of emergency services. Therefore we did not use the flood scenario any more in the following Cognitive Walkthroughs. Instead, the participants were asked to distinguish between disaster relief (or major) operations and regular operations.

2.2. Data collection and analysis

The Cognitive Walkthroughs were recorded with a voice recorder. In addition, one person of the research team took notes. Key aspects of the discussion were visualized on pin-boards or on a flip chart. The different types of organisations (police, fire brigades, ambulance services) were distinguished with the help of cards in different colours. The fourth data source was the participants' written feedback after each use case discussion.

3. Results

The following sections present the main results of the Cognitive Walkthroughs. The results show similarities but also differences in the perceived usability of the presented applications between emergency services.

In general, the participants of the Cognitive Walkthroughs saw various benefits in the extended use of commercial networks in their work. Compared to the radio network commercial networks cover also peripheral areas (like mountain regions). Additionally, the use of smartphones as terminal devices was considered less expensive than the use of radio devices. The functionalities of PS.NET applications on smartphones offer an easier way for sharing information than the technologies currently in use – within and between organisations. On the other hand, however, commercial networks were regarded less fail-safe than radio networks; in highly time-critical situations, radio messages were seen as the fastest method of communication.

3.1. Alerting (volunteer) members of an emergency service

This application presented during the Cognitive Walkthrough alerts members of emergency services via voice mail. A voice mail can be recorded and sent automatically to a defined group of people. The receiver of the voice mail can respond with a text message. This application is intended

especially for organisations working with volunteer staff (e.g. volunteer fire brigade) that do not carry radio devices with them all the time.

The participants' feedback shows that those organisations currently using radio devices for their alarms clearly prefer this method compared to other technologies. However, organisations like the volunteer fire brigade see an asset in alerts via voice mail. Participants from fire brigades thought this could be a useful way to inform their volunteers about an incident. Still, they were not inclined to use this method exclusively but rather deploy it together with other methods (e.g. pager). The possibility of receiving a confirmation (via text message) was regarded less important for the fire brigades.

Although participants from the police and ambulance services thought there was little use for this application for alerting their staff, they came up with concrete ideas on the design of the response function. In their view, it was essential to design this function as simple as possible (at the touch of a button). It was also deemed necessary to provide a system that automatically collects and analyses the staff's responses: the operation manager needs to have an overview of how many persons will come and does not want to read a huge number of individual text messages.

3.2. The determination of the positions of staff

In this application, the smartphone is used to determine the position the staff members. If requested by the operation manager, the data is automatically sent to the control centre. This enables a more detailed view of the operation in general.

Generally, the tracking of staff is regarded useful for keeping an overview of the situation on the ground. This would enable operation managers to take better and faster decisions. The organisations of most participants in the Cognitive Walkthroughs already detect the position of their staff or vehicles through radio devices. For the volunteer fire brigade this seems to be especially important during major operations, while during 'regular' incidents, as experienced in the day-to-day work of a volunteer fire brigade, all decisions are being taken on-site. Compared to the fire brigade, police and ambulance services see also application possibilities in their daily work.

The opinions whether it is useful to track single staff members, vehicles or teams varied between emergency services. Participants from the fire brigade and from ambulance services thought it was of little use to know the position of every single staff member. During an operation it would be sufficient to know the position of a vehicle or the leader of a team. It was also suggested to combine further information with the position data of a vehicle or team leader (e.g. special competences of a team or equipment).

Participants from the police forces thought it more important to know the position of every single staff member on the ground than of vehicles. This was explained by the smaller size of teams (in general two persons per car) compared to the fire brigade, and by their greater mobility (e.g. during a pursuit).

Major concerns were articulated with regard to privacy issues when determining or tracking the position of staff. For the participants of the Cognitive Walkthroughs this topic was particularly sensitive if private smartphones were to be used (e.g. in organisations who work with volunteers).

3.3. The collection of broadband data on the current situation on the ground

This application as well wants to contribute to a more detailed picture of an operation by providing the control centre of an organisation with additional information on the situation on the ground. With this application the operation manager can request specific information from his staff in the

field which they then provide through the application. The request can be sent automatically to a group of people. If a staff member accepts the request he or she can take a picture or record something and send it together with a text message to the control centre.

Staff members from volunteer fire brigades, police and ambulance services assessed this application as useful during a major incident. Forwarding pictures, etc. to the operation manager could help to keep a better overview of the situation and to identify the focus of an operation.

In case of a regular operation, the respondents from police, fire brigades and ambulance services thought the application useful for their own documentation purposes but saw little benefit in forwarding the collected information to the control centre.

Still, concerns were articulated that more data does not necessarily mean better quality of shared information. Enabling every member of the staff to submit image, text or audio data could lead to a flooding with not very meaningful data. Especially during a major incident this would be difficult to manage.

3.4. The integration of broadband data into the common operational picture

This tool combines the data collected by the two previously described smartphone applications (3.2 and 3.3). It provides the control centre with a detailed operational picture by visualising the positions of staff members and the incidents reported via smartphone on a map. Users can select which data should be displayed.

Participants from the police forces and fire brigades saw a clear advantage in integrating the collected data in the operational picture in case of a major incident. As already described above (see section 3.3), the visualisation of collected data could help the control centre to keep an overview of the situation on the ground and therefore be useful for decision-making. Police and ambulance services would benefit if the mapping of collected data could also be available for staff in the field and not only for the operation manager. Participants from ambulance services especially underscored that it is not the control centre that needs the detailed overview but rather the coordinator on the ground.

In case of regular incidents, fire brigades and ambulance services saw little benefit in the integration of collected data (position of staff, pictures, text, etc. submitted via smartphone) into the common operational picture. For volunteer fire brigades this was the case, as there is no one in the background coordinating regular operations. Related to ambulance services, this application would be of little use in their daily work as they provide detailed information directly to the hospitals rather than to their control centre.

4. Discussion

Cognitive Walkthroughs are generally used to evaluate paper mock-ups or pilot versions of software with potential users. In our case we adapted the Cognitive Walkthrough methodology to discuss communication processes which are linked to the applications being developed. This brought valuable insights into the specific needs of different emergency organisations. Working with a scenario (in our case we used a flood scenario in the pre-test) only supports the discussion if it contains sufficient definition of which actions are expected to be performed by the different organisations.

In general, the participants saw great potential in the use of commercial networks for the communication of emergency organisations. The presented applications were regarded useful both

for major and for regular incidents. However, some of the use cases (e.g. use of the smartphone for documentation purposes) are rather linked to general smartphone features (camera) than to the discussed applications.

The discussion of determining the position of staff via smartphone in particular made clear that different emergency services have different technological needs. While for some organisations the tracking of every single person in the field would be an advantage, for other organisations it makes more sense to track vehicles or teams and connect this data with additional information (like equipment).

Privacy and data protection concerns were omnipresent during the discussions. In the use case ‘Determining the positions of members of an emergency service’ these issues are especially sensitive. Objections can be expected when such an application is introduced – particularly if private devices (e.g. in case of volunteer fire brigades) are used.

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COMPUTER-SUPPORTED CONTROL CENTER SYSTEMS AND MOBILE APPS IN THE CONTEXT OF DISASTER MANAGEMENT

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Keywords

control center systems, mobile apps, disaster management, usability, user study

Abstract

In the context of disaster management systems, enabling fast and effective responses is essential. To this end, in this paper we present a mobile app that facilitates the collection of on-site information and its further processing in control center systems. Additionally, we present the results of a usability study that investigates the user impact of a browser-based software application for real-time situation maps (RTSM) in the context of disaster management systems. According to our findings, the RTSM application improves the usability, i.e. keeping track of on-site activities is simplified and it is more convenient to share information.

1. Introduction

During the response phase of a crisis- or disaster management action, cross-organizational collaboration and the related information management today is still mostly based on face-to-face meetings, telephone calls, email exchange, paper charts or proprietary electronic systems, see e.g. Reuter et al. (2014). As a consequence, situation awareness and decision making is hampered by a fragmentation of relevant information into pieces held by different stakeholders. Within the collaborative scenarios of crisis management efforts, this fragmentation causes uncertainty whether the information base for critical decisions is up-to-date, comprehensive and valid. Modern control center systems aim at supporting a common understanding of the situation, providing always up-to-date information to everyone who has access rights. Besides the better structuring of information, the availability of proper sensors on the appropriate spots in the field will have a major impact on the quality of the provided common operational picture, e.g. see Yang et al. (2104). Hence, supporting connected systems and their proper integration in the overall workflow are crucial for

fast and reliable disaster management. Therefore, in this paper we describe: (1) A solution for integrating smartphones as sensors for control center systems in the form of a mobile Android-App that enables the users to report incidents via pictures, videos, text and voice messages in a well-structured manner to a control center environment. (2) A usability lab study that evaluates a control center scenario enhanced by a browser-based software application for real-time situation maps.

2. Mobile App

In this section, a developed mobile app is presented that extends common control-center setups with user-generated data.

2.1. Overview

The mobile app allows the reporting of incidents based on the OASIS Common Alerting Protocol (CAP) Version 1.2 (CAP 2009) using standard mobile phones. It sends these messages to a Frequentis Aggregator CAP Router module, which is responsible for further processing. The continuous reporting of the device position is also supported.

Key features are:

- Minimal user interaction for standard tasks like reporting an incident.
- Continuous device position reporting.
- Standardized (OASIS CAP Ver. 1.2)
- Generated reports include position (based on GPS, WIFI, Cell-Tower), pictures, device, date, time, user entered text and severity (subjective)
- Automatic reports (drone mode) include identical information as normal reports, but the application operates autonomous without any user interaction. This is useful for dangerous areas where users are not able to stay for longer periods.

Especially, in focus was the use of existing modern smartphone sensors in order to improve the situational awareness. The user creates incidents consisting of a combination of photo(s), video(s), voice/text messages. Additionally, each incident automatically includes geo-reference information by utilizing GPS-data (or other available location data) of the smartphone. Figure 1 depicts a schematic representation of functional blocks, users (dispatcher, respond units and volunteers) and the possible transmission channels. In general, received incidents are displayed in real-time via the (stationary or mobile) control center.

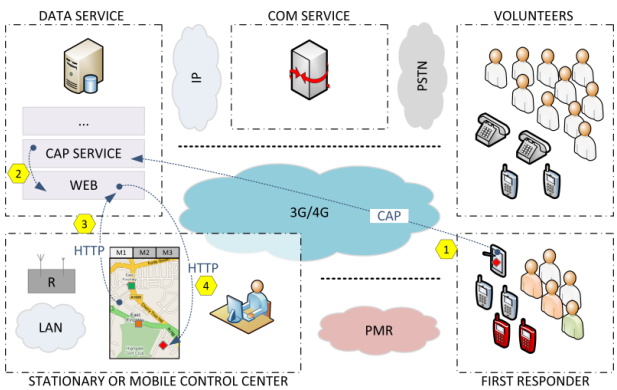

Figure 1: Reporting of incidents based on CAP.

Figure 2: Mobile App – Incident Reporting.

2.2. Reporting an incident

Incidents containing mission relevant information are stored locally on the smartphone. A final confirmation by the user (volunteer or first responder) triggers the data transmission via mobile networks (e.g., UMTS, LTE) to a central CAP service in the form of a CAP transfer message, see {1} in Figure 1. The CAP service validates the message format and content, against the CAP scheme version 1.2. In addition, message content is checked regarding plausibility before the information is further processed. Depending on the type of message (alert, update, close) there may be a link to an already existing incident date from previous messages. Finally, attachments are decoded, a checksum is calculated and the data is stored in a database. As a next step - {2} in Figure 1 – an automatic update process adapts geographical object information in the corresponding database in order to process incident-changes (e.g., new positions or updated color codes). The presentation in the front end of the control center is periodically updated by HTTP requests, see {3} and {4} in Figure 1. The administrator of the control center can specify the update interval, by default a value of 5 seconds is used.

In summary the developed mobile application can help to increase situational awareness and information transfer by utilizing commercial smartphones. Additionally, stationary and fixed control centers are supported and the software architecture guarantees a clear separation of incident creators (i.e. on-site forces) and consumers (i.e. control center operators). The front end of the control center is implemented as a web-based application, hence flexibility and comparability of the system is guaranteed.

3. Evaluation of an enhanced control center setup

While the previous section described a novel mobile application, this section focuses on the empirical evaluation of an enhanced control center setup in the context of disaster management systems.

3.1. Experimental Setup

In our usability test, we compared two different control center setups: Setup A, which represents the traditional well-established working environment and Setup B, which represents the novel working environment enhanced with situation-mapping software.

Both setups include printed maps, radio equipment/walkie-talkies and a laptop with an installed e-mail client and a Web browser for Google Maps. Setup B additionally contains a browser-based software for real-time situation maps (RTSM). The browser-based software for real-time situation maps (RTSM) provides a geographical overview about the affected area (in our scenario: Lower Austria) is extended with additional layers that display borders, water levels, position of disaster relief forces and status updates. Figure 3 shows some impressions of the laboratory environment.

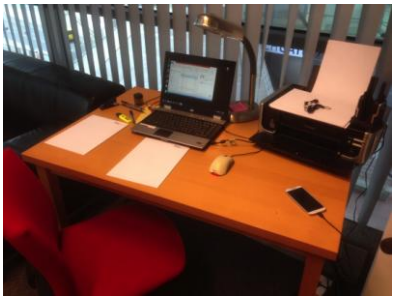

Figure 3(a): Workplace of the test participants.

Figure 3(b): Paper map of Lower Austria (Setup A and B).

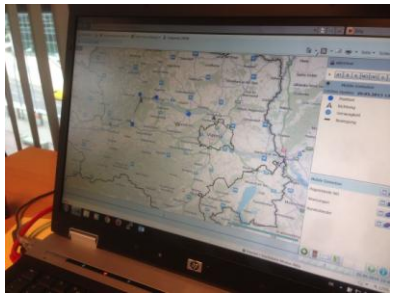

Figure 3(c): RTSM (Setup B only).

All recruited test users were professional control center operators, working for the Austrian public emergency service of Johanniter. The study was performed by FTW employees (test assistants) that were trained to act in a proper way regarding their specific roles in the task scenarios acted out during the study: whereas the test participants always act as the control center user, the test assistant plays several roles i.e., on-site disaster relief forces (Akkon 12, 13, 14 and 15), superior executive department and local fire departments. The whole test procedure contained five isolated tasks, based on a real world flood disaster scenario.

During the usability study, our test participants had to fulfill five tasks:

- Task 1: In the relevant geographical area, a flood protection facility is broken. Hence, all disaster relief forces (Akkon 12, 13, 14 and 15) are requested by the executive department to reach a safe position. The test user has to verify that all forces get the instructions correctly and are able to reach a safe position.
    - Old Setup (A): Positions of Akkons are displayed via pins on printed map i.e. relocation of on-site forces requires manual repositioning of the pins.
    - New Setup (B): Positions of Akkons are displayed in real-time via RTSM i.e. no manual repositioning is required.
- Task 2: Akkon 14 announces via radio, that the local flood protection facility is lightly damaged and Akkon 14 changes position. During the transmission the contact gets lost. Hence, the test user has to contact Akkon 13, which has to move to the last known position of Akkon 14 to check their status. After a while, Akkon 14 reported back to the test user.
    - Old Setup (A): Positions of Akkons are displayed via pins on printed map i.e. relocation of on-site forces requires manual reposition of the pins.
    - New Setup (B): Positions of Akkons are displayed in real-time via RTSM i.e. no manual repositioning is required.
- Task 3: The executive department requires on-site photos from each Akkon i.e. the test user has to ensure that the photos are taken. Subsequently, the test user has to transmit the photos via E-Mail to the executive department.
    - Old Setup (A): Akkons send the photos via E-Mail to the Laptop of the test user.
    - New Setup (B): Akkons send the photos directly to the RTSM i.e. the test user receives notifications in the RTSM, which include photos.
- Task 4: The executive department requires water level information from the test participants

  - Old Setup (A): the test participant radios local fire departments to get information about local water levels. This information is then transmitted via radio to the executive department.
  - New Setup (B): the test participant can receive the water level information directly from the RTSM. This information is then transmitted via radio to the executive department.

- Task 5: The executive department requires the current position of all Akkons.
  - Old Setup (A): the test participant radios all Akkons to get the information about their positions. This information is then transmitted via radio to the executive department.
  - New Setup (B): the test participant can receive the positions of the Akkons directly from the RTSM. This information is then transmitted via radio to the executive department.

3.2. Evaluation and Questionnaires

After each task, the user has to fill out a short, electronic questionnaire with three general usability questions and one task-specific, difficulty-level related question.

1. Single Ease Question according to Sauro and Dumas (2009): “How difficult was it to send the Akkons to the new position?”, Answer-options: “Very difficult” to “Very easy” via a seven point scale (Example from Task 1).
2. Question from the After-Scenario Questionnaire (ASQ) from Lewis (1991): “I am satisfied with the amount of time it took to complete the task”, Answer-options: “Strongly disagree” to “Strongly agree” via a seven point scale.
3. Custom question: “The used tools supported me to fulfill the task”, Answer-options: “Strongly disagree” to “Strongly agree” via a seven point scale.
4. Custom question: “The used tools supported me to capture all relevant information and to act accordingly ”, Answer-options: “Strongly disagree” to “Strongly agree” via a seven point scale.

At the end of task 5, the test participant has to fill out a System Usability Scale (SUS) questionnaire, originally developed by John Brooke (1996), which contains 10 questions with five answer options ranging from “Strongly agree” to “Strongly disagree” (see Figure 4):

Hence, each test participant fills out two SUS questionnaires: one after completing all five tasks with the old setup (A) and one after completing all five tasks with the new setup (B).

Additionally, each test participant was interviewed at the end of the experiment to get qualitative data regarding the usability and potential for improvements:

- “What do you like/dislike regarding the new/old setup?”
- „What would you change?“
- „How difficult was is it to fulfill the tasks?“

3.3. Results

Overall, 20 test users participated in our usability lab study (18 male and 2 female users) with a mean age of 34.6 years (median = 33.5, standard deviation = 6.16).

Figure 4 represents the results of the two SUS-questionnaires (System Usability Scale), which were handed out after the user tested the old resp. the new setup. According to the questionnaire design of John Brooke (1996), the questions with odd numbers address positive aspects of the system, while even numbered questions address negative ones. According to Question 1, most of our users would like to use the new system more often compared to the old setup. Both setups are considered as not very complex, but interestingly, the new setup gets slightly better scores (Question 2). Regarding easiness (Question 3), both systems are evaluated rather equally. Both systems are evaluated as non-support-intensive. However, the old system gets a slightly better evaluation (Question 4). Regarding integration, both systems get similar, rather good evaluation ratings (Question 5). The new system is evaluated as more consistent in contrast to the old system (Question 6). Although the new system involves the feature-rich web-interface, according to our test users the new system is easier to understand than the old one (Question 7). Both systems were evaluated as equally cumbersome (Question 8). Our users felt more confident while using the old system, which could be explained by the fact that the new system includes novel components (Question 9). For both systems it is not really necessary to learn new things (Question 10).

Overall, the resulting SUS score for the old setup is 70.5 and the SUS score for the new setup is 78.75 (for details regarding SUS score calculation please see Tullis and Albert (2013)). Hence, the new setup gets a higher SUS score i.e. the overall usability of the new setup with the RTSM component is slightly higher.

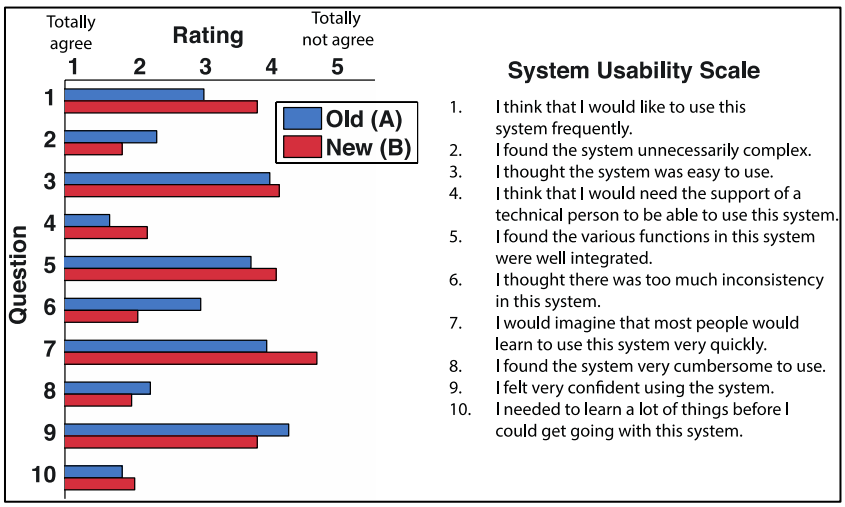

Figure 4: Results regarding average System Usability Scale ratings for both setups.

Figure 5 represents the results of the task-specific usability evaluation. The displayed confidence intervals (CI) represent a significance level of 0.05. Although most of the CIs are overlapping, it is possible to derive tendencies about the evaluation of the two systems. Although we used established questionnaires (see section 3.2), most of the average ratings are positioned around the value 4 i.e. the middle of the rating scale. For all tasks, the test participants evaluated the new setup as more supportive regarding information capturing ("The used tools supported me to capture all relevant information and to act accordingly"). According to our users, fulfilling the task while using the new setup was slightly easier compared to spare the RTSM (e.g. Task 1 "How difficult was it to send the Akkons to the new position"). Except for task 5, the new setup was slightly more

supportive regarding fulfilling the specific task ("The used tools supported me to fulfill the task"). Regarding the required amount of time to fulfill the tasks, the old setup were evaluated slightly better for Tasks 1, 4 and 5, whereas the new setup got slightly better ratings for Tasks 2 and 3. Hence, there are no clear differences regarding time consumption between the evaluated setups.

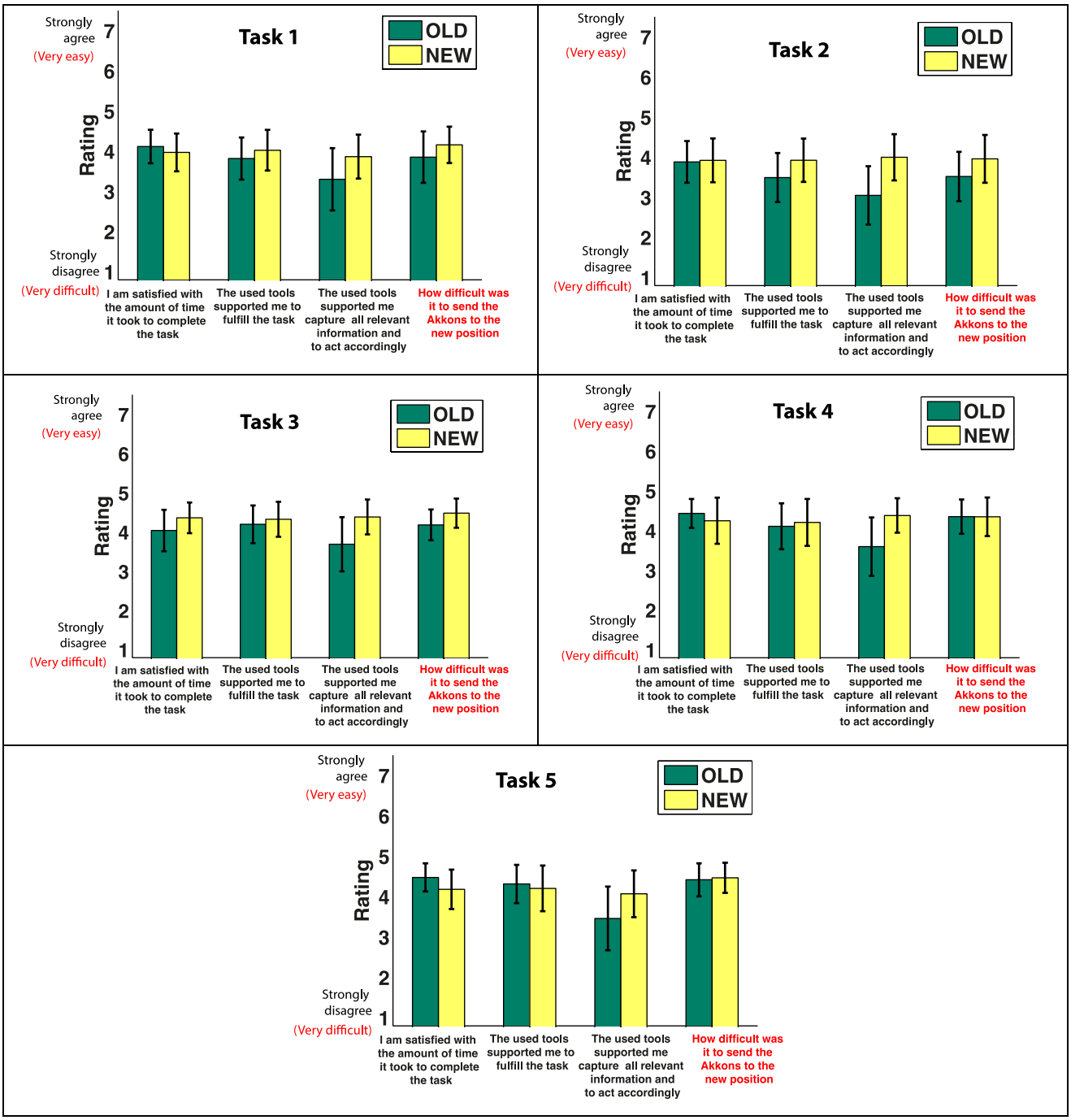

Figure 5: Average task evaluation scores for old (A) and new (B) setup.

Whereas the task-specific, quantitative results (see Figure 5) did not reveal the reasons behind the given ratings, the findings of the qualitative interview are quite insightful: According to Users 3, 5 and 18 many unnecessary radio calls could be avoided with the new setup, which helps to stay on top of developments. Also, photos can be easily shared with other users i.e. redundant sending of e-mails is no longer needed. User 4 emphasized the instant and very accurate location determination

of the on-site units. The RTSM was considered as “very helpful extension to the existing setup”. Users 5, 14 and 17 were delighted by the embedded information while using the new system e.g. direct access to the water levels. Users 7 and 12 highlighted the quick overview about available resources e.g., on-site units. User 9 said, that “the information starts to flow nearly by its own”. User 10 pointed out, that “the new system saves a lot of time” and “the sending and receiving of messages and photos is simpler compared to the old system”. Also, some room of improvement was identified e.g. user 5 pointed out, that more accurate filter/layers of the RTSM might be useful. According to user 19, it needs some time to work with the new setup i.e., the training period for the new setup might be too high.

4. Conclusions

In this paper we presented an easy to use, Android OS based mobile app to support information collection and data processing in a disaster management scenario. We also presented the results of a usability laboratory study that compares a traditional, commonly used control center setup with a novel, more advanced configuration featuring a browser-based software application for real-time situation maps (RTSM). The differences regarding usability between the two setups were small, but on average the novel setup received better evaluation ratings, especially for task-specific evaluation (see Figure 5). The novel setup also received a SUS score of 78.75 whereas the old setup only received a SUS score of 70.5. These findings are supported by the qualitative results of the user interview: most users highlighted the advantages of the new setup, but also useful comments regarding improvement possibilities were stated (e.g., offering more accurate filters).

5. Acknowledgments

PS.NET has been funded by the Austrian security research programme KIRAS of the Federal Ministry for Transport, Innovation and Technology (bmvit). The authors would like to thank Janina Gospodarek and Theresa Stürmer for their excellent support during the preparation and execution of the laboratory study and for their valuable input during the analysis phase.

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NEW ASPECTS OF POSITIONALY ENCRYPTED FORCED BROADCASTING IN SPECIAL EMERGENCY SITUATIONS

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Keywords

Broadcasting, cognitive radio, encryption, terrorism, transmission

Abstract

Organized terrorist attacks and individual criminal actions the European countries had to face in 2015 have triggered new concerns about the safety of the European citizens. Events that took place in France in January have proven that security forces still necessitate to find a way how to communicate without unintentionally informing the attacker about the measures to be taken. The following paper discusses a possible solution to this problem in form of a positionally encrypted forced broadcasting. Aside from possible scenarios where this kind of broadcasting could be implemented, the paper also presents an analysis of the system requirements while considering the possibility of engaging as one of the main elements Radio-Help system.

1. Introduction

The beginning of 2015 is from now on inextricably connected with violent events that caught France by surprise. Terrorist attacks which by its brutality and execution exceeded all similar episodes that France had to face ever before represent a new phenomenon by which the European community is taken aback. In January, the front pages of newspapers and the headlines of news broadcasts were for several weeks reporting the newest information about the outrageous attack on the magazine Charlie Hebdo. End of February, the French attacks were in Czech medias replaced by the tragedy that took place in a restaurant in Uherský Brod (*Ungarisch Brod*). Extraordinary brutality of seemingly different events has nevertheless a common denominator – in situations of aggression, attacks, terrorist actions or prosecution of the perpetrators there is currently no effective means of communication enabling to protect, warn and influence the activities of the potentially threatened individuals. Laws on Cybersecurity allow switching off all communication media. In many cases, however, such measures can be counterproductive and in the above mentioned cases were not even applied.

The aim of the following paper is to outline a path to finding a possible means of communication that would help to effectively reach vulnerable citizens and coordinate the interventions teams.

To remind, brief recapitulation of both events follows.

January 8, brothers and Chérif and Said Kouachi, the murderers of the editors of the magazine Charlie Hebdo, attacked during their escape a petrol station situated north of Paris. Both men, according to the media, were remaining in the surroundings of the town Villers-Cotteret. Another terrorist sanctuary was supposedly the village Longpont with three hundred citizens that police had searched house after house. Then, in a similar manner police also targeted the nearby village Corcy. Residents were forbidden to leave their homes.

The second day of the search for the two men police focused on an area about 80 kilometres northeast of Paris. The whole area was closed by the police (unfortunately at roadblocks, television crews and other media waited for further development of the situation). Local residents at that time spent countless hours of stress and great fear that the refugees would attack them in of outside their houses.

In the final phase of capturing the perpetrators of the attack on Charlie Hebdo, about 88,000 police officers and soldiers were involved. Assault squads struck simultaneously against the two men barricaded throughout the day in the printer complex in Dammartin-en-Goële, and against the assailant, who was holding hostages in a Jewish shop in Paris.

It is evident that the cost of protective measures was enormous. Aside from the price, which was paid by the taxpayers in direct relation to the disposal of terrorists that attacked Charlie Hebdo magazine, the additional costs associated with sending 10,000 troops for several weeks to guard public places increase the original cost greatly. In addition, the French government decided to extend the intelligence services of thousands of new workers.

The tragedy of the *Ungarisch Brod* was due to the motives of the attacker obviously different but the outcomes of this gruesome act, however, were very similar. On Tuesday, February 24, 2015 at 12.30 pm Zdeněk Kovář shot eight people in the restaurant Družba and almost two hours later when the police units interfered he committed suicide. Meanwhile, during the whole situation he was having a telephone conversation with the news editor of the Prima TV station.

The whole police intervention was accompanied by a series of controversial information and decisions – the investigation of any possible errors in the management and implementation of the police operation is still pending. The only direct witness communicated an interesting but at the same time horrifying information. In an interview for the magazine Respekt he said that from his hiding place he heard the TV crew in the restaurant deliver news right from the site of the massacre. Zdeněk K. was thus able to monitor in real time what future steps the police was about to make.

It is arguable whether targeted information could eliminate the tragic loss of lives. However, one can easily imagine a model situation where locally targeted information could help to protect the safety, lives and property of individuals and institutions. Procedures of research activities in this area are described below.

2. Threats of contemporary terrorism

Before we proceed to technological aspects of an early warning system we may mention three reasons (Going dark, 2015, p. 11) why the fight against terrorism is currently becoming more difficult.

- In January 2015, the director of the European police agency (Europol) announced that in the war conflicts in the Middle East and in Africa there is currently 5,000 European Union citizens who have joined the ranks of Islamic extremists and there is a possible danger that some of these radicals could return with the aim of attempting attacks on EU territory. EU

countries should consider as alarming beside the increasing number of potential attackers also other factors: the militants origin from the EU, therefore they can effectively use the internet and modern technologies; are organized in a decentralized manner, do not have a common leadership, sometimes the attacks are individual and more sophisticated which implies that for the anti-terrorist organizations is becoming very difficult to eliminate all the potential threats and stop all the individual attacks. Thus, the risk of terrorism currently threatens
us all.

- The second reason is that the attacks in a commando-style are easy to prepare and the defence against them is complicated. These actions do not require killing as many civilians as in the case of the plane attacks, but what is important is the propaganda of these acts that promotes the idea that it is possible to completely paralyze normal life in a major city with a bonus of continuous broadcast in news programs.
- Another challenge in the fight against terrorism is that Western security organizations slowly lose their technological lead that was so far allowing them to monitor the communication between potential terrorists. This may be caused by the fact that technology companies are competing in providing their customers an "unbreakable" protection of privacy through sophisticated encryption that is sometimes offered as standard feature of communication devices.

3. Model situations

In both situations described below it is suitable to use positional distribution of information (the concept of Radio-Help), which is based on the principle of local contextual services (LBS - Location Based Services). Recipients of information are therefore the users of devices that are moving in a certain area and not the users with a specific telephone number, IP address or MAC address of their devices. In other words, we do not know in advance what devices will occur in the area to which we want to send warning information.

Situations related to criminal or terrorist activities in which locally based encryption of information could represent a significant advantage can be divided into two groups:

- **Warning the civilians before entering the hazardous area** - in this situation, in the area of an industrial enterprise a nationwide wanted and potentially armed criminal is spotted. The criminal is captured by CCTV or is spotted by a person inside the premises of the enterprise. Then the police is informed about his presence. While the police are able to ensure security inside the campus it is also necessary to warn civilians who are potentially heading towards the area or are remaining near it in case the police intervention against the criminal fails. The goal is thus to minimize the risk, i.e. inform the greatest possible number of people that are close to the dangerous area while keeping the information secret from the criminal. In other words, in the area defined as the epicentre of danger, the information must be distributed through this warning channel as unreadable. Since the arrival of the police in the area of intervention undoubtedly takes time, it is desirable that the civilians bound near the epicentre were alerted as soon as possible - that is to say during the time before the police arrive. The system, which is described in the following chapters enables the above described feature of sending a warning message to the target area immediately after the detection of the criminal. This situation (including graphical representation) is in detail discussed in Žižka (2014).

- **Targeted disinformation directed to the epicentre of danger -** this model is based on the realistic situation that was already described in the introductory part of this article, in which a group of escaped terrorists barricaded in the area of the printer. There is a possibility of misinforming the refugees on the activities of the security forces and their plans which could help to induce the desired reaction - provoke the terrorists to escape. By misinformation we may understand e.g. notice that the police is about to enter the area from the north. Consider the fact that the terrorists have communication devices (mobile phone) and they have an accomplice outside the area who could inform them that the largest group of police officers is actually ready at the south entrance. Again, a key factor in this situation is that information (disinformation), which will be distributed via locally-targeted broadcast into the defined area (printer facilities) was for other positions encrypted and therefore unreadable. Compared with point a) the situation is therefore inversed. This situation is graphically displayed in figure 1. Crosshatched box defines the area to which the disinformation is directed.

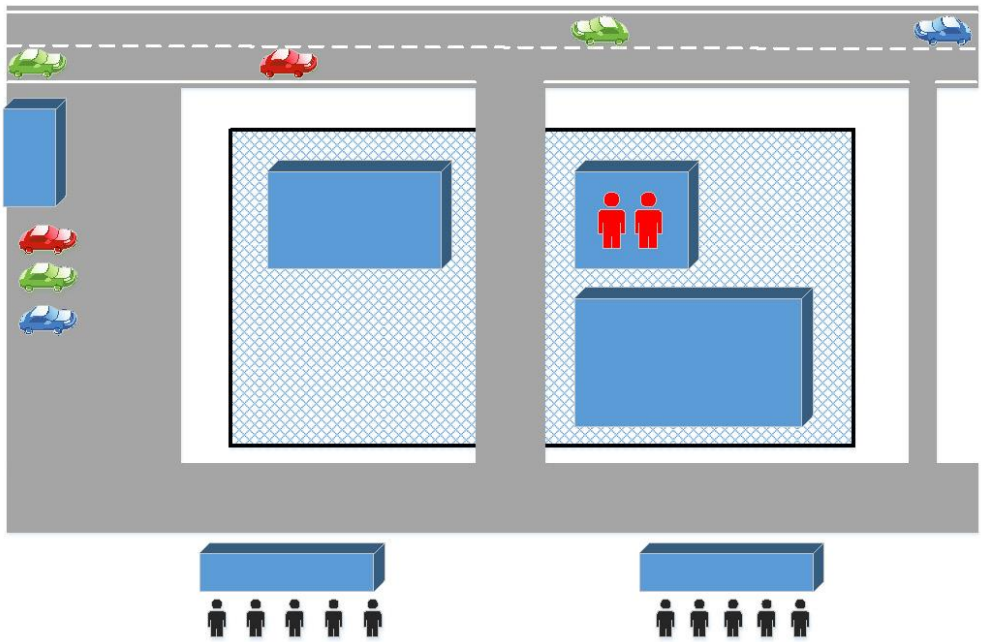

Figure 1: Targeted disinformation directed to the epicentre of danger

4. System aspects of positionally encrypted forced transmission of information

Radio-Help (Skrbek, 2011) is a system that is designed for the primary purpose of warning civilians not only in emergencies, such as floods, mass casualty, but also in situations where criminal activity endangering public safety occurs in a certain area. The basic concept of Radio-Help lies in positionally dependent distribution of warning information using longwave analogue signal into which a digital signal is superimposed. On the same principle works for example HD Radio system, which is used mainly in the USA. The idea of longwave broadcasting is of particular interest because to cover a large area (e.g. the Czech Republic) only one broadcaster would be sufficient whose protection would be provided by the country concerned. It is of course possible to use other wavebands (MW, VHF, UHF) which are common for broadcasting. In addition, the Radio-Help system may equally use digital communication networks that even represent the only possible solution for some of the extensive functions.

The system consists of basic elements that are schematically represented in Figure 2.

The operational centre of the warning system is a unit which should help the police or other institution to collect input information and data, create scenarios of safe information distribution, defining areas of reception for forced broadcasts and other coordinating activities. Personnel ensuring the functions of the operational centre should be able to flexibly and timely react to emergencies, decide on the appropriate form of warning messages, and also on whether to encrypt the broadcasted message. In the case of events when large areas are at risk, it is necessary that important decisions are made by a person with relevant competencies (governor, president, etc.).

Other elements mentioned in the scheme, will be discussed in more detail in the next section. These elements are: the encryption algorithm, the transmission channel and user terminal.

Figure 2: Basic elements of a system for positionally forced transmitting of information

4.1. User terminal

As user terminal we may use any device (currently the most often is a mobile phone), which is able to locate its position using commonly available technologies and methods. Among these methods the most common is the GPS system allowing to quite accurately target specific devices independently of the mobile networks. Main disadvantage is that the signal from the GPS satellites is less engageable inside buildings, underground areas, etc. Obviously, we need to take into account that some mobile phones, even today, are still not equipped with a GPS or it may be turned off by the user himself in order to e.g. extend battery life.

Another option consists in determining the location via mobile network. Contrary to the above described method, the GSM signal is very strong and reaches even the places where it is not possible to target user location using GPS – meaning the interior of a building. However, main disadvantage (compared to GPS) lies in the inaccuracy of location, especially in sparsely populated areas where the phone is in the range of only one BTS. The accuracy of this method increases as the number of BTS stations which are at the moment, within the range of a mobile device grows. It is necessary to realize though, that the police in some cases of endangering state security have a legal option of disrupting data flow, telephone and radio communications, which are mainly provided by mobile operators. If the GPS on the device is off and the mobile network is unreachable the positionally distributed warning message won't be successfully delivered to the recipient. This possibility needs to be considered even in the scenario a). However, even with these limitations, the warning message would reach a large group of civilians since we may assume that the GPS system will be active for the majority of devices in the area for which the warning message will be intended and that all communication channels will not be turned off and one of them will be retained for the purposes of warning system.

4.2. Transmission channel

The whole concept of Radio-Help is based on forced reception of warning information in a certain pre-defined area. If an emergency situation occurs, operation centre should ensure the distribution of warning messages to the pre-defined area. This approach allows to send the message simultaneously to several different locations. If the position of the user terminal, that meets the

requirements for receiving the forced warning messages, coincides with the defined territory the device will receive a text message, which may also be accompanied by a voice session.

If we did not require encryption of the warning messages we could use as a transmission channel the aforementioned analogue broadcast along with superimposed digital signal. Unfortunately, the analogue signal is not very suitable for applications that require encryption of data and information. In situations when we need to encrypt a warning message (see the model situations), digital transmission channel should be seen as the only option.

Digital GSM network, which is a global system for mobile communications, appears to be an adequate solution. If we stick to our original concept of Radio-Help that uses radio technology, we may include to the list of possible transmission channels also technology for digital radio transmission. According to the document untitled "Strategy of digital radio broadcasting" (Český Rozhlas, 2015, p. 15), Czech Radio, from 2017, plans to run in parallel along with conventional analogue broadcasting, also digital sound broadcasting of nationwide stations and specialty channels and digital programs. By the year 2025, the end of analogue and transition to full digital broadcasting of Czech Radio is scheduled. As stated in the document, this schedule may be updated as required by the legislative framework and under the influence of negotiation processes and cooperation with other broadcasters, state regulators and other stakeholders. Possible implementation of these technologies for the purposes of the warning system described in this paper cannot obviously be done without discussions with representatives of mobile operators and the Czech Radio. One of the potential problems - the lack of available frequency bands - could be solved using technology called cognitive radio. The concept of cognitive radio was first published by Mitola J. (1999) in an article entitled "Cognitive radio: making software radios more personal." The term *cognitive radio* is currently used for the *intelligent autonomous system*, which is able to monitor the radio activity of the environment in which it is located, with the aim to find an unoccupied zone for its own broadcasting (Žalud, 2007).

4.3. Encryption algorithm - positionally forced encrypted broadcasting

The majority of known encryption methods where the encryption is based on the position of the recipient uses a hybrid principle which is a combination of symmetric and asymmetric encryption algorithm.

The functional logic of the system for dissemination of warning messages including the possibility of encryption is illustrated with the help of an activity diagram (Figure 3).

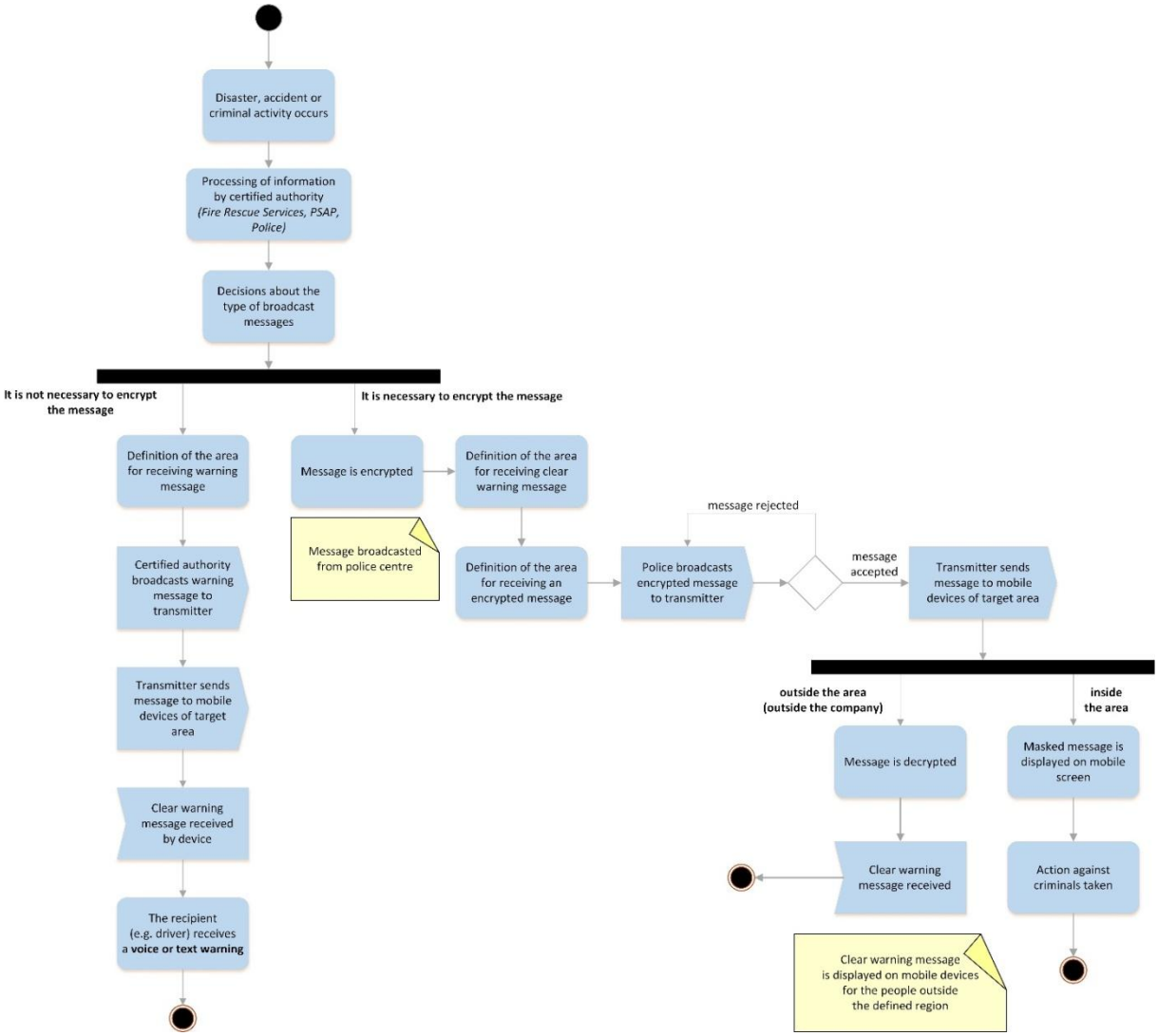

Figure 3: Activity Diagram

Location based encryption

Location based encryption is such an encryption, in which the encrypted text can be decrypted only at a certain specified place/location. If someone tries to decipher the message in a different area the decryption process fails and there are no details displayed about the original information.

One possible approach for encrypting information based on geographic location of the user which can be used in the case of a warning system described in this article is a method called Geo-Encryption (Scott, 2003). This model is effective under the condition that the sender knows the receiver's location and the time the receiver will stay in and around the destination. Moreover, if we know that the potential recipient of the message is stationary in relation to the defined area, this model is appropriately applicable to situations similar to our second model situation.

In the first situation, we must expect that the region for receiving the decrypted message will be much greater and, moreover, we need to take into account assumed mobility of potential recipients of the warning messages (or their devices) comprising also civilians that at the time of the broadcast are not yet present in the designated area. The authors Al-fuqaha et al. (2007) in their article extended the original Denning´s algorithm of Geo-Encryption. They take into consideration the situation where it is expected that the message recipients move with respect to the defined area.

Unfortunately, this extended algorithm presupposes the exchange of coordination messages between the sender and the recipient. Given the fact that the system of Radio-Help is designed as one-way communication, i.e. the warning communication takes place in the direction from the sender to the recipient which makes this extended version of the Geo-Encryption algorithm unusable. Resolving this situation will be part of the next research, which will also address the problem of mathematical interpretation of the algorithm with respect to its specific applications.

Model situations described in this paper were chosen for the reason that terrorist and criminal attacks currently represent a topic widely published in the media. However, the concept of positional encryption outlined here could be useful also for other types of emergencies - e.g. controlled evacuation of people from an area that is threatened by tsunami. There already are systems that a few minutes after the occurrence of the tsunami are able to evaluate this phenomenon and quite accurately determine when and where the tsunami will hit the coast and with what force. Regional operators receive this information within a few minutes, but unfortunately this solution is not very effective in terms of evacuation from the area that is about to be hit be the tsunami in e.g. two hours period. In several high tsunami risk areas are currently deployed loudspeakers, which in case of danger warn the population. The problem in these cases may be the panic that arises and spreads very rapidly, often resulting into blockage of roads and access pathways. In addition, the panic may arise even in places that are not immediately threatened making the throughput towards the center of a specific city (i.e. away from the coast) even worse. (Skrbek, 2015)

These situations imply to use the aforementioned information distribution using positional encryption because it can ensure that the warning message intended for one group of the population / area has not been read in another place. Consequently, it may facilitate a gradual evacuation of priority areas. This step though should be performed in a synergy with switching off the mobile network. If the mobile network continues to operate spreading panic in other areas would not be eliminated. The actual evacuation scenarios should be developed by cities, territorial entities etc. in relation to geographic characteristics and other aspects.

5. Conclusion

Above described system for forced positional warning during emergency situations does not have as primary purpose to avoid and eliminate these types of situations that appear when the safety of human lives and property are in danger during terrorist or criminal activities. Given the aforementioned information, such a use is not possible because terrorist organizations are nowadays technologically very advanced and we may say that they are always a step ahead. Same statement is valid for criminal activities of individuals since they as well are very difficult to predict. The main objective of the presented system is to improve communication processes which follow immediately after the event because even here there is a great scope for improvement by reducing losses of property and lives.

System designed to provide targeted warnings and notifications is called Radio-Help. This digital radio, whether transmitted through the Internet or terrestrial broadcasting, offers many possibilities of targeted broadcasting including the option of disabling the reception of broadcasts outside the defined area. Encryption technology based on the location of the targeted areas would help to optimize the warning process and warn individuals before entering areas at risk and without providing this information to the assailants in other area.

Of course, it always depends on the decisions made by groups or individuals with assigned responsibilities who in a given situation need to decide very quickly whether it is possible, or not, to use available means of communication. For this reason it is very important that the systems

implemented in these situations were adequately tested and assembled and that as many scenarios as possible were created in order to help accelerate the whole process of decision making.

Research team should consequently focus on the tasks of designing a specific algorithm for position-based encryption including its mathematical representations, creating additional modelling scenarios along with a testing mobile platform for the system Radio-Help. Possibility to include encryption of information as one of the Radio-Help's features is also one of the upcoming part of the system.

6. Acknowledgement

This work was supported by the SGS 21079 research project of the Technical University of Liberec "New possibilities of advanced information and communication technologies in solving of uncommon situation".

This work was supported by the project No. SGS-21073 "Analysis of project methodologies implemented by small, medium and large enterprises in the Czech Republic".

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SESSION B: ICT AND ITS IMPACT ON ECONOMY AND SOCIETY

IMPACT OF ICT ON ECONOMY AND VICE VERSA: RECENT FINDINGS AND FUTURE CHALLENGES

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Keywords

ICT, economy, input-output analysis, national accounts, intermediate consumption

Abstract

The aim of the paper is to present recent findings related to the assessment of the impact of information and communication technologies (ICT) on economy. Furthermore, the paper is focused on identification of challenges for the future interdisciplinary research.

Recent findings are divided into several parts, partly connected to the order of information contained in national accounts. Economic situation of the industries (and ICT industry in particular) was analysed from the point of view of the contribution of individual industries to the economic growth from the production side - output, value added, labour productivity, total factor productivity etc. An advanced approach to the total factor productivity measurement has been presented. The impact of ICT on economy using the input-output framework has been analysed. Many recent papers are focused on the analysis of the labour market and mainly its future participants.

As future challenges we consider the analysis of mutual character of the relations between ICT and economy. What is the impact of ICT on economy and what is the impact of economy on ICT? How the recent economic recession influenced ICT and how ICT industries contributed to exit from the crisis? Time input output tables using is a challenging issue. Regional aspects should be taken into account: regional structure of expenditures side of GDP and regional price levels (PPPs). Regional input-output tables compilation (Sixta et al, 2014) is the most demanding topic for ICT impact analysis at the regional level. Special attention should be paid on the historical time series: what was the role of ICT in the period 1970-1989?

1. Introduction

Information and Communication Technologies (ICT) sector is considered as one of the most important group of industries for the economic and societal development. In several papers, the size and structure of ICT sector is analysed, in some others the impact of ICT sector on economy is explored. The aim of the paper is to arrange and present recent findings in the research area

consisting in the assessment of the impact of ICT on economy and to identify challenges for further interdisciplinary research.

The rest of the paper is organized as follows. Firstly, recent findings are presented in division into five parts (ICT production and productivity, human capital and labour market, ICT usage, mixed models, other economic and societal impacts). Secondly, some ideas for further research related to ICT impacts on economy are brought. In conclusion, current state of the research in the field of ICT impacts is shortly assessed.

2. Recent findings

Recent findings are divided into several parts, partly connected to the order of information contained in national accounts. For more detailed description of the possibilities of using national accounts data for ICT analysis, see Fischer and Vltavská (2011). Our division of recent findings follows the approach of Hančlová and Doucek (2012, p. 124), who divide the impact of ICT on economy to direct impacts (ICT Production) and indirect impacts (ICT Usage). To division of Hančlová and Doucek we add the issues of human capital related to ICT.

2.1. Impacts of ICT on production and productivity

At this part the impact of ICT is presented from the supply side of the economy, where the economy is broken down into industries using CZ-NACE classification. Mainly the value added, employment, labour productivity and total factor productivity are analysed as the mainstream view, some alternative approaches like DEA are also used. As key findings at the production side of the economy in relation to ICT we consider following papers.

Pavlíček et al. (2011) presented the shares of individual industries on the total value added of the economies of the Czech Republic and Finland, Ireland, Slovakia and Austria as well as the shares of industries on the total employment. They also constructed the new indicator *effectiveness of the industry*, which allows the users an alternative view on the labour productivity and its differences among industries.

The economic situation of the industries (and ICT industry in particular) was analysed from the point of view of the contribution of individual industries to the economic growth from the production side (output, value added, labour productivity, total factor productivity etc.) by Vltavská and Fischer (2010). They pointed out that it is necessary to differ between ICT Manufacturing and ICT Services. Both these two parts of ICT are considerably different in terms of labour productivity, total factor productivity and average wages. Vltavská and Fischer also divided the data at 3-digit level of CZ-NACE and also provided the regional breakdown of selected indicators.

Fischer et al. (2013) brought an overview of the impacts of ICT on labour productivity and total factor productivity. They analysed both the supply side and expenditures side, they used index approach to the total factor productivity estimate. They concluded, that ICT services are more important for the development of labour productivity and total factor productivity than ICT manufacturing.

An advanced approach to the total factor productivity measurement has been presented by Sixta et al (2011). They introduced usage of capital services and labour services as the inputs for the estimates of total factor productivity and they pointed out that these two inputs lead to more accurate estimates. On the other hand, it is not easy to estimate capital services for individual

industries at 3-digit level of CZ-NACE classification so it is hardly useful for improvement of productivity measurement for the ICT sector.

Manďák and Nedomová (2014) introduced an alternative approach to the productivity analysis of industries. They used Data Envelopment Analysis (DEA) and compared the productivity of ICT sector among selected countries. They used data from EU-KLEMS database. Contrary to some other papers cited in this overview, they also considered ICT Trade as a part of ICT industry (besides ICT Manufacturing and ICT Services). Manďák and Nedomová (2014, p. 85) conluded that "the group of most efficient countries consists of Hungary, France, Ireland, Finland and Netherlands with average CEs between 1.03 (Hungary) and 1.15 (Netherlands)".

Delina and Tkáč (2010) offered an unusual view on the impact of ICT on productivity. They analysed the impact of ICT solutions adoption on productivity using correlation analysis and decision trees. Based on the correlation analysis they concluded that adoption of ICT in general does not significantly influence organizational perception of ICT on productivity level and productivity changes. In contrary, decision tree shows, that more than two third of organizations with more than two sales supported solutions, recognize impact of ICT on productivity within their organizations.

2.2. ICT impacts on human capital and labour market

Many recent papers are focused on the analysis of the labour market and mainly its future participants. Vltavská and Fischer (2014) presented what do Czech ICT students thing about their future career using the data from the EUROSTUDENT V survey and compared the data for ICT students with all students. Vltavská and Fischer (2014, p. 263-264) conluded that ICT students think more positively about their chances both on national and international labour market (at the national labour market 41.5% of ICT students assess their chances as very good compared to 22.3% of all Czech students, at the international labour market 17.3 % of ICT students compared to 8% of all Czech students).

Expectations of ICT students are in accordance with data on real unemployment. Fischer and Vltavská (2013), combining data on the total unemployment, data on unemployed graduates and data on total number of graduates from SIMS, compared the rates of unemployed graduates of ICT and non-ICT graduates. They concluded that "the hypothesis that there is significantly better employability of IT graduates contrary to non-IT graduates has not been verified, unemployment rates of both groups do not differ" and pointed out that "the unemployment rate of bachelors (for both IT and non-IT graduates) is significantly lower than for masters" (Fischer and Vltavská, 2013, p. 75).

Distribution of wages within the ICT sector of the Czech economy is analysed by Matějka and Vltavská (2013). They introduced Meyer-Wise model for assessment of the impact of minimum wage to employment and wages and found the best theoretical distribution for the description of wage distribution within the ICT sector. They concluded that the role of the minimum wage in the ICT sector is not significant (with positive impact on employment of 0.22%) but pointed out, that for the business (wage) sphere the conclusions are significantly different.

Fiala and Langhamrová (2010) compiled the demographic projection of the ICT experts using classical component method without the influence by migration. They concluded, that under the assumptions of the projection they expect growth of the number of ICT experts by about 50 thousands in the next two or three decades. Age structure of ICT experts will change, their average age will rapidly increase with faster ageing of ICT experts than the whole population of productive

age. Fiala and Langhamrová pointed out that the real development will probably be not as simple as the assumptions of the projection.

An alternative view on the ICT labour market is based on comparison of competencies expected by the labour market with the competencies provided by the educational institutions. Doucek, Maryška and Novotný (2014) compared the trends in the requirements of business practice on ICT managers in 2006 and 2010 with the coverage of these requirements by fields of study with ICT specialization, on the example of the Czech Republic. They concluded that requirements on knowledge and skills for the role of ICT manager in the Czech education market are quite well covered.

Rozehnal (2012) summarized the changes that caused the impact of ICT on the economy. According to him, "during the last two decades it has created a virtual world that has become part of the real world. This development is very dynamic and constantly brings technological innovation that is necessary to implement to the corporate infrastructure and the management and operation of the company." (Rozehnal, 2012, p. 140).

2.3. Impacts of ICT Usage

Fischer and Vltavská (2012) have analysed the indirect impacts of ICT on economy using the input-output framework. For individual industries, they analysed relation between share of ICT products on total intermediate consumption of individual industries or on total output of individual industries on one hand and labour productivity, total factor productivity and changes in value added at constant prices on the other hand. They found out the positive correlation between the share of ICT products on intermediate consumption and gross value added (0.66) and weak positive correlation between the share of ICT products on intermediate consumption and labour productivity (0.34).

2.4. Mixed approaches

Hančlová and Doucek (2012) connected the analysis of production and usage side. They built up an econometric model for estimating labour productivity of industries, using the division of industries into four groups regarding ICT capital intensity and ICT production. As the key conclusion, they proved the "evidence that ICT-producers have higher level of labor productivity growth and with increasing level of this indicator in previous year growth of labor productivity decreases". On the other hand, "sectors with higher share of ICT capital compensation as share in total capital compensation do not account for the majority of increase in productivity growth of the Czech economy during 1995 – 2007." (Hančlová and Doucek, 2012, p. 132).

2.5. Other economic and societal impacts of ICT

Šimpach and Langhamrová (2014) brought the analysis of the impact of ICT on households and municipalities. Using data of the Czech Statistical Office related to ICT facilities in households, they compared the households' access to ICT by among the NUTS-3 regions. From the methodological point of view it is important to point out that they also compared individual clustering methods and their suitability for this type of analysis. Šimpach and Langhamrová (2014) concluded that "that the nearest neighbour method is more appropriate for the conditions of countries with stable growth potential and Ward's method for the countries with differently developed regions (such as the Czech Republic)". (p. 70)

Delina and Dráb (2010) provided the research results from the project focused on effective trust building strategies development for electronic business platforms. Their results show that for the

initial phase of e-marketplace project, it is needed to start with more simple services with generally high level of trust.

Finally, Hančlová and Doucek (2011) confirmed the relation between ICT and education using panel data from EU countries.

3. Future challenges

The aim of this part of the paper is to bring some ideas for further development within the modeling of impacts of ICT on economy and vice versa.

3.1. Mutual relations between ICT and economy

As future challenges we consider the analysis of mutual character of the relations between ICT and economy. What is the impact of ICT on economy and what is the impact of economy on ICT? How the recent economic recession influenced ICT and how ICT industries contributed to exit from the crisis, both at the production and usage side? How are ICT direct and indirect impacts for economy recovery in 2014-2015? Are there any lags at the mutual relation between economy and ICT?

3.2. Time input-output tables

Furthermore, input-output models which could be used for modelling of ICT impacts should be developed. As one of the challenging issue we consider using time input output tables (TIOT) compiled by Zbranek and Fischer (2014). Time Input-Output tables allow the evaluation of the labour time needed for the production of specific amounts of products and also intermediates. Is there any difference between ICT goods and services on one hand and the goods and services produced by the rest of the economy on the other hand?

3.3. Regional aspects of ICT

For assessment of the impact of ICT, it could be useful to take regional aspects into account. How the ICT influences the regional structure of GDP estimated by Kramulová and Musil (2013) in terms of expenditures side? Is the share of ICT goods and services finally consumed equal across the regions? How ICT impacts the regional price levels and regional PPPs, compiled by Cadil et al. (2014)? As the most beneficial work for further research of regional impact of ICT we consider regional input output tables compilation (Sixta et al, 2014). Sixta supposes that the tables will be published at the end of 2015.

3.4. Historical time series of GDP

Special attention should be paid on the historical time series presented by Vltavská and Sixta (2015). What was the role of ICT in the period 1970-1989 in former Czechoslovakia?

3.5. Human capital

Participation of graduates in life-long learning is analysed by Mazouch and Suchánková (2013), using the data from Adult Education Survey. Does the participation of ICT graduates differ from others? Does the access to ICT influence the access to adult education?

4. Conclusion

Many findings related to ICT and their impact on economy and society have been brought in recent years, partly thanks to the introduction of the section "ICT and economy" to IDIMT conferences. There are different approaches to the analysis of direct, indirect and other impacts of ICT on economy: index approach, econometric approach and also DEA approach are used for the analyses related to the labour productivity and total factor productivity within industries.

As the economic and societal development is crucially dependent on the human capital development, many papers are justifiably focused on the topics related to ICT human capital, requirements on workers in ICT, population projections of ICT workers, current and future situation of ICT graduates at the labour market (in terms of both employment and wages) and the impact of ICT on education system.

Thanks to the recent methodological development in several areas of national accounts (time input output tables, regional input output tables, historical data on GDP etc.), there are also new challenges for further development related to ICT impacts on economy (and vice versa!).

5. Acknowledgement

This paper has been prepared thanks to the Institutional Support to Long-Term Conceptual Development of the Research Organisation of the Faculty of Informatics and Statistics of the University of Economics, Prague.

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IS IT ATTRACTIVE TO BE THE ICT PROFESSIONAL IN THE CZECH ECONOMY?

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Keywords

Human Capital in ICT, ICT Professionals, Wages in ICT, Inflation Rate, Real Wage in ICT

Abstract

This article analyzes the wages of ICT professionals in the Czech economy during the years of 2011-2013. The analysis first identifies the groups of job positions of ICT professionals based on the CZ-ISCO methodology and is followed by a summarized analysis of the trend in the number of ICT professionals in the Czech economy during the years of 2011-2013. The analysis of wages for the time period of 2011-2013 comprises of a summarized analysis and an analysis by profession groups based on the CZ-ISCO methodology, by education, gender and sector employment. Toward the end, the article analyses the average wage of ICT professionals in terms of the trend of the average wage in the Czech Republic and inflation rate. Finally, the article shows the trend in the nominal real wage of ICT professionals in the Czech Republic during the analyzed time period.

1. Introduction

Basl and Doucek (2012) presents that economic theory attributes and important role of the Information and Communication Technology (ICT) take up of businesses for increased efficiency, innovation and growth (Sabol et al, 2006). Therefore, the take up of ICT by world businesses is crucial for the raising of productivity, potential and future growth prospects (Doucek, 2010). We can easily see that the world trend is reflected in Central Europe (Bernroider et al, 2011), the Czech Republic (Fiala & Langhamrova, 2009; Fischer et al, 2013) and the Slovak Republic as well (Delina & Tkac, 2010; Dorcak & Delina, 2011, Delina & Dráb, 2010). The global trends, such as outsourcing and cloud technologies, make it possible to deploy ICT services to any place in the world provided that it has sufficient infrastructure and a sufficient number of qualified ICT professionals (Maryska et al, 2010), (Oskrdal, & Jelinkova, 2010). Every economy nowadays needs, and to some extent depends on, this type of people. In the context of the existing economic, financial and moral crisis, it is important to remember the central role played by the production and take up of ICT in driving innovation, productivity and growth (Hanclova et al, 2015; Mand'ak & Nedomova, 2014; Hanclova & Doucek, 2012; Hanclova & Doucek, 2011).

2. Research Questions

Our research analyzes the different impacts and aspects of information and communication technologies on human society. One of the analyzed aspects is the "social recognition and neediness" of ICT professionals translated into the size of their wages. Our goal was to analyze the trend of wages in ITC-related professions during the years of 2011 – 2013. Sources for our research are facts, presented for example in Hanclova (2006), or in Marek (2010), (Matejka & Vltavska, 2013) and Marek (2013). We focused on the overall trend in the wages of ICT professionals as well as on the trend by profession where we concentrated on two groups based on the CZ-ISCO methodology, i.e. "**ICT Specialists (CZ-ISCO 25)**" and "**ICT Technicians (CZ-ISCO 35)**." We also analyzed the trend by achieved education, gender and sector employment of ICT professionals.

The question arising from this analysis is as follows: "What was the average wage in ICT and the inflation rate during the years of 2011 – 2013 and did the real wage in ICT professions go up during the said time period?"

3. Methodology and Data Collection

For this article, we basically used and analyzed the data from publicly accessible databases of the Czech Statistical Office, Eurostat, OECD, Cepis (CEPIS, 2012) and the World Bank. For our research and analysis of the wages of ICT professionals in the Czech economy, we used the methodology of ICT professions classification – CZ ISCO. The classification of ICT professionals is provided in Paragraph 3.1.

3.1. ICT specialists and technicians

Based on the generally used methodologies, such as CZ-ISCO, ICT work positions are divided into two fundamental profession groups (CZSO, 2010):

- Specialists (CZ-ISCO 25) and
- Technicians (CZ-ISCO 35).

More detailed information about the individual groups of professions and their job descriptions is provided below.

ICT Specialists

ICT specialists research, plan, design, write, test, provide consultations and improve ICT systems, hardware, software and related concepts for specific applications; process related documentation, including policies, principles and methods; design, develop, supervise, maintain and support databases and other information systems to ensure optimal performance and data integrity and security. Most occupations in this class require level 4 skills (CZSO, 2010). Their work description usually includes: research of ICT use in corporate positions and search for areas for improvement and for researching theoretical aspects and operational methods for using computers; evaluation, planning and designing of hardware and software configurations for specific applications, including the Internet, Intranet and multimedia systems (Smutny et al, 2013); development, creation, testing and maintenance of computer programs; research and development of database architecture and database control systems; development and implementation of security plans and data administration policy and administration of computer networks and related computer environments; analysis, development, interpretation and evaluation of the parameters of designs and architecture

of complex systems, data models and charts in the development, configuration and integration of computer systems. The occupations of this class are divided into the following groups:

- Software and computer application analysts and developers (CZ_ISCO 251) research, plan, design, create, test, provide consultations and improve IT systems, such as hardware, software and other applications based on specific requests. Their job description usually includes: research of IT use in the organization's activities and search for areas for improvement in terms of maximum effectiveness and efficiency; research of theoretical aspects and operational methods for using computers; evaluation, planning and designing of hardware and software configurations for specific applications; designing, creation, testing and maintenance of computer programs based on specific requests; evaluation, planning and designing of Internet, Intranet and multimedia systems. The occupations of this group are subdivided into the following subgroups:
    - 2511 System analysts;
    - 2512 Software developers;
    - 2513 Web and multimedia developers;
    - 2514 Computer application programmers;
    - 2519 Software testing specialists and similar practitioners.
- Database network specialists (CZ_ISCO 252) design, develop, supervise, maintain and support the optimal performance and security of IT systems and infrastructure, including hardware and software databases, networks and operating systems. Their job description usually includes: designing and development of database architecture, data structure, glossaries and vocabulary conventions for IS projects; designing, construction, modification, integration, implementation and testing of database control systems; development and implementation of data security plans, data administration policy and documentation and standards; maintenance and administration of computer networks and related computer environments; analysis, development, interpretation and evaluation of complex system and architecture specification designs, data models and charts in the development, configuration and integration of computer systems. The occupations of this group are subdivided into the following subgroups:
    - 2521 Database developers and administrators;
    - 2522 System administrators, computer network administrators;
    - 2523 Computer network specialists (excluding administrators);
    - 2529 Data security specialists and similar practitioners.

Technicians constitute another group that represents a major share from the number of ICT practitioners.

ICT Technicians

ICT technicians support the regular operation of computer and communication systems and networks and perform technical tasks related to telecommunications and to the transmission of image, sound and other types of telecommunications signals on land, on the sea or in the air. Most occupations in this class require level 3 skills (CZSO, 2010). Their work description usually includes: support of information and communication systems users; installation of new programs and equipment; creation, service and maintenance of network and other data communication systems; installation, monitoring and support of websites, Intranet sites and website server

hardware and software; website modification; website server backup and recovery; supervision of devices for audio recording and for editing and mixing audiovisual records; supervision and maintenance of transmission, broadcasting and satellite systems for radio and television programs; supervision and maintenance of radio communication systems, satellite services and multiplexing systems on land, on the sea or in the air; technical assistance in the research and development of computer systems and telecommunications devices and prototype testing; design and execution of connection drawings based on required parameters; technical supervision over the production, use, maintenance and repairs of telecommunications systems. The occupations of this class are divided into the following groups:

- ICT operation and user support technicians (CZ_ISCO 351) support the regular operation of communication and computer systems and provide technical assistance to users. Their job description usually includes: servicing and supervision of peripheral and similar computer equipment; monitoring of systems in order to diagnose errors and defects in their functioning; installation of materials in peripheral equipment for their operation or supervising the installation of materials in peripheral equipment performed by peripheral equipment technicians; responding to questions regarding hardware and software operation for the purposes of troubleshooting; installation and minor repairs of hardware, software or peripheral equipment in compliance with design or installation parameters; supervision of the regular performance of systems; setting up equipment used by employees, installation of cables, operating systems or relevant software; setting up, servicing and maintaining network and other data communication systems; installation, monitoring and support of the reliability and usability of websites, Intranet sites and website server hardware and software; website modification; website server backup and recovery. The occupations of this group are subdivided into the following subgroups:
    - 3511 ICT operation technicians;
    - 3512 ICT user support technicians;
    - 3513 Computer network and system technicians;
    - 3514 Web administrators.
- Telecommunications and transmission technicians (CZ_ISCO 351) supervise the technical functioning of devices for image and sound recording and editing and of devices for the radio and television transmission of image and sound and other types of telecommunications signals on land, on the sea or in the air and perform technical tasks related to research in telecommunications engineering and to designing, production, installation, construction, operation, maintenance and repairs of telecommunications systems. Their job description usually includes: supervision of devices for audio recording and for editing and mixing audiovisual records; supervision and maintenance of transmission, broadcasting and satellite systems for radio and television programs; supervision and maintenance of radio communication systems, satellite services and multiplexing systems on land, on the sea or in the air; technical assistance in the research and development of telecommunications devices and prototype testing; design and execution of connection drawings based on required parameters; technical supervision of the production, use, maintenance and repairs of telecommunications systems. The occupations of this group are subdivided into the following subgroups:
    - 3521 Audiovisual recording and transmission technicians;
    - 3522 Telecommunications and radio communications technicians.

We analyzed the data using MS Excel tools and statistical functions.

The analysis results are presented mainly for the years of 2011 – 2013 because of the two following reasons:

- We have already presented the analysis of previous years in the article (Doucek, 2010);
- The classification of job positions changed in the Czech Republic at the beginning of 2011 and the KZAM-R methodology was replaced by the CZ-ISCO methodology. Therefore, the comparison of some values by profession could be incorrect.

The results are presented in Czech Crowns due to the recent, very volatile exchange rate and its uncertain trend in the future.

More detail information about relation between job classification and required knowledge and skills are for example in (Doucek, 2009) and (Doucek et al, 2013).

4. The Czech ICT sector and Wages

The overall results of the analysis of the wages of ICT professionals are presented in this article based on analyzed criteria. The starting point is the trend in the number of ICT professionals in the Czech economy. After that, we analyze wages by:

- ICT profession group and then by selected profession;
- Achieved education;
- Gender and
- Sector employment (business and non-business).

We performed many other analyses as part of our research, but could not include them in this article due to a lack of space.

4.1. Number of ICT Professionals in the Czech Economy

Total Number of ICT Professionals

During the past years, the Czech economy has become one of the advanced world economies with all the advantages and problems that come with it. This fact is also proven by the level of the Czech Republic's involvement in the informatization of the European Union not only because of the wide variety of offered services but also because of the number of ICT professionals. The number of ICT professionals in the Czech Republic has kept growing in the long term (Figure1), except for a small fluctuation in 2004. Not even the economic crisis in 2008 could stop this positive trend.

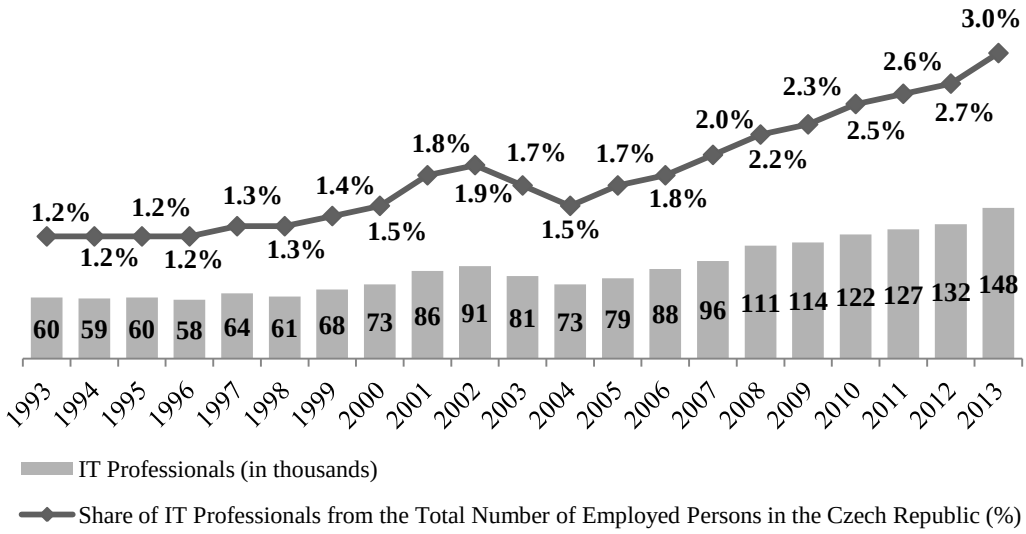

Figure 1: Share of IT Professionals From the Total Number of Employed Persons in the Czech Republic, Source: (CZSO, 2014)

In 2013, there were 148 thousand active IT professionals – 13,300 women and 134,700 men. A more detailed analysis of the number of ICT professionals in the Czech economy during the years of 2011 – 2013 is provided e.g. in (Nedomova et al, 2015). These professionals practically worked in all sectors of the economy. The next part of this article analyzes the wages of this group of professionals.

4.2. Wages in ICT Professions in General

As evident from Figure 2, wages in the ICT sector show a permanently growing trend during the years of 2003 – 2009.

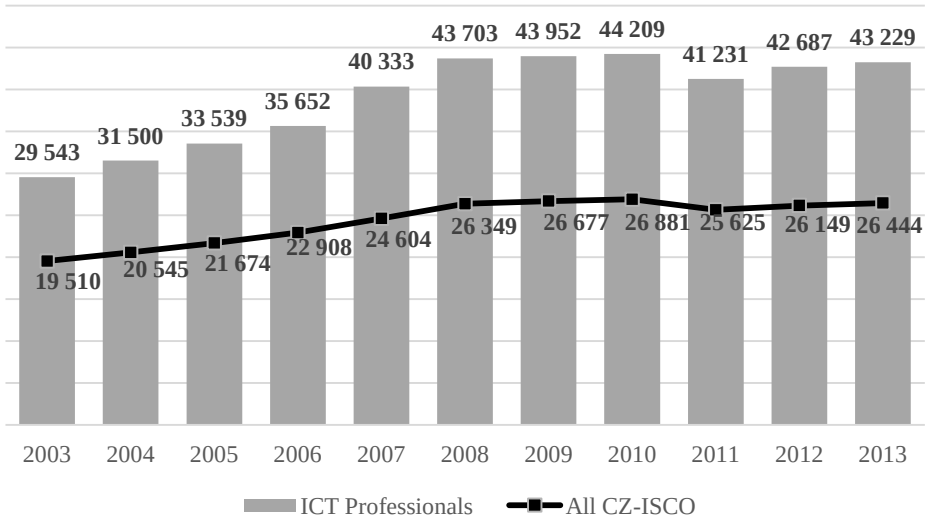

Figure 2: The Average Wage in the Czech Republic and of ICT Professionals, Source: (figure authors, data CZSO, 2014)

A note to Figure 2: "All CZ-ISCO" represents the average wage in the Czech Republic.

The average wage of ICT professionals dropped in 2010 and did not reach the average wage of 2008 until the year 2013. The year-to-year change (in %) in the wages of ICT professionals compared to the year-to-year change in the average wage (in %) in the Czech economy is shown in Table 1.

	2002/2003	**2003/2004**	**2004/2005**	**2005/2006**	**2006/2007**	**2007/2008**	**2008/2009**	**2009/2010**	**2010/2011**	**2011/2012**	**2012/2013**
Employees Total	3.20	5.30	5.50	5.70	7.40	7.10	1.20	0.80	-4.70	2.00	1.10
ICT Professional	11.40	6.60	6.50	6.30	13.10	8.40	0.60	0.60	**-6.70**	3.50	1.30
Annual Difference between Employees Total and ICT Professionals	8.20	1.30	1.00	0.60	5.70	1.30	**-0.60**	**-0.20**	**-2.00**	1.50	0.20

Table 1: Growth of Wages in Czech Economy in Percents, Source: (authors)

It is the result of the economic crisis that, although started in 2008, did not affect ICT until the years of 2009-2010 when it slowed down wage growth (in-progress projects had to be finished) and finally hit ICT professionals in 2011 when new and costly projects were no longer planned. This is why wages dropped by 6.70% between 2010 and 2011. During that time, the wages of ICT specialists dropped even more than the average wage – by 2%. Another indicator of the crisis in 2009 is the growth of the wages of ICT professionals between 2009 and 2011 that was lower than that of the average wage in the Czech Republic. The year 2012 already shows some recovery in the ICT sector indicated by a faster growth of the wages of ICT professionals.

4.3. Classification by Profession

We analyzed the data concerning individual ICT professions only for the years of 2011 – 2013 due to the change in the classification methodology as already mentioned in “Methodology and Data Collection.” The results are provided in Figure 3.

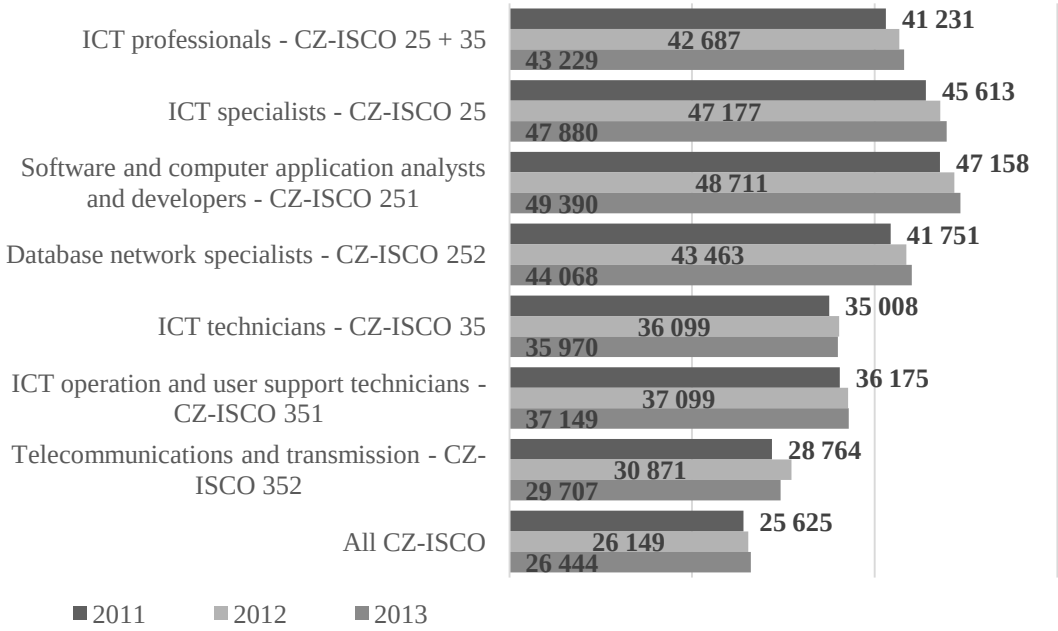

Figure 3: Wages by Profession During the Years of 2011- 2013, Source: (figure authors, data CZSO, 2014)

Figure 3 clearly shows that the wages of "ICT Specialists," specifically of the "Software and computer application analysts and developers" group, are permanently higher. The wages of the "ICT Technicians" group are lower, but out of this group "ICT Operation and User Support Technicians" have the highest wages. The reason for this wage gap between the profession groups is in the achieved education of individual groups. The analysis shows that tertiary education is mostly required in "ICT Specialists" while "ICT Technicians" usually have secondary education with a baccalaureate diploma or even lower education.

4.4. By Education

The time series of 2011 – 2013 clearly show the basic trends with respect to achieved education and wages that ICT professionals in the Czech Republic can earn for their work.

Year 2011

In the year 2011, the education of the individual profession groups was as follows: 58% of the "ICT Professionals" had tertiary education, 37.2% secondary education with a GCSE (General Certificate of Secondary Education) exam and 4.8% other education. A more detailed analysis is provided in (Nedomova et al, 2015).

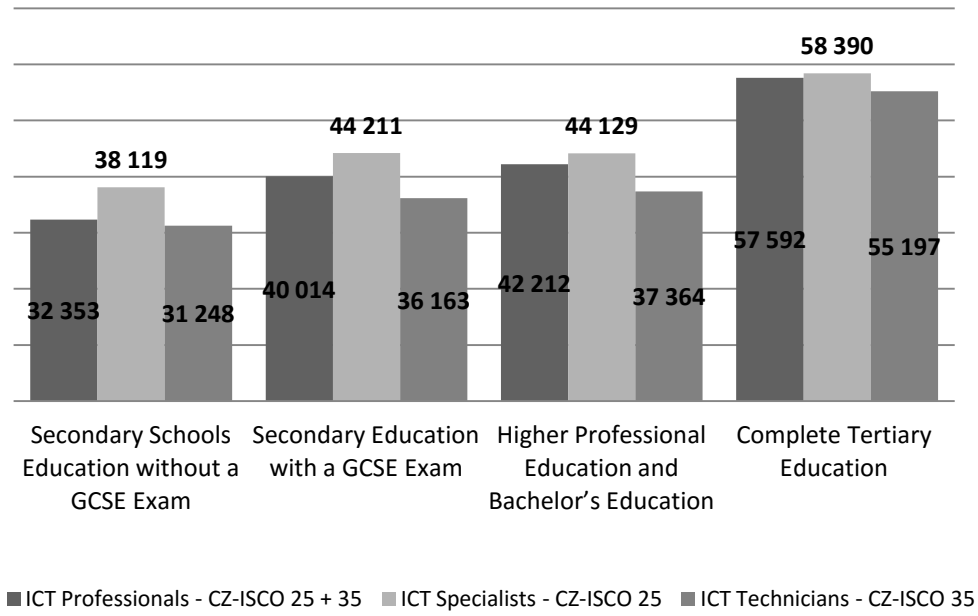

Figure 4: Wages by Education in 2011, Source: (figure authors, data CZSO, 2014)

In the year 2011, the wage gap between secondary education with and without a GCSE exam was 8,000 CZK a month on average, see Figure 4. Those with secondary education with a GCSE exam earned 2,000 CZK a month less than those with a bachelor's degree and those with complete tertiary education earned approximately 15,000 CZK a month more than those with a bachelor's degree.

Year 2012

In the year 2012, the education of the individual profession groups was as follows: 56.2% of the "ICT Professionals" had tertiary education, 38.2% secondary education with a GCSE exam and 5.6% other education. A more detailed analysis is provided in (Nedomova et al, 2015). Our findings for the year 2012 are shown in Figure 5.

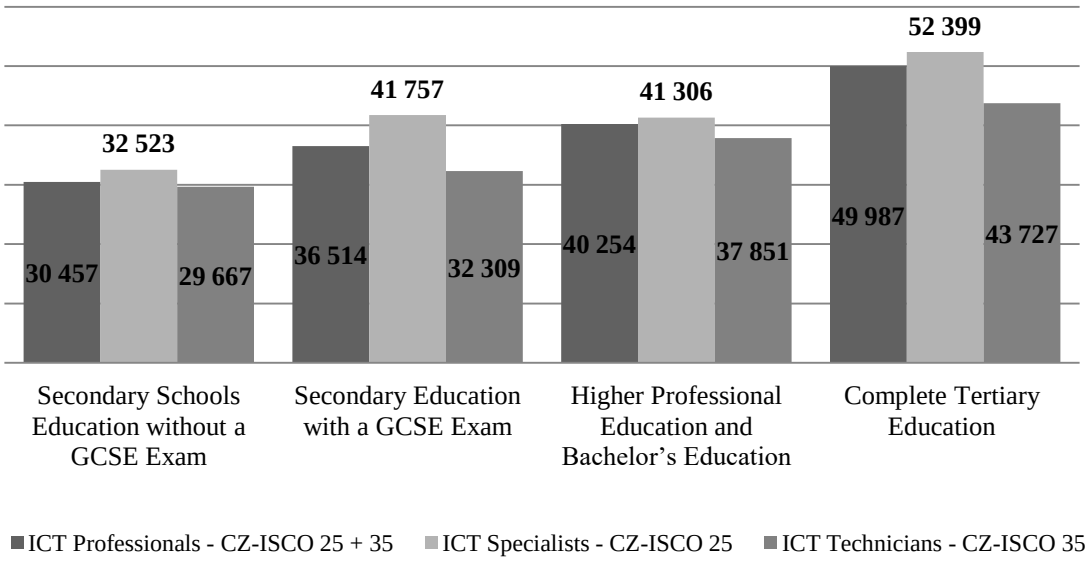

Figure 5: Wages by Education in 2012, Source: (figure authors, data CZSO, 2014)

As expected, "ICT Professionals" with tertiary education earned the highest wages. The wage gap between secondary education with and without a GCSE exam was rather big (more than 9,000 CZK a month on average). Those with complete tertiary education earned approximately 11,000 CZK a month more than those with a bachelor's degree.

Year 2013

In the year 2013, the education of the individual profession groups was as follows: 56.6% of the "ICT Professionals" had tertiary education, 38.3% secondary education with a GCSE exam and 5.0% other education. A more detailed analysis is provided in (Nedomova et al, 2015).

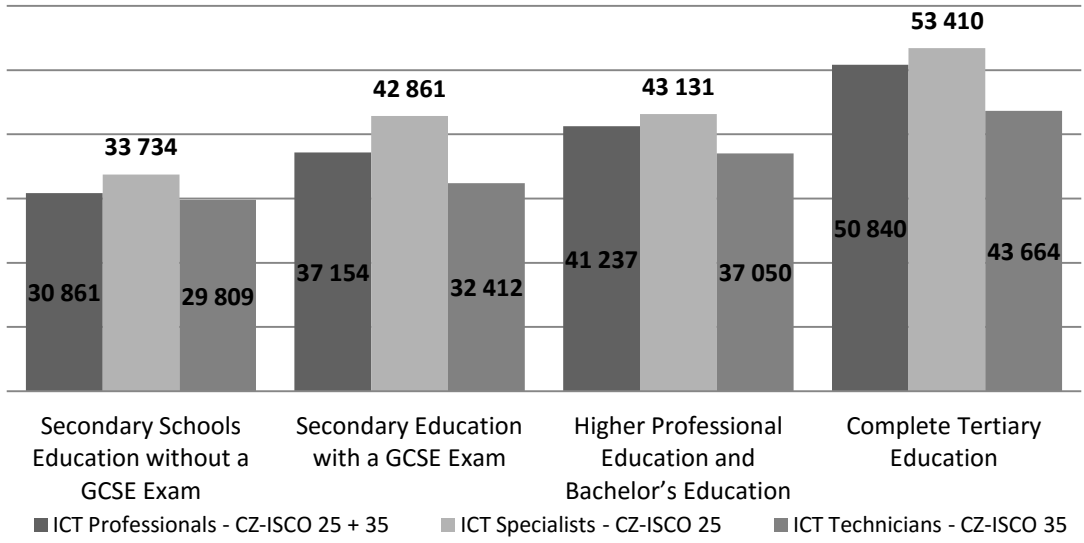

Figure 6: Wages by Education in 2013, Source: (figure authors, data CZSO, 2014)

In the year 2013, the wage gap between secondary education with and without a GCSE exam was approximately 6,500 CZK a month. The wage gap between those with secondary education with a GCSE exam and those with a bachelor's degree was approximately 4,000 CZK a month and the wage gap between those with a bachelor's degree and those with complete tertiary education was approximately 10,000 CZK a month. (Figure 6).

Based on the overall wage trend during the analyzed time period, we can say that the wage gap between the individual groups of professionals analyzed by education is slowly diminishing. Yet, the wages of practitioners without a GCSE exam are markedly the lowest, while the wages of professionals with tertiary education are markedly the highest. The wage gap between those with secondary education with a GCSE exam and those with a bachelor's degree is not all that striking.

4.5. By Gender

Using the data of the Czech Statistical Office, we also analyzed and compared the wages by gender. The positive thing is that the average wage of female ICT professionals rather considerably exceeds the average wage of women in the Czech economy. Figure 7.

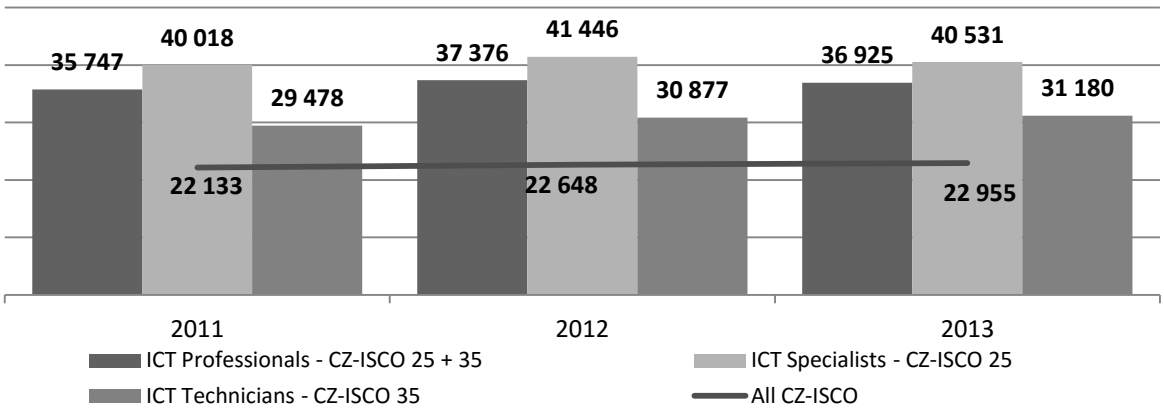

Figure 7: Wages of ICT Professionals by Gender – Women, 2011- 2013, Source: (figure authors, data CZSO, 2014)

On the other hand, the negative thing is that the average wage of female ICT professionals is approximately 20% lower than that of men (Figure 7, Figure 8). However, the positive thing is that the wage gap is not as big as in the case of the average wage in the Czech economy where the wage gap in 2012 was 27.4% and in 2013 even 27.8%.

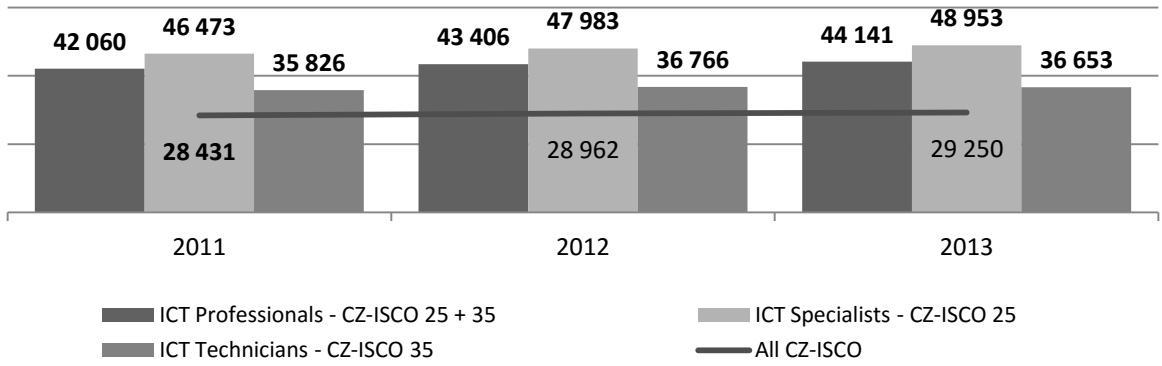

Figure 8: Wages of ICT Professionals by Gender – Men, 2011- 2013, Source: (figure authors, data CZSO, 2014)

In the year 2012, the year-to-year increase in the average wage of ICT professionals (3.5%) was mainly covered by a 4.5% year-to-year increase in the average wage of women and a 3.2% year-to-year increase in the average wage of men. In 2013, the year-to-year increase in the average wage of ICT professionals (by 1.3%) was covered by the increase in the wages of men (even though the average wage of "ICT Technicians" slightly dropped) while the wage of women dropped from year to year by 1.3% on average.

4.6. By Sector Employment

The wages of ICT professionals also differ depending on whether they work in the business sector or the non-business sector. The impact of sector employment on wages is shown in Figure 9.

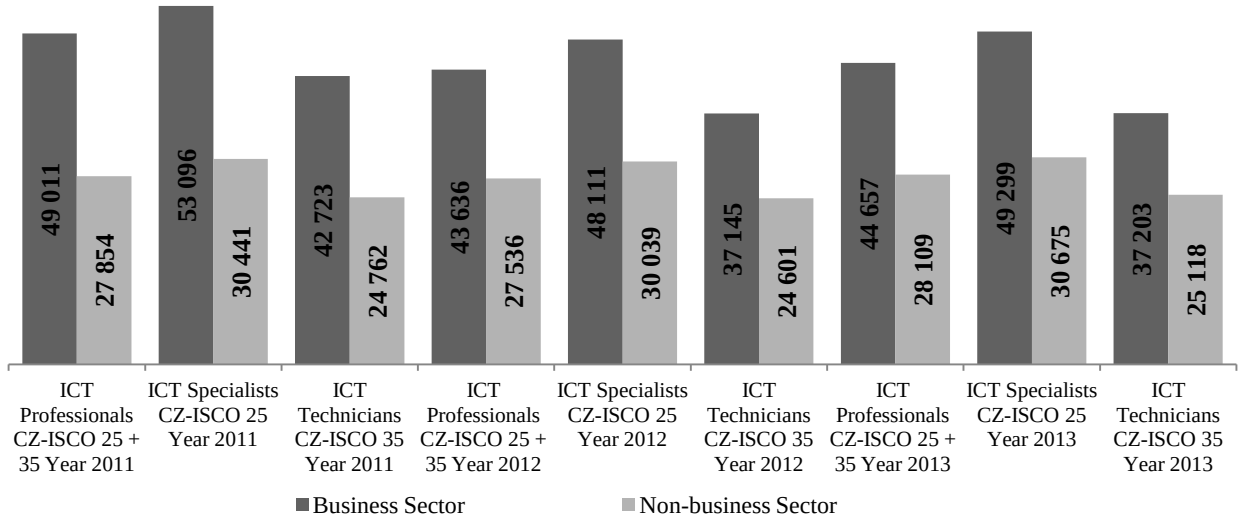

Figure 9: Wages of ICT Professionals by Sector Employment, 2011-2013, Source: (figure authors, data CZSO 2014)

The figure clearly shows that the business sector pays much higher wages than the non-business sector. While the average wage in the non-business sector during the analyzed time period remained practically the same (a slight drop by 300 CZK month in 2012 and an increase by 600 CZK a month in 2013), the average wage in the business sector shows a drop by 6,300 CZK a month in 2012 and an increase, even though only by 1,000 CZK a month, in 2013. This is mostly the result of the drop in the average wage of "ICT Specialists" – a 9.4% year-to-year drop during the years of 2011 and 2012 and a 2.5% year-to-year increase during the years of 2012 and 2013.

4.7. Comparison with the Inflation Rate

Now, let's look at the relationship between the wage of ICT professionals and the inflation rate during the years of 2003 – 2013. This relationship is depicted in Table 2.

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Average Annual Inflation Rate (in %)	0,1	2,8	1,9	2,5	2,8	6,3	1	1,5	1,9	3,3	1,4
A year-to-year increase in wages in the ICT sector (in %)	11,40	6,60	6,50	6,30	13,10	8,40	0,60	0,60	-6,70	3,50	1,30

Table 2: Average Inflation Rate and a Year-To-Year Increase in the Wages of ICT Professionals, Source: (CZSO, 2014)

By comparing both lines of Table 2, we can see the trend in the nominal and real wages of ICT professionals in the Czech Republic.

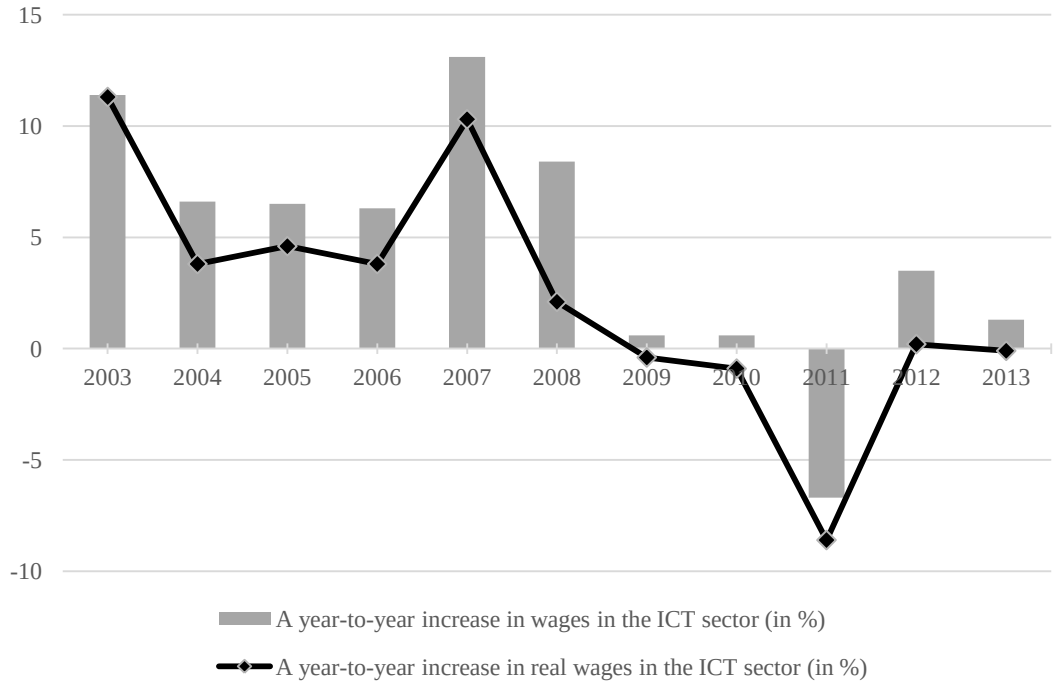

Figure 10: Average Nominal and Real Wages of ICT Professionals in 2003- 2013, Source: (figure authors, data CZSO, 2014)

Figure 10 shows that the real wage during the years of 2003 – 2008 kept going up by more than 5% from year to year. The effects of the economic crisis in 2008 put a halt to this trend, ending with a huge slump in 2011. Since then, the nominal wage has kept growing but has been counterbalanced by the inflation rate. This means that the real wage growth is about zero. However, ICT professionals can relax because the average real wage in the Czech Republic during 2012-2013 actually dropped.

5. Conclusions

The overall findings, although for a relatively short time period, are interesting. We can say that the overall trend in the number of ICT professionals in the Czech Republic was stable. In analyzing the trend in the wages of ICT professionals, we reached the following conclusions:

- The wages of ICT professionals went up during the analyzed time period, except for the year 2011 when the wages of ICT professionals dropped from year to year by 6.70%, due to the delayed impact of the economic crisis; their wages had not reached the level of 2010 by the year 2013;
- "ICT Specialists" earn the highest wages; their average monthly wage is higher by approximately 8,000 CZK than that of "ICT Technicians;"
- As expected, practitioners with tertiary education earn the highest wages. An interesting fact is that the wage gap between those with secondary education with a baccalaureate diploma and those with a bachelor's degree has become slightly bigger. There is a major wage gap between those with secondary education without a baccalaureate diploma and those with secondary education with a baccalaureate diploma and then between those with a bachelor's

degree and those with complete tertiary education. The wage gap between the groups has slightly diminished during the analyzed time period;

- When comparing wages by gender, we can conclude that the wage policy of ICT professionals copies the conventions of the Czech economy – the average wage of women is approximately 20% lower than that of men; the positive thing is that this situation is better than that in the entire Czech Republic where the average wage of women is lower than that of men by another 7%;
- The wages are considerably higher in the business sector than in the non-business sector; the average wage in the non-business sector during the analyzed time period remained practically the same; the average wage in the business-sector shows a drop by 6,300 CZK a month in 2012 and an increase, even though only by 1,000 CZK a month, in 2013;
- The trend in the nominal and real wages during the years of 2003 – 2013 shows that although the wage of ICT professionals were higher than the average wage in the Czech Republic (CZSO, 2015), the real wage growth practically stopped in 2011. During the years of 2012 and 2013, the growth of the wage of ICT professionals practically copied the inflation rate and thus the real wage growth was only minimal (Figure 8). It seems that the years when ITC professionals were making big money are coming to an end, but the real average wage in the Czech economy is dropping even faster (a 1.3% year-to-year decrease in 2012, a 0.3% year-to-year decrease in 2013).

6. Acknowledgement

Paper was processed with contribution of long term support of scientific work on Faculty of Informatics and Statistics, University of Economics, Prague. (IP400040)

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NEGATIVE IMPACT OF ICT ON THE ECONOMY AND SOCIETY

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Keywords

Information systems, ICT, Cyberspace, Information society,

Abstract

In the last ten years the continuous growth of internet penetration and the wider palette for spreading ICT tools have changed the availability and quantity of information, communications methods and the learning processes. ICT tools are already extensively used in education, everyday life, business etc. and we have reached the turning point when, after the era of PCs and laptops, e-learning based on internet connected tablet PCs is here.

Introduction of computers in all spheres of life substantially changed the ways of how people communicate and exchange information. It is creating a virtually paperless work environment. Also we can now send a message very easily to anywhere in the world in seconds. From education point of view we can have a virtual class where the instructor could sit in any part of the world and his students scattered in all different parts of the world through video conference with presentation of study materials as well as question and answer sessions... These simple examples show where we stand today compared to what it was half a century back. But as we know nothing in this world is purely good as everything has a dark side. In this paper we would discuss the influence of this dark side on economy and society.

1. Introduction and related works

Bawden & Robinson (2008) report that by the late 1950s and early 1960s, with an exponential expansion of publication, particularly in science and technology, and the increasing take-up of mechanised documentation and computerised information handling, information overload was generally accepted as a problem. The situation worsened, for those dealing primarily with academic and professional publications as information sources, due to the increase in volume of the primary literature throughout the 1970s and 1980s. Beginning in the 1970s, this trend has been exacerbated

by the rise of the Internet, and more specifically the World Wide Web, in the 1990s, and latterly by the advent of the social networking tools of Web 2.0. These technical advances have led to a much more rich and complex information environment, with a greater amount of information available, in a greater variety of formats and types of information resource, and accessible through a greater variety of media and communication channels. This diversity of provision, however, is typically delivered through a limited number of interfaces: most usually a web browser, whether on a computer screen, a mobile device, an e-book reader or some other device. The result is a 'homogenisation' of the information, with the look and feel of different resources of the print age—a text book, a newspaper, a hand-written diary entry, a photocopy of a journal article, a printout of a data file, etc.—being largely lost. It is this 'homogenised diversity' of information communication which lies at the root of the problems discussed here, a much as the expanded volumes of information which are available.

Doucek et al. (2014) aims at exploring the macro-economic impact of ICT (information and communications technology - or technologies) in a comprehensive way, overcoming the supply-side and infrastructural perspective of most of the existing empirical literature and present increasing importance of ICT sector in the whole economy by means of the development of selected macroeconomics indicators.

Satti S., & Nour O. M. (2002) argued that ICT could impose some negative impacts for the developing countries, particularly, because the developed countries will have more advantages to raise their competitiveness in the global world at the expense of the developing countries, mainly because ICT will provide more comparative advantageous for the developed countries by facilitating the attack and open some new markets in the developing countries. So, not only will it be hard for the developing countries to compete with the developed countries in the international market, but it will also threaten / deprive the developing countries in their original local markets. Additionally, it might delay the catching up of the developing countries to the developed countries. Hence, it could raise the already existing differentials and widen the already existing gap between the developed and the developing countries. Moreover, ICT also might create some negative impacts on the status of the poor by raising the already existing inequalities in income distribution and increasing the poverty of the poor.

Pros and Cons of using new social networks are detailed discussed for example by Pavlicek, (2014)

1.1. Information and Communication Technology

Tech Target (2015) introduced that ICT is an umbrella term that includes any communication device or application, encompassing: radio, television, cellular phones, computer and network hardware and software, satellite systems and so on, as well as the various services and applications associated with them, such as videoconferencing and distance learning. ICTs are often spoken of in a particular context, such as ICTs in education, health care, or libraries.

ICT has become the backbone of our economic growth and is a critical resource which all economic sectors rely on. It now underpins the complex systems which keep our economies running in key sectors such as finance, health, energy and transport; while many business models are built on the uninterrupted availability of the Internet and the smooth functioning of information systems.

Adewunmi (2012) pointed out that as it is known from time immemorial that everything in life is like the two side of a coin, there is always a positive and negative side of every phenomenon. But whether the effect is positive or negative the effects of Information Communication Technology is far reaching and cannot be overemphasized. The Effects of ICT lens looks at how our lives have

been changed, for better and for worse, by the impact of ICT. It includes both positive effects and negative effects and looks at how individual's organisations and society are affected

According to the European Commission, the importance of ICTs lies less in the technology itself than in its ability to create greater access to information and communication in underserved populations. Many countries around the world have established organizations for the promotion of ICTs, because it is feared that unless less technologically advanced areas have a chance to catch up, the increasing technological advances in developed nations will only serve to exacerbate the already-existing economic gap between technological "have" and "have not" areas. Internationally, the United Nations actively promotes ICTs for Development (ICT4D) as a means of bridging the digital divide, as is mentioned in Tech Target (2015).

In our paper the positive impacts will be suppressed because this one are preferably identify by users.

The paper is organized as follows: on the background of the impact of ICT on the economy and society is focused to taking into account the negative impact on the economy and society, where are described problems with missing or overload of information. Next part is dedicated information society and cyberspace and last but not least is mentioned the negative impact of the ICT on society and economy. Finally is described conclusion and future work within this problem.

2. Information society

The fast diffusion of ICT is now evident and its influence on economic systems in both the developed and developing countries has increased during the last two decades. Both the rapid development in ICT and the recent trend of globalization and their influences on different economic systems have been an exciting and interesting recent research issue that received increasing interest amongst economists in both developed and developing countries. Satti S., & Nour O. M. (2002)

This area is also actively supported by European Union (EU) in terms of information society policy (IS). Banghemann (1994) wrote „Preparing Europeans for the advent of the information society is a priority task". Information society can be understood in different ways. Most often we meet with a socio-economic explanation, so it is a company that understands basic information as an economic good and generates profit by handling it. We could of course also monitor multiple additional aspects - such as free access to information and its disclosure or degree of electronic communication (Capek & Ritschelova, 2010).

The way to the information society is supported by the current technological revolution, which is based on the interconnection of information and communication technologies (Achimugu & Oluwagbemi et al., 2009). These processes result in a dramatic reduction in space and time constraints, and in an increase of the number of public accesses to information. Unlike previous waves of technological development networked information, communications and media technologies are characterized by a wide flatness and high-speed of penetration into all areas of society. Development of information technology with its consequences begins to interfere in many fields of human activity... Information technology is and always will be a tool that people can use to more effectively carry out what they consider necessary or appropriate to carry out. (Siddiqi Z & Buliung R., 2013)

From Figure 1 it is visible, that the complexity and diversity of ICT impacts are important reasons for the interest in the ICT 'phenomenon'. However, these characteristics also help to explain why measurement of ICT impacts is not a simple undertaking. Another major reason that ICT impacts are difficult to measure is that any impact of one factor on another is difficult to demonstrate

because a positive correlation cannot readily be attributed to a cause-and-effect relationship.(OECD, 2007),

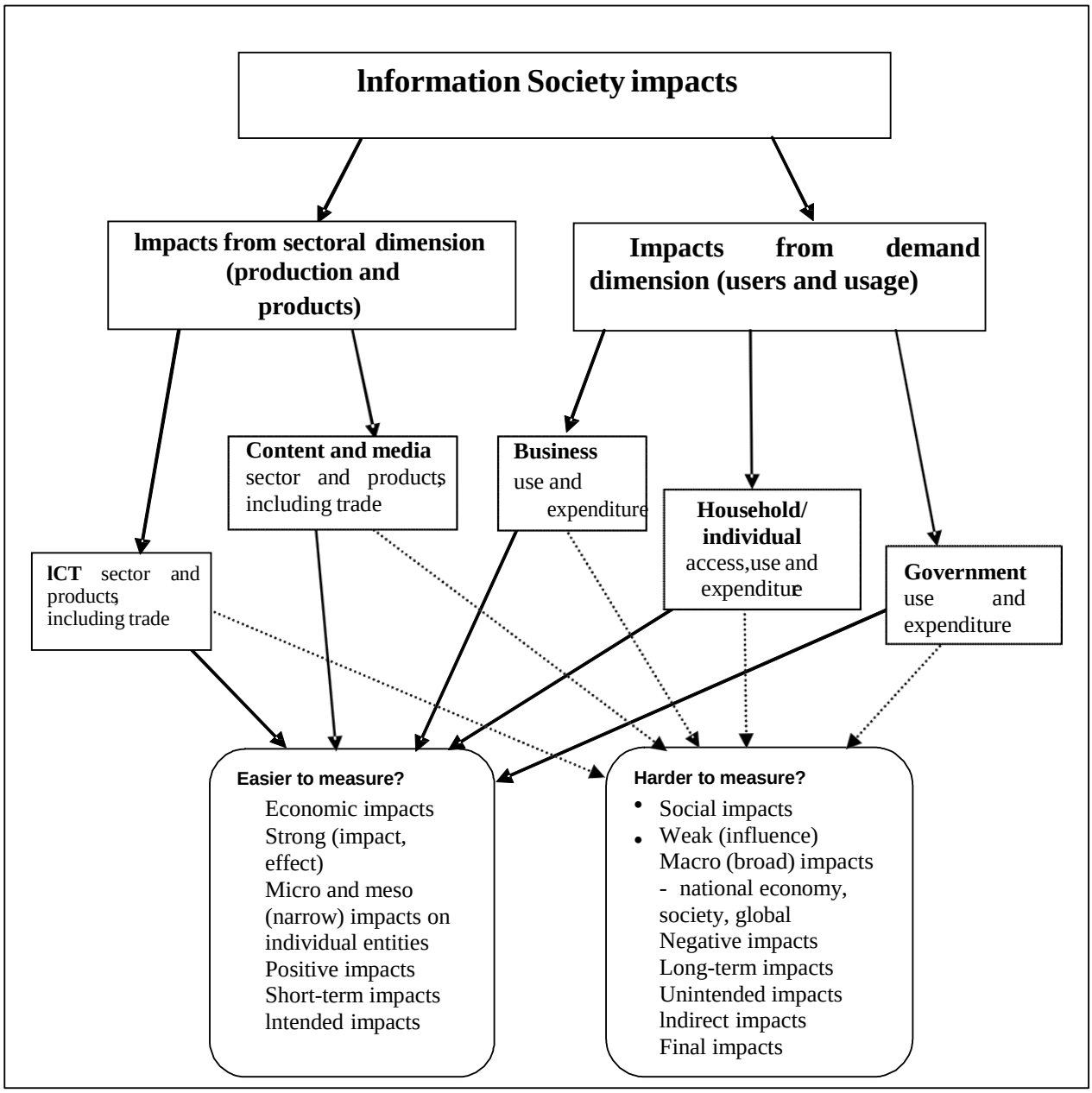

Figure1 Information society impacts measurement model (source: OECD, 2007).

It is better think instead of impact ubiquitous ICT on economy and society how they are used to transform organization, processes and behaviours.

3. Cyberspace

Satti S., & Nour O. M, (2002**)** argued that over the last two decades, the Internet and more broadly cyberspace has had a tremendous impact on all parts of society. Our daily life, fundamental rights, social interactions and economies depend on information and communication technology working seamlessly. An open and free cyberspace has promoted political and social inclusion worldwide; it has broken down barriers between countries, communities and citizens, allowing interaction and

sharing of information and ideas across the globe; it has provided a forum for freedom of expression and exercise of fundamental rights, and empowered people in their quest for democratic and more just societies.

Unlike most computer terms, "cyberspace" does not have a standard, objective definition. (Cyberspace, 2014). Instead, it is used to describe the virtual world of computers. For example, an object in cyberspace refers to a block of data floating around a computer system or network. With the advent of the Internet, cyberspace now extends to the global network of computers. So, after sending an e-mail to your friend, you could say you sent the message to her through cyberspace. However, use this term sparingly, as it is a popular newbie term and is well overused. The word "cyberspace" is credited to William Gibson, who used it in his book, Neuromancer, written in 1984. Gibson (1989) defines cyberspace as "a consensual hallucination experienced daily by billions of legitimate operators, in every nation, by children being taught mathematical concepts. A graphical representation of data abstracted from the banks of every computer in the human system, unthinkable complexity, lines of light ranged in the non-space of the mind, clusters and constellations of data".

In the process of information system creation, one should take into account that the information is produced (processed) in one physical site, stored in the same or in another site and communicated through the physical means to the site of utilization. All the three entities (production, communication and utilization) exploit instrumental items as facilities that are hosting pertinent devices, hardware, software, operation systems, applications, files, physical means of communication (internal and external networks). All these are linked to such human factors as operational management policy, training, working activities and the end purpose of the delivered information. The delivering systems provide information to the end users who exploit it for their specific purposes. Information and all the instrumental items, which are the components of the delivering system, need specifically dedicated interdepartmental protection in order to reduce the possibility of information breaches. (Abbo, 2012).

The search engines on the internet provide access to many sites on a given topic. For many negative phenomena that are the concomitants of cyberspace can include, for example (Notes to Presentation**,** 2014): **Flaming:** Online fights using electronic messages with angry and vulgar language; **Harassment:** Repeatedly sending nasty, mean, and insulting messages; **Denigration:** “Dissing” someone online. Sending or posting gossip or rumours about a person to damage his or her reputation or friendships; **Impersonation:** Pretending to be someone else and sending or posting material to get that person in trouble or danger or to damage that person’s reputation or friendships; **Outing:** Sharing someone’s secrets or embarrassing information or images online; **Trickery:** Tricking someone into revealing secrets or embarrassing information, then sharing it online; **Exclusion:** Intentionally and cruelly excluding someone from an online group; **Cyberstalking:** Repeated, intense harassment and denigration that includes threats or creates significant fear.

According (Cyber Threat News, 2014) Main attack tools include denial of service attacks and attacks on a scale ranging from amateur to medium level, primarily because the capabilities and means of terrorist organizations in cyberspace are limited. So far terrorists have not demonstrated the level of intelligence-gathering preparation and cyber penetration capabilities as those shown by nation states.

4. Negative ICT impact on society and people

With the development of computer industry and Internet networks during the last three decades things have changed and global communication has reached an unprecedented height. Probably the largest effect that ICT use has on society is allowing members of society to have greatly increased access to information. This can have numerous negative effects, such as: causing a digital divide between those who can access information and those who cannot, reducing levels of education and understanding due to the vast amount of incorrect and misleading information that is available causing moral and ethical problems. Sagarmay D., (2014) argued that this is a good way to communicate. People use the web to send emails to people at other ends of the world. They do this because it is a cheap and easy and quick way to communicate Ciaran, (2010) introduced that this is a bad thing because you do not know who you are talking to and if you arrange to meet this person they might not be who you think they are and this is a big danger and can hurt people a lot.

Adewunmi (2012) find job loss as probably one of the largest negative effects of ICT can be the loss of a person's job. This has both economic consequences, loss of income, and social consequences, loss of status and self-esteem. Job losses may occur for several reasons, including: manual operations being replaced by automation. e.g. robots replacing people on an assembly line.

The other two negative ICT impacts on society are reducing personal interaction and reducing physical activity. This explaining by being able to work from home is usually regarded as being a positive effect of using ICT, but there can be negative aspects as well. Most people need some form of social interaction in their daily lives and if they do not get the chance to meet and talk with other people they may feel isolated and unhappy. A third negative effect of ICT is that users may adopt a more sedentary lifestyle. For example (Čapek & Hola, 2010).

5. Negative ICT impact on economy

For the past 10 years ICT provides general standards in information and communications infrastructure companies to ensure communications support to the whole operation. ICT resources are seen as instruments that can be used very effectively but at the same time become fatal factors in their failure threaten the functionality of all (Holá & Čapek, 2014) and without management competencies investments in technology to become counterproductive, evaluations of the technology must be more sober as well as evaluate managers (Ruck & Welch, 2011).

The effects of ICT lens looks at how our lives have been changed, for better and for worse, by the impact of ICT. It includes both positive effects and negative effects and looks at how individual organisations and society are affected. As the negative impact of ICT on the economy, we can consider its heavy reliance on ICT, most companies are not only managed with the help of ICT but also their technological processes are depended on ICT., With the development of information society is also increasing reliance governance on ICT, increasing importance of cyber-security.

Yet ICT technologies also show an important element of organisational communication and its effectiveness will certainly have an impact on business. The Internet and emails become the standards of communication, accelerate communication, on the other hand, electronic communication brings many misunderstandings between communicators and may even worsen relations in the workplace which can decrease an engagement of workers and disrupt the functioning of the company (Holá, 2011).

6. Conclusion

In this paper we studied the impacts of information and communication technology in our lives so far. We also discussed the negative effects of ICT like loss of privacy, unauthorized access to important data. Hacking of government run systems by hackers can paralyse a government functioning and can cause immense disruptions. But we believe benefits from information technology far outweigh the negative aspects of information technology. As we discussed we can access information for our studies or research very quickly these days. Also the global communications have become unbelievably quick through email services. ICT in business include setup information and communication infrastructure in the organization for the needs of organisational communication - information systems, remote access, equipment and facilities, availability, reliability, safety, quality, etc. While the importance of ICT use for development cannot be underestimated, it should not be seen as a panacea that will solve problems of unemployment or social exclusion in the near future. A fundamental question about how ICT and the digital divide relate to the process of global development is not about technology or politics; it is about reconciling global and local practices. The challenge is to give culturally valid meaning to the use of new technologies.

ICT penetrate into all side of our life that is hardly to possible react to all positive or negative possibilities of this influencing.

Future research in the field of cyberspace and/or cybersecurity will be focused to suppress information chaos, suppress risk reduction of losses information, and suppress negative impact of ICT to society with aspect increase security of the cyberspace.

7. Acknowledgements

This paper was created with partly support of the Grant Agency of Ministry of Interior of the Czech Republic, grant No. VF20112015018.

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THE INTEGRITY OF INFORMATION SYSTEMS ON THE ENVIRONMENT IN THE CZECH REPUBLIC

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Keywords

Information systems, environmental integrity, users

Abstract

The paper deals with the development, current state, and the integrity of information systems on the environment in the Czech Republic. A brief overview of the development in this area uncovers major causes of current unsatisfactory situation in this area, and identifies major issues related to building of the Integrated Information System on the Environment in the Czech Republic. A major focus is primarily given to requirements put on information systems on the environment by public, which represents one of subjects these systems are intended for. The authors propose some possible methods to alleviate the current problems and streamline the integration of various information systems on environment into one comprehensive whole. The paper contributes to the investigation of the studied issue under specific national conditions, but at more general level also to understanding of informatics problems of public administration, primarily to the issue of systems integration.

1. Introduction

A level of information and knowledge required to support decision-making, as well as associated quality of information systems, is an important factor of economic growth (Mildeová & Brixí, 2011). According to Jandoš & Feuerlicht (2005), an increasing complexity and heterogeneity of applications, associated with the growing importance of system integration, represents a typical feature of current information systems.

Among important topics, both the Ministry of the Environment and all other users of information systems on the environment in the Czech Republic are currently engaged in, belongs *also* an integrity of these systems. The issue of environmental information systems has been extensively studied (Hřebíček & Kubásek, 2011). This paper aims to describe and analyze major features of the current form of the Integrated Information System on Environment (hereinafter IISE), to identify related major problems, and to propose possible solutions, especially from perspective of users from among public, or corporate sector.

According to experts (Přibilová, 1992) to define the term "environmental information" from a theoretical perspective represents fairly comprehensive problem. However, in everyday life an intuitive understanding and simple perception of this notion is a common practice. Environmental

information is collected, sought out, and utilized by different entities for various reasons. These are mainly: *(a)* e*nvironmental protection authorities* which need this information primarily as the basis for qualified and quality decision-making, but also to fulfill other tasks (education and training, scientific knowledge development, promotional purposes, etc.); *(b)* o*ther government authorities* and professional bodies (like territorial planning bodies, Statistical Office, and others), which also need this information to make the right decisions and to fulfill their respective other tasks; *(c)* b*usinesses* that need this information primarily to create development strategies, as well as for specific behavior and decision making in their place of activity; *(d)* p*ublic,* this group is very diverse and uses environmental information for a vast array of different purposes (students for study, civic associations for reasoning and achievement of their goals, individual citizens to learn about their surroundings, etc.). Into this group media can be included too, not only as an important user of information about the environment, but also as an entity that is involved in the distribution of this information, and provided interpretation of the information obtained may significantly affect the attitudes and behavior of all other subjects.

Requirements put on unified information system on the environment depends primarily on a user preferences, as each of them has different needs and expects from the system something else. These requirements focus on two major areas: which information the system should contain, and on user convenience (easy access, simple orientation, and others). An analysis of these requirements is a fundamental and challenging task, which would have to initially, in collaboration with all user groups, to gather their requirements on the content and method of access. Subsequent evaluation of the requirements of individual groups would then have to be confronted with the technical and technological capabilities, and discussed with IT professionals.

A requirement to unify the information system on the environment has been also declared by the EU, particularly European Environment Agency (Hřebíček, Jensen & Steenmans, 2015). Therefore countries facing similar problems (Prášek, Valta, Hřebíček, 2013; Soukopová, Hřebíček & Valta, 2015) seek the experience of the Czech Republic in this area, as the Czech Republic is to some level ahead in this effort.

In the Czech Republic there currently exist a large number of information systems on the environment or on its individual components or sub-topics. While these systems had emerged gradually from 70th, this number has increased significantly even more after the year 1989.

In a report of the Supreme Audit Office on the control of information and communication technologies in the Ministry of the Environment of the Czech Republic, including its specialized institutions which are the Czech Hydrometeorological Institute, and the Czech information Agency on Environment (CENIA), conducted in 2014 (for more see Bulletin of the Supreme Audit Office, 1/2015), is stated that the Ministry of the Environment currently uses 125 separate information systems and databases. Provision and operation of the Integrated Information System on the Environment is an obligation of the Ministry of the Environment defined by Act no. 4/1969 Coll., as amended, On the establishment of ministries and other central government bodies (so called Competence Act,), as one of the competencies from the very inception of this ministry on January 1, 1990. The Ministry therefore has been trying to build such a system since 1990, to integrate existing partial information systems, to interconnect and streamline their operations. Such unification would bring numerous benefits to all users (government, businesses, professionals, and the general public) – an access to the information collected would be improved and simplified, duplicate data collection would be eliminated, and many other benefits would emerge. However, until current days, this objective has not been met. While the entire set of existing information systems and databases relating to the environment is formally reported as an Integrated Information System on the Environment (IISE), in fact, it is still fragmented and incompatible, though

considerable resources were invested to ensure its integrity. It is therefore questionable to what extent the effort to integrate information systems on the environment is genuine, and particularly whether this is in fact necessary, or even possible. Therefore this paper deals also with possible alternatives to the current unsatisfactory integrity of existing information systems, and looks for options to achieve positive results in obtaining and providing information on the environment and its various components or any parts.

It should be noted that in addition to the public information on the environment, there is a large volume of information that is not and can't be in any public system, yet they are very important for the decision of the competent bodies. It is a confidential information of private actors (households, companies), regarding for instance costs of private environmental protection projects. According to Fiala, Šauer (2011), Šauer et al. (1998) models dealing with this kind of information can significantly contribute to, and enhance the overall level of information utilization efficiency.

2. Analysis of the current state and its results

Despite all the efforts the Ministry of Environment evolved since 1990 in building of IISE (Prášek, Valta & Hřebíček, 2013), (Soukopová, Hřebíček & Valta 2015), the current state is far from being considered satisfactory. The Ministry on its website declares that the system is just a formal label for a decentralized system of information systems and data applications, which have in common that all relate to the environment. The ministry speaks about the IIS architecture as a decentralized; individual information systems are operated as separate applications without direct integration into a common reference framework. The Ministry expects the historical development, the uniqueness of each individual agenda, and management of IT infrastructures by individual departmental organizations to represent major reason for this state.

Currently, the Ministry and its professional organization CENIA on their respective web pages provide an incomplete list of information systems, registers, and other databases they run; the websites offer an option to go on from this basic, incomplete list of information systems for more detailed information on featured systems – but not directly to them.

The available systems are incomparable in terms of size. Some referred to by the Ministry as "robust" are very extensive, contain large amount of information, and are divided into subsystems or modules. Other "systems" are rather just an Excel spreadsheet, than real information system; just a simple list, into which information is continuously added and modified according to the current state (for instance, An overview of the holders of eco-labels.)

Most of the data in these systems is gathered as a result of a legal obligation to provide it. This obligation has been placed on various mandatory subjects from corporate sector or local government and state administration. The basic structure of the required data has been set by a law, while more detailed requirements have been specified by the ministerial order or other subordinate legal norms. Part of the data for the previous year is transferred to the Ministry till March 30 of the current year. This happens through the Integrated Reporting Compliance System (ISPOP), which was launched in 2011, and allows reporting entities to pass through information on water, air and soil pollution, and on waste production and disposal. Other information flows into these information systems as a result of separately defined procedures (like data from Integrated Pollution Register), but also from internal resources of the Ministry and its specialized institutions. Concerning mandatorily reported data for the previous year, the Ministry has an additional term to process it (usually three months), and only then the information will appear in the relevant register.

The first conclusion from the analysis relates to the Integrated Information System on the Environment itself, which the Ministry of Environment is, according to the Competence Act, obliged to build and guarantee. This obligation of the Ministry was declared, together with its other competence, in the moment of its inception in 1990, and has never been satisfactorily carried out. It was a very ambitious idea, but the authors of this plan were not, as it looks like, able to assess whether it is possible to accomplish this task, and whether it is really necessary to have it. Most of those who work with environmental information do not need all information about environment, as they limit to single topics and components of environment.

The analysis also suggests that various subjects interested in the Integrated Information System on the Environment, complain on something else:

Supreme Audit Office, which responsibility is to control public funds spent for this purpose, especially bothers inefficient and ineffective spending of public funds invested into construction and operation of this system. In its supervisory administration report mentions such problems as: *(a)* multiple data storage in various information systems (higher operating costs associated with the need for storage capacity); *(b)* cancellation of SIRIUS project without any substitution; this project was designed to implement the IISE (wasted resources around 21 mil. CZK); *(c)* data incompatibility with selected factually related systems (there is need of additional resources to eliminate this problem); *(d)* inability to evaluate the effectiveness, efficiency and effectiveness of resources spent on information systems because the Ministry does not count approaches to the single information systems.

Entirely different problems with IISE and other information systems and databases face users from the general *public*. To provide public with access to environmental information is responsibility of the government, which arises from the international convention (Aarhus Convention.) In the Czech Republic, public access to environmental information is regulated, in relation to this Convention, by Act no. 123/1998 Coll., On the right to information on the environment.

This very diverse group of users has all sorts of reasons to look for such information. The Ministry is responsible to provide environmental information to applicants from the public, if someone asks for it, and if there isn't any legitimate reason to reject such request. It also has an obligation to be proactive and in an appropriate way provide this information within own initiatives (for instance via Statistical Yearbook on the Environment, press releases, educational literature, etc.)

For users from the public the most convenient and fastest way to obtain information about the environment is to find it themselves via internet. This requires: *(a)* it must be possible to identify which systems and databases exist, and what information is included - for most users, it is not necessary to cover the entire spectrum of information relating to the environment, but are only interested in a particular segment of it; *(b)* it must be clear if the searched system is publicly available, and if not, whether, for whom and under what conditions access can be provided; *(c)* if the system is open to the public, than this must be as simple and user-friendly as possible.

3. Conclusion

In the *first* place, it is worth considering the possibility to abandon the idea of the Integrated System of Environmental Information, and as the case may be to reformulate the relevant task in the Competence Act. Thus the Ministry could stop spending its resources on additional, not much successful attempts to reach fully integrated solution, and focus more on integrity of smaller groups of information systems (conservation, water, air, etc.).

The *second* proposal suggests a fundamental alteration of the method used to inform potential applicants for environmental information on the website of the Ministry or its specialized agencies. The existing method demonstrates (from user perspective) number of drawbacks and difficulties. Individual information systems and databases are located at respective websites at various locations under various sections names, so the search takes some time, especially if the user looks for that kind of information for the first time or just sometimes over long period. It is questionable whether behind that is an intention to discourage lay users, or whether it is some form of professional blindness, when the creators of the chosen configuration even do not realize which complications for those interested in finding information it causes. This process could be significantly facilitated, if those interested to find information could find necessary guidelines to search it. This might work for instance in the following manner: *(a)* as the very first, the Ministry would list all sub-environmental themes, on which collects some information (conservation, water, air, soil, waste, geology and mining, EIA, environmentally friendly products, EMAS, or other). Depending on area from which the searched information is, users should be able to open a sub-list of all information systems and similar forms of information databases that the Ministry and its specialized units operate on the subject; *(b)* in the next step each item on the relevant list could be open, and the user would get brief information on the content, and whether it is publicly accessible; *(c)* in the last step it would be possible to get directly into the relevant selected system(s) and retrieve data.

To develop the proposed arrangement cannot be a serious problem for any relevant expert working at the Ministry. Similarly, technical and technological problems associated with concentrating systems under a single gateway cannot be insurmountable. Proposals for such an arrangement appeared already in the 90s (Hřebíček & Pitner, 1998).The proposed arrangement would enable to integrate basic information about existing systems and their accessibility or inaccessibility, to facilitate the work with it, and make it friendly for a wider range of potential users. It would make clear what information is actually available for public – and which not. In later case it would be interesting to investigate the reasons for this inaccessibility, and/or to discover who actually works with this information, if anybody at all, and whether it would be possible to make at least some segments of it accessible.

Apart that, it would also be possible to respond to one of the findings of the Supreme Audit Office, that the Ministry does not count amount of accesses, and therefore cannot evaluate the effectiveness of the operation of these systems. In the proposed architecture, such monitoring would be easier and the results seem to make possible to suggest possible changes.

For future research in this area might be interesting to consider, and allow one to be inspired by approaches, typical for systems integration at company level. As some authors states (Nedomová et al., 2014) these approaches can be considered as progressive ones in relation to the enterprise architect role. Currently works are going on to develop available information into more detailed schemes that would complement basic overview of stages, steps, and progress reached in building of a unified interconnected system of environmental information, and thus would allow deeper analysis of the issue in hand, which the Ministry of Environment tries to solve since 1990. However, that goes beyond the scope of current works in this area.

4. Acknowledgement

The research project was conducted within VŠE IGA 2/21/2014 “Analýza systému nakládání s textilním odpadem v České republice" [Analysis of the management of textile waste in the Czech Republic].

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AN EVALUATION OF PRODUCTION EFFICIENCY OF ICT SECTORS IN THE EU: A STOCHASTIC FRONTIER APPROACH TO MALMQUIST PRODUCTIVITY INDEX

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Keywords

ICT sectors, technical efficiency, technological progress, stochastic frontier, translog production function, Malmquist productivity index

Abstract

The aim of this paper is to assess the efficiency of ICT sectors (manufacturing, trade, service) in nine EU countries and time period 2001-2011. A translog stochastic production frontier with time-varying efficiencies is estimated. The capital positively influence value added in ICT manufacturing and ICT trade sector while labor has statistically significant impact on value added only in ICT trade sector. It seems that in EU ICT sectors there isn't a substitute relation between the capital and labor. The performance was evaluated based on Malmquist productivity index. ICT service sector was the only sector, where the productivity grew in the whole period, but the trend of MPI was declining. MPI's of ICT manufacturing and ICT trade sector were lower or equal to 1, productivity of these sectors is stagnating and declining. From the comparison of the efficiency of selected EU countries it is evident, that the countries with most efficient ICT sectors are Slovenia, Finland and Germany. These countries were ranked on the top three places in the comparison of Malmquist productivity indexes.

1. Introduction

Intensive development of information and communication technologies (ICT) cause interest of analyses of impacts of ICT on competitiveness of economies, i.e. economic growth, employment, labor productivity and other key economic indicators. Impact of ICT on economic growth and labor productivity has been confirmed in many studies. According to the OECD (2004) or Quiang (2003) three main channels can be identified through which ICT can affect potential growth rates:

1. an acceleration of productivity in the ICT sector themselves, and a growing size of ICT sectors in the economy,
2. capital deepening across the economy, driven by rapid investment in ICT equipment, and resulting in a boost to labor productivity,
3. total factor productivity growth through reorganization and ICT usage.

The first important economic impact of ICT is linked to having a sector producing ICT goods and services (OECD, 2004). Having such a sector can be important for growth, since ICT-production has been characterized by rapid technological progress and very strong demand. The sector has

therefore grown very fast, making a large contribution to economic growth, employment and exports. Moreover, having a strong ICT sector may help firms that wish to use the technology, since the close proximity of producing firms might have ad-vantages when developing ICT applications for specific purposes. Having an ICT-producing sector can thus support growth, although previous OECD work has shown that it is not a prerequisite to benefit from the technology.

2. Malmquist productivity index

When the development of the efficiency in time is evaluated, it is necessary to take into account changes in production technologies. For assessment of the efficiency it will be beneficial to divide efficiency into efficiency caused by new technology in the whole industry and efficiency caused by "individual" successes in increasing organizational efficiency. A suitable tool for dividing total efficiency into technological and technical changes is Malmquist productivity index.

A production unit transforms inputs x^t into outputs y^t. Distance function $D^t(x^t, y^t)$ characterizes technology at time *t*. Based on the distance function, Coelli, et al. (2005) defines Malmquist productivity index (MPI) as:

$$MPI_t\left(x^{t-1}, y^{t-1}, x,^t\ y^t\right) = \sqrt{\frac{D^{t-1}\left(x^t, y^t\right)}{D^{t-1}\left(x^{t-1}, y^{t-1}\right)} \cdot \frac{D^t\left(x^t, y^t\right)}{D^t\left(x^{t-1}, y^{t-1}\right)}}. \quad (1)$$

The **change of technical efficiency** can be defined as:

$$TEC_t = \frac{D^t\left(x^t, y^t\right)}{D^{t-1}\left(x^{t-1} y^{t-1}\right)}. \quad (2)$$

The ratio D^t to D^{t-1} represents the change in the relative distances from the observed output to the potential maximum output at time *t-1* and *t*.

Technological change has the following form:

$$TCH_t = \sqrt{\frac{D^{t-1}\left(x^t, y^t\right)}{D^t\left(x^t, y^t\right)} \cdot \frac{D^{t-1}\left(x^{t-1}, y^{t-1}\right)}{D^t\left(x^{t-1}, y^{t-1}\right)}}. \quad (3)$$

The technological change is calculated as the geometric mean of the shift in the production frontier from time *t-1* to *t*. The first component inside the square root is the shift in the production frontier evaluated at x^t and y^t relative to the maximum outputs specified by the production technology available at time *t-1* and *t*, respectively. Similarly, the second component is the shift in the production frontier evaluated at x^{t-1} and y^{t-1} relative to the maximum outputs specified by the production technology available at time *t-1* and *t*, respectively.

Finally, Malmquist index is computed as $MPI_t = TEC_t \cdot TCH_t$. Productivity indexes MPI_t, TEC_t and TCH_t are calculated as index with a threshold value of 1. If a certain index value is equal to 1, then it indicates that the performance of a sector remains unchanged with regard to that measure from period *t*-1 to *t*. On the other hand, an index value greater than 1 represents improvement and a value less than 1 indicates a decline.

3. Stochastic production frontier

For measuring the technical efficiency of ICT sectors the **stochastic production frontier (SPF)** approach within a translog functional form was used (Batesse and Coelli, 1992). The stochastic production frontier is parametric approach based on the production theory, which utilizes the technique of econometric estimation. There are several strengths of SPF, e.g it is possible to account for measurement errors and random noise, SPF can be used for hypothesis testing and in comparison with data envelopment analysis (DEA) there is no need to assume constant or variable returns to scale. However, this approach has also its conditions: it is necessary to specify a distributional form of the inefficiency term and a functional form of the production function. In comparison with DEA, it is more difficult to accommodate multiple outputs.

A **translog stochastic production frontier** was estimated using maximum-likelihood method and has the following form (Coelli et al, 2005):

$$\begin{aligned} \ln VA_{it} &= \beta_i + \beta_1 \ln C_{it} + \beta_2 \ln L_{it} + \frac{1}{2}\beta_3 (\ln C_{it})^2 + + \frac{1}{2}\beta_4 (\ln L_{it})^2 + \\ &+ \beta_5 (\ln C_{it} \ln L_{it}) + \beta_6 t + \frac{1}{2}\beta_7 t^2 + \beta_8 (\ln C_{it} t) + \beta_9 (\ln L_{it} t) + \varepsilon_{it} - u_{it}, \end{aligned} \tag{4}$$

where VA_{it} is the value added of the country i in the year t; C_{it} denotes the capital of the i-th country in the t-th year; L_{it} is the labor of the country i in the year t; ε_{it} are random errors which are assumed to be independent and identically distributed with $N(0, \sigma_\varepsilon^2)$ distribution and u_{it} are non-negative technical inefficiencies to be $\left|N(\mu_{it}, \sigma_u^2)\right|$.

The technical efficiency of country i and year t can be obtained by taking:

$$TE_{it} = e^{-U_{it}}. \tag{5}$$

The parameters in the stochastic production frontier model (4) as well as the total error variance and its two components $\sigma^2 = \sigma_v^2 + \sigma_u^2$ and the parameter $\gamma = \sigma_u^2 / \sigma^2$ are estimated using maximum likelihood method.

The Malmquist productivity index as well its components was computed according to Hančlová (2014). The first component of the Malmquist productivity index, technical efficiency change TEC_{it}, can be obtained as follows:

$$TEC_{it} = TE_{it} / TE_{it-1}. \tag{6}$$

For technological change (i.e. the change of technical progress), $TCHC_{it}$ between years (*t-1)* and *t* for the *i*-th country needs to be calculated directly from the estimated parameters β. We first evaluate the partial derivatives of the production function with respect to time using the data for the *i*-th country between year (*t-1)* and *t* using (8). Then we calculate technical change $TCHC_{it}$ as the geometric mean of these two partial derivatives (7). For our translog functional specification, this is equivalent to the exponential of arithmetic mean of the log derivatives, computed as follows:

$$TCHC_{it} = \exp\left\{\frac{1}{2}\left[\frac{\partial \ln Y_{it}}{\partial(t)} + \frac{\partial \ln Y_{it-1}}{\partial(t-1)}\right]\right\}, \tag{7}$$

where

$$\frac{\partial \ln Y_{it}}{\partial t} = \beta_T + \beta_{TT \cdot t} + \beta_{KT} \ln K_{it} + \beta_{LT} \ln L_{it}. \quad (8)$$

Malmquist productivity index is computed as

$$MPI_t = TEC_{it} \cdot TCHC_{it}. \quad (9)$$

The statistical program *R* and its library *frontier* (Coelli and Henningsen, 2013) was used to obtain the parameters in the stochastic production frontier (4).

4. Data, variables and ICT sectors definition

This study is based on the data from the *STAN (Structural Analysis) Database* (OECD, 2015), which is very useful for analysts and researchers, because it provides with a comprehensive tool for analyzing industrial performance at a relatively detailed level of activity across countries. The industries in the *STAN Database* are based on the *International Standard Industry Classification (ISIC 4)*. The data are available for three types of ICT sectors in selected countries of the EU over the period 2000 to 2011.

As recommended by Fischer, et al. (2013), value added (VA_{it}) at current prices in millions of euro is the output of production function. There are two inputs - capital and labor. The capital data (C_{it}) are represented by gross fixed capital formation in millions of euro. The value added as well as capital input was divided by its deflators in order to have data in constant prices. Labor (L_{it}) is defined as the total hours worked by persons engaged.

Data for this study were available for the following countries of EU: Austria (AUT), Czech Republic (CZE), Denmark (DNK), Finland (FIN), Germany (DEU), Italy (ITA), Norway (NOR), Slovenia (SVN) and Sweden (SWE).

The aim of this study is to analyze the technical efficiency in three types of ICT sectors - ICT manufacturing, ICT trade and ICT service. Therefore it is necessary to define these ICT sectors. Classification of ICT sectors is available in Table 1 and is based on industries in *STAN Database*.

Type of ICT sector	**Code**	**EU KLEMS definition**
Manufacturing	D26	Computer, electronic and optical products
Trade	D46	Wholesale trade, except of motor vehicles and motorcycles
Service	D58	Publishing activities
	D61	Telecommunications
	D62T63	IT and other information services
	D95	Repair of computers and personal, household goods

Table 1 Three types of ICT sectors

5. Discussion of results

5.1. Estimation results for stochastic frontier

Table 2 shows estimates of three (one for each ICT sector) stochastic production functions (1) across a panel of 9 EU countries in period 2000-2011. The estimated coefficient of $\ln C$ is statistically significant in ICT manufacturing and ICT trade sectors, while coefficient of $\ln L$ is statistically significant only in ICT service sector. The terms of the cross products between capital and labor are not significant. Thus, we can declare that in these sectors there isn't a substitute relation between the capital and labor. The parameters of the square of capital and labor are not significant, so it seems that the Cobb–Douglas production function would be more appropriate. The parameter γ is statistically different from zero so the inefficiency effects are causes of the deviations from the production frontier.

ICT sector	Manufacturing	Trade	Service
Production function			
Intercept	-53.730^{o}	127.720^{o}	-36.913***
$\ln C$	10.307***	-2.890^{o}	0.011
$\ln L$	-3.967	-7.610	5.930**
$0.5 \ln C^2$	- 0.334**	-0.006	0.001
$0.5 \ln L^2$	0.402	0.016	-0.027*
$\ln C \cdot \ln L$	-0.159	0.022^{o}	-0.001
time	-0.138***	0.002***	0.035***
$time^2$	0.010	-0.006***	-0.004
$\ln C \cdot time$	-0.045*	0.002***	0.001***
$\ln L \cdot time$	0.063**	0.002***	-0.001***
σ^2	8.216	3.063***	2.611*
γ	0.988***	0.990***	0.990***
log likelihood	-43.638	88.910	126.117
Note: Significance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 'o' 0.1 ' ' 1			

Table 2 Estimation results of SPF

5.2. Malmquist productivity index and its components

At first results of the computation of technical efficiency change (*ZTE*), technology progress (*ZTCH*) and Malmquist productivity index (*MPI*) across countries during the period 2001-2011 are presented. Mean values across years are calculated as geometric means and annual mean values across regions are computed as arithmetic means.

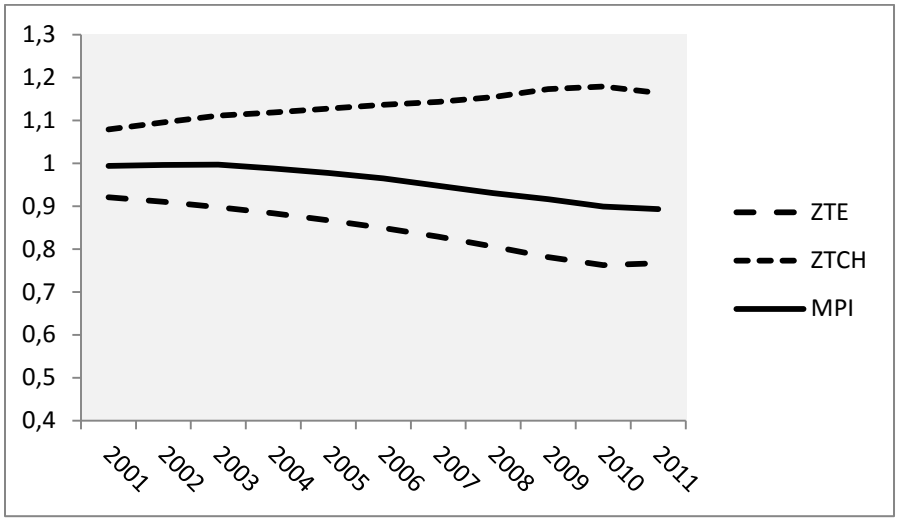

Figure 1 Average annual *MPI, TCHC* and *TEC* in ICT manufacturing sector

As it is clear from Figure 1 the trend of productivity change *MPI* in the ICT manufacturing sector and also technical change is decreasing in the whole time period. The *MPI* is declining despite the fact that technological change grew from 2001 to 2010. The impact of declining technical change on Malmquist productivity index was higher than impact of technological change.

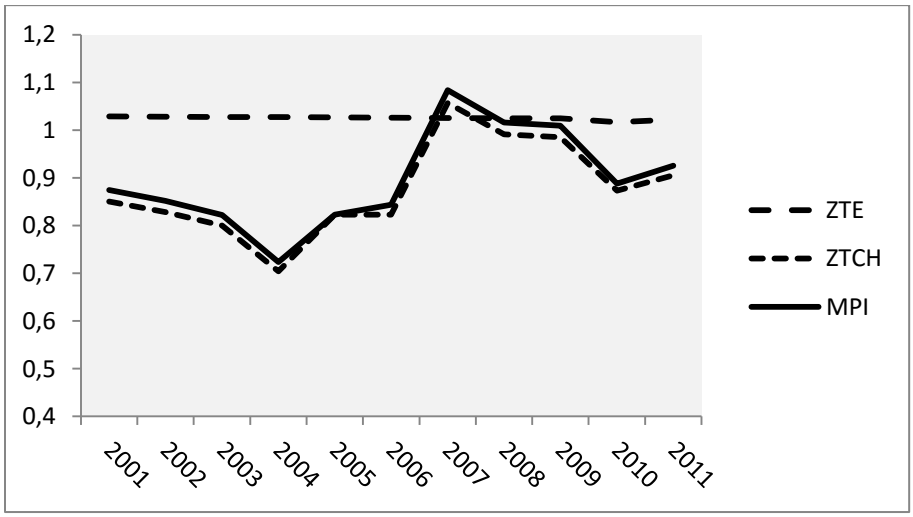

Figure 2 Average annual *MPI, TCHC* and *TEC* in ICT trade sector

Figure 2 shows development of productivity indexes for ICT trade sector. The impact of economic crisis is evident in the Malmquist index and also in technological change - from 2007 these indexes started to decline. This decline ended in 2010 and in 2011 values of *MPI* and *ZTCH* were again higher than in the previous year. Because technical change is stable with average growth equal to 2.5 %, the development of *MPI* is similar to the development of *ZTCH*.

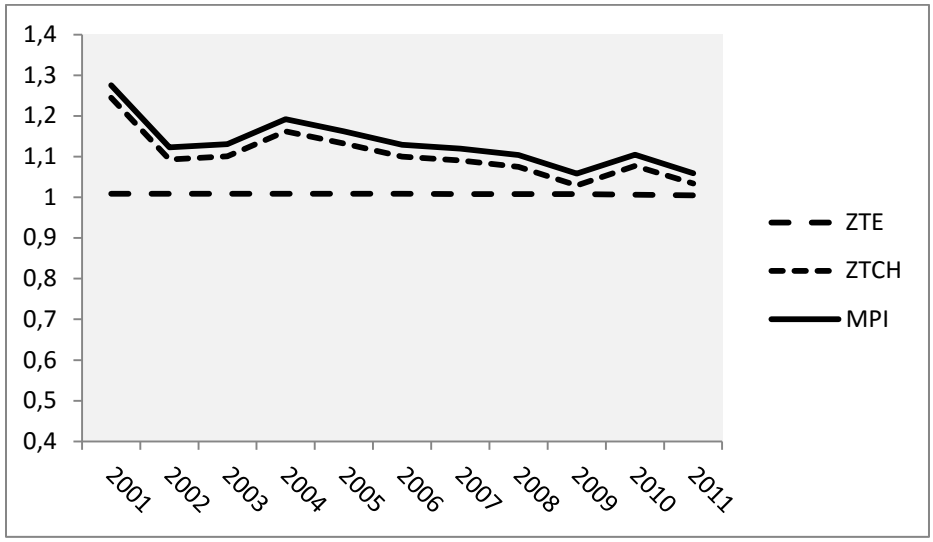

Figure 3 Average annual *MPI, TCHC* and *TEC* in ICT service sector

ICT service sector was the only sector, where all productivity indexes were higher than 1 for all years. Malmquist productivity index grew on average 13 % each year. Growth of technical and technological change was lower - technical change grew on average 0.8 % and technological change grew 10.2 % each year.

Table 3 presents average technical change, technological change and Malmquist productivity index across the time period 2001-2011 for 9 selected EU countries. For Germany and Italy data of Value Added weren't available, so productivity indexes for these countries are missing. For each ICT sector countries with 3 highest Malmquist productivity index are colored as grey. We can state that three countries with most efficient ICT sectors are Slovenia, Finland and Germany.

Index	***ZTE***	***ZTCH***	***MPI***	***ZTE***	***ZTCH***	***MPI***	***ZTE***	***ZTCH***	***MPI***
ICT Sector	***Manufacturing***			***Trade***			***Service***		
Austria	0,784	1,163	0,908	1,034	1,017	1,051	1,017	1,127	1,147
Czech Republic	0,925	1,052	0,972	1,001	0,875	0,875	1,000	1,049	1,049
Denmark	0,873	1,070	0,932	1,006	0,805	0,809	1,005	1,082	1,087
Finland	0,812	1,175	0,955	1,049	0,889	0,932	1,017	1,187	1,208
Germany	0,818	1,222	0,999	*NA*	*NA*	*NA*	1,003	1,276	1,280
Italy	0,743	1,210	0,896	*NA*	*NA*	*NA*	1,006	1,156	1,164
Norway	0,878	1,081	0,943	1,007	0,844	0,850	1,003	1,088	1,091
Slovenia	0,815	1,185	0,966	1,088	0,973	1,057	1,023	1,148	1,174
Sweden	0,989	1,073	1,061	1,002	0,864	0,865	1,001	1,081	1,081

Table 3 Average productivity indexes (2001-2011)

6. Conclusions

In this study the stochastic frontier analysis approach and Malmquist productivity index were used to assess the technical efficiency of ICT sectors (manufacturing, trade, service) in nine EU countries during the time period 2000 - 2011. A translog stochastic production frontier with time varying efficiency was estimated and further Malmquist productivity index was computed. According to results of estimation of SPF, capital positively influences value added in ICT manufacturing and ICT trade sectors while labor has statistically significant impact on value added only in ICT trade sector. The terms of the cross products between capital and labor are not significant - there isn't a substitute relation between the capital and labor in ICT sectors.

ICT service sector was the only sector, where all productivity indexes were higher than 1 for all years - productivity of this sector is each year higher than in the previous year, but the trend of the development of MPI was declining (from 1.27 in 2001 to 1.06 in 2011). Malmquist productivity index of ICT manufacturing and ICT trade sector was in the whole period lower than 1, except of year 2007 in ICT trade sector. From the comparison of the efficiency of selected EU countries is clear, that the countries with most efficient ICT sectors are Slovenia, Finland and Germany. These countries were ranked on the top three places in the comparison of Malmquist productivity indexes.

Acknowledgement

This research was supported by Student Grant Competition of Faculty of Economics, VŠB-Technical University of Ostrava within project (SP2015/117).

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COMPARISON OF PRODUCTION PERFORMANCE IN INFORMATION AND COMMUNICATION SECTORS IN THE EU SELECTED COUNTRIES

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Keywords

Information and communication sector, stochastic frontier, translog production function, Malmquist productivity index

Abstract

The paper deals with production performance evaluation and comparison among the EU selected countries in information and communication sectors in the period 2005 – 2012. We estimate a translog stochastic production frontier using Corrected Ordinary Least Squares (COLS) method in the total Information and communication sector (J) and also its two parts – Telecommunications (J61) and Computer programming, consultancy and information service activities (J62-63). We also compare the distribution of the Malmquist productivity index and its decomposition into technical and technological changes. The results confirmed that the translog production function is preferred over a Cobb-Douglas functional form with neutral technical progress. Estimated technical efficiency was the highest in the whole sector J and slightly lower is in subsector J61. Development of the Malmquist productivity index in the sector of Information and communication services exhibits a declining trend from 2006 to 2008, followed by a moderate rise till the year 2010 and another slight declining. Based on the decomposition of the Malmquist Index, we observed that technology efficiency change seems to have a rather small effect on the productivity growth.

1. Introduction

The selected EU countries include economies with a considerable disparity in economic output. As faster economic growth is achieved region's productivity is improved and we can identify channels which would help to increase it (Doucek et al., 2014). The majority of previous contributions provides studies estimating the total factor productivity through growth accounting Fischer et al. (2013) and neoclassical production modeling Arazmuradov et al. (2014), parametric stochastic frontier analysis Coelli et al. (2005) or non-parametric data envelopment analysis (Mandak & Nedomová, 2014). These approaches include some drawbacks. The studies assume that all production units operate on the efficient frontier and under constant returns to scale, but these assumptions are too restrictive.

This paper contributes investigation of the development of technical efficiency and also productivity changes in the whole sector of Information and communication in 24 selected EU countries over the year 2005-2012.

This paper is organized as follows. Section 1 reviews studies on productivity and a hypothesis is formulated here. Section 2 describes the concept of the Malmquist productivity index and its components. Section 3 presents the stochastic production frontier approach within a translog functional form. In section 4, a case study is conducted using panel data to investigate productivity change through technological progress and changes in technical efficiency. Final section concludes with comments on the overall contribution of the research and topics for future research.

2. Malmquist productivity index

A production unit uses input vector $\boldsymbol{x^t}$ to produce output vector $\boldsymbol{y^t}$, where t represents the time period. In production theory, we can define production process on an output set:

$$P^t\left(\boldsymbol{x^t}\right)=\left\{\boldsymbol{y^t}:\boldsymbol{x^t}\text{ can produce }\boldsymbol{y^t}\right\}. \tag{1}$$

The output set $P^t\left(\boldsymbol{x^t}\right)$ is assumed to be closed, bounded, and convex. We can define the output distance function $D^t\left(\boldsymbol{x^t},\boldsymbol{y^t}\right)$ on the output set $P^t\left(\boldsymbol{x^t}\right)$:

$$D^t\left(\boldsymbol{x^t},\boldsymbol{y^t}\right)=\min\left\{\theta:(\boldsymbol{y^t}/\theta)\in P^t(\boldsymbol{x^t})\right\}=\left[\max\left\{\rho:\left(\rho\boldsymbol{y^t}\right)\in P^t(\boldsymbol{x^t})\right\}\right]^{-1}. \tag{2}$$

Given an input $\boldsymbol{x^t}$, the output distance function $D^t\left(\boldsymbol{x^t},\boldsymbol{y^t}\right)$ includes a radial expansion of the output $\boldsymbol{y^t}$ that still resides within the boundary of the output set $P^t\left(\boldsymbol{x^t}\right)$. θ is the radial factor that adjusts the position of output $\boldsymbol{y^t}$ to $\left(\boldsymbol{y^t}/\theta\right)$ and $\theta\in(0,\infty)$ where $\theta=1$ represents staying at the current position, a value of $\theta\in(0,1)$ indicates an expansion, and value of $\theta\in(1,\infty)$ means a contraction. Since the goal is to expand, the range of interest is $\theta\in(0,1]$ where smaller θ indicates a longer distance to the frontier of output set. A greater θ denotes a shorter distance to the frontier, and $\theta=1$ defines that no expansion is possible as the output $\boldsymbol{y^t}$ is already on the frontier. The right part of (2) expresses the same concept with $\rho\in[1,\infty)$, and since it is the reciprocal, the valid range for the output distance function is still (0, 1]. The maximum of the output distance function $D^t\left(\boldsymbol{x^t},\boldsymbol{y^t}\right)$ is 1, denoting that the production unit is operating on the frontier and is perfectly efficient. When the value of output distance function is less than 1, the production unit is producing below the frontier and it is considered to be technically inefficient (TechIneff). Based on the output distance function, we can define the **Malmquist productivity index (MPI)** as:

$$MPI_t\left(\boldsymbol{x^{t-1}},\boldsymbol{y^{t-1}},\boldsymbol{x^t},\boldsymbol{y^t}\right)=\sqrt{\frac{D^{t-1}\left(\boldsymbol{x^t},\boldsymbol{y^t}\right)}{D^{t-1}\left(\boldsymbol{x^{t-1}},\boldsymbol{y^{t-1}}\right)}\cdot\frac{D^t\left(\boldsymbol{x^t},\boldsymbol{y^t}\right)}{D^t\left(\boldsymbol{x^{t-1}},\boldsymbol{y^{t-1}}\right)}}=\frac{D^t\left(\boldsymbol{x^t},\boldsymbol{y^t}\right)}{D^{t-1}\left(\boldsymbol{x^{t-1}},\boldsymbol{y^{t-1}}\right)}\cdot\sqrt{\frac{D^{t-1}\left(\boldsymbol{x^t},\boldsymbol{y^t}\right)}{D^t\left(\boldsymbol{x^t},\boldsymbol{y^t}\right)}\cdot\frac{D^{t-1}\left(\boldsymbol{x^{t-1}},\boldsymbol{y^{t-1}}\right)}{D^t\left(\boldsymbol{x^{t-1}},\boldsymbol{y^{t-1}}\right)}}. \tag{3}$$

In equation (3), in the second part, the leading ratio D^t to D^{t-1} outside the square root is equivalent to the **change of technical efficiency** (TEC_t) between periods *t-1* and *t*. This ratio represents the change in the relative distances from the observed output to the potential maximum output at time *t-1* and *t*. The second part inside the square root (3) represents **technological change** (TCH_t)**.** We note that the output distance function D^t represents the level of observed outputs relatively to

maximum outputs by using the production technology available at time *t*. Thus, technological change is calculated as the geometric mean of the shift in the production frontier form time *t-1* to *t*. The first component inside the square root is the shift in the production frontier evaluated at $\boldsymbol{x}^{t}$ and $\boldsymbol{y}^{t}$ relative to the maximum outputs specified by the production technology available at time *t-1* and *t*, respectively. Similarly, the second component is the shift in the production frontier evaluated at $\boldsymbol{x}^{t-1}$ and $\boldsymbol{y}^{t-1}$ relative to the maximum outputs specified by the production technology available at time *t-1* and *t*, respectively.

Malmquist index is defined as $MPI_t = TEC_t \cdot TCH_t$. Indicators MPI_t, TEC_t and TCH_t are calculated as an index with a threshold value of 1. If a certain index value is equal to 1, then it indicates that the performance of a country remains unchanged with regard to that measure from period *t-1* to *t*. On the other hand, an index value greater than 1 represents an improvement, and a value less than 1 indicates a decline.

3. Translog stochastic production frontier

Equation (2) suggests that the output distance function $D^t\left(\boldsymbol{x}^t, \boldsymbol{y}^t\right)$ corresponds to Farrell's **output-oriented efficiency.** This relationship enables us to compute the output distance function $D^t\left(\boldsymbol{x}^t, \boldsymbol{y}^t\right)$ using the methods of efficiency measurement like parametric stochastic production frontiers and non-parametric data envelopment analysis (DEA). In this study, we use the stochastic production frontier approach within a **translog functional form** to measure a technical efficiency of each region. Chou et al. (2012) introduce a comparison of stochastic production function and data envelopment analysis. There are a number of reasons for choosing **stochastic production frontier (SPF)** over DEA to calculate the Malmquist productivity index (*MPI*). First, given the aggregate nature of the data used for our analysis, we expect the data to involve measurement errors and random noise. Second, the data we analyze includes one output variable. Third, the coefficient estimates of parameters in the production frontier would be required for the computation of technical and technological change, before we can obtain *MPI.*

We use a translog stochastic production frontier as follows:

$$\ln Y_{it} = \beta_0 + \beta_C \ln C_{it} + \beta_L \ln L_{it} + \beta_T t + \tfrac{1}{2}\beta_{CC}\left(\ln C_{it}\right)^2 + \tfrac{1}{2}\beta_{LL}\left(\ln L_{it}\right)^2 + \tfrac{1}{2}\beta_{TT} t^2 + \\ + \beta_{CL}(\ln C_{it} \cdot \ln L_{it}) + \beta_{CT}(\ln C_{it} \cdot t) + \beta_{LT}(\ln L_{it} \cdot t) + \varepsilon_{it} - u_{it} \quad , \qquad (4)$$

where Y_{it} is the output of the region i in the year *t;* C_{it} denotes the capital of the *i*-th region in the *t*-th year; L_{it} is the labor of the region i in the year *t*; *t* is a time variable; β_i is a parameter to account for the *i*-th region's; ε_{it} are random errors and u_{it} are technical inefficiencies to be $\left|N\left(\mu_{it}, \sigma_u^2\right)\right|$. The translog function (4) has the time variable interact with input variables C_{it} and L_{it}, which allows for the non-neutral technical change. Technical progress is input *j* (*j* = variable C_{it} or L_{it}) – consumption (savings) if β_{jT} is positive (negative), and technical change is neutral if $\beta_{CT} = \beta_{LT} = 0$. If all β's are equal to zero ($\beta_{CC} = \beta_{LL} = \beta_{TT} = \beta_{CT} = \beta_{LT} = 0$), production function (4) is equivalent to the Cobb-Douglas function with neutral technical progress.

The technical efficiency score TE_{it} for each region *i* by each year *t* can be derived as:

$$TE_{it} = E\left[\exp(-u_{it}) \middle| \varepsilon_{it} = \varepsilon_{it} - u_{it}\right]. \quad (5)$$

The technical efficiency score TE_{it} falls between 0 and 1 with higher value indicating a higher technical efficiency. Technical efficiency change TEC_{it} can be obtained as follows:

$$TEC_{it} = TE_{it} / TE_{it-1}. \quad (6)$$

For the change of technology progress TCH_{it} between years (*t-1)* and *t* for the *i*-th region needs to be calculated directly from the estimated parameters β as follows:

$$TCH_{it} = \exp\left\{\frac{1}{2}\left[\frac{\partial \ln Y_{it}}{\partial(t)} + \frac{\partial \ln Y_{it-1}}{\partial(t-1)}\right]\right\}, \text{ where } \quad \frac{\delta \ln Y_{it}}{\delta t} = \beta_T + \beta_{TT} \cdot t + \beta_{KT} \ln K_{it} + \beta_{LT} \ln L_{it}. \quad (7)$$

Finally, we calculate $MPI_{it} = TEC_{it} \cdot TCH_{it}$.

4. Empirical results

4.1. Data analysis

We collected the data by selected EU countries over the period 2005 to 2012. The data were derived from the Eurostat Database (National Accounts aggregates by industry (up to NACE A*64) [nama_10_a64], 2015) following the NACE rev. 2 classification. Output Y_{it} is defined as the gross domestic product at current market prices in millions of EUR. Capital and labor are two inputs. The data on capital (K_{it}) are represented by consumption of fixed capital in current prices in millions of EUR. Labor (L_{it}) is defined as the compensation of employees (at current prices in million EUR). Data availability allowed us to include 24 selected countries introduced in table 1.

no.	**label**	**country**	**no.**	**label**	**country**	**no.**	**label**	**country**
1	BE	Belgium	9	CY	Cyprus	17	PT	Portugal
2	BG	Bulgaria	10	LV	Latvia	18	RO	Romania
3	CZ	Czech Republic	11	LT	Lithuania	19	SI	Slovenia
4	DK	Denmark	12	HU	Hungary	20	SK	Slovakia
5	DE	Germany	13	MT	Malta	21	FI	Finland
6	EE	Estonia	14	NL	Netherlands	22	SE	Sweden
7	EL	Greece	15	AT	Austria	23	IS	Iceland
8	IT	Italy	16	PL	Poland	24	NO	Norway

Table 1 The EU selected countries (Source – EUROSTAT database)

In order to compare development and changes in efficiency of whole the **Information and Communication Sector (J),** we also follow the classification in two selected subsectors: **the Telecommunications subsector (J61)** and the Computer programming, consultancy and information service activities (J62-63), which are presented in table 2.

J	Information and communication
J58-J60	Publishing, motion picture, video, television programme production; sound recording, programming and broadcasting activities
J61	Telecommunications
J62_J63	Computer programming, consultancy and information service activities

Table 2 Classification of subsectors in the Information and Communication sector J (Source – EUROSTAT database)

4.2. Estimation of translog production function

The estimation results of the translog stochastic production frontier as specified in (4) are reported in table 3. We use the corrected ordinary least squares (COLS) estimation using NLOGIT5 software. First, all regression parameters of translog production function (4) are estimated and then the appropriate variables, which were statistically insignificant at 10% level of significance, were excluded, as it is documented in the last three columns in table 3. We detect *statistically significant savings with respect to the technical progress in capital input* (β_{CT}) - especially in the whole sector J and the subsector J62-63, and *consumption with respect to the technical progress in labor input* (β_{LT}), which is the highest in the subsector J62_63 (0.074). Estimated production function (4) is not equivalent to the Cobb-Douglas function with neutral technical progress.

	Estimation of all parameters			Estimation of significant parameters		
Sector	**J**	**J61**	**J62_63**	**J**	**J61**	**J62_63**
constant	2.137***	2.341***	3.438***	2.125***	2.357***	3.240***
lnC	0.036	0.309	0.147	x	0.225***	x
lnL	1.037***	0.793***	0.760***	1.080***	0.893***	0.940***
t	-0.097***	-0.077*	-0.166***	-0.132***	-0.121***	-0.182***
lnC*lnC	0.456***	0.094***	0.177***	0.444***	0.096***	0.160***
lnL*lnL	0.216**	-0.029	0.060	0.199***	x	x
t*t	-0.008	-0.010	-0.005	x	x	x
lnC*lnL	-0.338***	-0.073*	-0.115**	-0.324***	-0.060***	-0.072***
lnC*t	-0.051***	-0.034*	-0.061***	-0.050***	-0.036*	-0.062***
lnL*t	0.061***	0.050***	0.074***	0.060***	0.053***	0.074***
R2 adj.	0.9878	0.9782	0.9739	0.9878	0.9782	0.9742

Table 3 Estimation of translog production function (statistically significant at 10% (*), 5% (**), 1% (***) level of significance)

Figure 1 plots kernel density of estimated *technical efficiencies* TE_{it} for selected (sub)sectors. The results also show the higher technical efficiencies for subsector J61 (Telecommunications) in average 0.590 with the higher standard deviation 0.135 comparing with the subsector J62-63 (Computer programming, consultancy and information service activities) (mean 0.262, std. dev. 0.093).

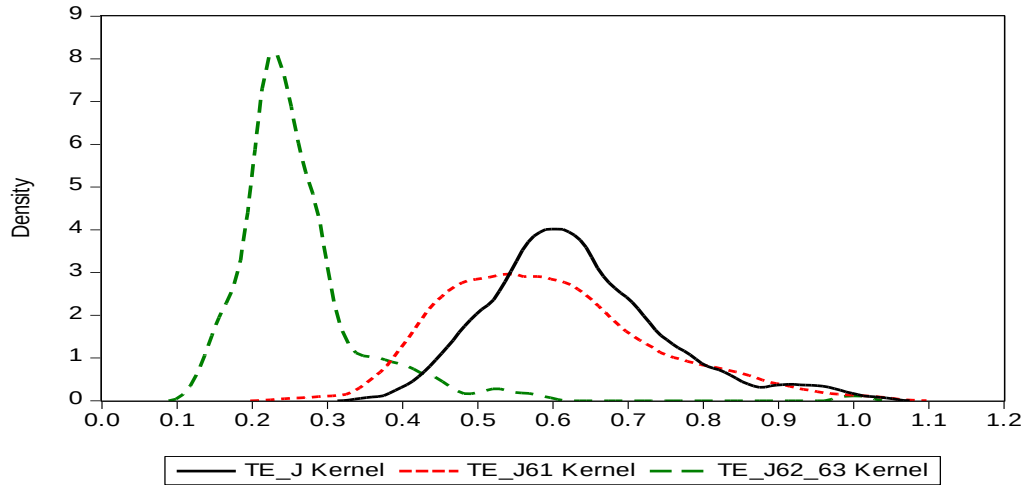

Figure 1 Kernel density of estimated technical efficiencies in selected sectors

4.3. Malmquist productivity index

Calculations of MPI_{it}, TEC_{it}, TCH_{it} follow the procedure described at the end of Section 3. Malmquist productivity index (MPI_{it}) is composed of two components (3) - technical efficiency change (TEC_{it}) and change of technology TCH_{it}. Figure 2 presents annual median of the MPI_t, TEC_t and TCH_t for the estimated model between the years 2006 and 2012 for whole sector J (top diagram) and subsectors J61 and J62-63 (bottom graphs).

The development of **productivity change** MPI_t **in whole sector J (**Information and communication) shows a declining trend from the level of 1.017 in 2006 to 0.974 in 2008, followed by a moderate rise to the value of 0.987 in 2010 and another slight declining to the 0.971 level in 2012. The cause of the *decreasing tendency of productivity growth* ($MPI_t < 1$) can be seen in similar developments in **technology efficiency change -** $median\,TCH\_J_t$ with respect to the economic and financial crises in 2008. On the other hand, index $median\,TEC\_J_t$ shows the stagnation in the range 0.975 – 0.980, which is also less than 1. It indicates **a steady decreasing technical efficiency** (TE_J) in the sector J during the period 2006 -2012 with the low variability. The development of median productivity changes in the subsector *J61 (Telecommunications*) follows the whole sector J. There is a slight difference in the development of technical changes (TEC_J61), which shows a decreasing trend from the level 1.027 in year 2006 into 0.982 until the year 2010. The development of technology changes (TCH_J61) was less than 1 throughout the investigated period. It is slightly increasing to year 2008 and then a moderate decline to a value of 0.973 followed in 2012. The biggest difference, however, indicates the subsector *J62-63 (Computer programming, consultancy and information service activities).* Figure 2 presents (bottom graph on the right) that the productivity changes (MPI_J62_63) follow the development of the technical changes in the sector J (MPI_J) up to the year 2009. They accelerate to the level 1.008 and 1.014 in 2010 and 2011, which demonstrates the improving productivity growth.

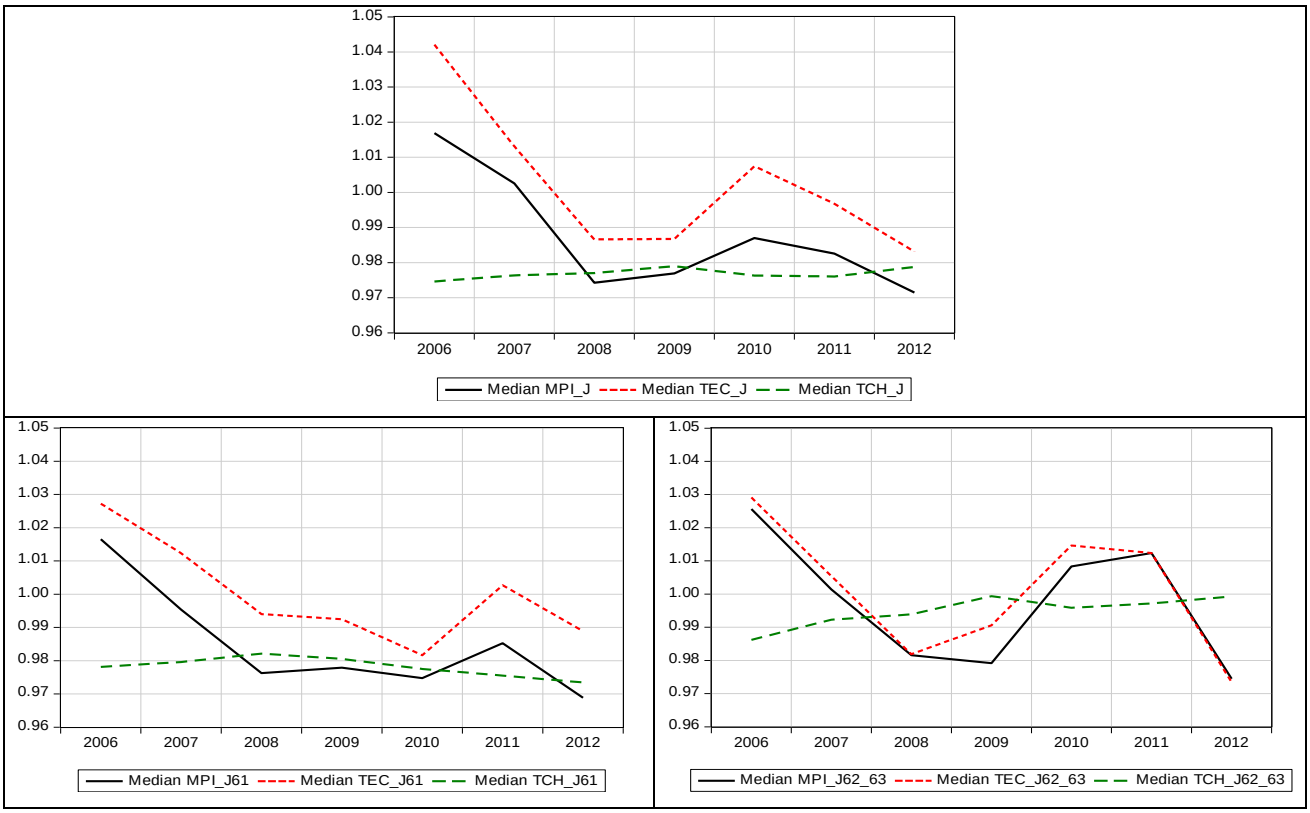

Figure 2 Annual median MPI_t, TEC_t, TCH_t and in period 2006-2012

The median productivity decrease was 1.68% in the period 2006 – 2012 mainly due to technological changes and a slight influence of technical efficiency change in the whole sector of Information and communication services.

5. Conclusions

This paper contributes to the literature for investigation of the development of technical efficiency and also productivity changes in the whole sector of Information and communication in 24 selected countries in the European Union over the years 2005-2012. The results are compared with the subsectors Telecommunications and also Computer programming, consultancy and information service activities. The estimate of the **stochastic translog production function** detected statistically significant savings with respecting a technical progress in the capital input and consumption with respect to technical progress in the labor input for whole the Information and communication sector and also 2 investigated subsectors. The results also showed that the translog production function is preferred over a Cobb-Douglas functional form with neutral technical progress. Estimated **technical efficiency** (TE) was found in the whole sector of Information and communication services (mean 0.631) and slightly lower is in the subsector of Telecommunications with mean 0.592. Significantly lower (roughly half) efficiency was discovered for the subsector of Computer programming, consultancy and information service activities (mean 0.262).

The development of **the Malmquist productivity index** in the sector of Information and communication services exhibits a declining trend from 2006 to 2008, followed by a moderate rise till 2010 and another slight declining after this year. The cause of the decreasing intensity of productivity growth can be seen in the economic and financial crises in 2008. Moreover, only for the years 2006 – 2007, the Malmquist productivity index was greater than 1, which means the

increasing tendency of productivity changes. Based on the **decomposition of the Malmquist Index**, we observed that technology efficiency change seems to have a rather small effect on the productivity growth. It was found out that the main reasons for changes in overall productivity are, in particular, technical changes, usually accompanied by stagnation or slight improvement in technology efficiency in the whole sector of Information and communication services and also in the subsector of Telecommunications. We also detected the best and slightly positive trend in technology changes in the subsector of Computer programming, consultancy and information service activities comparing to sector J and J61.

Further research will be devoted to comparison of parametric and non-parametric approach results and to analyses of differences original and new EU member countries. Another research question should be devoted to find new factors of regional economic productivity changes.

6. Acknowledgment

This paper was created with financial support of SGS project (SP2015/117) of Faculty of Economics, VŠB-Technical University of Ostrava and the Operational Programme Education for Competitiveness - Project CZ.1.07/2.3.00/20.0296. The support is greatly acknowledged.

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DIGITAL FORENSIC LABORATORY PROCESS MANAGEMENT USING ISO 27000 RECOMMENDATIONS

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Keywords

Standardization, ISO, business process, digital evidence analysis, process mapping, digital forensic laboratory, management

Abstract

The aim of this article is to describe the digital forensic laboratory processes and to propose a process framework (process map using BPMN diagrams) that can be used for managing and optimization of digital forensics laboratory operation. The digital investigation (analysis) process map focuses on activities performed by the forensic laboratory and the identification of the flow of the process and resources, thus making it different from other previously presented forensic maps (models). The model also includes business activities (accounting, customer communication) connected to the main business process of digital forensics laboratory - these activities are necessary for correct operation of digital forensics laboratory and cannot be excluded from the process as they also require resources and affect performance indicators of the process.

The aim of the proposed model is to allow optimization of laboratory resource usage for process of potential digital evidence analysis. We assume that similar approach is even applicable to other kinds of forensic laboratories; however, we must emphasize that digital forensic laboratory has its own specifics. The development of the process map employed best practice for digital forensics introduced by ISO/IEC 27043, ISO/IEC 27041 and ISO/IEC 27042.

1. Introduction

Organizational management is a challenging task no matter what organization we speak about. Management must supervise operations of business processes, resources, contracts, and

communication. There is a lot of existing “best practice” standards and recommendations; however, it is not always easy to implement them for a specific organization type.

Digital forensic laboratory is a special kind of forensic laboratory, that examines and analyses digital evidence (it may also collect digital evidence). Digital evidence is information or data, stored or transmitted in binary form that may be relied on as evidence (ISO, 2015c). Digital forensic laboratory is a unique type of organization and there are not so many alike. Perhaps, that is why there is no management system designed particularly for this type of organization. The uniqueness of digital forensics lab lies in the fact that contracts may vary considerably, and no small number of them is resolved through the project; consider also, that different parts of process or project need different resources, so resource planning is a true problem as well.

Contracts are usually granted by the police based on crimes that happened and need to be resolved. Of course, it is quite difficult to determine how many crimes require digital forensics. This also makes future planning even more complex.

The aim of this article is to introduce a management system for digital forensic laboratory main process (potential digital evidence analysis). The content of the article might inspire anyone who manages digital forensic laboratory or similar type of organization or encounters problems similar to the ones that we identified.

2. Problem Introduction and Motivation

Digital forensic laboratories in Czech republic (but we expect also in other countries) have the main process of potential digital evidence analysis (considering evaluation in terms of CMM(Paulk, Curtis, Chrissis, & Weber, 1993)) on level 1 - Initial or 2 - Repeatable. The main process is either constructed ad-hoc or repeated using inspiration from previous contracts.

However, laboratories cooperating with us, feel that the process could be optimized to improve resource utilization and thereby improve both the cost-effectiveness of the process and reduce the duration of individual contracts.

Resources are currently used ineffectively as the contracts are handled by one employee with sufficient qualification. However, this highly qualified employee (must be qualified enough to do also the parts requiring high qualification) spends a considerable part of his or her working hours doing unqualified tasks that could have been done by some less-qualified personnel.

Model presented in the article identifies the individual activities related to digital forensic analysis, so it is possible to consider resources (staff, hardware, software), and when to allocate them for each sub-activity. Thanks to this information the laboratory can significantly improve resources allocation efficiency while processing large quantity of contracts at the same time.

Previous models introduced for digital investigation are mentioned and summarised in (Selamat, Yusof, & Sahib, 2008); however these models were focused on quality of provided evidence (on the correctness of procedures) not on the business operation of the process.

The proposed model will be used for the development of a specialized laboratory ERP software. Such ERP software is currently developed with the support of the EU grant ("Czech Cybercrime Centre of Excellence" HOME/2012/ISEC/AG/INT/4000003882) by one of cooperating laboratories (Expert institute RAC). Specialized ERP software is necessary, because the process works with additional information (stored in database) – described in our process as well. Software should plan all available laboratory resources using the knowledge about the case needs and the knowledge of process flow.

3. Research Methodology

We work closely with an existing digital forensic laboratory in the Czech republic which is a part of company called Risk Analysis Consultants. It is an expert institution focused on digital forensic analysis. We also consulted our proposals with digital forensic laboratory FLAB that is part of CENSET association.

Our previous work led to the digital forensic laboratory process description from two following perspectives: economic and forensic/functional. Economic perspective process model (Hájek, Hykš, Koliš, & Veber, 2015) employed SIPOC diagram tracking all economic process requirements, and the process was based on current RAC laboratory process operation. Forensic/functional perspective process model (Veber & Klíma, 2015) was based on "best practice" recommendations introduced in the ISO 27000 family of standards (ISO, 2015a, 2015b, 2015c).

In this article, we would like to present the result of joining both approaches together resulting in a complete process description. We also considered resource management and data objects affecting the process operation. We decided to model the process using BPMN v 2.0 (Dijkman, Hofstetter, & Koehler, 2011) (OMG, 2011) notation in order to express almost everything connected to the process management while make it understandable.

4. The Proposed Process Model

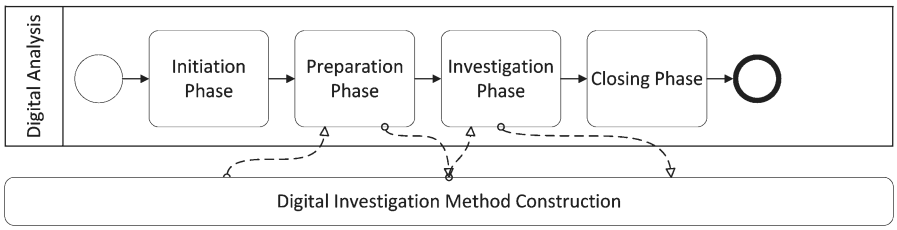

Figure 1 – Process component overview

Overall, the model is complicated, and it would be problematic to fit its description onto one page, so we split the process into four phases. We also introduce additional process model connected to digital evidence method construction. Process overview is on Figure 1. The later phases are introduced and described in the following chapters.

4.1. Initiation Phase

The Initiation Phase (see Figure 2) is the beginning phase of digital evidence analysis process. It starts when the customer asks the laboratory for an analysis. The customer may be either from the private sector, or he also may come from the police.

This phase is about negotiation with the customer. The laboratory is responsible for asking as much details as necessary for it to estimate the price and duration of the analysis because that is the information the customer often wants to know before accepting the contract.

The laboratory always requires at least the following:

- basic information about the case (What is the investigation about?),
- investigation questions (What information should the analysis provide?),
- how much data is collected (How many and what kind of devices will be involved?).

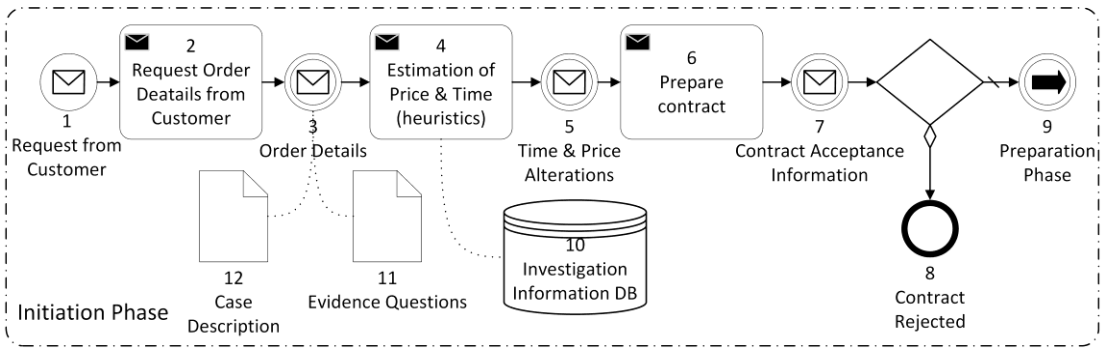

Figure 2 – Initiation Phase of Digital Analysis Process

The information provided by the customer may not be accurate, and the customer also does not provide sufficient details for detailed identification of needed activities, so it is a bit problematic to present exact price until the laboratory acquires the potential digital evidence (devices). Additional investigation needs may still arise even after all the necessary information is provided. However, the laboratory management is often forced to provide the price and duration of the analysis at this point. The price and the duration of the contract may be estimated using the database of previous investigations, but it will not be accurate, and the customer must be warned about it.

Also, in this part of the process, necessary data objects are acquired: the "Evidence Questions" and "Case Description". The evidence questions describe in detail what should the analysis answer to, and case description describe what is the intention of investigation and how should final report look like.

It is also possible to estimate necessary resources during this phase. It will be again only an approximation of possible resources usage that will be clarified in later stages, but it allows the laboratory to estimate duration of the investigation and reserve the required resources.

4.2. Preparation Phase

Preparation phase (see Figure 3) starts when the contract is signed. During this phase, the devices containing potential digital evidence are accepted, and the data is extracted for analysis.

The customer provides devices containing potential digital evidence. The laboratory accepts the "Evidence" and inspects it. As a result of inspection the laboratory obtains data object "Digital Evidence Type". It is necessary to extract data from different kinds of devices and the procedure depends on evidence type. The laboratory employee may find proper method in "Digital Evidence Extraction Method database"; however, it may also happen, that the method for extracting data from this type if device is not known so in that case it is necessary to prepare new method using associated process "Digital investigation method construction".

The extraction step is simple usage of selected extraction (& normalization) methods in order to obtain data, that are later stored in "Digital Evidence Data database". Let’s mention that laboratory must conduct analysis on a copy of digital evidence (or a copy of a copy) and only in exceptional cases on real devices.

The digital evidence data that are stored in database are not only downloaded from devices but also normalised to data format, that is given for similar devices. And that is prepared for potential digital evidence analysis methods.

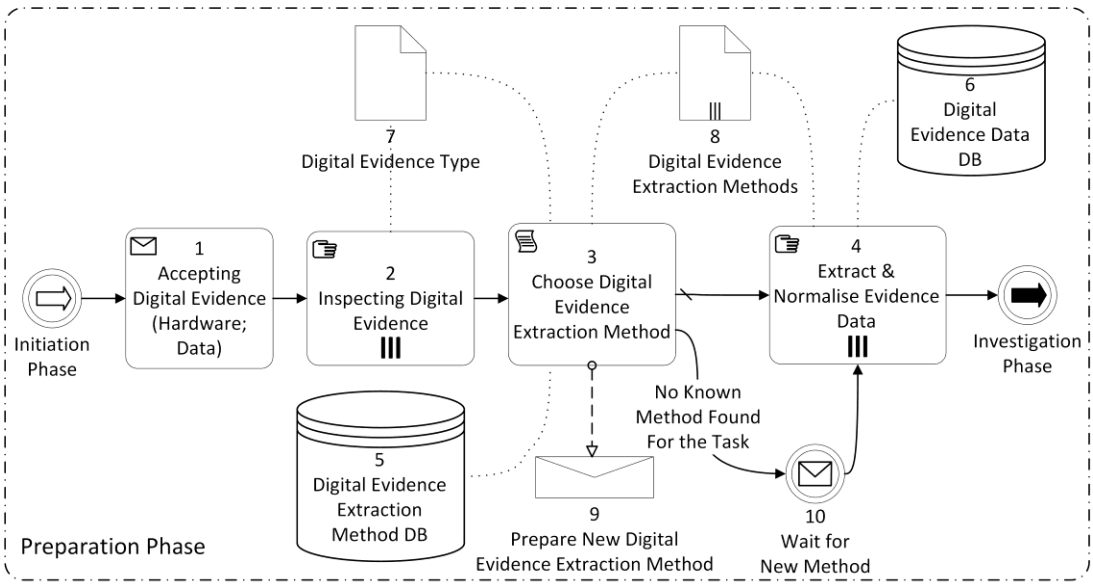

Figure 3 – Preparation Phase of Digital Analysis Process

4.3. Investigation Phase

Investigation phase (see Figure 4) is the core of the digital evidence analysis process. It starts when the potential digital evidence is extracted from devices.

Beginning of the investigation phase is the action of digital analysis planning. During this action the laboratory must take into account all the evidence questions provided by customer and decide what to search for and how. The digital analyses may run in parallel or in sequence. Planning of analyses should also clarify what resources will be necessary and when, so the resource planning for current contract may be finalized in this step.

Once everything is planned employees with sufficient qualification may conduct planned tasks of digital evidence analysis. It consists of digital evidence identification and following digital evidence analysis steps, while using decision model for methods based on methods stored in "Digital Evidence Analysis Method database". Consider also creation of new methods if known methods are not sufficient to provide answers to investigation questions.

Digital evidence interpretation is a step, that summarize analysis findings ("Digital Investigation Findings") to conclusions presentable to a customer. Investigation findings must be written in the "Analysis Report" depending on case description and customer requirements. The report is sent to the customer.

Let us mention that this part of process also present lot of feedbacks because results of fractional steps may require repeating previous steps in order to understand the case. But in ideal case the pass is straightforward.

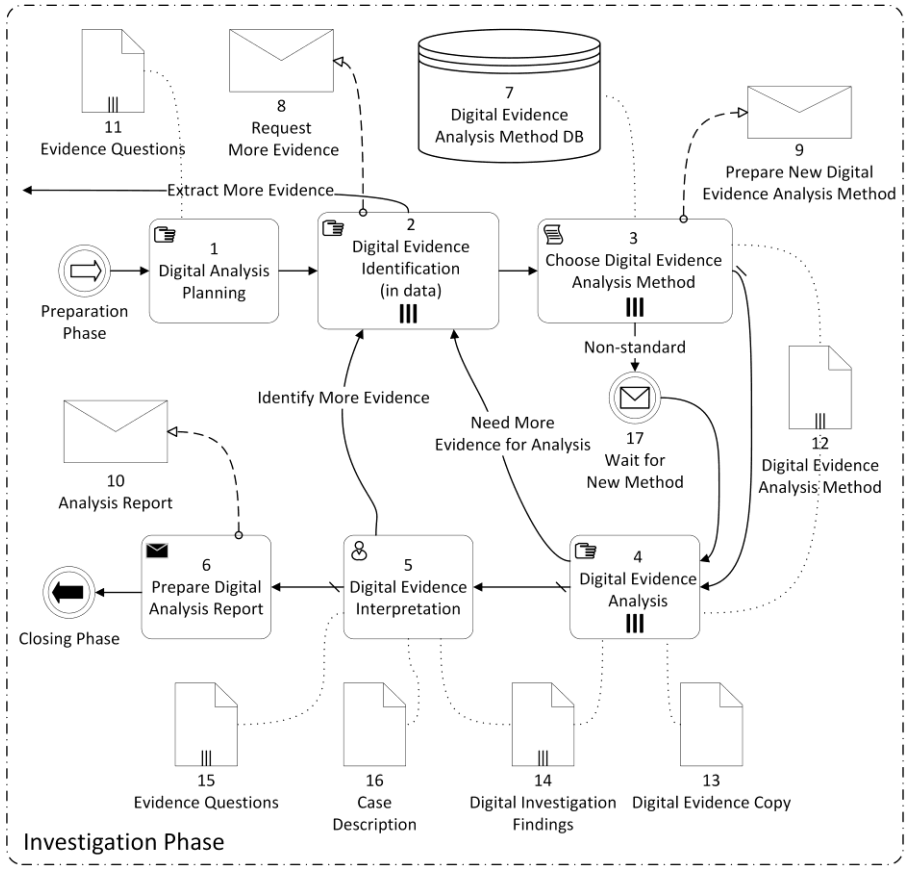

Figure 4 – Investigation Phase of Digital Analysis Process

4.4. Closing Phase

The closing phase (see Figure 5) is mostly about negotiation with the customer about the price of the contract. All the work on the case is already finished and the procedures and the investigation attributes may be archived for future usage or vindication of procedures to the "Investigation Information database".

The laboratory summarizes the work on the contract and prepare the "Invoice" for the customer. If the customer does not agree with the price it must be either clearly substantiated or reduced in order to satisfy the customer. After the price negotiations the supplied devices containing potential digital evidence are returned to the customer and contract is closed thus the process ends.

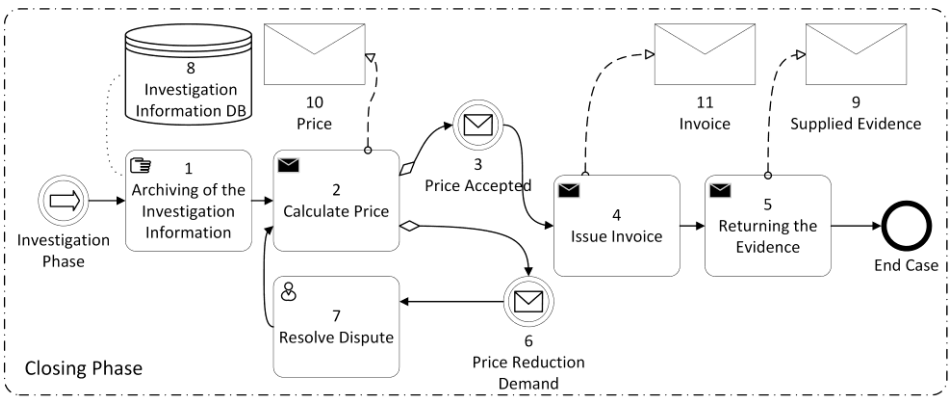

Figure 5 – Closing Phase of Digital Analysis Process

4.5. Digital Investigation Method Construction

Digital investigation method construction process (see Figure 6) is different standalone process however; it is closely connected to the digital analysis process. The process is initiated only when the new method for digital evidence extraction or analysis is needed by digital analysis process. The process is based on ISO/IEC 27041:2015 recommendations and is nested to the framework presented in this article.

As mentioned at the outset, a considerable part of the analysis is also addressed on a project basis. This fact was partially resolved by introduction of additional process that is focused on design of digital investigation methods. Although it is still a process purposed to research something (the project part is not completely eliminated), it is important for method construction procedure to meet the requirements of forensic investigation (auditability, repeatability).

The basics of method construction process is common research procedure. It starts with summarization of conditions and requirements of the new method. Then comes the design part (project part) this process sub-action should also specify what tools (software & hardware) will be used. Designed method must be implemented and verified before deployment.

Digital forensic laboratory should store all methods into database for the future usage. New methods are mostly needed when the laboratory employees encounter new kind of device or new kind of case question to answer.

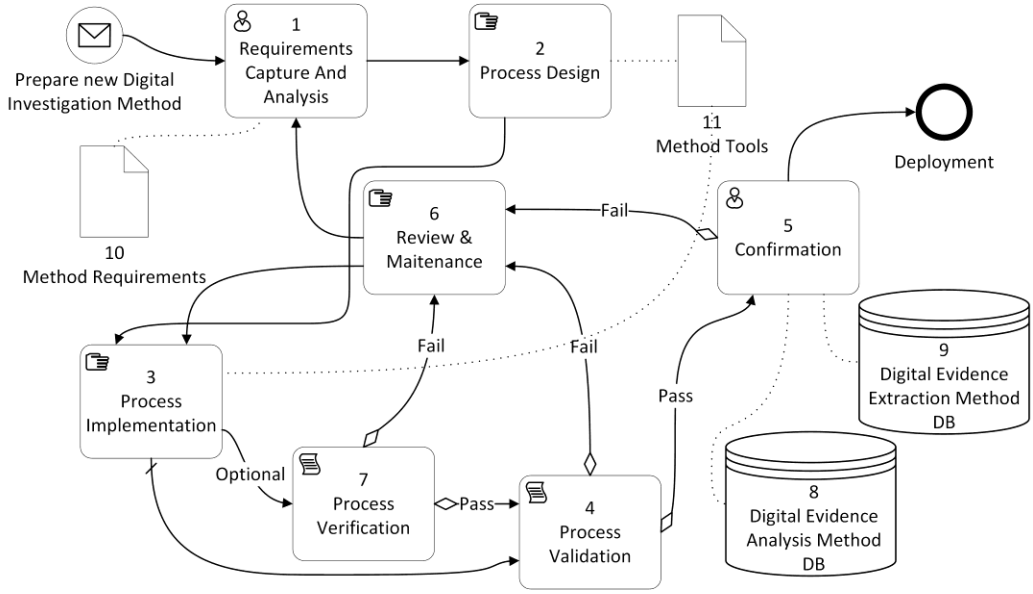

Figure 6. Digital Investigation Method Construction Process

5. Discussion

The present process has been somewhat simplified in the interaction with the customer. The customer may for example modify the inputs of the process during its operation by providing more evidence, more questions, new findings from physical investigation and also by requests for earlier termination of the investigation. The process is ready for it but it might be necessary to return few steps back or even start the process from scratch.

There are also other related processes for example digital evidence storage process, but such processes are above the scope of the article and are considered to be simple.

We also plan to verify our documented model using simulation system however, in this article we present the purposed final model before ongoing simulation in order to discuss it and even modify it before simulation takes place.

6. Conclusion

In this article we presented the model of the main business process of digital forensic laboratory. We presented complete scheme of the process and described the pass through the process. The scheme implements the practices used in real forensic laboratories and also best practice for digital investigation as presented in ISO/IEC 27041, 27042, 27043.

The description of process stages is not enough for the management of the laboratory to promote its operation to optimized but it is the first and necessary step on the way to optimize the process. We recommend also additional tools for example specialized ERP system for digital forensic laboratory in order to maintain all the mentioned databases and effective resource planning that should be pretty simple once all resources available/necessary are identified.

7. Acknowledgement

The article was prepared with the help of a grant from the Internal Grant Agency of University of Economics, Prague: IG409024 – “Innovation management system, digital forensics labs”. The authors wish to thank to Marian Svetlik (Risk Analysis Consultants) and Ales Padrta (FLAB) for the helpful comments while developing this paper.

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JOB PERSPECTIVES AND FINANCIAL SITUATION OF THE CZECH PHD CANDIDATES IN ICT

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Keywords

IT students, students costs, employability

Abstract

The aim of the paper is to present the current financial situation of the Czech PhD students in ICT study programmes, their current job attendance, relation between current job and study field and perspectives of receiving the future job after graduation both at the national and international labour market. The unique national survey DOKTORANDI 2014 consisting of more than 3,000 responses from the PhD students in the Czech Republic serves as the data source for our analysis. The data for ICT students are compared to the whole population. Financial situation of the PhD students and their social conditions do not constitute the good assumptions for keeping the national system of PhD studies efficient, although the public costs for subsidies to PhD students exceed 5% of the total public costs on educational activities of higher education institutions. Closeness of the current job to the field of study surprisingly does not influence the students' chances at the labour market.

1. Introduction

Efficiency of PhD programs provided in the Czech Republic and social conditions of their students are in the centrum of interest of the state authorities and the national students' representation. Ministry of Education, Youth and Sports (MEYS) consider PhD studies as one of the important challenges for the period 2016-2020 and plans to deeply analyse the quantitative and qualitative aspects of PhD studies even with possible re-design of the studies (MEYS, 2015, pp. 7 & 11). The Student Chamber of the Council of HEIs put emphasis on the social aspects and social conditions of PhD studies, including payments of contributions to the health insurance (Moulis et al., 2014, p. 21). On the other hand, the interest of the researchers in this topic is quite lower comparing to the undergraduate studies. One of the reasons probably consists in the lack of data: the first national survey focused primarily to PhD students has been realised by the MEYS in 2014.

The aim of the paper is to follow the analysis of the social conditions and job perspectives, which have been made for IT undergraduate students using data from EUROSTUDENT V survey (Vltavská & Fischer, 2014). Are the subsidies which PhD students receive sufficient for covering their living costs and the costs of studies? Do the higher education institutions (HEIs) contribute to PhD students with the payment to the health insurance? Do the PhD students an opportunity to get

an extra job within their HEI? How closely relates their job to the study field? And how the PhD students assess their changes at the national and international labour market?

The change of PhD studies from quality to quantity and impacts of this change to the PhD students, their social situation and their perception of the future position at the labour market in different countries is overviewed by Cyranoski et al. (2011). According them, there are few jobs for PhD graduates in well-developed economies such as Japan and U.S., on the other hand, PhD graduates are well-absorbed by the labour market in emerging economies like China or Singapore. In Germany, the system of PhD studies has been strongly changed to the progressive and professional doctorates in recent years and majority of German PhD graduates leave academia after graduation. PhD graduates are also demanded rather by industry than by academia in India. For the Czech Republic, the strong warning comes from Poland, which is geographically close. After the increase in the number of PhD students, which is similar to the recent development in the Czech Republic, PhD holders are not more satisfied at the labour market comparing to graduates without PhD degree. Cyranoski et al. (2011) also points out the issue of higher drop-out rate in Poland which is also recorded in the Czech Republic.

The rest of the paper is organised as follows. The survey DOKTORANDI 2014 is briefly introduced in the Data and Methodology section. Results of our analysis are presented and discussed in the chapter 3 and some remarks and recommendations related to PhD studies in the Czech Republic are given in the final part of the paper.

2. Data and Methodology

For this analysis we use micro data from survey DOKTORANDI 2014 which was focused on the overall opinions of PhD students at the Czech HEIs. This survey was carried out by the Ministry of Education, Youth and Sports in 2014. The survey covers 22 public and 2 state higher education institutions and 2 private higher education institutions. After removal incomplete questionnaires the dataset consists of 3,283 respondents. The response rate reaches 16% which differs from the response rate during the EUROSTUDENT V survey (approximately 4%). From all respondents we choose those whose study programs relates to IT. For the analysis we have 254 respondents. Table 1 shows descriptive statistics of the dataset. There are 84.5% male IT students, 67.3% of IT students belong to the age category from 26 to 30 years old, they are mainly full-time students and they evaluate themselves mainly to the average third of all students in the same study programs.

gender	male	84.5
	female	15.5
age category	up to 25	16.5
	26 to 30	67.3
	31 to 35	10.6
	over 36	5.5
formal status	full-time	76.0
	part-time	24.0
student's category	best third	38.8
	average third	51.4
	worst third	9.8

Table 1 Descriptive statistics, IT students, % Source: DOKTORANDI 2014

For the analysis we use standard statistical and descriptive methods (e.g. contingency tables, Chi-Squared test) which are describe in detailed by Field (2009).

3. Results and Discussion

We choose questions related to the finance and future jobs. From the results one can find out that the average amount of scholarship mostly range from 5,000 CZK to 9,999 CZK (64.8%) which corresponds with the results gained from all respondents (57.4%). The average amount of scholarship reaches 7,172 CZK. Only 18.9% of IT students gained some money from parents. The average amount reaches 4,347 CZK. Students could evaluate if the scholarship fulfil their living costs and costs related to the study (figure 1). The results of PhD students' opinion meet with the thinking of all respondents. The scholarship amount is absolutely insufficient to cover living and study costs (56.6% of IT students contrary to 59.2%).

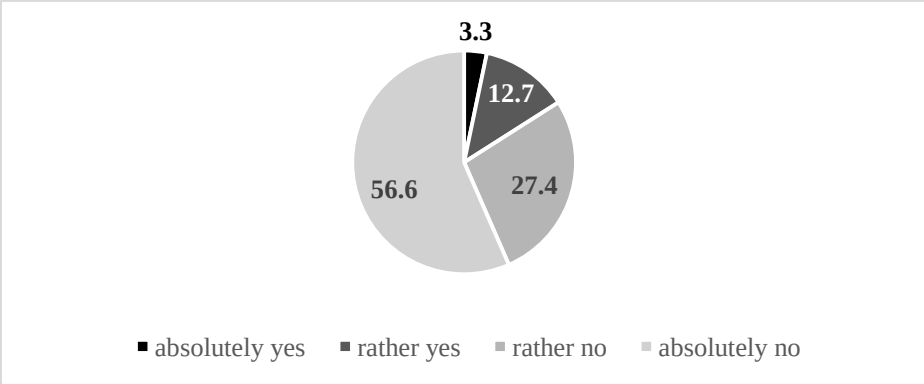

Figure 1 Do you consider the scholarship amount sufficient to cover your living and study costs? Source: DOKTORANDI 2014

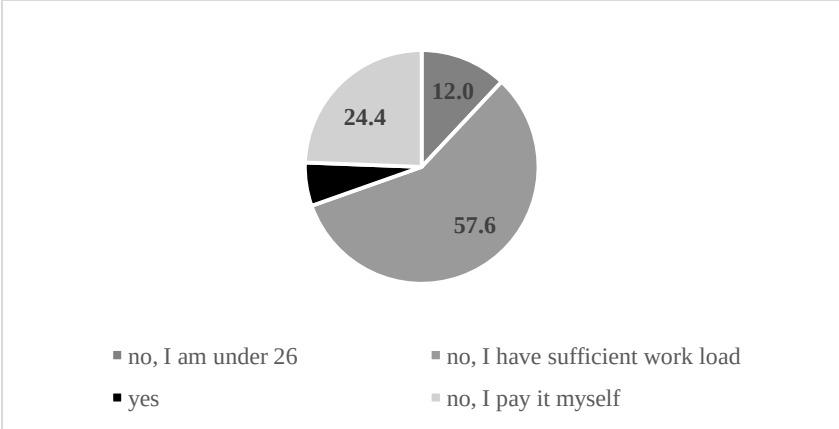

Figure 2 Does the HEI contribute with the payment of health insurance? Source: DOKTORANDI 2014

The payment of health insurance closely relates with PhD studies. 57.6% of IT students and 55.5% of all respondents state that the HEI does not have to pay their health insurance as they have sufficient workload and the insurance is paid by their employers.

Next question relates to the job possibilities at the HEI. As the figure 3 shows more than a half of IT students (52.4%) has the opportunity to work at HEI and they take the advantage of it. They work approximately 19 hours per week. There is no statistical significant dependency between the opportunity to work at HEI and the gender and the age category of respondents.

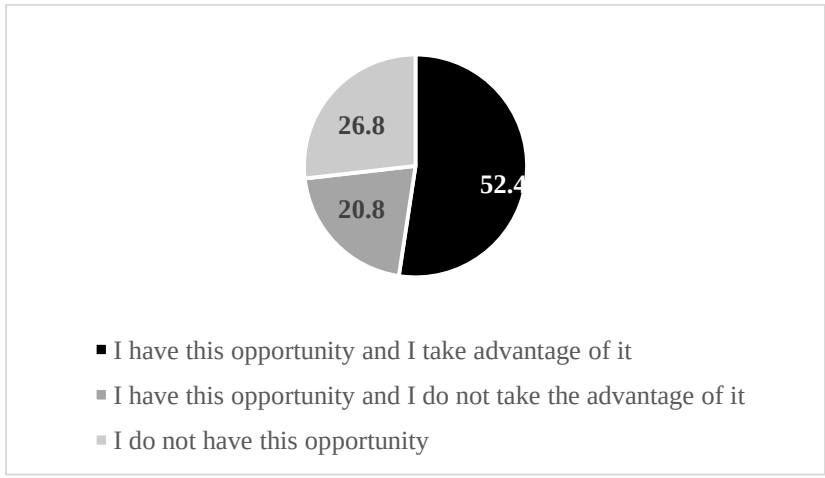

Figure 3 Do you have the opportunity to have the extra job at HEI? Source: DOKTORANDI 2014

If students have the opportunity to work outside the HEI (at private companies or other institutions) and they take the advantage of it (49.6% of IT students) they work there approximately 25 hours per week. Students could evaluate how closely this job relates with their studies. Figure 4 shows that 35% of IT students have job which closely relates with their studies. This result goes along with the results of all respondents (31.9%). Employing 5% level of significance there was not found statistical dependency between the relevance of the opportunity to work outside the HEI and the connection of job and study, gender and age category.

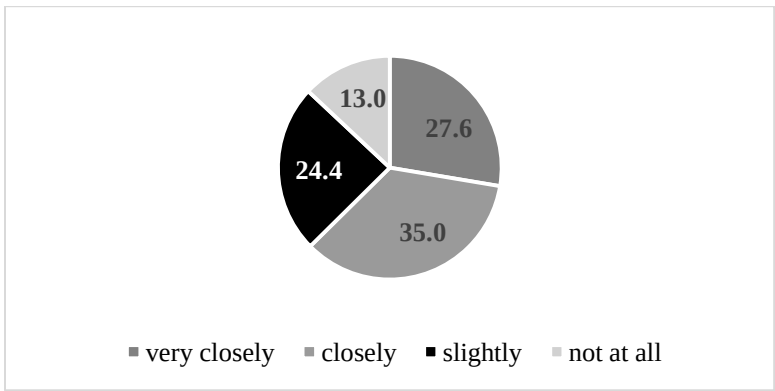

Figure 4 How closely relates your job to your study? Source: DOKTORANDI 2014

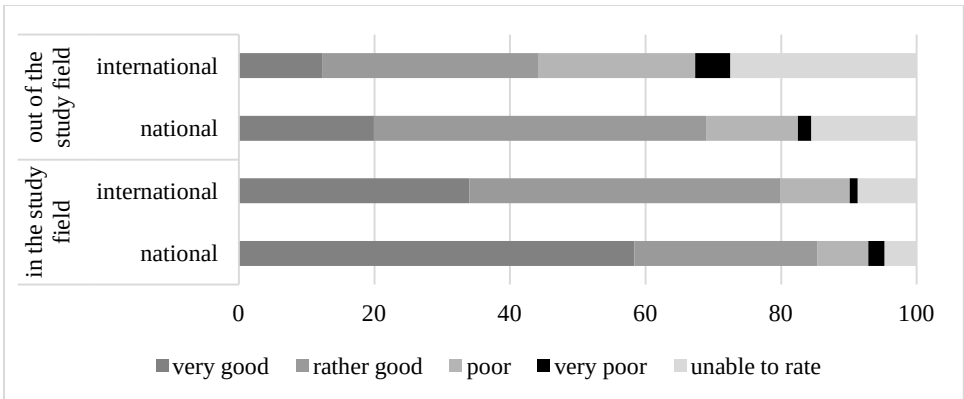

Figure 5 How do you evaluate your chances on the labour market? Source: DOKTORANDI 2014

Students evaluate their chances on the national labour market more positively than the chances on the international labour market. In their field of study they evaluate their chances on the national labour market as very good in 58.3%. IT students think more positively than all Czech respondents who evaluate their chances in their study field on the national labour market as very good in 37.3%. In the field of study on the international labour market they evaluate their chances mostly as rather good (45.8%). This meets with result of all respondents (44.2%). IT students evaluate their chances out of the field of study on the national labour market mostly as rather good (49% in comparison with all respondents 43.6%). We investigate the statistical dependency between the evaluation of the chances on the labour market and gender and age category of respondents (see Table 2). Using 5% level of significance shows the only one dependency between gender of the respondents and the evaluation in the study field on the international market (p-value 0.006).

		gender		age	
		Pearson Chi-Square	p-value	Pearson Chi-Square	p-value
in the study field	national	6.034	0.197	8.419	0.752
	international	14.508	0.006	12.467	0.409
out of the study field	national	4.596	0.331	7.940	0.790
	international	1.686	0.793	10.644	0.560

Table 2 Results of Chi-Squared Tests Source: DOKTORANDI 2014, own calculations

We analyse the dependency between the question ‘how closely relates your current job with your study” and the evaluation of the Ph.D. students’ chances on the labour market. From the results (Table 3) one can see that there is no dependency between these two questions (using 5% level of significance). If we apply 10% level of significance we find the dependency between the relation of current job and evaluation of students’ chances on in the field of study on the international labour market.

		Pearson Chi-Square	p-value
in the study field	national	18.501	0.101
	international	19.986	0.067
out of the study field	national	11.408	0.494
	international	11.018	0.527

Table 3 Results of Chi-Squared Tests Source: DOKTORANDI 2014, own calculations

4. Conclusion

Financial situation of the PhD students and their social conditions do not constitute the good assumptions for keeping the national system of PhD studies efficient. Although the public costs for subsidies to PhD students exceed 1 billion CZK (around 36 million EUR), i. e. 5% of the total public costs for the educational activities of the public higher education institutions in the Czech Republic, the subsidies per 1 PhD student are low and not sufficient for covering their living and study costs. This fact implies that students need to find a job during the study (within or outside their universities) and they have to work many hours per week. For more than one third of ICT PhD students the work is not related to the study field so the job is not complementary to the study and should be considered as a substitute. The reason of this situation probably consists in the high number of PhD students, partially caused by the requirements for the sustainability of projects funded by the EU structural and cohesion funds. We fully agree with the statement of the MEYS

(2015) about the necessity of the deep analysis of the quantitative and qualitative aspects of PhD studies.

As the challenges for further research we consider estimating the returns of the investments in human capital for PhD studies using the Mincer model as for the undergraduate studies (Finardi & Fischer, 2011), analyzing the quantitative expansion in PhD studies and its impacts using methodology presented by Mazouch & Vltavska (2014) and, particularly related to the ICT programs, analysing the relations between ICT PhD graduates and the requirements of the enterprises within the Czech ICT industry (Doucek et al., 2011). According to Stehlik (2011), special attention should be paid to the mature-aged PhD students.

5. Acknowledgement

This paper is prepared under the support of the project "Regional estimates of gross domestic product based on the expenditure approach" of the Czech Science Foundation, project No 13-15771S. This paper was processed with contribution of long term institutional support of research activities by Faculty of Informatics and Statistics, University of Economics, Prague.

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DO GENDER AND PERSONALITY TRAITS INFLUENCE USE OF DEAL SITES?

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Keywords

adoption, deal sites, personality traits, empirical research

Abstract

Deal sites became widespread, there are numerous both international and local players in the market. The research presented in the paper investigates if gender and personality traits influence use (versus non-use) of deal sites. Big Five Inventory-10 is used to measure personality traits. The findings are that gender, agreeableness and neuroticism significantly influences use of deal sites. These findings hold true regardless whether non-awareness is deal sites is considered or not.

1. Introduction

Deal sites can be described as web portals that offer a certain product for a discounted price for a limited period of time, usually a day; therefore they are also often called daily deal sites or deal of the day sites. Probably the first popular deal site was Woot; it was launched in 2004, and it was acquired by Amazon in 2010. Since then, many deal sites emerged. From the better known deal sites, LivingSocial was launched in 2007, and Groupon was launched in 2008.

According Delina (2014), transparency of prices and demands plays a significant role in achieving fair market prices. Deal sites use transparency for accumulating marginal acceptable demand which provide possibility to offer bargain price. Smutný (2015) presents importance and the use of online marketplaces (e.g. AppStore, Groupon) for marketing activities by Czech companies, which doing business over the Internet.

Overall, there has not been published too much about deal sites so far. In the Web of Science Core Collection database, the query Topic=("deal site" OR "deal sites" OR "deal of the day" OR groupon OR livingsocial) yielded 49 hits, of those 21 journal articles and one review published in a journal. The review was a false hit (it was about HIV). Of 21 regular journal articles, 2 were false hits (again medicine-related), 3 were published in Forbes, 1 in Harvard Business Review. The remaining, relevant academic articles dealt with marketing, technical, legal and ethical issues.

The most relevant articles investigated efficacy of Groupon as a marketing venue for the travel industry (Hsu, Chen, & Ting, 2012), use of mobile social media for marketing research,

communication, sales promotions/discounts, and relationship development/loyalty programs. (Kaplan, 2012), timing of auctions (Liu & Sutanto, 2012), seven key factors that influence a merchant's sales using a Groupon promotion in restaurants and healthcare services (Lee & Lee, 2012), consumers' loyalty that is a challenge because of low entry and switching costs are low (Krasnova, Veltri, Spengler, & Gunther, 2013), consumers' attitude toward deal sites and their motivations for purchasing (or not purchasing) (Boon, 2013), influence of characteristics of the online social network structure on consumer's decision for purchasing from the deal sites (Park, Shin, & Ju, 2014). (Dror, 2015) provides a rhetorical analysis letters to investors published within last year by Google, Groupon, Zynga, and Facebook. But none of these articles investigated what percentage of people does not use deal sites.

The aim of the presented research is to establish whether gender or personality traits can be linked to use of deal sites. The rest of the paper is organized in the following way: In the next section, there is a description what data were collected and how, and how they were analyzed. In the following section, results of the analysis are presented. The last section offers conclusions.

2. Data and methodology

Data were collected in the spring semester 2014 using an on-line questionnaire. Respondents were 284 university students from Denmark, of which 153 were male and 131 female. Most of them were from Aalborg and Aarhus universities in their first to fourth year of study. *Use of deal sites* was measured using the question - How frequently do you use deal sites? The answer never was coded as 1, all remaining possible answers indicating use were coded 2.

This question was preceded by a question measuring awareness of deal sites - Have you ever heard about websites for finding deals online? (e.g. sweetdeal.dk, groupon.com, livingsocial.com, dealnews.com, offers.com, coupons.com, or others?) Overall, 237 respondents stated that they were aware of deal sites, 47 stated that they were not aware of them. The analysis of awareness of deal sites is provided in (Sudzina, 2015). Of 237 respondents aware of deal sites, 106 never used them and 131 did.

Personality traits were measured using the Big Five Inventory-10, i.e. a 10-item version of the questionnaire for the Big Five Inventory, developed by Rammstedt and John (2007). The instruction was to rate "How well do the following statements describe your personality" with statements "I see myself as someone who..."

- ... is reserved,
- ... is generally trusting,
- ... tends to be lazy,
- ... is relaxed, handles stress well,
- ... has few artistic interests,
- ... is outgoing, sociable,
- ... tends to find fault with others,
- ... does a thorough job,
- ... gets nervous easily,
- ... has an active imagination

on a 1-7 Likert scale where 1 meant strongly disagrees and 7 stood for strongly agree. *Extraversion* was calculated as an average of the 1st (reversed-scored) and the 6th answer, *agreeableness* as an average of the 2nd and the 7th (reversed-scored) answer, *conscientiousness* as an average of the 3rd (reversed-scored) and the 8th answer, *neuroticism* as an average of the 4th (reversed-scored) and the 9th answer, and *openness to experience* as an average of the 5th (reversed-scored) and the 10th answer. The questionnaire contained additional questions which were not used in the analysis presented in this paper.

Binary logisitic regression was used to analyze impact of *gender* and five personality traits (*extraversion*, *agreeableness*, *conscientiousness*, *neuroticism*, *openness to experience*) on *use of deal sites* (where non-use is coded as 1 and use is coded as 2). A multivariate approach was used. SPSS software was used for the analysis.

Two models are presented. In the first model, non-users are 106 respondents, who were aware of deal sites but never used them. In the second model, non-users are 153 respondents who never used deal sites regardless whether they were aware of them or not. These two models are tested because a definition of a non-user can vary.

3. Results

In the first model, only respondents, who were aware of deal sites but never used them, were considered as non-users. Respondents, who were not aware of deal sites, were excluded from the analysis. The research question is if *gender*, *extraversion*, *agreeableness*, *conscientiousness*, *neuroticism*, and *openness to experience* influence *use of deal sites*. Binary logisitic regression results for the full model are provided in Table 1. Cox&Snell R^2 is 0.093, Nagelkerke R^2 is 0.125.

Variable	B	S.E.	Wald	Df	Sig.	Exp(B)
Gender	.800	.291	7.567	1	.006	2.226
Extraversion	-.058	.131	.193	1	.660	.944
Agreeableness	.384	.154	6.221	1	.013	1.468
Conscientiousness	-.051	.135	.143	1	.706	.950
Neuroticism	.208	.122	2.900	1	.089	1.231
Openness	-.158	.138	1.303	1	.254	.854
Constant	-2.203	1.313	2.817	1	.093	.110

Table 1 Binary logistic regression for the full model 1

Classification table is provided in Table 2. Overall, the mode is able to correctly predict 64.1 % of cases. It is somewhat more precise for predicting users than non-users.

		Predicted		
		Non-users	**Users**	**Percentage correct**
Observed	Non-users	56	50	52.8
	Users	35	96	73.3
Overall percentage				64.1

Table 2 Classification table for the full model 1

Carlson and Wu (2012) suggest to exclude independent variables that are not significant. The least significant for *use of deal sites* were *extraversion* and *conscientiousness*, so they were dropped. Even then the p-value for *openness* hardly changed (.237 instead of .254), therefore it was dropped too. Binary logisitic regression results for the reduced model are provided in Table 3.

Variable	B	S.E.	Wald	Df	Sig.	Exp(B)
Gender	.792	.282	7.882	1	.005	2.209
Agreeableness	.367	.147	6.263	1	.012	1.444
Neuroticism	.215	.115	3.498	1	.061	1.240
Constant	-3.370	.892	14.285	1	.000	.034

Table 3 Binary logistic regression for the reduced model 1

Classification table is provided in Table 4. The overall percentages of correctly predicted cases stayed at 64.1 % of cases but the distribution changes a bit - one non-user is not classifies as user but one user is now classified as non-users.

		Predicted		
		Non-users	**Users**	**Percentage correct**
Observed	Non-users	57	49	53.8
	Users	36	95	72.5
Overall percentage				64.1

Table 4 Classification table for the full model 1

Cox&Snell R^2 is 0.087, Nagelkerke R^2 is 0.116. The impact of *gender* and *agreeableness* on *use of deal sites* is certainly significant. Although the significance of *neuroticism* is not below 0.05, it should not be dismissed. Baroudi and Orlikowski (1989) estimated that information systems researchers typically have a 40% chance of not detecting the phenomenon under study, even though it, in fact, may exist. According to Bosaková (2007), there are several aspects of the same phenomenon which are too variable to be defined without previous comprehension of the phenomenon itself.

In the second model, all respondents, who never used deal sites (regardless whether they were were aware of them), were considered as non-users. The same independent variables were used. Binary logisitic regression results for the full model are provided in Table 5. Cox&Snell R2 is 0.089, Nagelkerke R2 is 0.121.

Variable	B	S.E.	Wald	Df	Sig.	Exp(B)
Gender	.656	.276	5.663	1	.017	1.927
Extraversion	-.047	.124	.147	1	.701	.954
Agreeableness	.391	.143	7.477	1	.006	1.479
Conscientiousness	-.059	.130	.205	1	.651	.943
Neuroticism	.266	.116	5.220	1	.022	1.304
Openness	-.179	.131	1.868	1	.172	.836
Constant	-1.834	1.234	2.208	1	.137	.160

Table 5 Binary logistic regression for the full model 2

Classification table is provided in Table 6. Overall, the mode is able to correctly predict 67.3 % of cases. It is far more more precise for predicting users than non-users.

		Predicted		
		Non-users	**Users**	**Percentage correct**
Observed	Non-users	35	71	33.0
	Users	22	156	87.6
Overall percentage				67.3

Table 6 Classification table for the full model 2

The least significant for *use of deal sites* were again *extraversion* and *conscientiousness*, so they were dropped. Even then the p-value for *openness* hardly changed (.161 instead of .172), therefore it was dropped too. Binary logisitic regression results for the reduced model are provided in Table 7.

Variable	B	S.E.	Wald	Df	Sig.	Exp(B)
Gender	.653	.268	5.965	1	.015	1.922
Agreeableness	.373	.137	7.411	1	.006	1.452
Neuroticism	.278	.111	6.276	1	.012	1.321
Constant	-3.105	.831	13.954	1	.000	.045

Table 7 Binary logistic regression for the reduced model 2

Classification table is provided in Table 8. The overall percentages of correctly predicted cases stayed marginally improved - one non-user is not classified as user anymore.

		Predicted		
		Non-users	**Users**	**Percentage correct**
Observed	Non-users	36	70	34.0
	Users	22	156	87.6
Overall percentage				67.6

Table 8 Classification table for the full model 2

Cox&Snell R^2 is 0.081, Nagelkerke R^2 is 0.111. The impact of *gender*, *agreeableness* and *neuroticism* on *use of deal sites* is significant.

The results of the two models are roughly the same, so the precise definition of a non-users is probably not so important. Although men are typically more likely to adopt any technology, in this case, women were about twice more likely to use deal sites than men.

4. Conclusions

Although deal sites exist over a decade now, they are used only by approximately by half of the surveyed respondents and there are still some people (approximately one sixth in this sample) who never heard of them. As Pavlíček (2013) states, "[a]s with every new technology, we just have to learn, how to live with it and make the best out of it, because, once the technology is invented, it is here to stay." The aim of the paper was to investigate the influence of *gender* and Big Five Inventory personality traits (*extraversion*, *agreeableness*, *conscientiousness*, *neuroticism*, *openness to experience*) on *use of deal sites*.

With regards to the results of the analysis, *gender*, *agreeableness* and *neuroticism* significantly influence *use of deal sites*. It would appropriate for future studies focusing on adoption of deal sites to include these three as independent, possibly control, variables. Although a model with these three variables can correctly classify about two thirds of cases, together they explain only about one tenth of variance.

A somewhat surprising finding is that women are about twice more likely to use deal sites than men, though in general men are more likely to adopt any (other) technology. Further research could also investigate the mechanism why *agreeableness* and *neuroticism* lead to higher adoption of deal sites.

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SESSION C: ACADEMIC AND BUSINESS CO-OPERATION

USE OF NON-INVESTMENT SUBSIDIES IN ACADEMIC AND BUSINESS CO-OPERATION

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Keywords

Academic-industrial cooperation, SME, innovation vouchers

Abstract

The article deals with the use of investment grants provided by Moravian-Silesian region, in order to improve cooperation between universities and small and medium sized companies (SMEs) in the form of so-called innovation vouchers. The article describes the experience of implementing these vouchers and their influence on teaching at the university and in the activities and behavior of small and medium-sized companies.

1. Introduction

Collaboration between academia and industry is the basic premise of innovation (Carasco et al., 2009). Direct cooperation between the academic sector and SME support mutual knowledge transfer, while academics attach more importance to this exchange (Ministr & Pitner, 2014) than the enterprises. Research financed from public resources is crucial only for a small proportion of SMEs (Antlova et all, 2012). Publicly funded research can be understood as a general service and generally contributes to creating an environment for the realization of innovations (Doucek, 2010).

In terms of the effect on the transmission of knowledge, there are several aspects where universities and SMEs see the effect on transfer of knowledge differently (Johansson, Sudzina & Pucihar, 2014). The main differences include the transfer of knowledge (Tovarňák & Pitner, 2011):

- Academicians are usually not interested in patent texts (up 72%).

- SMEs show little interest in Ph.D. projects (up 76%), since these projects usually does not substantive or thematic benefit for them.
- SMEs are not keen on temporary staff exchange when companies expect financial compensation in case their employees are active at universities.
- Both SMEs and academia are not looking for common goals, opportunities, and projects between academia and SMEs.
- There is a reluctance of SMEs to participate in formulation of Master- and Ph.D. Theses;
- Only a few SME companies educate their employees through a contractual training at universities, which is often due to insufficient supply, not reflecting the specific requirements of SMEs (Vilamová, Janovská, Vozňáková & Kozel, 2012).
- For universities that want to collaborate with the commercial sector, it is important to expand their traditional activities (education and research) with a business, in which they economically evaluate their results of research and development (Danel et al, 2013).

It assumes that the following measures exist at the universities (Ministr & Pitner, 2014):

- adequate economic evaluation of scientific research results of the university;
- defining the innovation strategy of the university;
- creation of innovative networks;
- motivation of researchers.

2. Innovation vouchers

An *Innovation voucher* is a non-investment subsidy instrument fostering SME cooperation with a university or research organization based on knowledge transfer. In order to support entrepreneurship, the Moravian-Silesian Region provides two types of vouchers:

- *Innovation voucher Type 1* provides grants for businesses based in the Moravian-Silesian region where a university establishes a written contract for a knowledge transfer of a scientific or technical nature which are for new businesses and not widely available. Gaining knowledge must also lead to the strengthening of business competitiveness, especially by helping to innovate a product, process, or service.
- *Innovation voucher Type 2* provides grants for businesses based in the Region to co-finance the cost of the newly created research jobs in the company.

Universities may use the Innovation voucher Type 1 to cover the following costs:

- development of a product / process / service; tests and measurements; feasibility study;
- access to research facilities; analysis of the material suitability; product design;
- creation of business plan for an innovative product; assessing the economic impact;
- market analysis / creating marketing strategy; innovation / technological audit;
- setting up a new business or enterprise management model;
- optimizing operational business processes.

In the Innovation voucher type 2, the eligible costs are as follows:

- staff costs of researchers in the field of scientific research;
- costs of certified training of specialist researchers.

For both types of Innovation vouchers, there are limits for applicants according to the company size in the range of 300k to 500k CZK. Duration of the project is up to 18 months.

3. Implementation of vouchers in IT and their impact on the academic area

The impact of Innovation vouchers on the quality of academic activities have the following three layers which can be characterized as follows:

- *Design layer* – the base layer represented by software engineering activities: analysis of user requirements, design of application architecture. The merit of this layer is a standard part of science education at universities, and thus it is very beneficial for both students and teachers to gain practical experience in solving real-world task SMEs. Conversely, SMEs gain knowledge workers with advanced and relevant skills.
- *Implementation layer* – the next layer in the IT project life cycle, which includes activities that are not often practically trained at universities (testing, debugging, and documentation). There is also an opportunity of real mutual knowledge transfer between universities and SMEs.
- *Deployment layer* – the last layer including activities related to installation, maintenance, and use of commercial software created.

The first two layers require that the university researchers poses hard skills which can be transferred to SMEs in order to introduce new principles of design and implementation of software. Further, the academicians and students can gain soft skills in obtaining and processing user requirements that cannot be obtained otherwise than in a concrete practical project (Motschnig et al, 2014). The third layer (deployment) is taught at the universities mostly only in theory, though it is essential for the success of the project and particularly requires soft skills that can only be gained when directly communicating with the users of the new software which helps academia to better prepare its students for the practice.

All three layers must often be supported administrative processes. The administrative demands on the researchers depend on the support of the university or faculty. The advantage of a dedicated role of *project administrator* at the faculty that records the project results and supervise the project schedule allows researchers to concentrate on the substantial part of the project. Unfortunately, this role can also frequently burden the researchers with unnecessary paperwork.

4. Case study

The Department of Informatics of the Faculty of Economics at the VŠB - Technical University of Ostrava won in 2013 a voucher with a company headquartered in Ostrava and operating on the market in the Czech Republic and Slovakia. The aim of this voucher was to transfer knowledge in the design and implementation of a new module WebProcessor in order to extend the functionality of a commercially successful CRM system Leonardo to use ontologies and the Semantic Web. The system architecture is shown in Figure1.

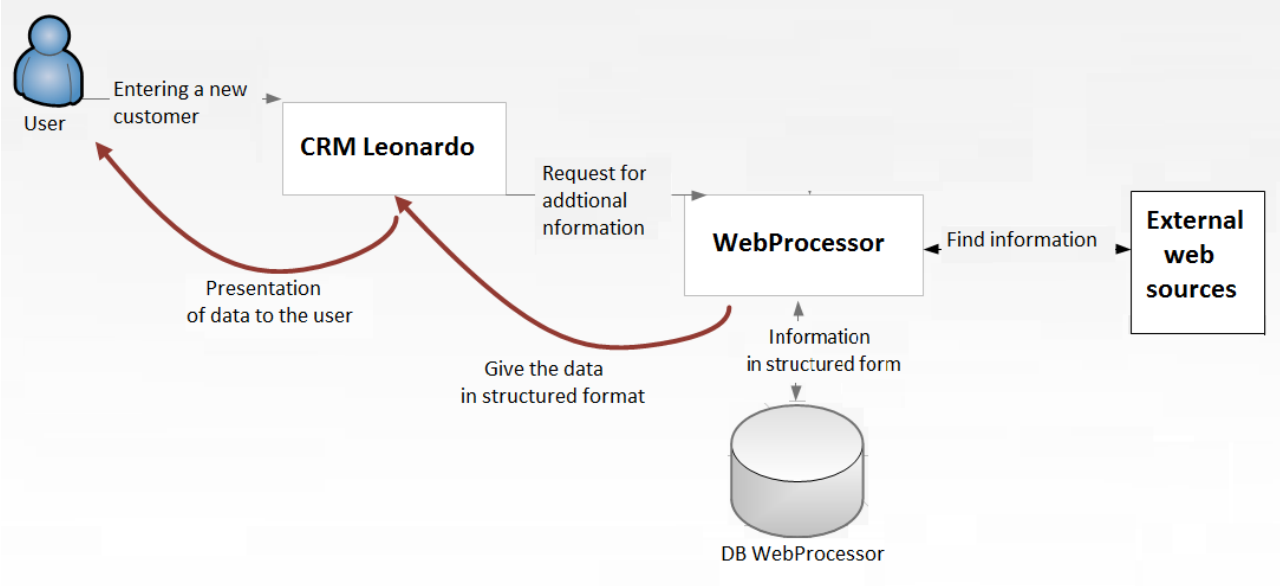

Figure 1 Architecture of solution the project [Source: own]

The planned duration of the project (18 months) has been divided into the following stages:

- Initialization (build research team);
- Process analysis and identification of potential data sources;
- Ontology design;
- Implementation of RDF (Resource Description Framework) data;
- Creation of OWL (Web Ontodology Language) metamodel;
- Integrating the new module *WebProcessor* into the system architecture of the CRM Leonardo;
- Testing;
- Overall evaluation of the project.

The actual implementation of the project was ensured by an experienced research team consisting of the following roles:

- A designated employee of the company taking care about the internal research team within the company and ensuring communications with the company management;
- A designated employee of the university responsible for managing the knowledge transfer from the professionals;
- An assistant of knowledge transfer, which realized the merits of the project, including a substantial portion of its administration (treatment of individual stages, including the presentation of results solutions at meetings of the research team);
- An advisor for knowledge transfer project from the grant provider, which monitored the progress of the project.
- Project management has been implemented using SCRUM where each sprint interval was one week.

Project costs are made up of the following items:

- Salary of the authorized employee at the university;
- Salary of the (junior, student) assistant of the knowledge transfer expert, which worked full time for the project within the company;
- Salaries of the responsible person from the university and his/her assistant;
- Assistant training costs;
- Consumables for the project, such as paper, cartridges.

The following main benefits of the voucher project for the university have been identified:

- Practical application of theoretical methods and techniques, which are subject of *research and teaching*, and thus connecting theoretical knowledge of new and emerging discipline focused on data acquisition and validation from various sources;
- Transfer of the new theoretical know-how into the *company operation*. Additionally, new software was created and integrated into an existing software product – Leonardo CRM system;
- Application of research know-how of the university, as the software application was made up an entirely new way (from scratch) with all the design parameters and decisions based on agreed principles of cooperation, input and technical parameters;
- Acquiring new knowledge and inspiration for *other academic activities*, e.g. new topics for graduation theses, and further theoretical development in the field.
- Practical application of knowledge and the getting into informal *personal contacts* within the company, which further evolved based on the voucher;
- Creation of a *permanent job* for the assistant who joined the company after the completion of the project;
- Gaining experience with the *administration* of this project type.

5. Conclusion

Cooperation between universities and industrial partners based on projects like innovation vouchers represents an opportunity to update university curricula according to current trends, based on the practical needs of regional companies. The vouchers thus create conditions for the development and verification of soft and hard competencies of teachers and students in projects that require interdisciplinary knowledge and experience.

Finally, the vouchers and similar projects form a platform for establishing informal relations between the university staff and management of the companies that in case of a successful project usually lead to long-term collaboration. Since the budget of the voucher is relatively small, the benefit/cost ratio is high. Another benefit of these projects is to promote the scientific work of the university in the field of applied research and spreading the reputation of the university through their high quality graduates who are successful in their professional life.

6. Acknowledgements

This work was supported by Grant "The Research Team for the Modelling of Economics and Financial Processes at VSB-Technical University of Ostrava" with reference number CZ.1.07/2.3.00/20.0296.

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ANALYSIS OF WEAK POINTS OF COLLABORATION OF VŠV - TECHNICAL UNIVERSITY OF OSTRAVA WITH INDUSTRY IN THE FIELDS OF AUTOMATION AND INFORMATION SCIENCE

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Keywords

Contractual research, innovation path, EARN project, preparation of graduates

Abstract

This paper deals with the often debated topic of improving the level of collaboration between universities and industry. The analysis focuses on the situation in technical fields – automation, applied information science and control in industry. The paper describes the weak points at Czech universities with respect to contractual research, transfer of innovations to industry and preparation of graduates for work.

1. Introduction

When compared to other countries, the interlink between research and commerce in technical fields in the Czech Republic is not so extensive. The research potential of universities and their resources are not utilized to the extent they could be. Collaboration is usually not conceptually managed; individual worksites (departments, institutes, faculties) implement their own procedures. Another problem is the insufficient management of administrative procedures – numerous activities are done in an "everybody does everything" way.

The analysis of the relationship between universities and industry focuses on three areas:

- contractual research,
- transfer of innovations to commercial products
- preparation of graduates for their commercial application.

In the case contractual research the initiative is with the companies – they commission the research assignments, are interested in collaboration whether in the form of measurements, utilization of laboratories or equipment, or more extensive and long-term research collaboration.

The second area – transfer of innovations – is an opposite process. The result of research at universities is a new or innovated product, service, methodology, procedure, and we look for a way to apply such results in industry and commerce.

With respect to preparation of graduates the problem is the fact that graduates do not have the necessary know-how and skills which companies expect and require of their employees.

2. Problems of Contractual Research

Collaboration of industry and universities can be divided into the following categories:

- Specific research assignments commissioned by companies,
- Utilization of university resources (performance of various measurements, tests, utilization of laboratories and apparatus, performance of simulations, etc.)
- Solving of partial assignments, alternative solutions and models for companies in the form of thesis works, internal student grants or semestral projects.

The main problem in this area is the different work philosophy at universities and industry and, therefore, dissimilar expectations from potential collaboration.

Companies expect quick solutions to critical problems from contractual research (companies solve simple problems using their own resources). The notion of some companies that these activities will be cheaply and quickly provided for in the form of semestral projects or graduates´ theses is a big misconception.

On the other hand, university staff are usually very busy in their pedagogical work, research activities, formalization of conclusions and administrative-technical work. Therefore, it is not realistic for them to dedicate all their time, over a longer period, to a single project. Long-term projects, which adapt to the internal working organization (academic year schedule), are more suitable for universities.

Complicated administration of collaboration also poses a complication for the development of collaboration between a university and industry. The complex administrative process often deters parties from joint projects. The calculation and scope of overhead costs on the part of the university is a significant aspect in itself. The current situation means that project involving purchase of a larger quantity of equipment and material are becoming unfeasible, when overhead costs are calculated from the total amount of the contractual research and not from generated income (after deducting project costs).

Another major drawback for effective university-industry collaboration is the fact that there is no central database of university resources (available equipment, laboratory apparatus, devices, know-how and responsible and contact persons). At a global school level there is no clear definition of procedures, responsible persons, methods of funding, etc. Each university is trying to solve this problem, there are various local databases, and even whole university projects, but there is no conceptual approach and a common source for searching (publishing) information. The process of how to proceed if a commercial entity is interested in collaborating with a university (who should be contacted) is often not established and elaborated. Therefore, the university´s potential may remain unexploited for the simple reason of a missing suitable contact person.

Another problem is the funding of research projects, where public research funding is available, but companies often cannot effectively use these resources. An example of cooperation where the university processed financing capacities of suitable operational programs under the EU Structural Funds for industrial enterprises is mentioned by Kušnierz (2011). Kozel (2012) describes the project where a company won the Moravian-Silesian Region innovation voucher and a university prepared a business plan focused primarily on information and system support (using the Internet

and social networking for further communication between the company and its target groups). Examples of successful implementation of contract research in the field of electrical measurement are shown in (Kolář, 2014) and (Kolář, 2013). Another examples of cooperation between the university and industry are described in (Mikoláš, 2013), (Ministr, 2015) and (Ministr, 2014).

3. Transfer of Innovations from Universities to Industry

During transfer of innovations to commercial applications the difference to contractual research is that the initiative is on the part of the university. The result of academic staff work or research project solution is a new invention, patent, innovation, methodology, prototype, applied solution. However, even the most brilliant discover or invention will not turn into a commercially applicable solution by itself. Even in this area there are processes which are more and less successful.

At VŠB-Technical University of Ostrava there is support for sourcing and transfer of innovations at whole university level (Innovations Support Centre, http:\\agent.vsb.cz). However, many university staff have little or no knowledge of how to use this support and what procedures are used to transfer innovations to industry.

Recently, VŠB-Technical University of Ostrava, Institute of Economics and Control Systems was involved in solving the EARN international research project (European Automation Resource Network, 2011-2014), which, amongst others, included mapping of the chain of transfer of innovations to industry at various universities. The main project coordinator was the university JAMK Jyväskylä, Finland. Besides VŠB-Technical University of Ostrava the project included participants Vorarlberg University of Applied Sciences (Austria) and University of Applied Sciences Esslingen (Germany). The aim was also to compare how transfer of innovations is approached by all four project participants and finding the best possible procedure which would be universally applicable.

The innovation path in Finland is linked to the regional innovation structure including local authorities and innovation services. The present situation is scattered: there are separate organizations and ‘help desks’ where the innovator can turn to but the process is not integrated into the HEI education and R&D activities.

There is a difference between innovation and invention. Innovation exploits new ideas leading to the creation of a new product, process or service. Invention is useful only for the inventor. Invention transforms into innovation if the invention improves some product, process or service.

One of the goal of the EARN project is to improve the ways of ensuring the good transfers of ideas, thoughts and innovations from the university environment into practical use in industry. The aim is achieved by creating a clear innovation process path for students and university staff by planning and taking into use the innovation process which can vary from university to university.

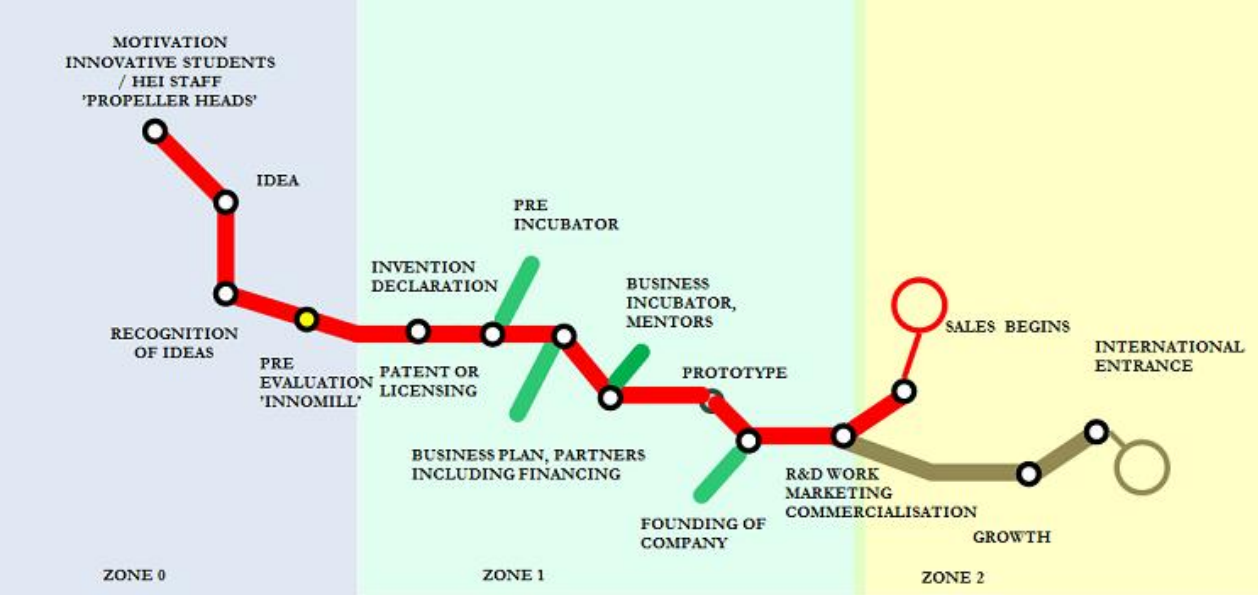

Figure 1 Innovation path for students and the HEI staff at Jyväskylä University of Applied Sciences Finland [Author: Seppo Rantapuska]

The proposal of innovation chain from JAMK University, which also includes students' ideas, is shown in Figure 1. Zone 0 represents the area of academia in the specific university faculty. Zone 1 falls under a specialized department for all-university activities for fostering innovations, zone 2 represents an area of commercialization of the idea. The idea of the chain is as follows. If students come up with new ideas within a project solved at the university, and an academic worker recognizes the commercial potential of this idea, s/he contacts the competent department of innovation. If the innovation has a commercial potential, the author of the idea obtains financial support from the university so that s/he can develop a functional sample. Depending on the nature of innovation, one of the following procedures is selected (marked in green colour in the diagram) – support of the creation of a business plan, support of setting up the person's own business (microcompany), or finding a business that would be interested in the idea. The next step is to create a prototype, which in this context is understood as a product or service that is ready for commercial use. In Finland, the city also fosters collaboration between companies and the university; the city financially supports projects related to knowledge transfer from university to commerce.

The integration of education and R&D&I best practices developed in EARN project has been or will be taken into use in partner universities. This will continue after the project as the European Automation Resource Network (a network environment for resource sharing between partners - laboratories, equipment, offered courses or training, know-how, consulting and learning materials) and serve for both - industrial companies and also automation education at the universities.

4. Preparation of Graduates

Even though the share of the population with university education is continuously growing, it contrasts with the permanent shortage of graduates of technically focused professions. This trend is very strong particularly in the field of automation and information sciences. As Vilamová (2012) stated, rises emphasis on the growing complexity of competency and high specialization of staff, as well as the requirements for excellence and narrowly defined professional skills.

During communication with companies and discussions of what they expect from graduates and potential employees, certain repeating insufficiencies surfaced:

- inflexible leaning plans – forma emphasis on education according to certification – resulting in slow changes, teaching of "obsolete" subjects and difficult application of current trends in curricula
- lecturers who are not developing themselves – teaching procedures which are no longer contemporary; while current trends are not included in curricula
- emphasis on memorizing and theoretical knowledge – but students don't know how to apply and use knowledge in practice
- universities teach and practice subjects which have no practical use at the respective level of studies – e.g. emphasis on general and conceptual procedures at bachelor-degree level, without knowledge of technical backgrounds and necessary practice (an example at VŠB is the subject Systems Integration, requiring extensive cross-disciplinary know-how and experience, which is however unsuitably included in curricula in the second year of the bachelor degree)
- insufficient development of communication skills and students are not pushed to independent solving of problems – students don't know how to put forward questions and are passive.

Also, on the part of companies, everything is not ideal in terms of collaboration with graduates and we see unrealistic expectations. Companies sometimes expect quick results with little effort and cheaply, as the result of semestral projects or graduation theses of students. Companies are of the opinion that in this way they can solve their own lack of resources (and thereby a critical project situation) or some really complex problem for which they currently don't have capacity. But solving of critical operating problems is not a suitable type of work for students. Students do have a fresh approach, ideas, they are not hindered by operating routines, etc., but, on the other hand, results are limited by the academic year schedule (the graduation assignments and results contained therein are available at VŠB from 30.4, i.e. deadline for handing in assignments) and also by the abilities of the students (and therefore the risk that the students will not be able to handle some assignments).

There is also a reluctance to collaborate with universities and students during their studies (and thereby model potential future employees); companies don't want to invest energy and money in someone something without an immediate effect.

The above said problems with education and preparation of graduates for work is partially also caused by organization of work, where academic staff, besides research assignments and pedagogical activities, spend excess time with administrative–technical activities.

For example, teaching of automation in specialized laboratories requires, besides actual preparation of courses, study materials and examples for practicing, time for commissioning equipment, and maintenance and service (which must usually be periodically repeated after each semester). At Czech universities this is done by the laboratory administrator, which is typically the academic staff providing education in the respective laboratory. However, at partnering universities in Germany and Austria, administration of laboratories and maintenance of equipment and apparatus is done by specialized staff that closely collaborates with the lecturers in preparing and implementing. The lecturer can therefore concentrate on teaching (research) instead of losing time maintaining equipment.

There is also a significant visible difference in the approach of foreign universities to supporting application of results from students´ graduation assignments in the commercial sector. The Department of Automation at the University of Esslingen (Germany) employs a person whose sole job is to support the commercial application of graduation assignments – whether in the form of marketing products, initiating collaboration with companies which are interested in using the results, and even providing support by incorporating micro-companies (with the aim of creating functional companies based on the achieved results).

At VŠB-TU Ostrava, there is an effort to interconnect learning and practice more. At the Faculty of Mechanical Engineering, teaching is guided toward creating teams for solving projects in programming (Farana, 2012a) (Farana, 2012b) and (Fojtík, 2009). The idea is to offer students an alternative option that will motivate them to better knowledge acquired through teamwork. At the Institute of Economics and Control Systems we started cooperation with the company ICZ a.s in project solution within the scope of the subject "Analysis and Design Systems" in 2014. ICZ defined assignments for semestral projects and provided consulting support during the solution.

5. Proposals for improvement

Improving cooperation between technical universities and the commercial sector is not a matter of a few specific proposals, but it is a long process. Nevertheless, we can give several recommendations based on a performed analysis and our experience.

- On the level of departments, the employee responsible for the communication with companies should be appointed. This worker has to be aware of the department possibilities (technical means, know-how offered, personnel structure, and financial possibilities). It is also important that this function is not purely formal; the appointed worker of the department should have an inner motivation to pursue this activity. It is not always ideal to fill such a position only based on the titles and previous functions.
- Administrative process should be dealt with in case the company shows interest in contract research (i.e. it has to be determined who should be contacted, what documents are to be handled, what happens during the approval process, how the economic aspects of the given requirement are addressed, staffing ...)
- Like at the partner university JAMK in Finland, it is advisable to prepare a procedure for involving students and using their ideas to be commercialized. The procedure prepared in advance should contain a well thought-out way of funding the stage, in which functional models or prototypes are created.
- It is also important to carry out the audit of staffing and workload of staff. If it is possible from technical and personnel point of view, it is appropriate to separate the educational-research work from the work of the technical-administrative nature. In general, the scenario where everyone is doing everything should be prevented.
- If possible, manpower should be allocated for project support in case of joint projects business-university (searching possible sources of co-financing, preparation of applications for support, administrative project management).

Cooperation with the commercial sector in the area of contract research can also operate more effectively if facilities, laboratories, technical equipment, services and expertise that the workplace can offer to companies are audited. There is space for creating an information system that provides information related to each service on how the service can be used, under what conditions, and

contact to the responsible persons. In the framework of the aforementioned project, EARN, we began to create an information system, accessible to the public on the Internet – Figure 2 shows groups of services offered by a consortium of four universities for the commercial sector.

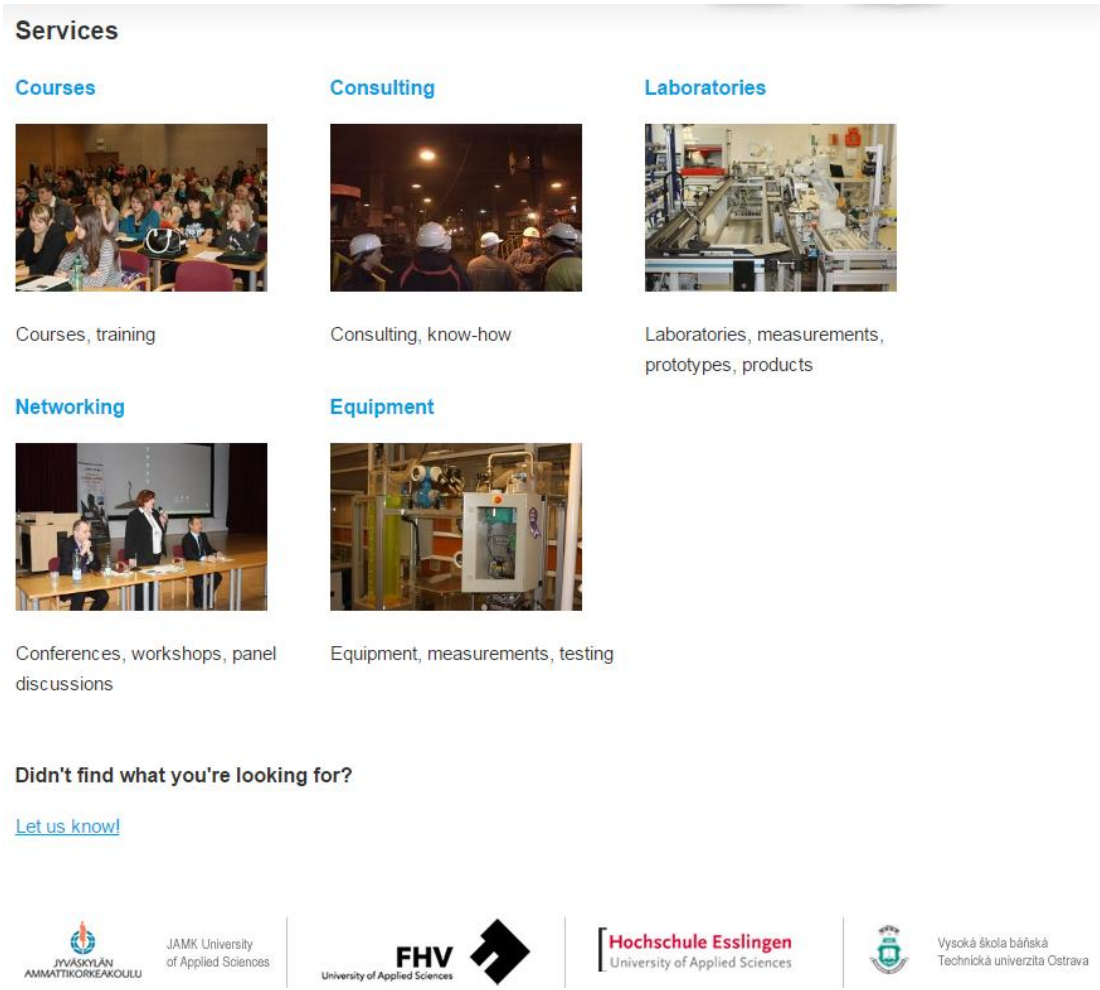

Figure 2 Screenshot from EARN information system – services offered

[Source: http://www.earnproject.eu/en/homepage/services]

Companies (or public institutions) can get information about services or facilities, and if they do not find the appropriate service, they can use an inquiry form. Other universities, for example the University of Miskolc (Hungary) and WSG Bydgoszcz (Poland), have already expressed interest in the integration into the system.

6. Conclusion

The functioning of universities and the extent of collaboration with industry is primarily affected by financial resources. The scope of assigned resources is dictated by economic and political factors. Similarly, certain administrative procedures are given by legislation and regulations of the Ministry of Education. However, in numerous other areas it is possible to achieve improvements – simplification of procedures, conceptual work, working with human resources and particularly improved communication with the commercial sector. One of the goals should be the increase involvement of commercial entities in financing research and increasing pressure on universities of applied science to achieve results applicable in industry.

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SOFTWARE QUALITY ASSURANCE COMPETENCE CENTRE

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Keywords

Academic industry collaboration, Software Quality Assurance, Competence Centre, testing

Abstract

The main contribution of this paper lies in the demonstration of a real academic-industry collaboration in the field of Software Quality Assurance. This collaboration is illustrated on the example of the Software Quality Assurance Competence Centre, being a part of the Faculty of Informatics and Statistics, at the University of Economics in Prague since 2012. Two successful projects implemented by the SQA CC are presented to illustrate the core activities of the competence centre. The main areas that are specific to competence centre management are identified and further discussed in lessons learned.

1. Introduction

As software expansion accelerates into the majority of medium and large enterprises and at the same time software acquisition costs decline thanks to an emergence of new technology and development methodologies, application development starts to focus on the issue of quality in software development as a way of gaining a competitive advantage. A number of authors as for example (Osterweil, 1996) or (Orso & Rothermel, 2014) confirm such a trend in application development. Moreoever, Jones & Bonsignour (2011) dealing with the issue of quality in their book the Economics of Software Quality identify potential cost savings in achieving high quality when developing a software product. It holds true that the larger the software project, the greater the savings. Indirectly, this fact presents a reason for pursuing high quality in projects and confirms that quality strengthens company's competitiveness.

Continuously, costs and investments into information technology have gradually been falling in the United States as well as in Europe since the outset of the financial and economic crisis. Companies strive to minimize their IT related costs to save company's financial means, increase operational efficiency and profit. The merits that distinguish strong software companies from their competitors are quality, reliability and low maintenance costs of software. These merits are crucial for European and American companies seeking inexpensive but reliable partners for software development.

Winter et al., (2011) point out that instead of the traditional approach to quality (i.e. complete, testable and consistent requirements, traceability to design, code and test cases, and heavyweight

documentation) agility is needed due the demand for continuous and rapid results in a world of continuously changing business decisions.

With an increasing role of software quality, the issue of human resources that actively take part within the development process and shape the quality of produced software becomes an important success factor, especially the level of knowledge and experience. However, a research focused on the level of testing and quality management in software companies in the Czech Republic (Havlickova, 2012) showed that the employees engaged in shaping product quality had a very low level of understanding of basic concepts in the area of software quality. The research also pointed out a low availability of managed and structured training on quality management and testing aimed at the particular employees. This lack of training and education on quality management within software companies provides an opportunity for universities to engage in practice and provide expert guidance in this field. The knowledge of academics and their experience from the research field represents a substantial source of know-how as well as an opportunity to enhance company's processes and operation. On the other hand, collaboration with practice provides universities with an insight in practical business world and helps them to enrich course syllabus with real life situations and also better prepare the students for their future career.

Mandviwalla et al. (2015) point out that an academic industry collaboration is a strategic necessity in today's fragmented and turbulent economy as it addresses the human capital as well as knowledge challenges that IS practitioners and academics face.

Pilgrim (2013) states that research conducted in Australia points out to existing tensions between universities and industry regarding the design of curriculum for ICT degree programs. Primarily, universities focus on developing key knowledge foundations rather than particular ICT skills. Employers are then dissatisfied with graduates' understanding of business processes, project management and communications skills. Pilgrim concludes "that the main skills that industry requires from new hired persons are: team work, testing and evaluating capabilities, effective communication skills, quality measurement, and process improvement".

Various surveys focused on requirements of business practice on ICT managers and their coverage by ICT curricula was undertaken also in the Czech Republic, first in 2006. Doucek, Maryska & Novotny (2014) present a comparison between the 2006 and 2010 surveys and state that there was a substantial improvement in agreement between the requirements of company practice and the knowledge offered by university graduates between these surveys. Nedomova, Doucek & Maryska (2013) identified larger requirements on ICT knowledge by small enterprises than by medium enterprises which have on contrary higher requirements on "non-ICT" knowledge.

However, Software Quality Assurance knowledge domain is not explicitly covered in these surveys nor is the role of Quality engineer or Tester. To meet the growing needs of practice in the area of software quality and testing, it is necessary to educate students with adequate knowledge and skills as stated for example by Rusu et al. (2009). Rusu et al. claims that "many of the skills that students are expected to have can only be learned by doing. These include interacting with real customers with tight deadlines and budgets but high expectations, and being able to work effectively in an almost exclusively team oriented environment with increasingly complex team structures and compositions." Eldh & Punnekkat (2012) reach similar conclusions as they state that "students are taught theory of different processes, but often lack real work experience to understand their differences, the nuances and the impact that has on the work product – the software systems."

A suitable way how to enable students to participate in practical projects is the collaboration among industry and academia. There is a significant amount of research that shows the importance of such collaboration (Wohlin, 2013), presents its benefits (Lee, 2000), challenges (Runeson, Minör & Svenér, 2014) and gained experience (Bučar & Rojec, 2015).

The aim of this paper is to show the possibilities of academic industry collaboration in the field of Software Quality Assurance (SQA) and present lessons learned gained from such collaboration. This paper is organized as follows. First, the importance of SQA within IS development is outlined. Then, the Software Quality Assurance Competence Centre (SQA CC) is introduced and its main services that provides to business customers. To demonstrate provided services and core activities of the competence centre, two successful projects implemented by the SQA CC are presented. Finally, lessons learned gained from the implemented projects and personal experience are stated..

2. SQA Competence Centre

This section introduces the foundations and core activities of the SQA Competence Centre. The idea of creating competence centres at universities was introduced by the IBM Company. These centres were supposed to develop competencies in particular areas and provide them to business users and practice as a whole. This way a competence centre Software Quality Assurance (SQA CC) was established in 2012 being a part of the Faculty of Informatics and Statistics, University of Economics in Prague. The aim of this competence centre is to provide companies with expert advice and guidance in planning and implementation of software quality management processes, especially testing. Initially, it was focused on co-operation with IBM and application of IBM testing tools. Nevertheless, the competence centre had gradually become independent from the exclusive co-operation with IBM and now provides services as a fully independent competence centre using both commercial, namely IBM and HP tools being the main players, as well as open source testing tools.

The SQA Competence Centre has currently over 20 members. These include PhD students, students of bachelor's and master's program of Informatics and Information technologies. We plan to involve also students from other faculties of the University of Economics into the competence centre, particularly in the area of project management and marketing. Students have the possibility to participate in real and practical business and research projects during their studies and thus gain valuable experience. We also focus on their personal development and organize internal training and educate them in regular as well as block courses. Within bachelor and diploma theses, students develop a number of methodologies and manuals that serve as a basis for other students and also for educational purposes. Within the SQA Competence Centre, we collaborate especially with the following companies:

- NESS Czech, s.r.o.
- HEWLETT-PACKARD, s.r.o.
- TRASK SOLUTIONS, a.s.
- IBM Czech Republic, s r.o.
- Tesena s.r.o.
- T-Mobile Czech Republic, a.s.
- MSD

The SQA Competence Centre offers services in the field of quality management, which include know-how and special skills that are not usually available in the practice. These include:

- Automated functional testing using commercial and open source tools,
- Performance testing,

- Integration testing,
- Mobile application testing,
- Testing methodology implementation,
- Testing tools integration.

These areas are in compliance with the concerns stated by Engström & Runeson (2010) based on a recent survey of regression testing practices and challenges pointed out by Orso & Rothermel (2014).

3. SQA Competence Centre Projects

This section describes two examples of projects that were carried out within the SQA Competence Centre to illustrate concrete examples of academic industry collaboration.

3.1. REGAN Project

The Software Quality Assurance competence centre team successfully finished a project focused on an analysis of regression testing for the company T-Mobile Czech Republic a.s. (hereinafter TMCZ) in January 2015. According to ISO/IEC/IEEE 29119-1 (2013), regression testing is "selective testing of a system or component that has previously been tested to verify that modifications have not caused unintended side-effects and that the system or component still complies with its original requirements." There is a gap between research and practice of regression testing as stated by Engström & Runeson (2010). Research on regression testing mainly focuses on selection and prioritization of test cases with several techniques proposed and evaluated. However, industry practice on regression testing is mostly based on experience alone, and not on systematic approaches. (Engström & Runeson, 2010)

The objective of the REGAN (REGression ANalysis) project was to evaluate the possibility of regression testing automation. The project was carried out in collaboration with Hewlett-Packard s.r.o. The aim of the project was to determine a range of circa 20 systems out of a large number of available systems that would be analysed in detail in terms of possible automation of regression testing. The analytical team of the competence centre gathered information about the analysed systems, examined release and test plans, went through test case scenarios and conducted interviews and questionnaire surveys among the TMCZ's testers. The team members also participated in actual testing. This way the team gathered sufficient information to provide an adequate recommendation in terms of which systems and specific test cases are suitable for an implementation of automated regression testing including a timetable plan. This should allow TMCZ to move over testers' capacity in the future which could be then utilized for an even better assurance and management of software quality.

To fulfil this goal, the competence centre team developed a methodology for assessing the suitability of regression testing automation together with a method of estimating labour-intensity of automated testing implementation. Although the methodology was adapted and tailored to development and testing processes in TMCZ it could be applied also in future projects. Based on the developed methodology, automation could be viewed from both technical (whether it is possible to automate testing using standard tools) as well as economic perspective (whether it is feasible to implement such automated testing). Alongside, the competence centre performed an analysis of testing tools and recommended suitable tools for testing automation.

3.2. ITN Project

In the middle of 2014, the SQA Competence Centre was contacted by a Czech software company TRASK s.r.o. with a proposal for collaboration in the development a technical solution targeted at a comprehensive and integrated use of open source tools within software quality management. The proposal of this technical solution then resulted in a project aimed at development of an Integrated Testing Tool (ITN). This project involves a Supervisor (a head of the competence centre) and five students within the competence centre and two employees from Trask s.r.o.

The project rationale behind is as follows. Given the high price of commercial tools supporting testing, companies strive to utilize open source tools that are free of charge. However, the current method of deployment and usage of open source tools for software testing has a number of process as well as technical limitations. These tools are used, installed and deployed independently without any integration in place. Alongside, it is quite difficult to deploy such tools because they require numerous customizations due to their universality (openness) that prolong the entire deployment process. Currently, there is not any complex open source solution aimed at the testing area. Thus, the Integrated Testing Tool strives to fill this gap. The main aim of the project is to develop a software tool that supports software quality management within large software projects for external customers. The benefits of this system are as follows:

- Software support of the whole testing team (Test Managers, Test Architects, Testers and Programmers),
- Unified solution linking up test management, bug management and individual applications for automated software testing (functional, performance, integration and other),
- Low deployment price – the ITN will be delivered as a single functional package; that means low cost of human resources that will not be needed for installation and preparation of the environment, the ITN will allow zero software license costs given the use of open source tools.

The result of the first stage of the project lasting for one year is a functioning version of the ITN tool that interconnects test management with bug reporting and functional and performance testing. At this point, the tool is ready for deployment on a pilot project.

4. Lessons Learned

Being the head of the SQA Competence Centre for three years, I have gained a number of valuable experience that I would like to share with the expert and business community. The lessons learned are divided into three areas that are further described below.

4.1. Testing Specifics

Software testing is specific in the way that it is necessary to co-operate with the team that develops software as well as with the customer. Further, the test team members need to have an access to both the contractor's company and the customer. This access means not only the physical access to a building, but also to an information system environment. This requires administrative solutions and significantly prolongs the beginning of the project indeed.

Moreover, testing is carried out in various environments. Usually, a test environment is used and administered by the development team and an operating environment is then utilized by the customer. In this case, the testers get into a contact with sensitive company data. Thus, it is

necessary to ensure a Non-disclosure Agreement NDA is included in the contract. An NDA is a legal contract between at least two parties that outlines confidential material, knowledge, or information that the parties wish to share with one another for certain purposes, but wish to restrict access to or by third parties.

Lastly, the competence centre's provided services in the area of testing require greater knowledge and skills and are usually associated with the use of software testing tools. The problem lies in the fact that commercial tools for testing are very expensive. Thus, companies that are interested in testing services prefer a complex delivery of such services, i.e. without having to buy licenses for testing tools themselves. However, neither the SQA Competence Centre nor the University of Economics are able to purchase such commercial tools. This is why the competence centre focuses on usage of open source tools and why it strives to develop the integrated testing tool which will be then utilized within future projects.

4.2. Resource and Project Management

Managing the competence centre that has more than 20 members is quite demanding. There are several projects running at the same time within the competence centre that need to be managed separately. Thus, the overall management includes management of the competence centre and management of individual projects. At the level of competence centre management, we defined the roles of a Head of the Competence Centre, Competence Centre Manager and Competence Centre Member. The Head of the Competence Centre is an academic staff or PhD student and represents the competence centre in negotiations with partners and customers, signs contracts, conceptually leads the competence centre and decides on remuneration. The Competence Centre Manager is a student who manages the competence centre, coordinates individual projects, assists the CC Head, organizes activities (e.g. internal training, lectures), handles promotion of the competence centre and manages human resources. The Competence Centre Member works in the competence centre on individual projects or is a part of a pool from which people are assigned to particular projects. At the level of individual projects, we distinguish the role of Project Manager who manages the whole project and Project Member who works on an individual project.

To manage the competence centre, we utilize a tool for teamwork the Active Collab. However, this tool does not fully cover the needs of competence centre management. Thus, we decided to develop our own tool for managing competence centre resources and projects.

A key role in the success and sustainability of the competence centre plays human resource management. The issue lies in the different degree programmes within the Czech Republic education system – the bachelor's and master's programmes. As we require the students to poses a basic level of knowledge in programming, software engineering and testing prior to joining the competence centre, we look for students in the second year of their studies. However, most of the students are about to finish their bachelor studies when finally completely trained, assigned to a project and fully engaged as the bachelor's programme lasts only for three years. It is not certain whether the students will continue to the master's programme at the University of Economics and thus it is hard to predict the number of active members within the competence centre. With the master students, the situation is even more difficult since the bachelor's programme lasts just for two years. Also, most of the high scoring students often participate in the Exchange programme and study abroad for the whole semester. This also disrupts their activities in the competence centre. A more favourable situation then comes in the case that the master students continue with their PhD studies at the University of Economics.

Another issue related to resource management that we permanently struggle with represents the time constraints of individual students. In case of a project for practice, a full-time involvement of

project members is usually required. However, the students are not able to satisfy such time requirement because they study full time and some of them even work on top of that. Thus, it is necessary to cover for the students and double their number in order to achieve a full working capacity. This significantly increases the complexity and demanding character of such project management. From the experience, innovative projects that are carried out by the students within their bachelor or master theses have proved to be an effective and functioning model.

4.3. Knowledge Management

Third key area for the sustainability of the competence centre represents knowledge management. Due to the high fluctuation rate of the competence centre members explained above, it is essential to preserve and transfer the knowledge acquired by the students throughout the project to others. There are already a number of resources that have been created within bachelor, master or PhD theses and can be made a good use of by the competence centre. These include the following resources:

- Testing methodology following the international standards,
- Selenium tool testing methodology and manual
- HP Quality center test management tool manual,
- Automation testing methodology and others.

5. Conclusions

The main contribution of this paper lies in the demonstration of real academic industry collaboration in the field of Software Quality Assurance. This collaboration between universities and business was showed on the example of the Software Quality Assurance competence centre, being a part of the Faculty of Informatics and Statistics, at the University of Economics in Prague since 2012. Two successful projects implemented by the SQA CC were then presented to illustrate the core activities of the competence centre. Finally, the main areas that are specific to competence centre management and contribute to its demanding nature were identified and further discussed in lessons learned.

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CREATION OF SYSTEM SUPPORT FOR DECISION - MAKING PROCESSES OF MANAGERS

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Keywords

System support for decision-making process, strategic management, cooperation, industrial companies, school, managers, Factor analysis, Porter's analysis of competitive forces, SWOT analysis

Abstract

The global economic crisis significantly affected industrial companies in the Moravian Silesian Region. These companies are now looking for new market opportunities in the current competitive environment and therefore need the correct structure of information. And that is why a consulting company ESAP Consult in cooperation with the research team representing the VSB-TU Ostrava, in particular the Institute of Economics and Control Systems of the Faculty of Mining and Geology, are jointly working on creation of a complex system for processing the strategic analysis in industrial companies, which should greatly help the managers with making thorough decisions when dealing with current needs of their company. This article presents a SGS project called "Creation of system for competitive analysis of the industrial companies" and demonstrates selected outcomes of this system particularly Porter's analysis of five competitive forces and SWOT analysis.

1. Introduction

There are many factors that may influence the decisions of managers for example the changes within the whole society that further influence other subjects on the market, especially customers. That is precisely why the managers should be provided with information that will help them make the right decisions. The information they will receive should be in optimal amount, quality and time.

According to Dostal (2005) it is always good to have the correct data at hand (simple partial statement of current state of things) and use them as an information source for creating consequent information that complexly explains the phenomenon. The information is formed as structured data. Only if the information serves to comprehend the whole context and therefore allows the managers to promptly react to current development, primarily in the strategic level, we can speak about knowledge.

However, this information quite often remains unused. Negative phenomena resulting from these findings are remarkable. The managers are looking for grounds upon which they could build their

decisions. Most of the companies admit that they do not have the full summary of their business activities results. Almost half of them believe that this may cause future mistakes in business decisions and therefore have negative influence on their business (Kozel, 2011). But a purposeful search, selection, processing and use of information helps to facilitate the decisions at all possible market decision-making stages – strategic, tactic as well as control.

1.1. Strategic management and system support

The fact, that managers at various levels of decision-making process demanded the necessary system support, is proved by number of articles published in the past by authors such as Houndeshel (1987), who devoted his article to MIDS information system that helps managers of different organizations to make decisions, improve production and provided guidance in many more business aspects. In the same year (1987) Henderson described how to set the instructions for monitoring and control of administrative activities. Miniati (2012) also proves that the above mentioned is still a current affair, not only in business or industries, by publishing an article bringing information about a system aiming at supporting the decision-making (DSS) for management and technological planning of field hospitals. He also states that when handling the planning part in the field hospitals the use of the DSS in emergency situations lowers the large number of variables, which should be taken into account in case of a disaster.

At present, the main problem is not the lack of information, but its selection. The information must be selected so that it may serve as an entry that would help to make better strategic decisions within the companies. Different known analysis about the market and entities operating on it usually miss the most essential measure – the complexity. With their growing size and economic power, the companies prefer research services that provide wide and deep knowledge of the market, with the possibility to consult and prepare specific recommendations. To be able to do that, it is necessary to have a systematic solution of continuous collection and analyse the information from more sources at once. The systems Market and Business Intelligence present such solution (Crowley, 2015). They are based on understanding of the market, companies, competition, customers, consumers and all thus obtained information is evaluated within a context. Both of the systems use data gained from surveys, researches, accounting, CRM databases, and so on. And when the information is then correctly used by combining the sources, we will get the desired synergic effect.

1.2. Cooperation of private companies and state university

The global crises, at the beginning of this century, resulted in dramatic cut-downs, when most of the companies started to lower their expenses and costs. It is the high price of the previously mentioned Market and Business Intelligence systems or other professional alternative analytic systems that more and more often drives the companies into cooperation with the academic researchers. From the part of the universities, this kind of cooperation is very much welcomed as it brings along an alternative source of income that the schools usually lack from the state funds. In the following paragraphs you will read through a short summary of good practice when the cooperation of companies and universities was put into specific results. In particular we are referring to cases that involved members of VSB-TU Ostrava research team or their close co-workers.

The most common form of cooperation is called contractual research, when the companies seek for help at universities on the basis of contractual or invoicing mutual agreement. This kind of cooperation is presented by e.g. Danel (2013). He points out a cooperation that led to creating the informational support of quality management and sale of coal and coke for a mining company. Řepka (2012) and Danel (2012) inform in their articles about cooperation between companies and

schools that focused on improving the quality of education (and therefore also the graduates) in the field of automation and programming. Samples of contractual research results including the findings of both of the article's authors, are presented in the paper from the IDIMT 2012 Conference (Kozel, 2012). A local company needed help with their launch and therefore approached the VSB-TUO with a demand for a business plan. Both parties had agreed on an additional cooperation that included a creation of a functional information system for the target groups of the submitter and involved new communication platforms (social networking, above all Facebook) in marketing communication of the submitting company.

The companies appreciate the vocational support of the university workers especially in the cases, when there are not enough of secondary data from their own operation. However, they are unable to process them or make a correct evaluation out of them. Such case was presented by Janovská (2011), whose article points out the assistance of academic sphere and steel companies hit by the global crises, with setting the cost of steel production by the means of real economic and mathematic methods of structural analysis dealing with fuelling and complexity of operation. Another article, published by Ministr (2014), presented a mutual cooperation leading towards creation of an eco-system for academic-industrial cooperation. The cooperation is described mainly in the sphere of information and communication technologies used in the condition of Czech market and university systems. Other form of cooperation between the companies and universities provides the academic workers with consequent feedback. Those workers then offer the companies the results of their researches, which can be used in their operation, just like it was done in case of the comparison of factors of the innovation tools regarding the information and communication technologies in small and middle sized enterprises (SME) in the Czech-Polish border area (Hančlová, 2013). The results confirm the rising trend in the use of management information systems.

2. Basis of the SGS project

The Market and Business Intelligence systems are too costly for many companies as they cannot be built without a purchase of external data and without the access to knowledge portals and hubs. And that is precisely why they need a tool that will provide them with adequate system support and more importantly will meet the criteria that are essential for working with the information systems. For this very reason the project SHS no. SP2015/36 "Creation of system for competitive analysis of industrial companies" has been submitted. The research team from the Institute of Economics and Control Systems of the VSB-TU Ostrava in cooperation with the consulting company ESAP Consult has been working on a system that will meet the above mentioned requirements.

2.1. Main aims of the project

The aim of the SGS project is a certain part of an ambitious plan. In particular it is the creation of a system, model and software security that would process the competitive analysis of industrial companies. The main objective of the project is then divided to partial goals. Firstly a database with parametrical indicators that will be used to analyse the competition would be created on the basis of researches that were carried out among the managers in B2B companies.

Another important goal is to create a model of mathematical apparatus that would set the statistical data and is linked to another goal – creation of visualized outcomes through positional maps and graphical outputs that are suitable for strategic decision-making of the top management working in industrial companies. The last partial goal is to design a user-friendly SW security that would be

based on equipment that is commonly used in companies, such as the MS Excel spreadsheet that uses the utilities and menu in Visual Basic language.

2.2. Topic of the project

By using the methods of operational research and sophisticated statistic procedures, the topic of the research aims at creating the analytical tool for industrial companies when evaluating their competition. The tool must be done so it is possible to quantify the entries by the means of questionnaires and then work these results up to visualised graphic outcomes. The research team from the Institute of Economics and Control Systems of the HGF VSB-TU Ostrava puts its efforts together and tries to find parameters that would allow them to clearly specify and compare the biggest competitors within the given industry, standardizes the outcomes and creates a database of possible parametrical indicators that would help to evaluate the competition. For this very reason it is essential to get all possible and available theoretical sources and background researches and find out the current state of knowledge, particularly in the following two fields: strategic management and its system support, competitive analysis.

The importance of strategic management of enterprises came through at the beginning of millennium due to negative impacts of the global economic crises. It was confirmed that those companies placing enough emphasis on strategic management were able to get themselves out of the negative situation much faster. Properly formulated strategy must be tailor made for the company. The most important thing is to base upon the synthesis of strategic analysis results. Situation analysis done in a quality and thorough way provides a good circumstantial knowledge for the company and all that greatly enlarges the possibility to satisfy the needs of the market.

As another consequence we may state the negative global tendencies that have been leaning towards escalating the competition in many sectors, most of all industrial ones. Due to increasing competition in the above mentioned sectors there is a raising need to identify one's competitors. And if the company shall succeed in today's market, it must know its competitors very well and do its best to satisfy the needs of customers better than the competition.

3. Methodology and Selected Results of SGS Project

3.1. Methodology of SGS Project

The first step was to get the current state of knowledge of the strategic management analysis together with the state of competition from all the theoretical sources and background researches. Linked to this activity a survey was carried out in the first quarter of 2015 among hundred managers mainly from industrial companies in the Moravian-Silesian region. The survey was put together by the means of questionnaires and interviews aiming at identifying the factors that are the most significant to them. The outcome of this activity is a functional database of evaluated factors.

The results of this survey served as a basis for creating the support system for managerial decision-making processes. At present a model supported by certain methods and statistical procedures is being made. The following methods are considered pivotal: methods of operational research, multi-criteria evaluation of alternatives, comparison based on pairwise comparison, mathematical models for management decisions.

Out of the conducted analyses suitable visual tables, outcomes and graphs were gradually prepared. Consequently the user SW is created aiming at maximum standardization of analyses that were used, so that their visualized outcomes offer specific results suitable to be presented by the TOP

management. The main efforts are placed into creation of appropriate user software environment so the individual analysis can be carried out by the managers of industrial companies themselves, since usually they do not address this issue at all. Verifying of the system capability is carried out on real data of industrial enterprises, located mainly in agglomeration surrounding the city of Ostrava, in the areas of mining, metallurgy and engineering.

The methodology used in the analysis typically uses the evaluation of selected statements that express the power / ability of the investigated factors and its impact / importance to the process of achieving the corporate goals. The agreement with a given statement is expressed on a scale, e.g. 0 – 10 (0 – I do not agree, 10 - I agree completely, or 0 – no influence, 10 – huge influence, etc.). In the analyses some of the factors are pre-set and the managers / users only evaluate them or may complete the statement with their own needs, or eventually may define completely new factors that meet their needs in a more appropriate way. The values obtained for evaluation of individual factors are then calculated by the arithmetic averages. If the pre-set statements do not have the same influence on the submitter / company, the arithmetic average is converted to a weighted average. It is only used in that case when individual values have different importance / weight.

3.2. Selected Results of SGS Project

3.2.1. Research of the importance of the system support factors for its users

The first primary data were collected among the managers of companies settled mostly in the Moravian-Silesian region. For the means of this article the most important was to find which things were evaluated as the most important tools when using the tools of system support. The managers were given a list of thirty characteristics and their task was to evaluate them on the scale of importance from -3 (absolutely not) to +3 (yes without a doubt). A factor analysis was used to evaluate their answers. Factor analysis (Hendl, 2006) is a statistical method that helps to explain a large number of observed variables by a smaller number of latent variables – so-called factors / components. The analysis describes every variable as a combination of impacts of individual factors. That is why the aim of the research team lies in naming the small number of new factors that are created from the large number of original characteristics. The Principal Component Analysis, Rotation Method: Varimax with Kaiser Normalization, were used.

In the final rotated matrix (see Table 1) the research team determined three new pivotal factors arising from the fourteen original characteristics. These newly formed factors have an essential importance for the managers and above all their satisfaction with the new tool of system support (Factor/Component 1: transparent, F/C 2: simple, F/C 3: complex). It is therefore important for the research team to create a simple and user-friendly SW tool allowing the managers to find their way through the results and make appropriate decision. To achieve this result the outcomes must be in form of clear quantifiable graphical outputs. To match the decision with the relevant and specific situation it is essential to remember the last, but very important factor – the complexity. For this reason the new system will consist of a number of analysis that will provide the manager with a different view on the perceived issue.

Rotated Component Matrix[a]	Component			
	1	2	3	4...
definite	0,765			
quantifiable	0,721	0,317		
chaotic	-0,714	-0,435		
clear	0,616			
well-arranged	0,552	0,397		
summarizing	0,464			
comprehensible		0,679		
intuitive		0,624		
complicated	-0,453	-0,589		
friendly	0,314	0,476		
complete			0,657	
partial			-0,529	
maximal			0,358	
overall			0,326	
....	....	....	....	....

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

Table 1: Factor analysis outcomes

3.2.2. Porter's five forces analysis and SWOT analysis

Currently there are two analysis of the system support ready to be used by the managers. These were tested by the members of our research team or representatives of companies that are clients or are otherwise engaged with the consulting company ESAP Consult, a company actively involved in the creation of the system. Detailed presentation of both of the functional analysis will be a subject of other articles, this one only focuses at presenting the input and output tools.

In the basic user menu of both analyses (Figs. 1 and 2), the manager / user can select whether to start the whole analysis or only run some part of it (e.g. the bargaining power of buyers and the company strengths).

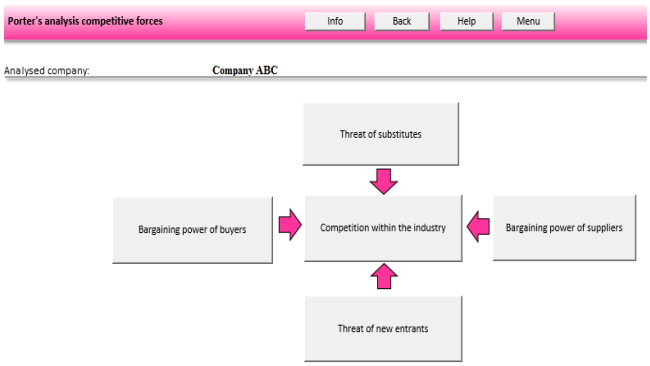

Figure 1 – User menu of the Porter's analysis

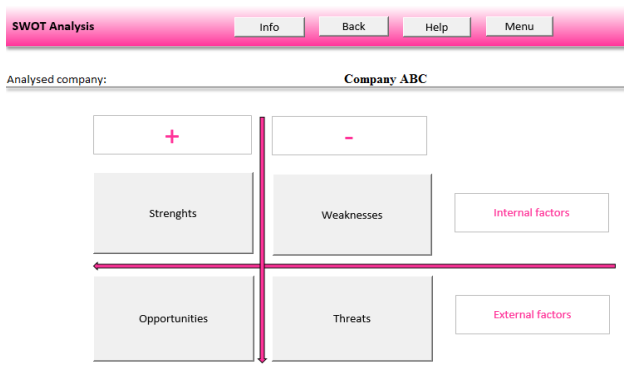

Figure 2 - User menu of the SWOT analysis

Then by the use of set of tables the manager enters the secondary data to the system (e.g. the volume of distributed production) or carries out a primary evaluation of characteristics and factors that are pre-set / written in the table. The outputs of both analyses are simple adjustable and quantifiable tables and graphs. The manager may once again select a table according to their current need. Figures 3 and 4 show both: the outcome of Porter's analysis in form of tables, as well as graphs with outcomes displaying both of the analyses.

Competitive force	Average evaluation
Competition within the industry	5
Bargaining power of suppliers	4
Threat of new entrants	7
Bargaining power of buyers	9
Threat of substitutes	5

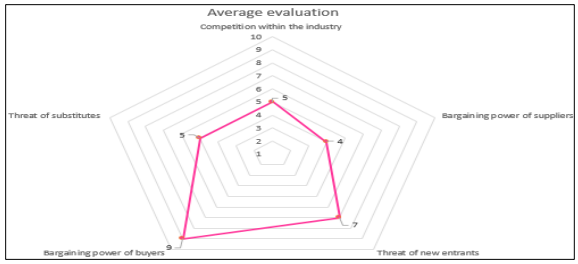

Figure 3 – Examples of outcomes of the Porter's analysis

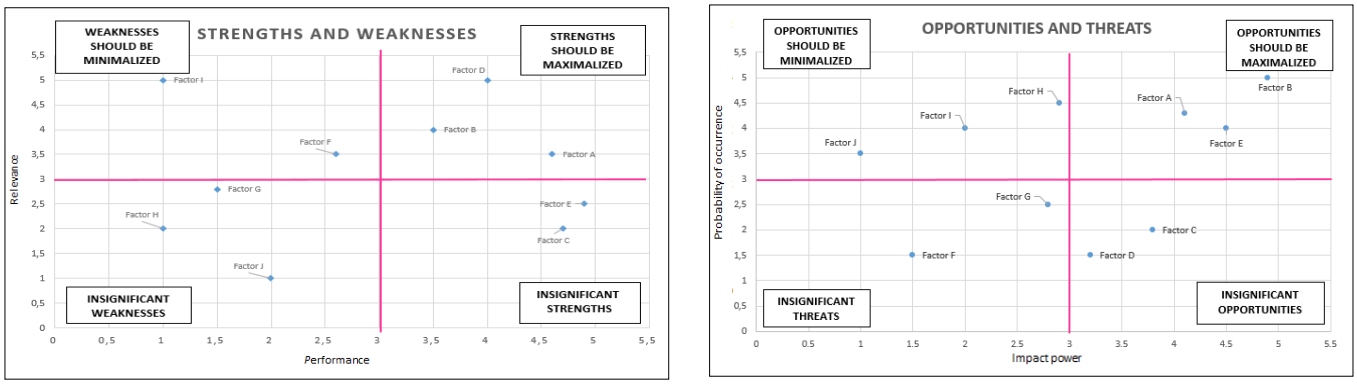

Figure 4 - Examples of outcomes of the SWOT analysis

4. Conclusion

The article presents one example of current cooperation of the Institute of Economics and Control Systems HGF VSB-Technical University of Ostrava, with current business practices. The vocational potential of individual team members and joint cooperation with the partners from the consulting company, who are in close contact with managers of selected industrial companies, brought about the first results in creating the new system support for decision-making processes of managers.

The SGS project is also a part of this cooperation. It has clearly defined methodology and progress chart of the results, so each step is made in the context of the project's assignment and it is logically linked. Even in this phase of the project this fact has contributed to the accurate implementation of the primary research carried out among managers of industrial companies. The research serves as groundwork for further system preparation in order to meet the requirements of its future users, i.e. the managers, who will use it in their decision-making process.

Given the scope of the article, it is not possible to present all particularities of the already programmed analyses. This model will be consequently developed and tested on other important industrial companies with the aim to comply with three major requirements the managers demand from the system – transparency, simplicity and complexity.

5. Acknowledgement

The work was supported by the specific university research of Ministry of Education, Youth and Sports of the Czech Republic No. SP2015/36 Creation of competitive analysis system for industrial companies

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SOFT SKILLS DEVELOPMENT DURING LONG TERM SUPERVISED PLACEMENT

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Keywords

Education´s demand, long-term placement, project learning, supervised workshops, soft skills and hard skills

Abstract

The objectives of this paper are to explain the experience with the conceptual and systemic approach enable to align the soft skills and hard skills in the context of educational process. Therefore in the year of 1993 the interdisciplinary program Business Informatics started at the Faculty of Economics, Technical University of Liberec. The major aim of this program was to equipped university graduates with a spectrum of knowledge, abilities and experiences in accordance with demands of their real or potential employers. Since this time we have repeated continually research about demands and needs of business environment for our graduates. Main topic of the research of business demands was to teach students to work on projects in teams. Their education has to be as near as possible to business reality. Content of majority of most learning modules was during time totally changed. What stays stable is the integration of long-term supervised industrial placement into study program and working with project as an integrated part of many modules. This is the best way how he students can learn not only application of high technologies in realisation of real business projects but also soft skills.

1. Introduction

The university's role in producing graduates in various fields to fulfil the market needs does not focus on academic achievement, but also on generic skills or "soft skills" required for them to compete in the global market. Furthermore, employers now place great importance on generic skills and personality in choosing their future employees. Soft skills including communication and interactive skills, problem solving skills, or behaviour skills these are necessary to be acquired in order to apply technical skills and knowledge at a workplace (Weber, et al, 2009). Hard skills are clarified that they are techniques or working management that can be quantified and measured. On the contrary, soft skills are skills that involve the relationship between a person and social surrounding. Hard skills can be learned and trained explicitly; whereas, soft skills are typically developed through personal experience and ref lection. At the Faculty of Economics, Technical University of Liberec, we tried to find very soon after the "velvet revolution" our own way for designing of an interdisciplinary program Business Informatics (BI). The program is based on the best practices of Great Britain and Switzerland and on demands of business environment for

knowledge, abilities and experience of our graduates, more in Skrbek and Antlová (2007). Especially orientation on environment was not always well accepted by tutors of the university. The main argument was that university research – and on this base also the education – has to be absolutely independent. Companies had also very low interest for cooperation – they saw no profit of any support of universities.

This situation was dramatically changed during last years in the Czech Republic. The researchers from University of Economics Voříšek and Novotný (2007) realized broad research about demand and supply analysis of ICT specialists in the Czech Republic. Demands of companies for different types of IT specialist were compared with the profile of graduates of faculties of economy with their specialisation in informatics.

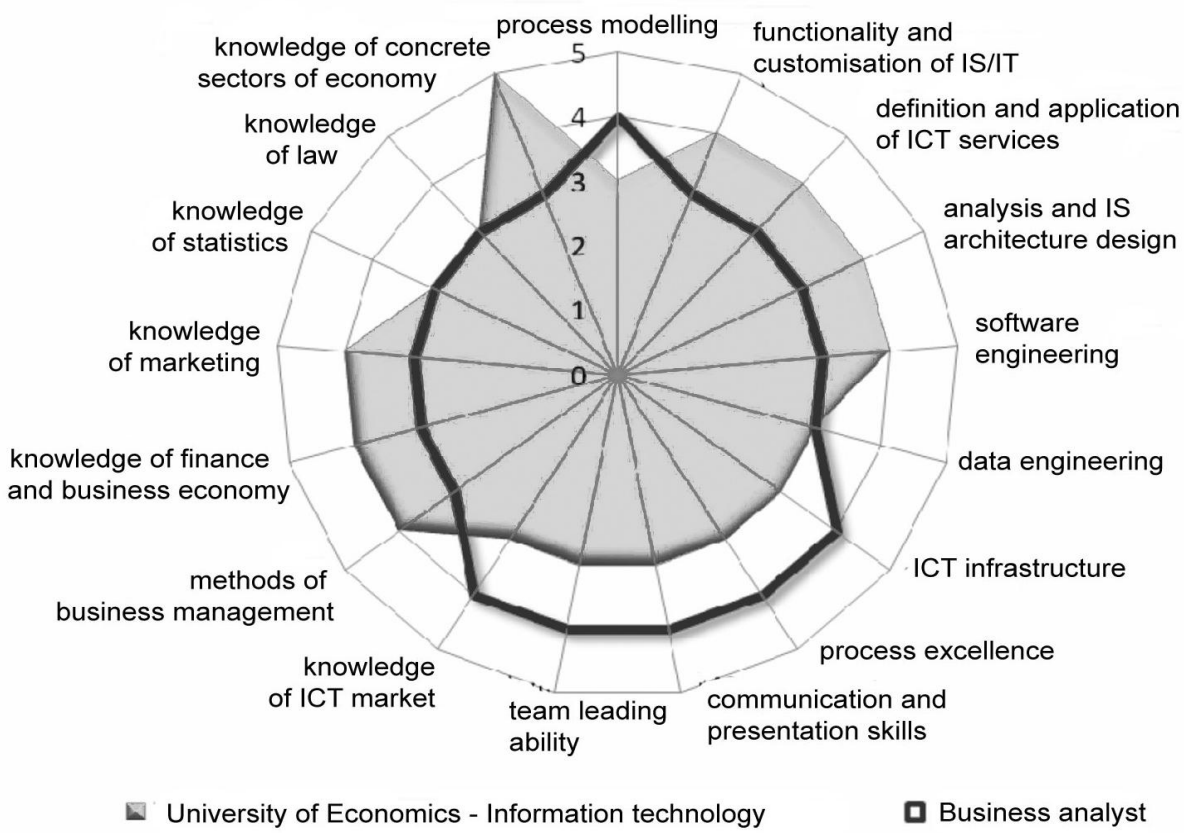

Figure 1: Profile of ICT graduates and demands for profession of Business analysts, Voříšek and Novotný (2007)

Main results of this project are presented in Doucek et al (2007). Research in the field of ICT started to be an inspiration for research in other disciplines as well. The results of them are similar. They stress attention of university managers to close cooperation with real or potential customers (firms, companies) of their products (students). The ideal way - that is currently supported by Forum of Industry and Universities - is the cooperation in the frame of long-term practical placement based on the integration of students into project teams of individual companies.

2. Materials and Methods

Integration of project learning approach enables to combine soft and hard skills. This approach was the main factor during the design of the multidisciplinary program Business Informatics. It was

originally designed as bachelor program that integrated two semesters of supervised placement in the frame of the 3rd year of study. During first ten years we reached accreditation for all higher levels of Informatics programs – master program of Managerial Informatics and doctoral program of Informatics and Economy. These programmes from the beginning of their existence reached remarkable success in exercise of their graduates. One of very important reasons of these results was very close and intensive contact with business surroundings and common projects. The reason for our steps was the expansion of information society and globalisation aspects that asked for radical changes of the profile of our graduates, more in Skrbek (2007). The conflict is done by more wide overviews through business and entrepreneurial disciplines and ICT applications (as a main enabler of changes and development) on one side and the ability of students to get down very quickly to the nitty-gritty for solving specific problems.

There were several important implications for building Business Informatics program:

- The days of major companies annually absorbing vast numbers of newly qualified graduates are gone. Although opportunities still exist with the bigger companies they are few and far between.
- Recruitment is commonly the responsibility of smaller business units rather than centrally administrated.
- Many of the roles previously filled by graduates within large organisations are now found within small and medium-sized enterprises.

These factors and others general facts (such as, growth of higher education) explain why today's students must be oriented to their own career management long before completing their degree. They will need to be able to "design" their product or service that will satisfy customer expectation – those of prospective employer. To take advantage of any advance orders the product must be ready for sale before finishing university. Its specification should be based on both: a knowledge of the marketplace (demands of employers) and own capabilities (to be excellent goods on business market).

Through 21 years of existence of BI program we got enough experiences that allowed us to continuously improve this program. The whole time of managing the Business Informatics we were permanently trying to find new aspects. Very soon after first contacts with co-operative companies we set up an important aim – as much as possible to integrate project learning approach into study program and content of regular modules. Current need of firms is to have ability to respond dynamically to changes of competitive surroundings, market and global and local influences – especially in context of potential of modern information and communication technologies. One of the most important effects of this situation is new demand for qualifications of graduates of faculties of economy. In addition to "traditional" disciplines more and more requirements for "soft skills", so to be useful member of teams. We found that optimal way for forming appropriate profile of our graduates is to give them opportunity to learn needed style of working abilities during their study. Major new social abilities that are required by business environment are following:

- to be able to work in teams,
- to be a team member in a project,
- to be a leader of a team in a project,
- to prepare a project for application,
- to present ("sell out") results of a project.

It is rarely possible to find appropriate ways to learn students the art to work with project in the frame of individual modules. Better effect can be reached through workshops, where students can work in teams on projects that need to use, apply and integrate knowledge of more disciplines. In teams they are getting in such way important skills for common work, sharing information and realizing project with synergistic effect. Anyway such kind of workshops during introductory semesters are necessary steps before realizing pivotal part of ability to work with project – long-term supervised industrial placement.

Workshops as very important modules of first four semesters allow in the form of project learning use and practice knowledge of various theoretical modules. First two semesters of workshops are called "Practical exercises". The main aim is based on simple projects to teach students important principles of team work and to present results of realised projects. Workshops in next semesters ("Practical training") are aimed on special concrete topics (projects) and problem solving approach. Their topics are often going out of practical needs of society and companies. The workshop of the final semester in the 2nd year is used as preparation for placement period. Every year we are repeatedly trying to find appropriate partners for placement period: students with their interest to work on real projects of concrete business partner, and firms with ambitions and interest to introduce and integrate students to their project teams.

3. Working with projects during and after the placement

The multidisciplinary program in the frame of placement period asks for integration of following skills:

- theoretical and practical knowledge in economics and business administration,
- theoretical and practical knowledge and skills in collecting, processing, transmitting, and using of data and information,
- the knowledge of social psychology, sociology and interpersonal communication.

Students have to get sufficient level of these skills in pre-placement period. Two semesters of supervised placement allow them to confront their abilities with needs of concrete companies and firms and extend their professional background. We found that there is no other way for meaningful placement period then to base it on working with projects. A project in the form as paper work (placement project or bachelor project) and its presentation is the only way for getting credits for placement period.

The topic of any project has to be set up in advance – in the preliminary agreement between company and university. This agreement also define student's supervisor in a company – mostly project manager. It is surely possible to refine the topic of the project at the beginning of placement period but final assignment has to be dated every year not later than October, 31st.

Such policy allows companies to find in advance appropriate project teams and topics for students. It is only one reason for companies to take students for placement period of long duration – their expectation of profit of such activity. The implication is that they have to give students additional information to their previous university education (e.g. in the form of special courses or in discussions and under leading of good professionals) and manage them to be useful members of project teams. These project teams consist sometimes just from two persons (student and his/her supervisor). In major examples students are working together with regular employees on project.

The whole placement period is under supervision of both sides – university and company. Employment supervisors play key roles in ensuring the success of placements. They are on regular

basis responsible for student's welfare and training; they provide feedback on student's personal development and on progress in acquiring technical skills. University tutors, normally, visit students twice during the work experience period. The visiting tutor discusses the work and progress the student is doing, how well he/she meets expectations, fits in, accepts responsibility, takes initiative etc.

During placement period visiting tutors need to be informed about the running of the placement and progress of the project. For this purpose students have to elaborate monthly "Periodic Record and Analysis". Purpose of this document is also to serve as a record of work done, problems encountered and knowledge gained. It encourages students to be critical of their performance and then to improve it. It is used as a discussion document for visiting tutors. All documents are available in database on internet (http://informaticke-praxe.tul.cz).

Placement projects are presented for all of the 3rd year students as well as for other students of Business Informatics program twice during placement period. Additional procedure allows disseminating placement - experiences on several levels:

- seminar for placement and pre-placement students,
- access to information and students' assignments concerning to placement,
- elaboration and presentation of BA projects based on placement projects.

4. Results and Discussion

Through twelve years of realization of long term supervised industrial placement in the frame of Business Informatics program we cooperated with more than one hundred companies (Skrbek, 2007). Some of them stayed over time our stable partners and they set up the integration of our students into project teams as regular base for their activities. As an example I can introduce Skoda-Auto Company in Mladá Boleslav with its Department of Quality Management. Topics of project of our students have continual face – the new students are building their projects on the results of previous ounces. Topics of them have theoretical as well as very practical orientation, e.g.:

- Information systems for quality control in automotive industry
- Evaluation of process management in production of new car A5
- Application of Pocket PC for data collection for Quality information system of Skoda-Auto
- Ways of problem solving in Skoda-Auto
- Problems of migration of firm's IS to concern's IS in Skoda-Auto
- Quality control in Skoda-Auto
- FMEA methodology in theory and practice
- Optimisation of SQS Global II system on the base of statistic processing of outputs

Good examples of small and middle cooperating companies (SMEs) are OR-CZ and Miton. OR-CZ, company in small town Moravská Třebová, started at the beginning of nineties as a system integrator and distributor of own information system OR (Ortex). Through time they extended their activities to many other areas – from information systems for local authorities to support and information systems for medical care and hospitals. Heads of this company found immediately invention and potential of placement students – they started to cooperate with our program from the first year of placements. The general director of OR-CZ Mr. Václav Mačát repeatedly declared the

contribution of our students for a company. Decision of our students to spend their placement period in company OR-CZ was from the beginning based on topics of potential projects. The company offers students every possible support to be right members of project teams – from the necessary literature through participation at useful courses and conferences to consultations with experts inside as well as outside OR-CZ company.

Miton, an internet company from Jablonec n.N, started in 2000 as student project with a support of professors from the Faculty of Economics. The major activities of Miton were based on project of placement or post-placement students. They mostly stayed to continue in cooperation on projects with company Miton in post-placement period. Now Miton belongs between most successful companies in this branch. Their first product – Stahuj.cz (Download.cz) was launched in early 2000 as one of the first services of this kind in the Czech Republic. Since its beginning Stahuj.cz has been designed as a wide archive of free software. It uses the well-proven "try and buy" principle that is gaining grounds in other fields. It does not mean that everything is for free - but you can try and test everything before you buy. Such kinds of projects are very attractive for our students. They can apply their creativity based on knowledge of informatics as well as business and managerial disciplines. Currently Miton is the company that offers to our students' not only major amount of concrete projects but also the workplaces after finishing their degree.

Final projects of our students are really used and applied by high number of companies and student often get an opportunity to continue in further cooperation with a company leading to the full time employment. We found a set of reasons why companies repeatedly as to work on projects with our students:

- Students are bringing new ideas to projects; they are "virgins" in companies' procedures, but equipped with newest theories from more disciplines.
- Students-trainees are "not danger" for stable employers, they cannot threaten their positions; there is no information barrier among placement students, supervisors and other co-workers (students are not danger for their positions).
- Co-workers are helping students, common sharing of information resources
- Students are bringing dynamics in project teams if it is necessary.

Long term supervised placement were also supported by European Social Fund Project Operational Programme Human Resources and Development: "Increase the efficiency of the educational process in the context of cooperation between the university and the business environment" CZ.04.1.03/3.2.15.2/0211 (2006-2008) and "Theory and Practice" CZ.1.07/2.2.00/07.0321 (2008-2011).

5. Conclusion

The contribution of this article is the introduction of the conceptual approach that describes the combination soft skills and hard skills in learning process. Working with project in the frame of supervised long-term placement is still an exception in Czech university education. Important advantage for all partners is also all side feedback. It is necessary to work on such projects that fulfil needs of educational process as well as interest of students and demand of companies. We hope that expect reform of Czech system of higher education will take stress on practical output of university products – graduates with profile corresponding to the needs and demand of social and business environment. In the future work the authors would like to continue in evaluation of the long term experiences from reports by text mining tools (more in Antlová et al, 2012). Existing

results demonstrates that the soft skills and hard skill are necessary for the successful employment of our graduates.

6. Acknowledgement

This work was supported by the Specific research project of the Technical University of Liberec 3320/21073.

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SESSION D: SOCIAL MEDIA FOR INFORMATION MANAGEMENT

SOCIAL MEDIA AS SOCIALIZATION TOOL FOR ERASMUS STUDENTS AT UNIVERSITY OF ECONOMICS IN PRAGUE

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Keywords

Social media, communication, education, information sharing, students, Erasmus

Abstract

The paper focuses on the social media behavior of Erasmus students at University of Economics, Prague. Engaging in an Erasmus semester is an adventure that offers many opportunities but also challenges that have to be mastered. We have analyzed the major university's Erasmus Facebook group and conducted a survey with nearly 100 Erasmus students that came to Prague from all over the world. Our findings implicate that Facebook is the most important tool for communication and connection during the first months of the program. The fact that the group activity declined after the first month could be a sign for a stronger independence from the social network the more real-life friendships are established. While this is a question that needs further scientific evaluation, the survey and the group analysis proved the thesis that educational topics are of lower priority during the Erasmus program.

1. Introduction

Social networks are defined as a body of applications that increase and support group interaction and shared spaces for collaboration, social connections, and aggregate information exchanges in a web-based environment. (Sediva, Mullerova, 2014, Kiralova, A. et al., 2015). Students to manage their networks, especially since they adopt mobile technologies that can access online social networks (Barkhuus, Tashiro, 2010). As Yang et al. (2004) observed almost decade ago, living in a new culture, especially in an Erasmus semester, always involves uncertainty and unfamiliarity. Besides improving general skills, Yang et al. (2004) has identified that use of mass media reduced uncertainty and unfamiliarity by e.g. learning faster about new cultures. Nowadays, social media help by sharing norms, traditions and even hidden society values via specific created user groups. In addition, many exchange students seem to use social networking sites to connect with other exchange students, whom they have just met. Apparently social media is used for maintaining contact with friends at home but also to stay in contact with recently met acquaintances. Due to the same experience, Erasmus students gathered often feel a sense of a common ground due to their similar situation. Social media might help to build up this shared fundament from scratch (Yang, 2004).

2. Literature review

The most popular social network service in the world is Facebook (over 1.3 billion worldwide users in 2014), which keeps the leading position for interactions with both local and international friends. According to Facebook´s official statistics the "average user is connected to 80 community pages, groups and events and creates 90 pieces of comments each month. Facebook´s aim is to allow slow, detailed and thoughtful discussions and conversations among users compared to Twitter. While it is mostly used by adults for keeping virtual communities informed via national and international news, teenagers are more likely to use it to inform their virtual surrounding about their social status (Sacks, Graves, 2012).

Today's social media paves the way to make friends, exchange information or find partners in a different way than in the last decades. People use networks for diverse purposes: maintaining existing relationships, making new relationships or taking different paths to find jobs. (Mazman, Usluel, 2011) The latest statistics have shown around 42% of online adults use multiple social networking sites, while not surprisingly the majority of social media users is under the age of 30. On average, Americans spent 7.6 hours a month using social media, with the majority of individuals accessing social networking sites through cell phones. (Pavlíček, 2013)

As our analysis is mainly focusing on Facebook and its influence on Erasmus students, other networks (as LinkedIn, Instagram or WhatsApp) are maybe named, but not emphasized in the following (especially as Facebook is seen as the most popular social media among our respondents). In the following, surveys as well as research will show how social media influences student life in different ways.

A recent survey of polish former Erasmus students about the use of online social networks showed rapidly increasing role of online social networks in education, job search and other areas of life of young Poles. 85,4 % of the participants kept in touch with their former fellow-student via Facebook. (Brył, 2014). In popularity, Facebook communication was followed by email and face-to-face. Furthermore the survey examined which social media is used for which purpose. Researchers came to the conclusion that Facebook is rather used for socializing, whereas LinkedIn plays an important role for professional reasons (e.g. Job searches or maintaining a professional network) (Brył, 2014). In conclusion, it can be said that university education and its purpose of information exchange is always present on social media, but especially in case of Facebook-socializing is definitely extending the usage in educational interest (Bryła, 2014).

Another survey examined the fact if a larger community on Facebook leads to a better information exchange or if people struggle to manage the flow of information and maintain high quality, meaningful relationships with fewer fellow users in their network. The survey showed that the more friends/students belong to a group, the less people concentrate on meaningful relationships. The so called "card-gathering" also appears in professional networking; where people just want to maximize their contacts instead of developing meaningful lasting relationships. (Sacks, Graves, 2012) Network size reduced the network quality, as people are overwhelmed to distinguish between people who could share their interests than people who could rather be just acquaintances. Accordingly, people are putting less effort in social interactions when the size of the social network is increasing. (Sacks, Graves, 2012)

Large-scale survey (S. Güzin Mazman, 2011) about gender differences in using social networks shows that there are significant differences in the frequency of use and reasons for participating in social. "Maintaining existing relationships" reflects a higher ambition in using Facebook for women than for men, whereas "Making new relationships" was significantly higher on the men's

side. Possible reasons on the women´s side could contain the interest of hiding identity and personal information on websites or their former role in society their belonged.

Several studies have tried to find difference between Erasmus students living in dorms compared to students living in the city center, or among American students who have lived either on- or off-campus. Even though they lived on-campus they had group work also off-campus, so that each student had multiple sets of friends and acquaintance as well as school-related contacts (e.g. teacher, fellow-dorm students). Facebook was used as a communication tool to see how students incorporate Facebook into their array of everyday activities, researchers found that students socialized less with their dorm-neighbors in the residence hall than they did within other settings (e.g. Sport clubs). They found their social surroundings while "hanging around" with rather close friends than with unknown students from the dorm. (Nathan, 2005)

Comparing all mentioned surveys and research it is getting obvious that Erasmus students are at a stage in life where their social life is pivotal to their overall wellbeing, it's the time where friendships are made. Staying in dorms, distinguishing between gender or age or whatever students use as a purpose to use social networks, all surveys indicate that Facebook is a crucial factor when considering social networks during the Erasmus semester of young individuals. (Pavlíček, 2011)

3. Methodology

To examine the student's behaviour in the official Facebook group "Exchange/Erasmus at University of Economics Spring 2015" we captured every post between January 10 and March 28, 2015 (509 in total) with all likes and comments associated. The conclusions were confirmed by a survey with 97 exchange students (out of 227 – response rate 43%) who are members of the VŠE Facebook Erasmus group. Students answered 28 questions about their origin, their social media habits, and their goals during the Exchange program, their Facebook usage and the meaning that Facebook has for them during their time in Prague. Next to a minor amount of open-ended questions our main form of questioning was multiple-choice. The survey was conducted online with the help of www.qualtrics.com.

4. Results and discussions

With 733 members the Facebook group: "Exchange/Erasmus at University of Economics Spring 2015" offers information about the first steps in Prague and in the dorms, the VSE introduction week and activities organized by the Buddy System Prague. Furthermore the group provides all its members with the possibility to ask questions or post information and invites that can be commented and liked by other members. The analysis of the Facebook Erasmus group consists of three parts. 1) we show the frequency of posts on the Facebook group per month. 2) we studied the most reoccurring topics per month 3) we analysed the most commented and the most liked topics per month and in general.

4.1. Frequency of post on the Facebook group

Our analysis covers 77 days in which 509 posts were created in the group. This results in an overall average of 6.6 posts a day. During January we discovered the minor activity in the group with 44 posts in 21 days. That results in an average of 2.1 posts a day. The maximum number of posts was achieved on January 13 with 5 posts. February 2015 shows the highest activity in the Erasmus Facebook group: in total 271 posts were made with at least three posts created on one day. This

results in an average of 9.7 posts a day with a maximum of 17 posts achieved on February 11. The reason for this maximum is probably the arrival of the majority of Erasmus students during the time between February 8 and 14 and the ongoing introduction week. Both factors provided enough foundation for questions and information about a number of topics. In March the number of posts dropped: we counted only 194 posts (average 6.9 posts a day). The maximum of 15 posts was reached at March 9.

4.2. Frequency of topics in the Facebook group

For our analysis of the Erasmus group we categorized the content into following 10 topics: Administration; Buddy system information (e.g. Travelling, general info, group events); Commercial invitations (paid sport activities, N2N, Party adds); Dorm administration; Fun comments and documentation (pictures, jokes,…); Student information by students (tips for buying food, going out etc. freely given); Student Invitation for meeting people/partying or travelling; Student question about life in Prague (Where I find food, doctor, etc.); Student question and comments about VSE (Who is in which course? Where do I find…, etc.); Various small student requests (e.g. someone has a knife? Someone saw my smartphone?).

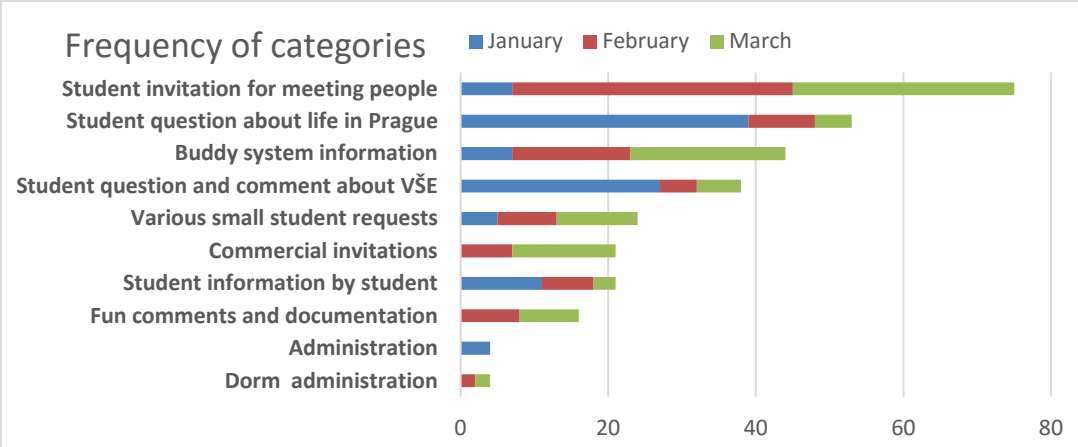

Figure 1: Percentage of posts by month

When considering all 77 days we analysed the Facebook group we discovered that the most reoccurring topic was “Student Invitation for meeting people/partying or travelling” with 165 posts, indicating that most of the students want to meet new people and use different activities to accomplish this. There were as many posts asking for a casual meeting, a trip to the city or to an area outside Prague as there were requests to do some kind of sport or invitations to various private student parties. The fact that roughly 1/3 of all posts can be branded with this topic proves that students consider the Facebook Erasmus group as an easy way to find fellow students with the same interests.

The second most frequently used topic was “Student question about life in Prague” with 86 posts in total. This shows that the group is used to exchange crucial information and tips about how to get along in the city. Furthermore, the high number of posts indicates that students believe in the value of the Erasmus group as a source of reliable and fast information.

The third highest pillow in our analysis had the topic “Buddy system information”, a service of the group owners that consisted of different offerings for day or weekend trips and general information for Erasmus students. Posts with this topic occurred 51 times during the timeframe analysed and

although some of the posts are reminders they show the commitment of the Buddy System representatives to the program.

The topic "Student question and comments about VSE" was only used 37 times and thus plays a minor role when we consider the complete timeframe. This raises the question if the Erasmus students see the educational part of their program with a lower priority. While this could be the case, we have to consider other reasons e.g. easy accessibility of suitable information about educational topics through official channels like the VSE website. The topics described above are the most important factors in our analysis about the influence of Facebook on the Erasmus program.

4.3. Analysis of comments and likes

In analysing the comment and like behaviour of the Erasmus students in our targeted Facebook group we try to discover which type of topic becomes most viral and which topics are discussed by students. This will probably give us new insights about the meaning of Facebook for the Erasmus experience of students in Prague. First, we take a look at the general numbers of likes and comments in general and for every month. The 509 posts recorded during the 77 days we analysed the Erasmus group received a total of 2125 likes and 1800 comments. This results in an average of 4.2 likes and 3.7 comments per post. While this is an interesting number it can bring further insights to compare the monthly average.

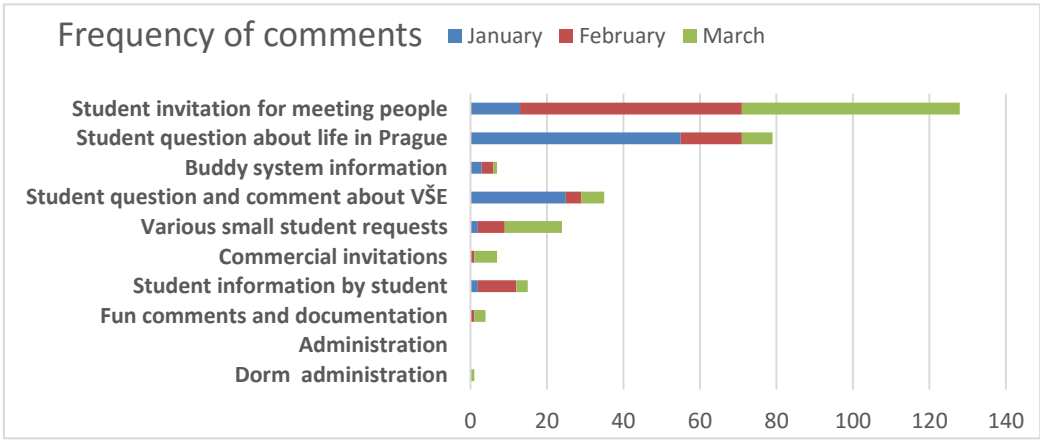

Figure 2: Percentage of comments by month

42 posts created in January received a total of 311 likes and 416 comments resulting in an average of 7.4 likes and 9.9 comments per post. These exceptional high numbers in the month in which the smallest total number of posts was created have several reasons. First, on January 14 a post was created that received 108 comments, 26% of all comments written in January. This question about the rooms in the dorms became highly viral and thus had a vast effect on the statistic. The same situation happened on January 29 with a post that received 72 likes and therefore 23% of all likes given in January. While these two events had a large impact on the average number of likes and comments it has to be noted that even without them the average likes and comments per post in the group are higher in January than over the whole timeframe of 77 days.

A potential reason for that could be the high interest of soon-to-be Erasmus students in discussions around the Erasmus program and their insecurity before arriving in Prague. This hypothesis is supported by the topics that dominate the discussion. In the same way "Student question about life in Prague" and "Student question and comments about VSE" had the most posts in January they also are the most discussed topics with 230 comments connected to Prague and 104 connected to the VSE. Additionally information posted by students to help others received 76 likes. This fact underlines the high significance of the Facebook group in the preparation phase of Erasmus students. Another interesting detail can be found when observing the end of January. It seems that some students arrived early and searched for new contacts using the Facebook group. A post, generated on January 29 about "Student invitation for meeting people/partying or travelling" received 79 likes and 49 comments, boosting the average likes and comments per post of a topic that was of no significance in January. However, this shows the desire for contact to other students right after the arrival in Prague and the potential role Facebook plays in the satisfaction of it.

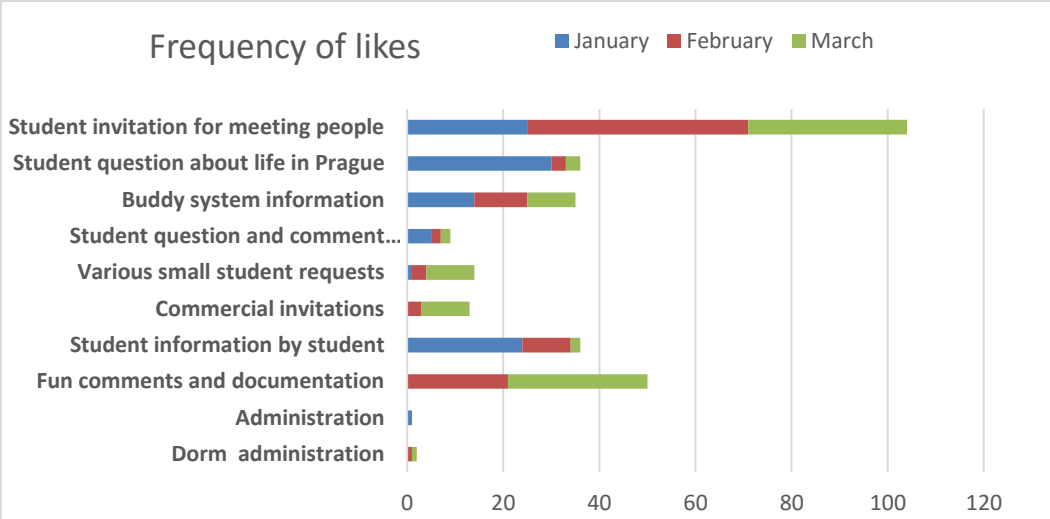

Figure 3: Percentage of likes by month

In February, 247 posts received 1099 likes and 933 comments. This leads to an average 4.4 likes and 3.8 comments per post. While about 50% of all posts, likes and comments we captured were created in February, the average likes and comments per post are not as high as in January. This can have multiple reasons. First, we can observe a kind of like/comment cannibalism, meaning that the post creation frequency in February was so high that students either lost track of all the topics or just continued their discussion on another post. A strong indicator for this idea is the absence of one or more dominating posts as found in January. Likes and comments can be found in equal numbers for more or less every post created. When looking at the most frequently discussed and liked topics we find that the topic "Student invitation for meeting people/partying or travelling" leads in February with 521 likes and 563 comments created for 104 posts. This topic seems to be responsible for 50% of all communication during February proving the already mentioned desire to connect to other students at the start of the Erasmus semester. We can discover the same as in the post analysis for "Student question about life in Prague" with 37 likes and 151 comments and "Student information by students" with 115 likes and 76 comments. As already pointed out, students used the Facebook group to share and get information about the life in Prague and solve various challenges. The fact that the high number of questions created received answers probably motivated the students to ask even more questions because they saw the value of the group as information source. Furthermore the high number of likes that students received that shared information can be seen as appreciation of their service and function as motivation to share more information further increasing the value of the Facebook group as source for information. At last it

should be mentioned that the topic "Student question and comments about VSE" wasn't discussed in a significant way in February supporting the argument that the students think of the University as secondary priority. In contradiction to that fact the topic "Fun comments and documentation" received 237 likes for 22 posts resulting in an average of 10.8 likes per post. Students seemed to be eager to share and like special and funny pictures about recently finished events and build a closer connection with each other.

In March, 163 posts received 591 likes and 405 comments, resulting in an average of 3.6 likes and 2.5 comments per post. This decrease can have several reasons that were partly mentioned before. First of all the number of posts in general decreased significantly in March. While this most likely resulted in fewer opportunities to like or comment a topic we recorded the numbers in January proved that there can be a large number of comments or likes without many posts. The absence of this in March could be explained by an absence of interesting topics, missing interest of group members or possible alternatives to ask for, discuss and share information. It seems that the students get less dependent on the Erasmus group the longer they are in Prague. Instead of using the group for communication they use other ways, e.g. direct contact, various messenger services or alternative, more private Facebook groups. To find a more satisfying answer for this phenomenon, a longer and more intense study that is out of the scope of this article, would be necessary. In terms of most important topics we discover that "Student invitation for meeting people/partying or travelling" covers about 50% of all likes and comments created in March. Furthermore the 15 posts about the topic "Fun comments and documentation" received 190 likes, proving once more that students search for points of contact and communication in the Facebook group. While student information, questions about Prague and other various topics are still discussed, their importance is decreasing heavily for the same reasons as mentioned above. Additionally, questions and comments about the University of Economics are once more rare and commented poorly.

5. Conclusions

In January the major concern of students was to organize there Erasmus semester and thus topics about the life in Prague and the University of Economics were of interest. This changed in February when the highest priority was on meeting new people, partying and travelling. The fact that this continued in March and in total 33% of all posts can be connected to this topic leads to the assumption that it is the major concern of Erasmus students. An assumption was also supported by the survey in which 88% of the students indicated that the highest priority is meeting new people during the Erasmus semester.

When examining the complete 77 days we see that the February was the month with the highest activity in the Erasmus group. In March the activity decreased fast, probably resulting from the weakening dependency on the Facebook group to get in contact with other students. In February we can also observe a kind of like/comment cannibalism in which the post creation frequency is very high and therefore no post received overwhelming participation.

We discovered that 97% of students living outside the dorms came from a European country. This fact is almost certainly connected with the greater challenge of finding a suitable apartment while living on another continent.

Another finding is that Facebook seems to be the most important network for a vast number of students with 94% declaring it as their main social platform. In addition the fewer friends a student had on Facebook the more he knows in real-life. Furthermore, 72% of the people who added more than 80 new friends during their time in Prague had already more than 600 friends. Thus, there could be a connection between the general willingness to add new contacts on Facebook and the

readiness to add new contacts during the Erasmus program. Moreover the willingness to add people quickly as contacts on Facebook seemed to increase in the Erasmus semester compared to the usual behavior of students.

Another finding was that students living outside the dorms visited more events advertised in the Facebook group then students living in the dorms. This could be a result of their decentralized position compared to the other dorm inhabitants.

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HOW EMPLOYERS USE LINKEDIN FOR HIRING EMPLOYEES IN COMPARISON WITH JOB BOARDS

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Keywords

LinkedIn, recruitment, job boards, Human Resources

Abstract

The purpose of this paper is to explore how the ten biggest companies in three different European countries (Norway, France and Germany) use LinkedIn for hiring in comparison with the most popular job boards. In addition, we compared the number of job positions on LinkedIn with the various companies' own corporate websites.

In the theory part, we found that LinkedIn is a very important recruiting tool for companies. Our overall finding is that LinkedIn is not used as much by companies as theory suggests it should be. The investigated companies seem to lack in encouraging their employees to update their LinkedIn profile regularly. We cannot conclude that there is a correlation between the number of jobs offered and the number of followers. The results and discussion show that job postings on corporate websites compared to the job boards on LinkedIn are much higher for the Norwegian and French companies. This result differs for the German companies where we observe that four of the companies have more jobs posted on LinkedIn than on their corporate website. The same trend also appears for the ratio between jobs posted on LinkedIn versus jobs posted on popular job boards in the country. This tells us that German companies clearly focus more on using LinkedIn than the Norwegian and French companies. This research is definitely limited to quantitative data.

1. Introduction

LinkedIn is a business-oriented social networking service. It now has over 332 million members in over 200 countries, and it is by far the most popular professional social media website in the world. In particular, it gives recruiters quick and easy access to a large range of resumes from skilled potential employees all around the world. LinkedIn is built upon a simple philosophy: "Relationships Matter." Social networking in the workplace has become a crucial communication tool in many businesses. It provides a platform for creating communities based on similar interests, hobbies or knowledge. (Pavlíček, 2014) LinkedIn is advantageous for Human Resources, who use it for both networking and recruiting. The potential for LinkedIn to play a major role in employee recruiting strategy increases as millions of potential employees profile themselves on this social network each year. It is not enough anymore just to post a job vacancy on Monster.com, CareerBuilder.com, Craigslist.com, or other online job boards. Employers are spammed with

hundreds of resumes from unqualified applicants when they post on the big boards. The world of recruiting is changing.

"LinkedIn has revolutionized the recruiting world" (Forbes, 2014). This claim proves how important this social media tool has become in the field of recruitment, both for companies and job seekers. LinkedIn is now the world's largest professional online service. Europe is their biggest market outside the United States, and Norway (1+ million users), France (8+ million users) and Germany (3.5+ million users) are some of the countries with the highest adoption rates. (LinkedIn, 2014)

The title of the Economist (The Economist, 2014), stating some of the key advantages of LinkedIn, confirms that the main benefit for recruiters is finding 'passive' jobseekers. They correspond to those who could miss the job offer, but who would still be good potential candidates for the company.

A study by Jobs2web Inc. shows that companies look through about 219 applications per job through a major job board before finding someone to hire. They only look at 33 applications per hire on their own corporate career site and 32 per hire when a job seeker types the job they are looking for into a search engine. (Forbes, 2011)

2. Research Methodology

The purpose of the research is to find out how the 10 biggest companies based on market capitalization from France, Germany and Norway use LinkedIn for hiring employees in comparison with job boards. We are also looking to see whether we can find differences between each country. In this study, a quantitative research method based on collection of primary data through observation of activity on LinkedIn was used. The data was collected based on observation of online activity on LinkedIn over one month by students of courses focused on New Media. In addition, the number of job positions on LinkedIn was compared with the number of jobs advertised on job boards. We had three factors which we observed and studied.

The first factor is the number of followers, which explains the company´s ability to create interest towards the general public and attract followers. Thus we can get a picture of the use of LinkedIn. It is interesting to look at this factor together with job postings on LinkedIn, to see if the number of followers really is influenced by the company´s activity level on LinkedIn.

The other two factors, which are connected, are job postings on LinkedIn and job postings on job boards. We chose to observe these factors to research how the company use LinkedIn compared to other job posting places. The job boards are different between the three countries, but they serve the same purpose. For Norway we used data from Finn.no, for France from Indeed.fr and for Germany Monster.de.

The analysis of the data was divided into two parts: one concerning the absolute value of the factors, and the other one focusing on the ratio between some of the factors. We analyzed the absolute value for the following factors: followers, posts per week and job postings on LinkedIn. When we analyzed these factors, we simply looked at the numbers and compared different companies in each country, as well as comparing between the three countries.

Regarding the ratios, we used the numerical data for the factors and compared different factors by calculating the ratio between them. The ratios are calculated based on the factors for each individual country and in the further discussion these ratios will be compared between the countries, but also between companies in each country. We will look into two ratios for each

country: number of followers versus number of job postings on LinkedIn, number of job postings on LinkedIn versus number of job postings on job boards. These ratios were put into charts, which will be presented in the result section and used for further discussion.

3. Result of research

We will present the results from each country separately (with very basic comparison) and use this information in the discussion that follows.

3.1. Norway

The 10 biggest companies in Norway are Statoil, Telenor Group, DNB, Royal Caribbean Cruises, Yara International, Norsk Hydro, Seadrill Limited, Gjensidige Forsikring, Orkla and Marine Harvest ASA. (Oslo Børs, 2014) Of the ten biggest companies in Norway in terms of market capitalization, the biggest company Statoil also has the most followers with more than 230,000.

The average number of posts per week is only 2.40 for the Norwegian companies. Yara International was the most active with five posts, while both Royal Caribbean Cruises and Marine Harvest had zero posts in one week. The companies are restrained to share too much news about themselves on their LinkedIn profile.

Two companies use LinkedIn for more than half of the jobs offered on their corporate website – Seadrill and Gjensidige Forsikring. The average is that 26% of all jobs offered on their corporate website are also offered on LinkedIn. Note that DNB did not have any jobs on either their corporate website or on LinkedIn at the moment of observation. Marine Harvest had only three jobs on their corporate website and zero on LinkedIn. Norsk Hydro had as many as 22 jobs offered on their corporate website, but still zero offered on LinkedIn. These findings tell us that Norwegian companies do not use LinkedIn very actively to attract people to work for them.

The average ratio for jobs offered at LinkedIn versus jobs offered on the job board is about one. This is because Seadrill offers eight times more jobs on LinkedIn than on the job board. For two companies, Gjensidige Forsikring and Telenor, the ratio is just over one. The rest of the companies offer less jobs on LinkedIn than on the job board.

Followers/LinkedIn jobs is a ratio that tells us something about how visible each of the jobs offered on LinkedIn is for one company. Statoil has the most followers per job offered on LinkedIn with about 25,000. The average for all ten companies is just below 7,000. This is partly because some companies offer few or no jobs on LinkedIn, and partly because some companies have few followers compared to Statoil.

3.2. France

The LinkedIn observation for the 10 biggest companies in France included Groupe Danone, Vivendi SA, ArcelorMittal S.A., Société Générale, Orange S.A., AXA, GDF Suez, Sanofi S.A., BNP Paribas and Total S.A. (CAC 40, 2012)

The average number of posts per week is only 2.0 for the French companies. Group Danone is the most regular poster, whereas Vivendi has not posted anything on LinkedIn. The low number of posts could be explained by several reasons. Similar to Norwegian and German companies, LinkedIn posts can be used to make important announcements, such as the launch of new products. The main other source of content is communication about the corporate culture of the company, as explored by Group Danone for instance.

The most LinkedIn followers are generated by Total with 429,488, followed by Group Danone with 387,997. At the same time Vivendi SA, as France's second biggest company by CAC 40 ranking, has only 3,325 followers on the platform, which indicates that a high market capitalization cannot be regarded as a factor for high popularity on LinkedIn.

When measuring the importance of LinkedIn as a recruiting platform used by companies, one further has to analyze the ratio of jobs posted on a country's biggest job portal compared to positions posted on LinkedIn. In France the biggest job portal is Indeed.fr. The highest value is generated by Sanofi with 0.96, derived from a total of 195 jobs posted on Indeed.fr and 188 on LinkedIn. The lowest ratio comes from Société Générale with 0.004 due to the fact that the corporation offers only 29 jobs on LinkedIn while at the same time offering 7,307 positions on Indeed.fr, which is definitely a significant difference. We can observe that only Sanofi offers more jobs on LinkedIn than on Indeed.fr with a ratio of 0.96. Arcelor Mittal indicates a high value when analyzing the ratio of LinkedIn followers and jobs posted on LinkedIn. At Arcelor Mittal LinkedIn page there are 19,687 more followers than jobs offered. Total has the second highest ratio with 15,339 followers. These results can be explained partly by the very low number of jobs posted on LinkedIn by these companies.

3.3. Germany

In the following we will analyze the LinkedIn operations of the ten biggest German companies, which are Bayer AG, Volkswagen AG, Siemens AG, Daimler AG, SAP SE, BASF SE, Allianz SE, BMW AG, Deutsche Telekom AG and Deutsche Bank AG. (Finanzen.net, 2014)

The average number of posts per week is only 2.70 for the German companies, although at least that is 12.5% higher than the value measured for the ten biggest Norwegian companies. Most posts were added by Daimler AG and SAP AG, whereas Volkswagen AG did not post anything. The low number of posts could be explained by several reasons. One can underline that like in Norway, German companies try to regulate their LinkedIn posts, due the fact that they only want to post highly important information such as the launch of new products, which could be observed in the cases of BASF SE and Bayer AG. Both corporations launched an innovative product and announced the market entry of their products. Thus, LinkedIn seems to be used for announcing important company news, while German corporations at the same time try to post about interactive and interesting topics in order to engage their followers.

The most LinkedIn followers are generated by Siemens AG with 668,223, followed by SAP SE with 62,893. At the same time Bayer AG, as Germany's biggest company by market capitalization, has only 15,523 followers on the platform.

When measuring the importance of LinkedIn as a recruiting platform used by companies, one further has to analyze the ratio of jobs posted on a country's biggest job portal compared to positions posted on LinkedIn. In Germany the biggest job portal is Monster.de. The average ratio measured here is 4.25, meaning that the amount of jobs posted on LinkedIn is 4.25 times higher than the amount posted on Monster.de. The highest value is generated by BASF SE with 27 due to the fact that the corporation offers 546 jobs on LinkedIn while at the same time only offering 20 positions on Monster.de, which is certainly a big difference.

SAP SE again produces a high value when analyzing the ratio of LinkedIn followers and jobs posted on LinkedIn. At SAP SE there are 2,125 followers per job position posted on LinkedIn. Bayer AG and Volkswagen AG show even higher values with 3,220 and 2,897.

4. Discussion

In Norway on average 2.4 posts on LinkedIn are made every week. It is observed that only 80% of the companies posted on LinkedIn the particular week, which confirms the theory stated that corporations have to use LinkedIn as a recruitment tool in order to guarantee sustainable recruiting success.

In France an average of 2.0 posts every week is the lowest of the ones observed. When taking a more detailed look at the 10 companies, it is observed that 90% of the companies posted on LinkedIn during the week of observation. This is the highest value that was detected. This way France differs from the other countries in a positive way, since they have only one company that can be considered inactive. On the other hand, they have a lower average activity, which implies a lower use. In summary, it is hard to draw a conclusion concerning French companies' acceptance of corporate LinkedIn activity.

In Germany on average 3.4 posts are made every week, which is actually 1.0 percent point above the value measured for Norway. While taking a more detailed look at the companies, it is observed that 85% of the companies posted on LinkedIn during the week of observation.

When comparing the three investigated countries, a common presence of LinkedIn in the corporate world can be outlined, which is further supported by the huge amount of company pages on LinkedIn around the world, a number which exceeds four million in total. LinkedIn activity seems to be quite high overall. Four out of the 30 investigated companies, only 13 percent, did not post at least once in the week of observation. At the same time, the average amount of postings varies between 2.0 and 3.4 for the three different countries, implying slight differences in LinkedIn activity among the three countries.

5. Conclusion

In this paper we have looked at how the 10 biggest companies in three different European countries use LinkedIn as a recruiting tool, and we have compared it with the biggest job boards in each state. This has been done by observing specific factors for each of the companies over a one-month period. Our results have been discussed both for each country and by comparing the different countries.

We found that all of the 10 biggest companies in the three countries are registered on LinkedIn. Almost all of the companies update their profiles weekly, but the number of posts per week is on average only about two. The amount of followers each company has does not seem to depend directly on the overall corporate platform activity. By this we mean that we did not observe any correlation between posts per week and the number of followers.

We found a correlation between the number of jobs offered and the number of followers at country level. We did not find the same correlation at company level. This means that we cannot conclude that there is a correlation between the number of jobs offered and the number of followers. One possible explanation could be that LinkedIn`s popularity in the different countries is the variable that explains the number of job offers compared to the number of followers on the platform.

The results and discussion show that the ratio between job postings on job boards compared to job postings on LinkedIn is much higher for the Norwegian and French companies. This tells us that German companies clearly focus more on using LinkedIn than the Norwegian and French companies.

6. Acknowledgments

This article was prepared with the support of students on courses focused on New Media in the 2014/15 winter semester.

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SOCIAL MEDIA IN LEARNING PROCESS

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Keywords

Internet, social learning, social networks, education, student.

Abstract

The paper focuses on the use of social media in the learning process. The introductory section describes the basic approaches to social learning theory. They discussed the basic features in the development of knowledge in social communities. The second part shows the tools and opportunities of social networks in the learning procesu. The third part of this work presents the results of survey focused on the use of social media as tools to support the learning process.

1. Introduction

Social learning from a sociological perspective can be defined as the acquisition of certain social roles, behaviors, therefore, that the social environment of the individual expects in terms of age, sex, social status and situation in which an individual is. (Meyrowitz, 2006). The notion of social learning also reflects the influence of social experience in creating psyche, therefore, experience and behavior, ie. Every social environment has its own specifics, their language, norms of behavior, social mechanisms. Mastering social roles leads to social maturation and integration in society. The social maturing individual is chosen from their social environment behaviors, social norms, attitudes and creates a system for their behavior and thinking. (Nakonečný, 2009). In the process of social maturation individual acquires a more social role and deepen the role already acquired. This personality becomes richer and his social behavior is more effective. The principle of social learning is a concept in which people are taught separately (quite individually), but they share their personal experiences with the experience of others.

For every person from an early age begin a lifelong process of social learning concept called socialization. In the process of socialization experienced man "second birth", ie. Birth as a social individual, when there is a natural human ingrowth into the life environment of society. But it's not just a passive acceptance of knowledge, attitudes, etc., but also the active acquisition of experience in social interactions.

Family education, which is designated as the primary means of socialization, is essentially a system of interactions within the family (between parents, parents and children, between siblings) and as such, the social learning that in terms of teacher - students interaction takes place even during school hours. At primary socialization followed by secondary socialization through experience that one gets in school, peer groups, the organizations work.

By (Sak&Mareš,2007) personality development must take place not only in terms of intellectual but also moral, aesthetic, physical, hygiene and social personality. Educating the individual parallel with the process of social learning leads to its growing into society, leads to his socialization.

Social learning theory as behaviorism, constructivism and cognitive approach (Surowiecki, 2004) (Siemens, 2005), based on different approaches to the process of socialization of individuals. Behaviorism examined primarily external influences that impact on individuals and consequently behavior (reaction) that can cause. According to him, learning is based on the effect of environmental stimuli. Cognitive approach contrary, emphasizes the man who is helplessly adrift environmental influences. He considers it to be a thinking organism. Methods in learning are practice and testing. Constructivism maintains that reality is not given as a fact and behavior is constructed based on social interaction (in a specific cultural context). Man is not an empty vessel that can be filled with knowledge. On the contrary, knowledge itself creates through individual experience.

2. Social Networks and their Support of Learning

With the development of ICT and Web 2.0 tools that enable quick integration of the individual in a virtual community networks in the Internet, was further strengthened by the possibility of individuals to communicate and share common experiences, expertise and knowledge. Social media such as social networks, web forums, blogs and shared media support network users quick access to information and data, and not just passively. (Šedivá, Mullerová, 2014). An individual may, without deep knowledge of ICT, to communicate with a group, share files as well, thus extending the data storage of your data (files, photos, videos, blogs, ...) and provide them to other subscribers. Above all, social networks have become a virtual social networks, virtual communities with various objectives.

How can social networks be used in learning process? How can social networking help in to improve freedom of teaching and reinforcing? What means social networks provide for teaching? In the world there are a large number of social networks, which vary in scope, specific functions or different treatment. Let us give an example of the functionality suitable for learning process using the most popular social site Facebook.

Facebook works primarily as an information channel. Student and teacher can become a fan of a variety of sites and watch news channels need (to keep tabs on the political and financial situation in the world), the celebrities, the nearest museums and galleries (to know about current events or exhibitions), or her own school. Latest offers links to information pages from the fields of economics, science and technology or the arts. Those that relate to just-study curriculum must notify the teacher. For a better overview of the amount of data on social networks, it is preferable to use a so-called *social bookmarking*. This is a method of storing, organizing and managing bookmarks to Web sites using special applications (eg. *Delicious*).

Facebook is a powerful tool for connecting students with teacher outside the classroom in the school. The teacher can work with your personal profile and enable monitoring. Students can monitor all his public posts. It is suitable for example to share interesting information taught substance, to remind current tasks, to assign tasks for extra bonus points, to publish the best submissions or to highlight the theme of the upcoming session. Student can write questions and comments under the teacher’s contribution and a whole class can view them (in the case of private queries can be used communication via private message), so such a route linking pupils efficient than eg. e-mail.

Especially for schools can create Facebook *Groups for Schools*. Group will only connect students and teachers of the school (school by active e-mail addresses). The community is then possible to search for different groups (eg. by subject) and discuss them with other students, share resources, educational materials, upload documents and work together on assignments.

Other frequently used social media web forums and blogs for communication between students. For the preparation of background materials for the project (eg. for lessons of history, geography, biology, etc.) are an appropriate alternative tool shared media. It is already a very popular tool for sharing Youtube videos. Service very accessible, not only to play but also record video recordings. A resource that requires almost no technical background. Video recordings can be used for recording Video tutorials (ie. video guides representing a manual), or to record student presentations, etc.

On Youtube there are a huge number of entries focused on education. *YouTube for Schools* then provides students with access to hundreds of free tutorials, presentations or instructional videos that are located in a special category of *YouTube EDU*. The best-known channels by the number of customers who pay on Youtube education are *CrashCourse*, *SciShow* and *SmarterEveryDay*. The group of teachers is explained through approximately ten-minute lesson high school curriculum of biology, psychology, chemistry, history or literature. The second most popular educational channel on Youtube SciShow does not include the classic courses, but short videos that nonfiction form devote novelties and interesting discoveries in science.

3. Questionnaire survey focused on the use of social networks and other media

Above mentioned theory of social learning and the current ICT resources in social media, enable a significant shift forms of instruction in the educational process. The suitability of using social media in education (formal or informal level), we investigated in the survey. The aim of the survey was to determine how to access different ages of students selected to social media. The task was to determine how often users use social media, which media are most used and for what purpose.

The survey (Brychta, 2015) was approached by students at basic and secondary schools and adulds in companies in Prague. Questionnaires were distributed in electronic form. The survey was conducted during the month of March 2015. There have been 112 questionnaires processed.

The target group was mainly the young generation, and ninth grade students of elementary school, then the students first and fourth year of high school and the last groups surveyed were university students and adults across all age groups and professions. The questionnaire answered by 114 respondents. Of this, 32 elementary school students, 56 high school and university students and 26 adults of various professions. The questionnaire included fifteen questions, which represented a clear answer, and was carried out by means of written forms. Due to the limitation of the scope of this article, we present the most important results of the investigation.

Social media is used by the overwhelming majority of students in elementary and middle school. We wondered what the respondents use social networks. Answers to this question shows Figure1.

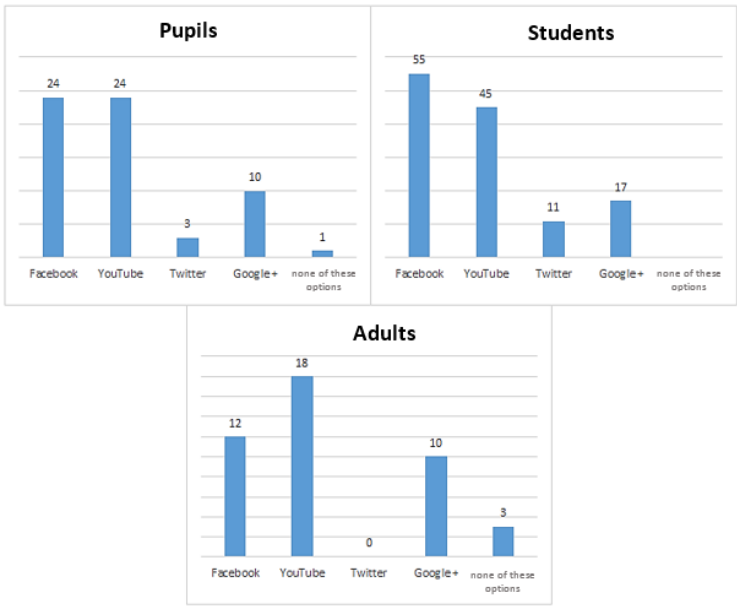

Figure 1 Use of social media by categories of respondents

The survey shows that the most widely used network in all categories is Facebook, a very common are sharing videos on YouTube and file sharing environment Google+. Less use of social networking is Twitter. Only four respondents said they do not use any of those options.

The other question was: "How often do you visit a social network?" Among the pupils of the primary school visit daily social networks by 18 respondents (56%), 11 respondents (35%) visit several times a week, 1 respondent (3%) visits several times a month and only 2 respondents (6%) not often. In category of students 46 surveyed (82%) visit social networks daily, 9 respondents (16%) several times a week, and one respondent (2%) visits several times a month. Among adult subjects attending daily social networks were 11 respondents (48%), 8 respondents (35%) visit several times a week, 3 respondents (13%) several times a month and 1 respondend (4%) visits a social network less frequently.

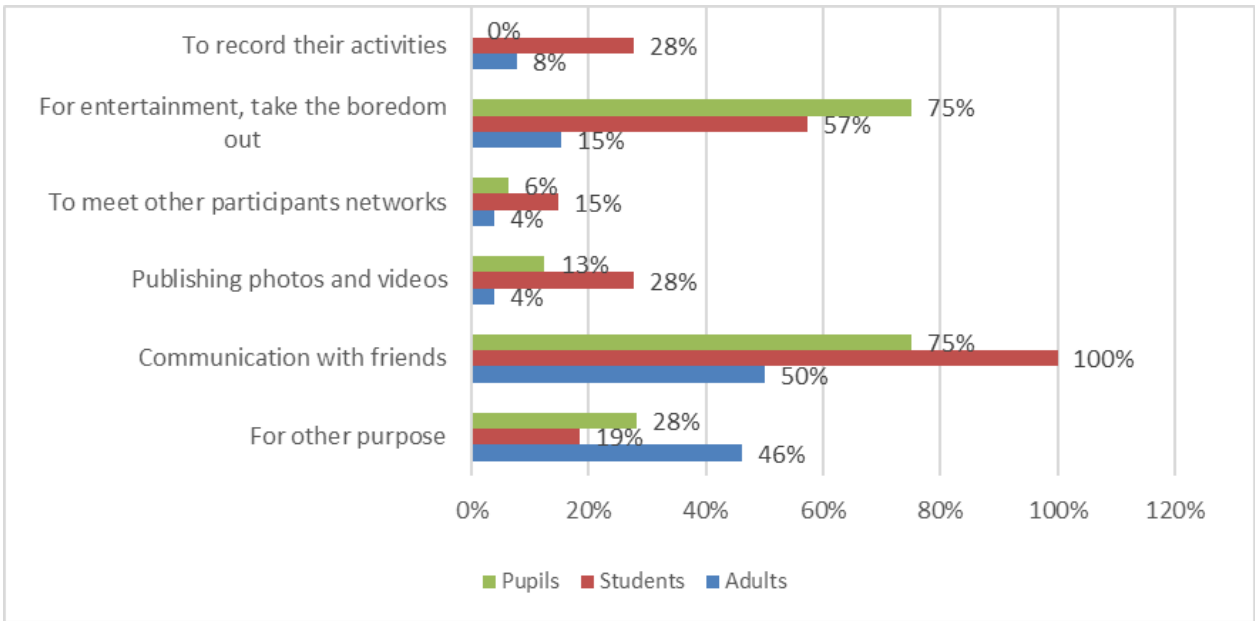

Figure 2 Reasons for using social networks

Another important information that was searched, was the reason for what and why users use social media. They were interested in aspects useful for teaching, ie. Use for communication and sharing and storing data. The reasons that respondents reported are shown in Figure 2:

The answers to the previous question implies a different approach to the use of social media in different age categories. While pupils and students use social media primarily for communication and entertainment, and take the boredom out, the adults are using social media primarily for communication, other activities are being used on a much smaller scale. It also reflects the structure of the answer to the previous question regarding the time spent on social networks.

We wondered whether the respondents ever used the processing of documents in a shared environment, either Google Docs or Office 365. Among the pupils surveyed reported 4 (13%) said they used technology, 27 respondents (87%) answered they have never used Office 365 or Google Docs. Among the students of these technologies ever used by 21 respondents (38%), 34 respondents (62%) said *NO*. For adults, seven respondents (27%) said answer *YES*, the remaining 19 respondents (73%) said that these technologies have not used. From the previous responses conclusion is that all three categories of users do not use the shared space online text editor very much.

Figure 3 presents the summary results of the question: "What activity on the Internet frequently you perform?"

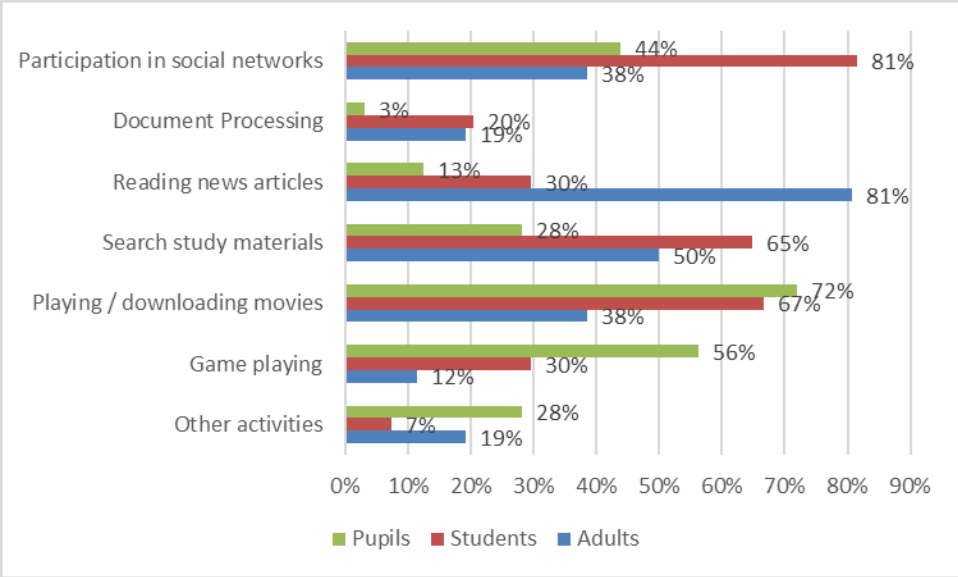

Figure 3 Activities on the Internet

Based on responses of this survey can be expressed a fact the most active on the Internet in terms of their study preparation are high school students. The pupils use the internet for fun and adults primarily seek information on news portals.

Social networks and other social media are used not only to communicate but also to share information and experiences, especially experiences in an informal way. And so we interested in how these respondents are influenced by informationi from the Internet in their own decisions. Of these responses show the fact that in the aggregate only 30% of respondents affected information on network access, two thirds of respondents are NOT at all or RATER NOT affected by the information on the Internet. Given that social media are primarily focused on the exchange of information and personal experience, and are therefore generally widely-attended, Answers are a surprising, since the respondents declared very little effect of such information on their decisions. It

is therefore necessary to consider whether the degree of influence the respondents admitted honestly. Therefore, whether their subjective judgment about the degree of influence was realistic.

4. Conclusion

In the second part of the paper were shown the functional possibilities of using Facebook in the classroom. The possibility to work in groups, the availability of large amounts of information and the possibility of defining limiting access to information to only specific groups or individuals are the advantages of the network. However, it is also necessary to mention the problematic use of Facebook in teaching a lesson. This is mainly due to the danger of procrastination its users. Therefore, the use of Facebook and other social networking sites recommended for work in other school activities (homework, preparing documents for projects and communication between students about learning outside the classroom.

With the coming of social networks was strengthened virtual world and a large degree of anonymity in communication. It allows people to put their own ideas, which is in direct contact for various reasons are not able to communicate, but also increases the risk of danger of abuse of anonymous identity. In the process of teaching anonymity can help students who have inhibitions to speak "face to face".

Therefore, it is necessary to carefully consider the form and extent of the use of social media in education in order to bring the two sides (teachers and students) effects you want. According to Pavlíček (2003): “Mental obesity, social media addiction, loss of privacy, cyber-bullying, those are all problems, which we have to deal with.” We have to think about that new technology and we have to learn, how to live with it.

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THE PLACE OF GAMIFICATION IN TOURISM DESTINATIONS´ MARKETING

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Keywords

Gamification, tourism, destination, marketing

Abstract

The paper describes how gamification can be used for attracting visitors´ attention, arousing interest and generating the desired behavior - visit a particular destination. It defines gamification in the context of the tourism destination marketing. The paper looks at the changes in visitors´ behavior towards gaming and highlights the gamification implications to destination marketing while stressing the benefits of gamification to destination marketing. The aim of the paper is to examine how gamification can be applied to tourism destination marketing. Based on the results of primary and secondary research, gamification objectives, success factors, and limitations of the use of gamification in tourism destination marketing are identified.

1. Introduction

The development and increasing use of information and communication technologies has radically changed the relationship between destinations and their visitors. Today's visitors have a large selection of destinations to choose from, but less time to make a buying decision (Kiráľová & Malachovský, 2015).

The decision-making process that results in the purchase of the tourism product is influenced not only by rational but also by emotional and irrational factors and word of mouth advertising (Kiráľová & Pavlíček, 2015; Kavoura and Bitsani, 2013).

Mobile plays an important role in the post travel time where visitors share their experiences via review sites and social media (Kiráľová, 2014).

Eric Schmidt, executive chairman of Google (Werbach & Hunter 2012, p. 151), suggested that: „Everything in the future online is going to look like a multiplayer game." Deloitte (Palmer & Hugo, 2013) listed gamification in their Technology Trends 2013; and Gartner (2014) appraises gamification as: „…a powerful tool to engage employees, customers and the public to change develop skills and drive innovation."

Bunchball (2012) states that by implementing gamification across websites, social networks and mobile applications the destination can engage visitors in a more meaningful way and gather business benefits.

Playing games that are connected to the destination can create visitors experience even before the visit and motivate them to repeated visitations.

2. Does Homo Visitor Transformed into a Homo Ludens?

Gamification draws on motivation theory and psychology. Ryan and Deci (2000) describe the differences between intrinsic and extrinsic motivation in terms of causing the respective action. Intrinsic motivation induces acting because it is interesting and enjoyable on its own. Extrinsic motivation raises acting related to a particular outcome or result that should be achieved. Intrinsic motivation only occurs when activities are intrinsically interesting for an individual; they offer a certain degree of novelty, challenge, and aesthetics for the individual. Interpersonal events and structures, such as rewards, communication or feedback that strengthen the feeling of competence during an action, increase the intrinsic motivation (Ryan & Deci, 2000).

From a psychological aspect, an important role in gamification plays the Csíkszentmihályi´s theory of the state of flow. Csíkszentmihályi (2008, p. 1) described flow as: „a state of concentration so focused that it amounts to absolute absorption in an activity." The state of flow can be reached through of cleverly set challenges, i.e., activities that are not too difficult and not too easy for the respective skills and abilities. The fact that the flow state is intrinsically rewarding means that individuals want to feel this flow experience again and again (Nakamura & Csíkszentmihályi, 2002). One of the key findings of the study commissioned by Amadeus Corporation (Stubbings & Curry, 2012) was the ascertainment of the importance of experience for the new generation. For the generation of experience is tourism more increasingly about the depth of adventures and experience rather than about their width. Technologies such as augmented reality gamification and smart mobile devices transform the travel experience.

Recent research shows that 85 percent of people aged 18 to 34 own a smartphone (Nielsen, 2014). This situation affects businesses globally. Millennials drive the mobile commerce market using smartphones as they are convenient, and the supply is large in the market. The research carried out by Oracle Corporation (Oracle, 2014) demonstrates that Millennials compare the experience obtained via a mobile or tablet application with the quality of the brand behind it.

In a study conducted by MTV in 2011, Millennials reported that a "game-like metaphor" is applied to almost every aspect of their life. More than half also reported that "People my age see real life as a video game" and "#winning is the slogan of my generation" (Bunchball, 2012).

"Good gamification design seeks to understand and align an organization's objectives with a player's intrinsic motivation. Then, through the use of extrinsic rewards and intrinsically satisfying design, move the player through their journey of mastery. This journey requires elements such as desire, incentive, challenge, reward and feedback to create engagement" (Zichermann, 2011).

3. Gamification and Tourism Destination Marketing

Gamification combines commonly used applications, such as visitor loyalty programs, with game playing techniques and rewards to create a more entertaining and competitive visitor experience that will results in strengthening visitors´ engagement and increase brand loyalty (DTTT, 2013).

According Zichermann and Linder (2013) and Burke (2013) gamification is a process that uses the best ideas from games, loyalty, and behavioral economics to engage people and motivate them to change behavior, develop skills or solve problems.

Gamification uses motivational techniques and psychological starters, like being alerted to a challenge or offered an opportunity for higher status, mostly in combination with digital rewards

like badges, points, and leaderboards to enhance visitors´ motivations and desires for community, feedback, achievement and reward (Bunchball, 2012).

According Werbach and Hunter (2012), three types of gamification can be distinguished: internal gamification, external gamification, and behaviour-change gamification. This study is focusing on external gamification that, applying on tourism, is about the involvement of visitors and is driven by marketing objectives. The increasing adoption of mobile devices by visitors leads to changes in tourism destinations´ marketing. The use of gamification can offer visitors the new experience of a destination and a completely different perspective. The main objective of gamification is to incentivize the visitors´ behavior that is most closely aligned with destinations´ clearly, appropriately, realistically and measurable set goals (Smutný, Řezníček & Pavlíček, 2013). The main goal of gamification is to achieve a better relationship between destination and visitors.

Functional gamification encourages visits, interaction, and experiences in an entirely new way. It allows visitors actively participate, and provides experiences that are emotional, that delights or surprise. As a benefit to destination, visitors act as a brand ambassadors and travel promoters through their social media networks. According to Koch et al. (2013, pp. 11-17) the visible status, accessible ranking, leaderboards and levels, quests, transparency of results, real-time feedback, epic meaning, cascading information, and community collaboration are attributed to successful gamification. Bunchball (2012) states that successful gamification should be based on performance, achievement and social interaction. In terms of performance real-time feedback, transparency and goal-setting were selected as gamification success factors. Badges, leveling up, onboarding and mastery create the success factors related to achievements; competition and teams are related to social interaction.

The following forms of gamification are the most used in tourism destinations: Transmedia Storytelling; Letterboxing; Quest; Geocaching; Waymarking; Scavenger Hunt; Wherigo; Quick Response; and Augmented reality. There is much room for the use of gamification in destination marketing although it must be stated that gamification is not about to turn the tourism business into a game but to incorporate game mechanics into destination´s marketing. It is about framing it in the language of metaphors of gaming, with goal of engaging and motivating visitors (Bunchball, 2012) in all stages of their travel experience - before, during and after the visit.

4. Data Collection and Methodology

The analysis and data presented in this paper are based on primary and secondary research. A qualitative research, using an inductive method, was applied to this study as it is suitable for use with a small sample. The research included face-to-face interviews in a one-to-one setting with thirty tourism stakeholders. The specific selection criteria for the purposeful sampling as (1) duration of employment in destination management organization or tourism business minimum five years, (2) and holding marketing role were determinate. The entire sample was selected by snowball sampling method.

In a semi-structured interview, the interviewees were asked to express personal opinions and display their expertise. The interviews were recorded on tape with permission of interviewees afterward analyzed through transcription and de-identified. For each interview, a summary was prepared. Content analysis and standard, systematic, qualitative coding techniques were applied. Given the qualitative nature of the information gathered and the size of the sample, the survey responses were not amenable to statistical analysis.

5. Calculation

Smartphones, tablets, phablets and mobile applications have an important relevance to visitors. Development of mobile applications enhances this trend. In the first quarter of 2015, global smartphone unit demand increased by 7 percent, compared to the same period last year. Sales reached 310m units; 4G unit share surpassed 50 percent of global smartphone demand for the first time. Q1 2015 saw a continued shift towards larger screen sizes (5"+), where sales of 166m units equated to 47 percent of the global smartphone market, up from 32 percent in Q1 2014 (GfK, 2015). It can be agreed with Amadeus Company that technology will enhance travel by layering information about history and culture over physical locations, enriching the subjective experience of travel (Stubbings & Curry, 2012).

The game industry comprised a market share of $93 billion in 2013, and the estimated growth is to $222 billion by 2015. Mobile games are almost doubling its revenue between 2013 and 2015 from $13 to $22 billion (Weber, 2013). The biggest market is expected to be the North America, followed by Europe. According to M2 Research in 2010 corporations around the world spent $100 million on gamification. This number is expected to rise to $2.8 billion by 2016 (Dugan, 2012).

The impact of gamification on online behavior is presented in Table 1(Gigya, 2013).

Web sites with gamification experience			
29% increase of in site actions	13% increase in online commenting	22% of increase in social sharing	68% of increase in content discovery

Table 1 Impact of gamification on online behavior Source: Gigya (2013)

6. Results and Discussion

The overall research questions for this study were stated as: How can be gamification applied to tourism destination marketing? What are the success factors for gamification approach in destination marketing? What are the limitations that are challenging gamification concept in the tourism destination marketing?

Trough an in-depth research of literature and the analysis of the expert interviews specific goals for gamification in tourism destination were identified. All interviewees stated that gamification in the Czech destination management organizations was still in its infancy. They agreed that gamification should contribute to the destination´s goals e.g., enhance visitation, demonstrate the destinations values, motivate longer-term engagement, create awareness, drive visitors´ loyalty, help visitors interact, learn, share opinions, help explore the destination, find brand ambassadors.

Interviewees see the place of gamification mostly in the destination´s communication mix, but segmentation and product mix were also mentioned as data gathered from playing visitors can be used in product development.

In the case of success factors of gamification in the destination, the opinion of industry experts to a great extent coincided with the literature. They listed clear objectives, compatibility with destination marketing strategy, visitor-centered approach, visitor friendliness, game design, and game elements. Interviewees also stated that they want to quantify the outcomes of gamification, but the measurability of the success of gamification projects is a critical factor. They pointed out the difficulty to break the success of gamification down into figures. The available data usually include visitor participation, daily activities, achievements, and levels.

The interviewed tourism experts also made some critical remarks and stressed some limitations of gamification, e.g., data privacy, costs, irrelevant or no measurable results. The main results are summed up in Table 2.

Some destinations already implemented gaming into their marketing to engage visitors in new ways and to create a culture of playfulness and fun. The most applied game in the Czech destinations is a smartphone application of geolocation game enriched by storytelling, Geofun that won a special prize in the category of Best Electronic Communication for the years 2014/2015 in the competition Tourism Grand Prix. Some destinations use games based on flash technology, multiquest games; augmented reality is also applied in some cases.

Application in destination marketing	Goals	Success Factors	Limitations
communication mix product development segmentation	enhance visitation demonstrate the destinations values motivate longer-term engagement create awareness drive visitors´ loyalty help visitors interact, learn, share opinions help visitors explore the destination find brand ambassadors	clear objectives compatibility with destination marketing strategy visitor-centered approach visitor friendliness game design game elements	data privacy costs irrelevant or no measurable results

Table 2 Summary of the main results Source: Author´s research

7. Conclusions

Smartphones make gaming part of life with the great potential for destinations to enhance a visitors´ experience. Visitors want to be entertained while experience the destination. Engaging them in a fun and competitive way is an opportunity for destinations that they cannot afford to miss.

Visitors are open to new challenges especially when connected with fun. Gamification can give them both. It works because it incentivizes visitors to fulfill different tasks by motivating their competitive natures supported by proven principles of rewards and incentives. Visitors help to promote the destinations by playing games while having fun. They stay engaged with destination for a longer time. Unfortunately, the most of destinations currently do not focus on socialization and gamification of their websites.

Both the visitors and the destinations can win by applying gamification in destination marketing. Visitors win by experiencing new attractions, and leisure time activities, and by experiencing the particular destination. Destinations win by increasing visitation, engaging visitors, extending the stay of visitors by motivating their engagement, and loyalty.

Entertaining, emotional and competitive visitor experience created by destinations helps visitors interact, learn, share opinions and explore the destination. As a benefit to destination, visitors act as a brand ambassador through their social media networks.

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E-WOM INTEGRATION TO THE DECISION-MAKING PROCESS IN BANK BASED ON BUSINESS INTELLIGENCE

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Keywords

Metric, dashboard, e-Word-of-Mouth, banking, unstructured data, internet discussion, social networks, Business Intelligence.

Abstract

Internet is the source of countless user feedback in unstructured form. It has the potential, which can be used to obtain information to a broader audience as companies, professionals, and retrospectively users themselves. This information are available as e-Word-of-Mouth (eWoM) on the Internet at various Web pages, discussions, forums and social networks. Users share there their personal experience with the companies, products and services and those are then followed by their transfer to other users. Simultaneously these sources create opportunity for companies to be visible and convince customers by communication on the quality of its services. As one of the approaches to achieve the better view of eWoM, we propose to design metrics as an integration of unstructured data to Business Intelligence process which should be followed to get valuable insight, where the company stands in terms of its customers. This paper focuses on obtaining an eWoM in banking sector using publicly available data from Facebook and websites related to topic of finances and banking. The aim of the paper is design of metrics and other characteristics which are intended to be a part of a dashboard as a presentation of obtained data. These dashboards then serve marketers and management to further decision-making on how to generate a revenue and keep reputation of the bank.

1. Introduction

People share their opinion in real life from user to user and value of this phenomenon called as Word-of-Mouth (WoM) is important science topic already more than 50 years (e.g. Brown a Reingen, 1987). As the emergence of social media promotes collective intelligence among online users, similar to WoM, research shown that in Internet environment electronic Word-of-Mouth (eWoM) may have "higher credibility, empathy and relevance to customers than marketer-created sources of information on the Web" as stated Gruen et al. (2006, p. 449). It affects individuals' decisions and influences organizations' operations. Researchers pay attention to customers' interactions on social networks and try to analyse their activity or content they share (e.g. Jašek, 2014; Veeck & Hoger, 2014; Pavlíček, 2014). Also business managers start to pay attention to

social networks communication and new type of Business Intelligence is emerging (Chen, 2010). In Business Process Management bringing together the worlds of structured and unstructured data can add significant value to the enterprise. User generated content is still difficult to assess because "the range and scope of related research still feels foggy". Even in post-Facebook era, tracking of consumer interest and deciding which channels of consumer content to measure, and thus demonstrating its relation to ROI, is complex and difficult task (Hardey, 2011).

1.1. eWoM for Business Intelligence purposes

General decision-making model in business world, especially in banking is outlined in Figure 1. Data Warehouses of banks today contain mostly structured data as an asset they can easily measure. But management of unstructured data determines how efficiently the company will deal with their customers in the future. The danger threatens from the ignorance of unstructured data can be sorted from dissatisfied customers, very loud customers, rapidly rising costs for customer service and their departure to breaching trust in the organization, the customer knows more than its employees. The new approach allows companies to consolidate unstructured data to central Data Warehouse is able to communicate consistently through all channels. The customer then feels that company knows him when he communicates with his counterpart, whether it's agent or vendor, or attends a customer portal. Also customer service operations at the same time can reduce costs while maintaining customer satisfaction.

Figure 1: General decision-making model in business world (authors)

General method how to make decision and thus increase performance in enterprises with Business Intelligence tools and applications is based on metrics. According to Kimball (2010) the metrics from the point of Business Intelligence view are expressed on the basis of dimensional modelling as indicators and their characteristics, analytical dimension and their characteristics and the relationship between dimensions and indicators. Metric is meant as degree, the extent to which company management is satisfied with the contribution of IT to meet business strategy. Metrics are viewed on dashboards from many dimensions, for immediate use in decision-making processes in the organization. For business users dashboards bring the visibility and clarity of all monitored metrics and their instant overview of improving or deteriorating. Thus users can immediately assess the plan or reality and save their time.

Following these method our aim is to integrate customer WoM as another source of data to Business Intelligence process which will enter into created metrics and dashboards to simplify and accelerate decision-making process based on unstructured data. With creation of integrated framework of Business Intelligence with the inclusion of unstructured data dealt already (Baars & Kamper, 2008), but they focus more on classic enterprise data and data from CRM not eWoM. Our intension is also unique with its focus to banking domain, which has specific requirements to business. This paper also expands article of (Sperkova, 2014) where the first content analysis of banking data were conducted. Designed metrics are based also on the results of that research.

2. Intention and motivation of the research

The main objective of this research is to create a periodic review of the data evaluating banks according to the context in which their users speak as often as banks are mentioned and generally

stands in the eyes of users. To achieve this goal it is necessary to identify the Web pages and social network sites where regular information from customers and users of banking services can be obtained. After processing of these information an overview of current customer behaviour will be given. Figure 2 shows our extension to the general model in Figure 1 of the data sources and inputs to the decision-making process used at this research. The findings will provide important insights into the business impact of social media and user-generated content - an emerging problem in Business Intelligence research.

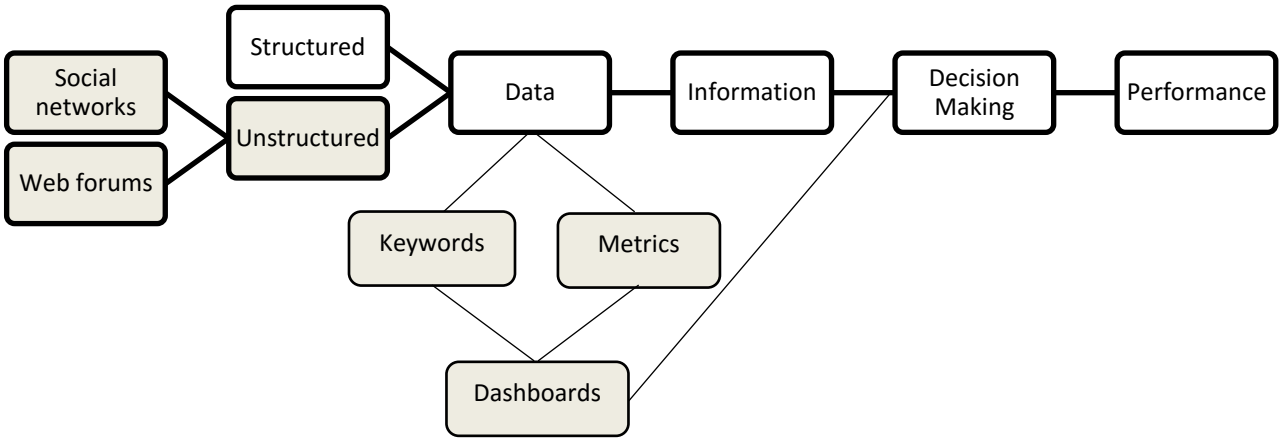

Figure 2: Extension of the general decision-making model of the research purpose (others)

The insight will be given based on metrics which have to be defined on the base of Facebook and Web comments. These metrics are then visualized on dashboards to express the sentiment of the talks about the bank in specific period and its position in monitored metrics compared to other banks in the market.

3. Methodology

Current methods of gaining insight from unstructured data are generally based at manual work, e.g. (Petz et al., 2013). According to Gebauer et al. (2008) and Robson et al. (2013) manual analysis is a case of human classification of text using a predetermined classification, automated analysis is performed by information technology. Automated analysis can lead to higher reliability of findings, as well as a greater ability to handle large amounts of text data. Gebauer et al., (2008) emphasize that automated content analysis is restricted in its ability to reveal the communicative intention of using words or symbolic meanings of words.

Our purpose is automation of the process of gaining the data and their pre-processing for further analysis. Automation of the evaluation in defined metrics, which summarize various aspects of the data in aggregated form, are then comparable among the surveyed companies. Automation can reduce cost and time-consuming, manual and comprehensive analysis conducted by people like reading posts and search links in them.

This evaluation will help to understand the WoM of customer. It is not able to capture the full transfer of expertise that customers write anywhere on the Internet. But at least in monitored publicly available sources can be analysed topics that interested users. Furthermore, these themes can automatically evaluate categories of sentiment and thereby obtain the distribution of subjects with positive or negative customer experience.

Basic methodology of the research

4. Creating a system that will ensure downloading of the necessary data from the Internet and storing them in repository.
5. Processing and data analysis.
6. Design of metrics and characteristics, which evaluate the bank from the customers' point of view.
7. Design of the dashboard for the visualising the metrics and more detailed information.

4. Methodology of data processing

For the purposes of analysis and a design of metrics we chose comments that relate to banking occurring on the Czech website or Facebook profiles of Czech banks. Five Czech banks with the largest balance sheet total in 2012 were chosen – Česká spořitelna, Komerční banka, Unicredit Bank, Raiffeisenbank, GE Money Bank. Downloaded pages from the Web discussions must meet several requirements as relation to the topic of finances and banks to put assume a high proportion of the discussions that deal with banking services. Further discussions must have well-structured and tagged HTML code, so they can be easily identified in the whole HTML page script. From the Web sources we chose Czech financial forums http://www.mesec.cz/ and http://www.penize.cz/.

For downloading the data from the Internet forums we programmed a web crawlers for automatic browsing website content by using Java language and open source crawler4j library under the Apache Licence v2. For acquisition of data from Facebook we used Java library RestFB which contains classes for working with Facebook objects. As a repository and analysis tool of gained data we used open source Elasticsearch software based on Apache Lucene library. Elasticsearch is a distributed scalable system for real-time search and analysis tool whose main function is the full-text search. It provides built-in support for analysis in the Czech language. The data from both connectors are stored to Elasticsearch in JSON format. The code clearly identified the name of the contributor, a text (comment), date of the comment and eventually the number of reviews of the comment by other users, in Facebook case also objects of the type post, comments, sub-comments and number of Likes. We also conducted sentiment analysis with OpenNLP library based on the principle of maximum entropy. For the training of the categorization model we used data from the University of West Bohemia as an output of sentiment analysis of data from the Czech Facebook sites and reviews from the Czechoslovak Film Database web using machine learning with a teacher. Outputs from Elasticsearch were then processed and visualized as dashboards in Kibana application. Further plugin Head for simplification of indexes (data file) and applications carrot2 for clustering documents were used.

5. Metrics design

The main purpose of metrics is to highlight the important facts that corporate resources or people need to be focused. From downloaded and indexed data is necessary to draw metrics and other characteristics evaluating banks from the customers' perspective. If the characteristics are of the quantitative type they are defined in proposed metrics in Table 1. The metric is measurable indicator which can be calculated and sliced according to selected dimensions. Metrics along with dimension form the value for gaining the eWoM from the data. The highest value have dimensions created from textual analysis. Some results of metrics can be further used as dimensions to slice

other metrics. For example one metric can be the *calculating sentiment* of different comments. Further this result can be used to slice metric *most active contributors* and show only those with negative sentiment. Considered dimensions in this case are:

- Time period (e.g. month, week, day, date)
- Source of the data (Facebook, Web forum)
- Type of the contributor (Facebook user, Bank, follower)
- Type of the page (individual Facebook page, individual forum page)
- Type of the contribution (comment, post)
- Name of the bank
- Name of the product (specific or generic)
- Sentiment (positive, negative, neutral)
- Topic/contribution

To better understand the content of posts and comments, the list of keywords has to be designed for better search of contributions according to user requirements. This is a domain knowledge of every enterprise which wants to use our procedure. This list can be always updated. The example of such list is shown in Table 2.

Name of the metric	**Definition**	**Calculation**	**Unit of meas.**
Number of Likes	Indicates people who liked the page/post/comment, shows the popularity of the bank on Facebook	Summary of individual likes	Like
Number of posts	Shows the activity of the bank and its followers or other Facebook users, indicates how many objects of the type post are on the wall	Summary of individual posts	Post
Number of comments	Indicates how many objects of the type comment are on the wall/under the post	Summary of individual comments	Comment
The ratio of the number of comments that contain the name of the bank or the product to all comments	Evaluates how important it is to monitor the website and its discussion	Number of comments containing the specific topic / all comments	%
Frequency of the topics/keywords	Summarizes themes, a common signs of comments that occur most frequently	Summary of topics/keywords	Topic / Keyword
Incidence rate of topics together with keywords	Indicates topics occurring together with the keyword	Number of pairs of specific topic and the keyword/ number of occurrences of the keyword	%
Sentiment of the topic/contribution	Count the overall sentiment of the topic or contribution. Serves for example for comparison between banks.	(number of positive – number of negative contributions) / number of all contributions	Sentiment
Most active contributors	Users contributing the most – potential opinion makers	Summary of contributors	Contributor
Net Promoter Score	Evaluates measure of customer loyalty	% of loyal customers – % of disloyal customers	NPS

Table 1: Definition of designed metrics (authors)

Names of banks	Other names of banks (used by customers)	Names of products - generic (common for all banks)	Names of products - specific
Česká spořitelna	spořitelna, spořka, čs	Účet Úvěr Půjčka Hypotéka Kreditní karta Debetní karta Kontokorent Internetové bankovnictví Internet banka	Osobní účet ČS II, SERVIS 24, Kreditní karta Odměna, iBod
Komerční banka	komečka, kb		A karta, MůjÚčet, Lady Karta, MojeBanka, Konto G2.2
UniCredit Bank ČR	unicredit, ub		U konto, Konto PREMIUM, PRESTO Půjčka
Raiffeisenbank	raifka, raiffka, rb		eKonto Smart/Komplet/Student
GE Money Bank	GE, GEmoney		Genius Free & Flexi, Genius Gratis, Genius, bene+, Expres půjčka

Table 2: Keywords for bank names and products (authors)

6. Dashboards design

Designed metrics need to be placed to the Dashboard realized in an application Kibana. Dashboards can be classified according to different criteria (Pour, Maryška, Novotný, 2012, p. 194). Two dashboard designed in this paper can be used from operative to strategic decisions, data origin is classified into marketing. Because it is a regular submission of information, the frequency of the update must be set, in our case it is weekly basis.

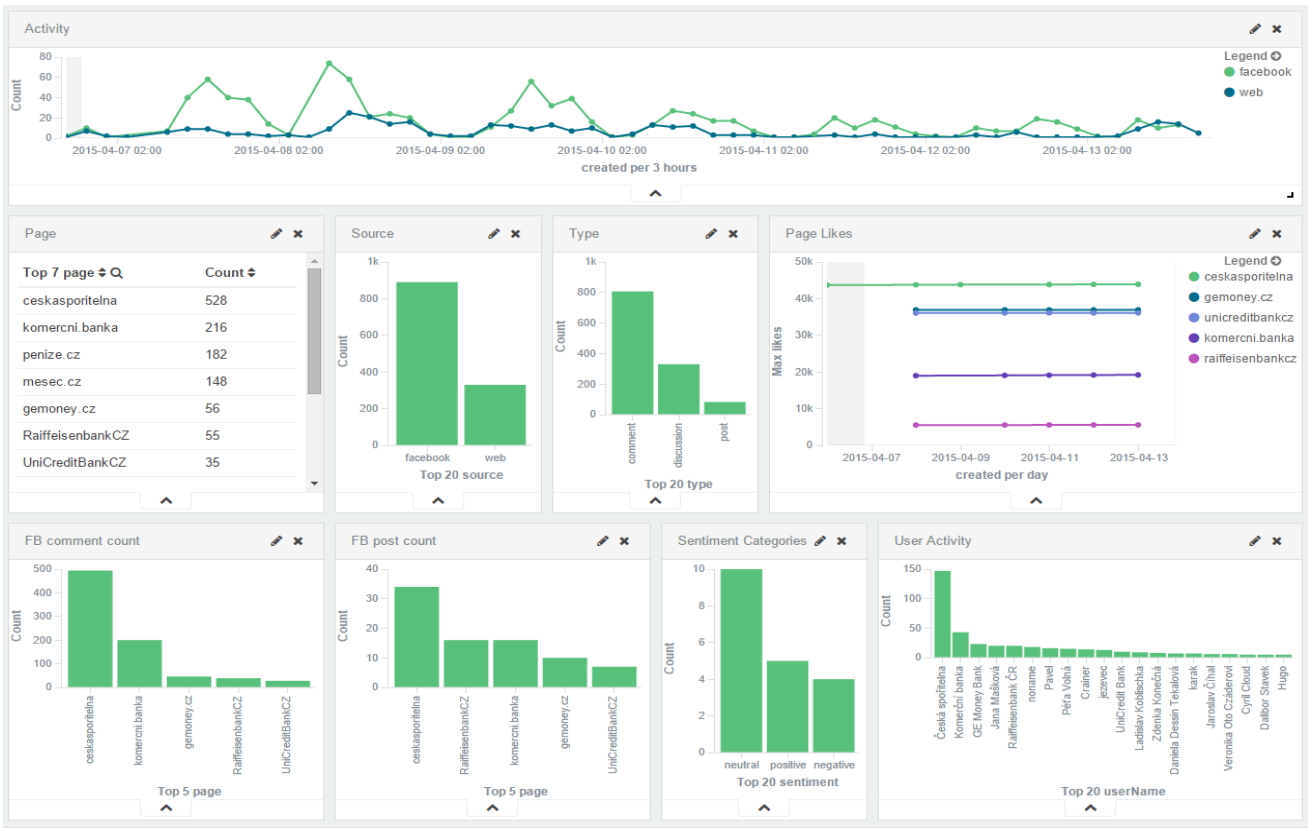

Figure 3: Preview of the Overview dashboard (authors)

Dashboard Overview shows defined metrics and contains a set of visualizations that correspond to the quantitative questions about the stored data. Topic analysis dashboard shows topics or words that frequently occurred, or may be potentially interesting. It is designed to gain insight on the

topics discussed in the context of the stored data. Dashboards are used for analysis of indexed data and final visualization. On the data can be viewed from different angles, search allows querying and display specific subsets of data. Data which contain the specific shapes of searched word or phrase are then displayed. All objects defined in Table 5 and placed to dashboards also serve as filters that allow view data according to user interest. For example, finding where there are many negative posts, which source caused a blip in the number of contributions and so. Another option is to enter a query into the search and thus, for example, to determine whether the messages contained some of the key words or how often a name of the bank occurs. What issues were of interest commenting can occur in several ways - with objects Frequent Terms and Top unusual terms and a frequency of posts in the course of time.

Object	**Description**	**Note**
Activity	Development of the number of posts in time	Filter allows to limit data, e.g. to period of high activity of users
Page	Names of the pages and number of documents	Filter by clicking on the name and change the sort by number of documents
Source	Number of documents from different sources	Filtering by sources
Type	Number of documents saved in single types of bank index	Filtering by the type of sources
Page Likes	Development of the number of Facebook likes in time	Popularity of sites can be compared between themselves
Comments count	Number of comments on individual pages	Filtering by contributors
Posts count	Number of posts on individual pages	Filtering by contributors
Sentiment	Summary of the sentiment evaluation	Sentiment is flow number from -1 to 1
User Activity	Most active users	Users with the highest number of comment or posts
Frequent Terms	Most frequent words contained in posts and comments	Identification of themes related to the contribution. It shows the word in the form after stemming rules and frequency of occurrence.
Top Unusual Terms	Terms that are statistically unusual	Terms which occur more frequently than they according to statistical model by other data should. It highlights the novelties in selected data

Table 3: Defined objects placed in dashboards (authors)

7. Discussion and further research

The purpose of the research was design of metrics (Table 1) evaluating individual aspects of bank services perception by customers and integration of eWoM to Business Intelligence process. Consolidation of these metrics to the dashboard (Figure 3, Table 3) may serve as indicator of the marketing department for the evaluation of bank in relation to others in the market. Dashboard can have wide range of consumers as a tool for simple presentation of results. It displays topics most discussed in specific period. Therefore, it may also serve as a feedback for new product introduction, overview of the competition or the discovery of the customer wishes. It indicates to clients what bank is customer friendly and what bank and issues people talk about. Longer-term monitoring metrics can therefore tell where to apply banking products. Alternatively, indicate what problems are solved by bank customers. From a managerial perspective, our results suggest that firms should pay attention to textual content information when managing social media and focus on the right measures.

This approach could lead to higher customer satisfaction and growth of agility, profitability and orientation to the customers. The advantage of our approach is its extensibility and also usability besides banking in other enterprises. There can be always added connectors for new sources of data. Also new metrics can be designed and incorporated to the dashboard. In this case domain knowledge and a knowledge of the business users needs is a necessity. Out further research will cover more data sources and Machine Learning approaches to define more complex metrics and also solving the problem of distortion. Analysed data do not necessarily reflect the views of their authors and also may be distorted by the efficiently generated comments and censored comments by stakeholders. The future work will focus how to eliminate this problem by recognizing these patterns in communication on the Internet.

8. Acknowledgements

This article was prepared with the financial support of the research project VSE IGS F4/18/2014 and with contribution of long term institutional support of research activities by Faculty of Informatics and Statistics, University of Economics, Prague.

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SESSION E: THE WISDOM OF CROWDS

COMMUNITY BASED DATA TRANSFER VIA MULTIPLIER AGENTS

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Keywords

Disaster management, situation awareness, reliable data generation, wisdom of crowds, multiplier agents, verification of information, trusted information, Social Media, communication flows, resilience enhancement, QuOIMA project, RE-ACTA project

Abstract

Crises and disasters occur all over the world with the highest impact on the most vulnerable in society. Generating a trusted status of information out of a multitude of reliable and relevant data about a critical situation is a priority for effective and coordinated disaster management and relief measures delivered by governmental organizations (GOs) and non-governmental organizations (NGOs). Data gathering, processing, information visualization and (internal as well as external) dissemination for decision support and mitigation is performed via a number of different channels. The QuOIMA-project, funded by the Austrian Security Research Program KIRAS, focused on the various possibilities to use publicly available, open source data generated in the sphere of traditional (online distributed) and social media.

This interactive gathered, multi-channel data, tapping the wisdom of crowds on the broadest possible level, could be used as vital and relevant input for situation awareness and decision support in disaster management. It could also foster and maintain active, bidirectional, participatory involvement of community members in the prevention and the relief phase of a serious

event – under the prerequisite of a trusted, reliable, and privacy safeguarding framework like the one applied within the REACTA-project or the MultiRes-approach.

This paper focusses on the outcomes of the post-project evaluation of QuOIMA that showed several important research questions and gaps: How can – e.g. in a small country like Austria – relevant data be gathered in a sensible amount? How can reliability and trustworthiness of the data be granted? How can open source data legally be localized and geographically positioned? And last but not least, how can a broad basis of the community be activated in prevention and relief taking into account the still existing digital divide?

1. Background – the QuOIMA[3] project and its communication approach

Crises and disasters are constantly covered and accompanied by today's media. While traditional media have a long history in covering disasters and crises, recent examples of natural as well as man-made disasters show that social media provide useful, effective, additional and complementary information and can help improve situational awareness. Social media interact with traditional media in various ways – providing different and sometimes unfiltered angles, sparking off initial coverage of the event, or amplifying information. Together they produce a wide spectrum of data about an event. As helpful as all of this raw data may be, it usually comes in various formats from multiple media sources, in different languages and levels of reliability, and is generally unstructured, inhomogeneous, and rarely specified in terms of the location.

To meet the challenges of using such data, the KIRAS project QuOIMA aimed at developing a cross-media content analysis framework and at extending existing technologies to improve the situational awareness of decision makers as shown in figure 1. The cross-media, multimedia and multilingual approach adopted by QuOIMA was expected to identify risk indicators and factors for efficient crisis and disaster management as well as the early detection of emerging threats and trends. Models for the improvement of situational awareness were developed and can contribute to faster reaction times.

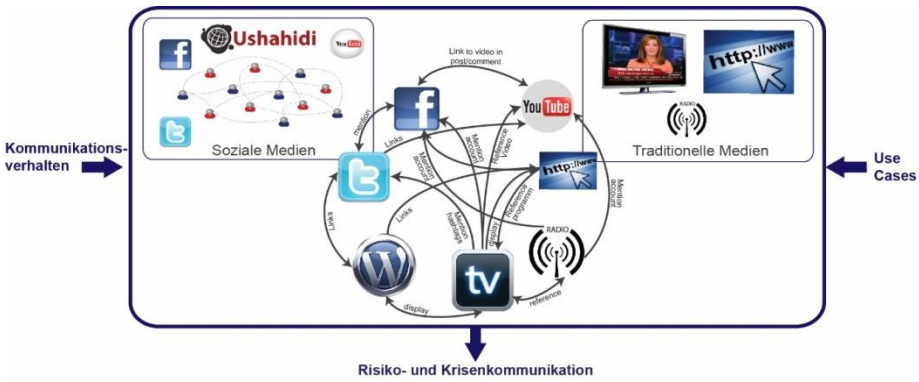

Figure 1: Systemic overview of the sources and information flows of the QuOIMA project

[3] QuOIMA – Integrated Open Source Multimedia Analysis (*German*: Quelloffene integrierte Multimedia Analyse). Following excerpts from the project information and dissemination material of QuOIMA; also to be published in modified form in the Central and Eastern European Legal Studies, 1/2015 (Rainer et al. 2015).

From a technical viewpoint, QuOIMA is based on the SAIL LABS Media Mining System for open source information (OSINF) and on the insights gained from a previous KIRAS project, MDL. Strategically, QuOIMA is based on a five-stage disaster management model developed by the Austrian National Defense Academy (Backfried et al., 2013). These technical and strategic foundations form a powerful basis for improving situational awareness during natural disasters.

The investigation and development of such methods consequently formed core activities within QuOIMA. Components for the analysis and selection of quality-assured scenarios for the deployment of the developed technologies as well as additional requirements posed by crisis communication within the context of enhanced early warning and resilience were further areas of activity. The comprehensive, cross-media, multimedia and multilingual approach represents unique and innovative research for crisis and disaster management. Research on sociological and legal aspects complemented and extended these activities.

Specifically, the vital factor of directly and indirectly concerned persons' trust towards official disaster management organizations and their activities during crisis situations are tightly connected with the appropriate channels and types of data and information distribution and thus the acceptance of communication and compliance to necessary measures (Siegrist et al., 2014). Taking into account the complex interactions and interdependencies in dynamic crisis scenarios, trust and its related phenomena and effects can only be defined as a continuum created over a long period of reliable information exchange and interaction between official disaster management organizations.

Long-term reliability as an objective criterion of information and the consistent external and internal appearance of disaster management organizations can be seen as a prerequisite for the development of trust. Even if there might be relevant and significant cross-cultural differences, the building of high-reliability organizations (Horsley, 2012) and the effecting benefits for reliable internal and external information and knowledge development for effective disaster response has to be developed timely and continuously.

Subsequent to the elaborated importance of intra-organizational developments in order to grant reliable information and knowledge management, interoperating components of a disaster response system, like the interaction with a potentially affected community, have to be taken into account. Specifically, the vital but often non-reflected issue of facilitating and promoting the social model of "trust" (Misztal, 1996; Siegrist et al., 2007) and thus representing the capacity to fulfil specific expectations, stands for disaster response organizations in a reciprocal relationship with reliable external information management and the authentic, ongoing interaction of organization and public.

In the wake of the QuOIMA-project, the question of trust in the community was researched more thoroughly via a restricted survey among the Facebook-community to stand as a qualitative example for the views and expectations of the citizens regarding information gathering in crises. As figure 2 shows, the matter of trust concerns not only directly affected citizens. Also the organizational sphere has to deal with information and has to verify them. Thus, the importance of trusted data respectively the verification of information is a core task. The study "Trust in social media in case of crisis and disaster" was dedicated to the point of view of the public recipients regarding trust in traditional vs. social media. The study was carried out in autumn 2014 and included a panel of several selected online communities from which 90 persons responded. It was an addition to the initial QuOIMA-project plan due to the constantly mentioned question of trust in workshops and expert interviews.

One output of the study was that traditional media are used more often than social media on purpose of information gathering. Traditional media are also classified as more reliable than social media. On the other hand, social media are used with a much higher frequency. The study also shows the varied possibilities of using social media in the context of crisis and disaster management

(Levy, 2015). In the case of disaster response organizations, this issue seems even more crucial as the effective facilitation of relief and support measures strongly rely not only on timely, but also on target group orientated communication as Reynolds et al. (2005) summarize for the health sector. Taking into account the above mentioned, internal processes of information and knowledge development measures, the prerequisites for the development of an externalization of effective procedures can be supported. Several factors seem to be of importance for this transportation and transformation of reliable information and continuous interaction to create framework parameters enabling trust in the community.

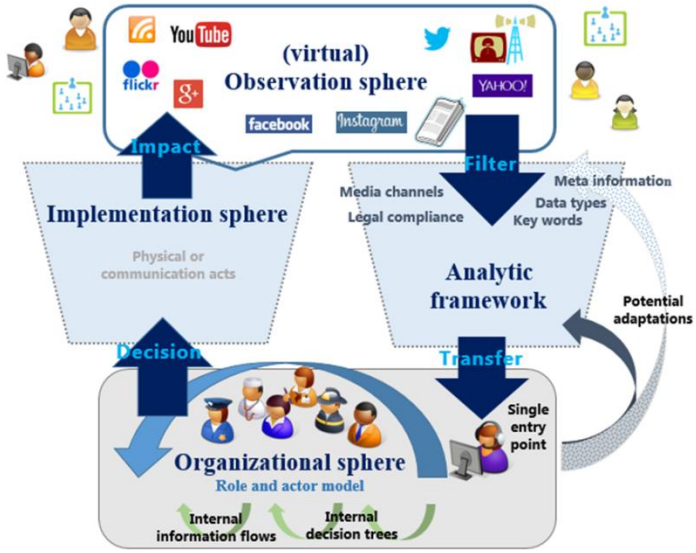

Figure 2: Communication and decision support model of QuOIMA

Using the virtual observation sphere where online communication and information acts of the community via social media or by professional media organizations as an arbitrary starting point, the collectivity of manifestations undergoes a pre-set filter process. In an initial setting the filters need to be tailored to the particular organization. In a running cycle it can be adapted regarding the current necessities and requirements of the setting, event or organization status. The filter settings can have different qualities and quantitative thresholds and refer e.g. to technical as well as to topic or source related factors. Even reliability parameters can be taken into account given that the required framework parameters can be provided to the filter layer.

2. Open questions and unsolved challenges

After the successful life-cycle of QuOIMA the post-project evaluation identified several important research questions and gaps that had to stay unanswered due to the specific focus and limited resources. Although there are several good practice examples like Ushahidi (http://www.ushahidi.com/) or the reliefweb (http://reliefweb.int/), the use of social media and open source data for situation awareness and disaster management actions is still not widely spread and at the beginning of a strategic use. From the experience of the project QuOIMA, one of the first questions that arise regarding the sensible use of this data source in a small country e.g. like Austria is how to get a sensible amount of relevant data – containing reliable location information. And above all, how can open source data legally be localized and positioned to contribute to timely situation awareness drafting?

The QuOIMA-team collected data during the flood in spring 2013 severely affecting several states in central Europe (Backfried et al., 2014). Beside information in traditional media, altogether approx. 470.000 tweets, 9.800 posts or comments on facebook in connection with the flood have been observed. Only a limited number of messages contained location information; either explicitly stating the location or embedded as metadata of the message. E.g. for Salzburg 1.062 messages in total could be contributed to the city, as the city's name was stated explicitly in the message. Also images contained in or referenced by social media messages are not as frequent as expected, From the 470.000 tweets only 4.998 (1.1%) contained links to images or videos. The hope that several users post images depicting the same spot does not hold under these circumstances; that would be useful to confirm the trustworthiness of information gained from images. Also those images tend to cover the more important geographic locations or locations somehow outstanding (e.g.; severely affected, focus of rescue activities). Messages referencing images or videos have a higher probability of containing location information. The percentage is approx. 33%. Although the information could be quite coarse, e.g. "Deutschland" ("Germany") or "Bayern" ("Bavaria"), the majority of location specifications is on the town level (see **Chyba! Nenalezen zdroj odkazů.**).

Figure 3: Level of location information in social messages containing links to images or videos.

Besides the obvious challenges in using open source and public social media data, these media/communities have a high participatory potential (Bertot et al., 2010). The threshold for contact and cooperation is very low for technically equipped and enabled citizens and innovative services aim to interaction with the communicating parties. Thus it becomes possible to make appointments for supportive actions or to help each other in the case of contingency (Gao et al., 2010). Institutionalized examples for this potential will be shown in section three with regards of the project RE-ACTA.

Another challenge that became obvious as a consequence of the missing quantity of the data is how to grant a certain level of quality of the data in terms of reliability and trustworthiness. Those two parameters are a core topic from the view of the emergency management and the involved persons as well (Merchant et al., 2011). Without the possibility to verify inputs via additional sources e.g. due to the lack of different sources– as was shown above – it becomes increasingly important to find additional forms granting the trustworthiness of sources and data.

In the course of the QuOIMA-project algorithms were investigated and implemented to allow the comparison of video and image data from different open sources to give more information about the trustworthiness and validity of the digital data. In addition to this technological approach, other possible ways of securing data reliability, quality, and quantity can be found as will be discussed in the next section.

Last but not least it became obvious, that as shown in figure 2, data management can never be a one way road and has to be seen and handled as an interactive system. Thus the challenge became obvious, how to activate a broad basis of the community in prevention and relief – also taking into account the still existing digital divide.

3. Wisdom of crowds – community based data transfer via multiplier agents

The International Red Cross declared in 2012 the urgent need to strengthen the resilience of the population. For instance, in Austria, the National Crisis and Disaster Management is based on the principles of self-protection on local areas and subsidiarity on higher levels of public authorities (Jachs, 2011). One of the pillars of the Austrian emergency response system is strong volunteer organisations. This strong level of voluntariness has to be both ensured as well as enhanced. Taking into account the multiple societal changes taking place nowadays such as the focusing on an individualistic lifestyle, new types of voluntary engagement have to be promoted. In this light, the RE-ACTA project has been set up (Neubauer et al., 2013). RE-ACTA is aiming at systematically tasking the crowd, specifically the members of the Team Austria of the Austrian Red Cross.

Within RE-ACTA new workflows for volunteer communication and coordination via mobile phones are implemented. RE-ACTA is integrating a multitude of basic processes such as community building, registration of volunteers as well as data maintenance (Sebald et al., 2014). More specifically, a task manager can launch tasks for the crowds, encompassing definition of tasks, selection of volunteers to be addressed in a specific crisis or disaster as well as distribution of the task. The volunteers are supported in their task execution by a specifically designed user interface. For compensation, they receive specifically designed information and individual guidance. For crisis managers analysis based on the volunteers reports are provided strengthening their operational picture.

An approach focussing even more concentrated on the questions and challenges presented before in regard to an enhanced situation awareness by persons on site adding up to current open source information from social media, was initially created and formulated by AEI, the Agency for European Integration and Economic Development, AIT, the Austrian Institute of Technology, and the Austrian Red Cross (ÖRK). With the aim to survey the potential of multiplying agents to enhance the resilience in Austria a plan for the analysis, suggestions and tools for a low-threshold implementation and integration with intermediary mediators in selected settings was set up under the name of MultiRes, and proposed for funding in the Austrian funding program KIRAS.

The initial situation identified in Austria via the outcomes of several pertinent projects of the working group showed several challenges and immanent problems in the broad field of preparedness and resilience among the population. In large parts of the population in Austria, a low hazard and risk awareness, especially regarding possible complex emergencies, crises and disasters is evident. Prevention providers such as civil protection organizations, the Red Cross and other actors who are responsible for preparing the population for possible incidents, state that the knowledge and the necessary willingness for preventive measures and self-efficacy are poorly anchored. In an Austria-wide survey the Civil protection association found a high level of trust in the emergency services and an equal lack of self-reliability regarding preparedness and prevention actions among the population (ÖZSV, 2007). This particularly manifests in urban areas by insufficient food and drinking water storage or exclusive reliance on public networks for heating and energy supply.

Research studies confirm that in Austria – and thus potentially in most comparable countries in Europe – the effect of depth and integration of existing, “classical” prevention communication in

the everyday reality of life of the population, is insufficient (Kirchner, 2011). The resources devoted to raising awareness such as brochures, online media or event concepts reach only a small part of the population and mostly on a superficial level. On the other hand there is also only scarce knowledge about possibilities of involvement and low-threshold offers of commitment and contribution to disaster prevention and management.

An improved awareness and knowledge of threats and possible self-efficacious measures are first essential elements for increased resilience of the population. These factors could improve significantly the efficiency of future measures to protect the population (e.g the introduction of new alarm concepts), and the wider cooperation of authorities, emergency services and the citizens. This cooperation could then contribute to specific coordinated and timely enacted activities – as shown by the example of RE-ACTA – as well as to a chain of reliable information gathering processes like the following approach:

The MultiRes-approach focuses on the possibility of implementing and enabling reliable persons, so called multiplier agents, who successfully communicate in various domains of their usual everyday life, e.g. with recipients in leisure clubs, the members sports clubs, and other interest groups. They can be integrated in a broader understanding of Disaster Risk Management (DRM) to provide specific content for awareness-rising regarding risks and appropriate preventive provisions. In addition to the traditional top-down communication strategies of prevention providers, complementary channels on a subjective level with a personal connection between the prevention content and the respective addressees of the information could be installed. This personal level of involvement and attachment could support the depth of anchorage of the information.

On the other hand, the hypothesis of the MultiRes-approach includes the possibility to garner the necessary, reliable additional onsite information. Targeted requests for specific data via this trusted, pre-registered channel of the multiplier agents aim on enhancing the situation awareness of command and control centers in the case of emergencies. Multiplier agents are supposed to be able to easily activate their respective group members and thus to fill the information gap regarding location, reliability and trusted sources.

Adding up to tackling the mentioned challenges of currently available open source (social) media data, this approach can also be used to bridge the digital gap as well as build up trust from sides of sensitized or specifically vulnerable person groups into the measures of emergency responders. This is essential to base prevention and response measures on all three pillars of an efficient civil protection system (Rainer et al., 2013), i.e. governmental, non-governmental and private sources of stability.

Disaster management – and above all preparedness and resilience building measures – have to take into account individual requirements of the population. This includes personal properties like gender, age, social and ethnical affiliation (Enarson and Morrow, 2000) as well as disabilities (McEntire, 2007) as well as the lack of language proficiency and knowledge of the local customs (e.g. in case of tourists, new migrants, refugees). Specifically in respect of age, low education or cultural limitations of the access of digital information systems, the “digital divide” represents a limiting factor to get critical information in time and to contribute actively to the information feedback for a better situation awareness of the disaster management. A person trusted by the community members as well as by emergency personnel, a multiplier agent, can act as intermediate to grant a stable flow of necessary information in both directions. The MultiRes-approach builds up on these requirements and necessities occurring in a diverse society confronted with crises as figure 4 shows.

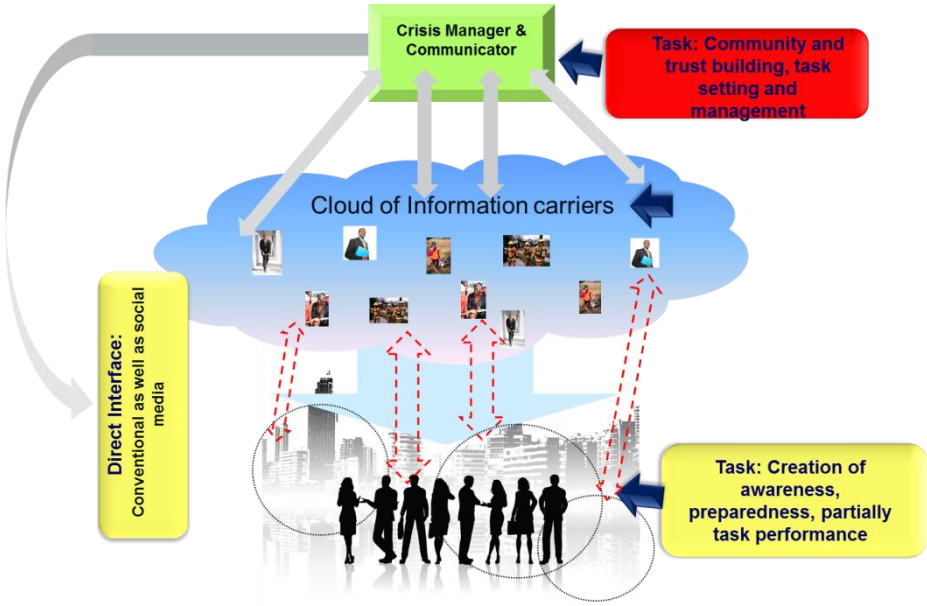

Figure 4: Concept of an enhanced multiplier agent approach for resilience building

Disasters are defined as "serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts" (UNSDR, 2009). Disasters are also able to tighten community bonding and make them more permeable (Neal et al., 2012) but on the other hand, they obviously apply excessive pressure on affected individuals. In the situation itself, immediate physical and emotional responses can occur (Benight and Harper, 2002; Bryce, 2001) as well as the manifestation of distrust and thus non-compliance to members of the disaster management (Morrow, 1999) and necessary disaster relief actions e.g. evacuation. Especially in communities with a lack of language proficiency or for individuals lacking literacy, the disadvantages of responding and recovering from a disaster are obvious. Cultural differences and even educational level can contribute to misunderstandings and thus deficits in preparing and responding to crisis situations (Phillips, 1993).

Basing on the inherence and belonging of the multiplier agent-approach to the respective communities (e.g. migrant associations), some of these disabling factors can be reduced or even neutralized. With a direct and personal access to the members of potentially vulnerable communities, factors as mistrust and/or misunderstanding of important actions in the relief phase of a disaster can be tackled. The practicability and real impact of the MultiRes-approach to enhance resilience and preparedness in disadvantaged groups has yet to be proven in a monitored field test.

Expected results of the MultiRes-approach

On the basis of a thorough requirement analysis, it will be surveyed which type of information is suitable to be disclosed by the emergency organizations to the multiplier agents and which media and channels are seen best fit for the transfer. A variety of characteristics of the information, such as language, level of education or religion, shape of the message (e.g. length, language, text vs. image), of the recipients, of the multiplier agents and their environment (the setting) and ultimately the channel for transmission of information are coordinated. Based on graph analysis, for selected examples, information and recipient-combinations are optimized taking into account the multipliers and input design (framing), as well as information channels (online-offline, print media, games, etc.).

MultiRes investigates whether intermediated paths via multipliers can be used to improve the perception of risk and preparing the population for possible incidents. This should add up to those

already existing, superficial channels of communication for self-protection, prevention and related content. Recommendations for prevention providers are generated to optimize the selection of multipliers on the one hand and on the other hand the shape of the information. Focused on the selected target population and the information to be provided the optimum orchestration for a best possible solution for a deep impact information transfer will be the outcome of the MultiRes approach that contributes a concept to enabling future practice.

4. Acknowledgement

The QuOIMA (2012-2014) and RE-ACTA (2013-2015) projects were supported by the National Security Research Program KIRAS by the Austrian Ministry of Transport, Innovation and Technology.

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THE WISDOM OF CROWDS: DOES INFORMATION TECHNOLOGY REQUIRE THE WISDOM OF THE NATURE?

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Keywords

Business intelligence, information, information technology, swarm intelligence

Abstract

This paper is focused on process analysis in selected systems such as operating systems, database systems, and Business Intelligence (BI) products. The importance of analysis is given by the need to realize pressing activities with support information technology. High demands are placed on efficiency, speed, and elasticity of firms, organizations, and individuals based on their everyday activities. It is natural that these demands are placed on processes which create background of implemented systems. Optimal analysis of existing processes and their lifecycle with comparing adopted solution shows space for innovations and further improvement with relations on swarm intelligence. The optimal links must be specified on actual perception designed processes via indicators of the best solution based on pheromones from swarm intelligence and nature. This collective wisdom positive influences process management via flexibility to support searching classified information. The presented analysis is based on Petri Nets.

1. Introduction

Our global information society generates a wealth of information. For correct decision within every human activity, information is required. This information must be accessible in an optimal format with an appropriate design, and most importantly, it must be timely. Every day, many users run a variety of systems to search for needed information. That is how information is manipulated with the help of processes. A default process is defined as set of interrelated or interacting activities transforming inputs to outputs. (Process Definition, EN ISO 9000:20004) The terms “information” and “process” are closely linked. Methods for processing information offer procedures for creating, and storing information with the ability of future searches and presentation.

The majority of systems designed to store and search for information use database systems as one optimal solution. Database systems usually run in a standard environment of a selected operating system. Starting point of work with information and further development realized activities do not stop here. (Larose, 2014) From this information, users can make educated predictions about a variety of areas such as client interest, vendor behavior, and optimal service or product offering. Users can estimate these results based on experiences or intuition, but in today’s modern society,

this is not enough. (Tergan & Keller, 2005) Today's society wishes to control existing processes and future development. In this context, BI products are lend a helping hand and are a good consultant. Users of various systems do not think about existing processes that provide a needed background.

2. Urgency processes in modern society

The current world economy is undergoing fundamental change. Today's knowledge society respects information, knowledge, and creativity. These elements are supported by visual perception with increasing pressure to be dynamic, original, independent, and helpful. In all these aspects the human element occupies a unique place also in small firms and organizations. The relationship creating is required ability to bring business, technology and people together. (Cragg et al.) The needs for any process realization far exceeded the possibilities of an intuitive approach. This situation is similar in the area of information technology (IT). Information technology users effectively use modern solutions, which are implemented in various systems. Accessible solutions are designed based on the patient development by many teams with the aim to create superior software. Information technology development offers freedom for many experiments. Options for applying effective support of realized activities for computer processes are infinite with real outputs based on competitive advantage. (The database market is considered fragmented and competitive achievements represent a shift of just a few percent, 2009) Effective support is not only in the creation of a corresponding system. Users need optimal implementation, a user-friendly interface, access to advice with the support of online discussion groups, and visions for further inspiration.

The existing urgency (of process quality management) is based on perfect precision, depending on the needs and abilities of users and the quality inputted information. Implemented systems create many system processes after running. These processes must be balanced and optimized. The main reason is for the ability to create a user-friendly interface that provides a quick reply with visual representation of information for business processes. The improvement of business processes is focus of many methods. For example, Lean Six Sigma (Harver, 2015) is a method for the amelioration of processes and increased profit. The key is power and flexibility of existing processes. This method is based on a structured, disciplined, for data oriented process, which is focused to improve organizational performance. (Lean six sigma) Stress is placed on philosophy, real vision, and elimination of mistakes. We can see a similar situation in the case of selected systems. Operating and database systems must have an optimal background in supporting existing processes. These backgrounds must be effectively managed with access to quick and effective resolution. The best practice is prevention of unexpected situations with monitoring and an elaborate alert system for all processes.

3. Processes in operating systems, database systems, and BI products

Operation-varied systems and products are implemented via specified processes. These processes create an environment for an operating system, database system, and BI product. Every one of the selected systems has an original interface to communicate with users. Available interfaces allow for activities of many users of existing computer systems. An operating system creates a background for hosting applications like Jaspersoft BI Suite, Oracle database system, and many others. A database system is designed to store information and further optimization in supporting the creation of queries, reports, and editions. BI products facilitate a highly desirable ability to

determine future development. The lifecycle of each of the mentioned systems and products is defined by its own processes with different structures, activation methods, and administration.

Process administration of operating systems is one of the complicated layers in the case of multitasking operating systems. Multitasking is the ability of a computer to run more than one program, or task, at the same time. (Multitasking and Multiprocessing) Multitasking enables transferring to another program without stopping work in progress. It is useful when implementing varied activities that must be realized in parallel. Multitasking is one of the basic conditions in implementing a multiuser environment. Every process has a unique number of process assigned (PID). PID is a positive integer, where a newly created process is assigned a number according to the last used value, increased by one integer. (Anderson & Dahlin, 2014)

At standard boot, the given system is moved from halt mode to multiuser mode. It is a traditional action to run hardware components and their administrator (operating system). The multiuser mode is primary the most used mode. In this mode, the operating system offers needed computer resources like the CPU, memory, disk space, and access to hosting applications, e.g. database systems or BI products. In this mode, all users perform activities like searching for new information or storing needed information. If necessary, the operating system's administrator can move the operating system to another mode. These modes are useful in case of hardware and software error, installation of a new device or programs. The disadvantage of these modes is that standard users cannot work with needed applications.

The database system is dedicated to storing, optimizing, monitoring, and future searching of stored information based on actual user needs. Database systems host a wide range of data types expressed in a variety of popular programming languages. (Hellerstein et al.) Processes of the database system are divided into user and server processes. If a user runs an application, a user process makes a connection with an instance. An Oracle database system instance is created by the main memory structure called SGA (System Global Area) and processes running in the background. This background is made up of a few specific processes such as System monitor, Process monitor, Database writer, and Log writer. System monitor is a set of processes that carry out required activities for database recovery after crashes. Process monitor is centered on monitoring running processes, and handles support for their correct activities. Database writer stores data to disk. Log writer stores records for rollback transactions.

The start and stop database system is restricted to the administrator. Experienced users easily create a script for to start all components of the database system from the operating system. Another way is offered with the use of Oracle Enterprise Manager. It is a user-friendly interface for easy administration of the Oracle database system in the form of a website. Work is based on web links and manipulation is carried out in a standard browser. The sequence to stop a database system is similar to starting a database system, but in reverse order. The Oracle database system must move from the open state to the stop instance through state close database and unmount database.

Under the name of BI, it is possible to imagine particularly powerful analytical and reporting tools that enable the use of organizational data not only for the analysis of past phenomena, but also to predict future developments. (Business Intelligence: You Need to Think, 2007) BI products are oriented toward future analyses of stored data from database systems. Users create reports and analyses based on Online Analytical Processing (OLAP). The user environment is friendly with web-interface support, offering menus for creating and managing reports and resources. For example, Jaspersoft Server (JasperServer User's Guide, 2015) needs the following components: web application (Apache Tomcat), database server (My SQL), and Java environment. For standard users, all mentioned components must be started, and Jaspersoft Server and iReport Designer too.

After installation these components are started automatically from the operating system with menus or scripts. An analogue procedure is used for stopping.

4. Simulation selected systems via Petri Nets

For the description of a selected area (lifecycle of selected systems and products), traditional analytical tools called Petri Nets are used. Petri Nets are primary used for simulation parallel systems with aim to describe state changes in a system with places and transitions. The created models specify important features of a given reality and the studied systems are better identified. A graphical visualization of the model is equally important to enhance the understanding of the software requirements. (Gold, 2004) The default Petri Nets C = <P, T, I, O> consists of: a finite set P of places, a finite set T of transitions, an input function I: $T \rightarrow Nat^P$ (maps to bags of places), an output function O: $T \rightarrow Nat^P$. (Nierstrasz, 2009) Classic analysis of Petri Nets for models is realized by matrix representation with incidence matrix and reachable marking. The definition incidence matrix is $C = O^T - I^T$. (Kochaníčková, 2008)

For example, the simulation with Petri Net objects for the analysis of the UNIX operating system (as Solaris, AIX, or HP-UX) lifecycle is displayed in Figure 1. This model shows the simulation for a standard UNIX operating system when starting and stopping. The starting point is place P1_HaltMode. This place displays the black screen with the basic interface for starting the system from the console. The route leads through transition T1_RunningSystem to place P2_MultiuserMode. The transition requires start corresponding commands from the console, such as boot, b, or CTRL+D. Place P2_MultiuserMode displays a situation where the operating system is started with all needed system processes and applications for standard activities of all users. The next route is intuitive through designed places and transitions with a return to place P1. A classic analysis for this model is shown in Tab. 1.

Incidence matrix				**t1→M1**	**t2→M2**	**t3→M0**
	t1	**t2**	**t3**	**M0**	**M1**	**M2**
p1	-1	0	1	1	0	0
p2	1	-1	0	0	1	0
p3-1	0	1	-1	0	0	1
p3-2	0	1	-1	0	0	1
p3-3	0	1	-1	0	0	1
p3-4	0	1	-1	0	0	1
p3-5	0	1	-1	0	0	1
p3-6	0	1	-1	0	0	1

Table 1: Analysis for operating system model with incidence matrix and reachable marking

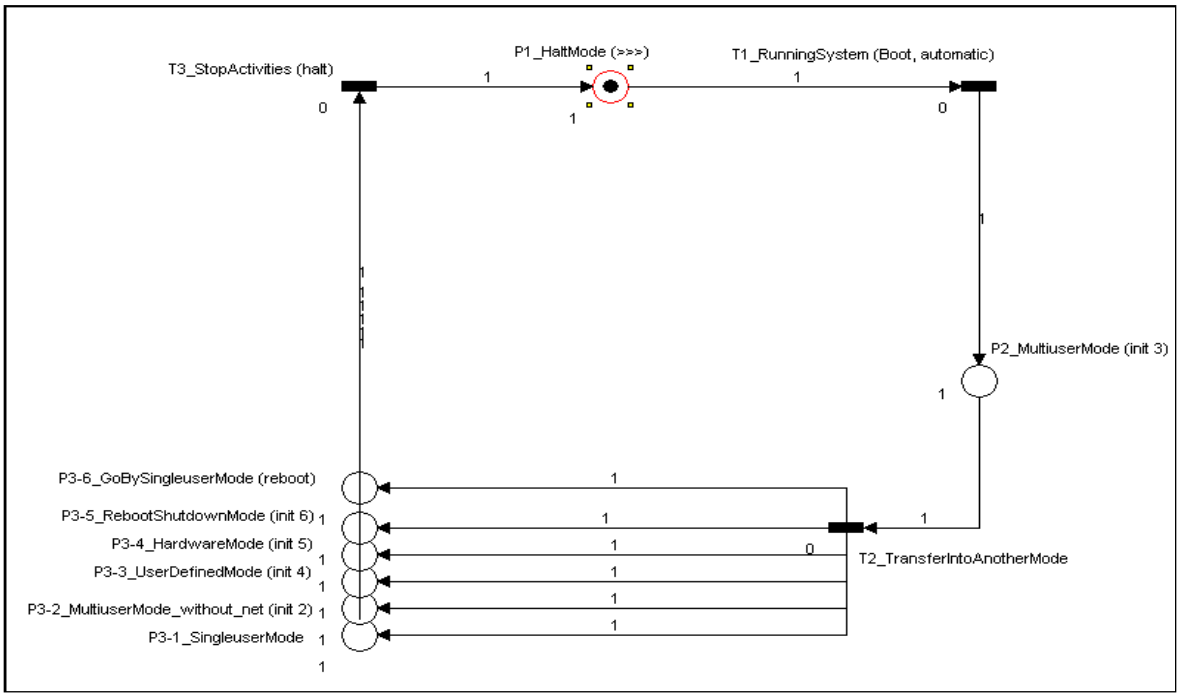

Figure 1: A model of an operating system's lifecycle

The model describes the life cycle of the operating system UNIX. It is clear that the lifecycle of the operating system (UNIX_Process) is given by the following equation:

$$\text{UNIX\_Process} = (\text{MH}, \text{MM}, \text{OM}), \qquad (1)$$

where MH represents a mode halt, MM is a multi-user mode and OM are other modes available to the operating system. The building up of the items OM is based on places $P_{3\text{-}i}$ (i = 1-6). This sequence process management (for the lifecycle of selected system) creates a dynamic and effective solution for easy implementation of the software to the user's computing environment to support the activities executed. There are solutions with only three objects for start selected application with the return to the operating system environment such as in the BI. The number of required objects is defined by the architecture and structure. Solutions using complicated sequences (for example, the Oracle database system or UNIX operating system) are not so effective. This approach is losing dynamism and simplicity. UNIX offers different modes of operation for the start and stop of the necessary processes with the necessary configuration information. The operating system needs modes like multi-user, single user, halt and partially multi-user mode without network support for testing. Therefore, the solution adopted should be simplified in the number of places available (modes of operation). Oracle database system provides a comprehensive system and management. This consistency is useful for such a sophisticated product with a dominant market position. On the other hand, the solution is more complicated and creates barriers to implementation in practice. Lifecycle Oracle must perform up to eight crossings using eight seats. Database administrator can simplify the situation to start (stop) database system using a script. This file can then start (stop) database system using a single step, as with other products.

Problems with practical application of IT products are oriented on an optimal strategy within short time and with minimal resources like finance, materials, background, or human resources. One of the suitable ways is searching for common rules for IT products. This approach defines a space for further optimizations. There are defined boundaries (numbers) specify a minimum and maximum amount of needed objects in various IT products for solving the process management for lifecycle

of implemented systems and products. The number of implemented objects for a given topic is given by the following relation:

$$\text{Minimum} \leq \text{ImplementedObjectForProcessManagement} \leq \text{Maximum} \quad (2)$$

The concrete numbers are specified based on simulation with Petri Nets. Based on practical analysis adopted resolution in selected IT products, there is defined that maximum (8 objects) is required from operating and database systems, and the minimum is provided by the BI products (3 objects). Identified comparison brings a new innovation for better stability in IT products. The description of implemented solution and common rules is the first step for innovation searching. The second step is oriented on a new design and integration of research results into global society. The question is what number of objects for a given solution is helpful. On the one hand, it can be a solution with the fewest number of objects, or a solution with the number of objects that allow sensitive setting and monitoring. A balanced implementation of the suitable solution is not always clear. There are methods and tools for the optimal resolution of needed innovations. Further research opportunities bring swarm intelligence design based on ant colony optimization (Dorigo & Stützle, 2004) or exponential particle swarm optimization (Ghali et al., 2009). Positive results such approach are visible in mobile social computing (Afridi, 2012), and virtual communities (Hancu, 2011). In practical application of the principles of swarm intelligence, agile approach helps with optimal software development. Further work will focus on the detailed simulations of designed solutions via places P_{ij} (i=1, …, n; j=1, …, m) for individual objects with "pheromones" via standard settings of necessary properties. The question is regarding the needed number of such practical settings and methods for their actualization. This approach is based on inspiration from nature. The pheromones are used by animals (like ants, birds, fish) to specify way through environment. Existing parallelism is visible in structure of designed places and properties. The optimal solution is closely linked to the question of directing the path by flow of information through a simulation.

5. Conclusion

The paper offers steps to clarify and create more attractive opportunities in the area of information processing. The analysis is focused on system processes, which create the lifecycle of selected systems such as operating systems, database systems, and BI products. UNIX operating system was selected as the performing operating systems, Oracle database system was selected to analyze the database system environment, and Jaspersoft Suite was representative of BI products. Users must carry out required procedures and activities with power and elasticity. Analogue principles must respect processes of selected software products. Correct analysis methods have an influence on the better perception and better conditions in various solutions with respect to innovation.

Petri Nets are used to describe the parallelism for selected topic and dimensions with classic mathematical analysis via an incidence matrix, and reachable marking. We can effectively see that a selected BI product is more user-sensitive. Users can start and stop a given product in one step. Jaspersoft BI Suite runs all initial components automatically, e.g. Apache Tomcat, My SQL, Java JDK, Jaspersoft Server, and iReport. For stopping, Jaspersoft BI Suite uses analogue methods. Activation of an analogical procedure for the Oracle database system is not so simple. For example, an experienced user can create a script to implement a similar database system sequence. Such a user must know the basics of creating scripts in the operating system. The mentioned facts impede fast and user-friendly solutions. A specific evaluation is presented for operating systems. An offered resolution is not effective and encourages simplification. The main modes used are

multiuser, single-user, and halt. Other modes are unnecessary. Above mentioned simulation create space for a better description of a given reality. Another benefit is the ability to compare different solutions with the aim to select the best solution for practice. This relation creates space for innovations. Good inspiration brings further research opportunities with swarm intelligence based on pheromones.

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The database market is considered fragmented and competitive achievements represent a shift of just a few percent. (2009). Connect!, February 2009, p. 11. [on-line]. Available from: http://www.intersystems.cz/iarchive/articles/2009/2m/01_Connect_0209_Cache_na_DB_svete_09.pdf.

SESSION F: eSOURCING AND ePROCUREMENT

THE SIGNIFICANCE OF TRANSPARENCY IN ELECTRONIC PROCUREMENT

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Keywords

e-procurement, electronic auction, transparency

Abstract

The "Digital Single Market" strategy of European Commission promotes importance of e-standards, interoperability and data economy to achieve trust and transparency for economic growth. The impact of transparency on prices, market structure and information asymmetry reduction is widely studied but with controversial evidence. In the paper, we focus our research on understanding the complexity of transparency within e-procurement processes on data gathered from electronic reverse auctions. We have found that transparency is more complex problem with different significance according to different dimensions and environments. Results show, that the transparency has different impact on prices when comparing electronic reverse auction with sealed bids and in the situation of reverse auction negotiation where the most important for transparency impact has the number of participants.

1. Introduction

Market transparency is the crucial factor for efficient understanding the market by buyers and in search of optimal contracts that maximise value for money. Suppliers want to achieve transparency of their product offers by effective product advertising (Saruc, Dorcak, Pollak, 2013). Information and communication technologies should provide effective tool for increasing this transparency on the market leading to higher competitiveness and objective market prices resulting from higher productivity (Doucek, 2004; Hanclova&Doucek, 2012; Fisher, 2013). It provides higher transparency efficiency through widening suppliers or buyers base, time reduction for searching and different specialized tools for e-sourcing strategies (EC, 2001).

The transparency in online environment is based also on interoperability and standards between different electronic tools, systems, platforms or simply data. Online business networks grew up together with their complexity which led to diverse environment. The pressure on interoperability and e-standards for business e-cooperation up-take for improvement of economic environment is evident also within several initiatives of European Commission, esp. Digital Single Market.

When we are considering transparency requirements in B2B space, the most significant pressure is visible on purchasing side. eProcurement development provides higher effectiveness and efficiency for procurement processes in whole global supply chain. Development and adoption of specific

tools like eCatalogues, eAuctions or other eSourcing and eNegotiation software determine the way how the search for optimal purchases and maximize utility of purchases are achieved.

According to several sources, one of the most promising tools is electronic reverse auction. Although, it's high complexity is still considered as the main barrier for wider adoption in private and public sector. On the other hand, e-auctions are perfect source for gathering new quality of data from procurement processes and buyer-suppliers behaviors.

2. The position of transparency within Digital Single Market Initiative

2.1. Digital Single Market Initiative

Strategy EU2020 represents plan facing a huge society-wide challenges. Five keys areas are: employment, education, research and innovations, social inclusion, reduction of poverty and energy / climate. EU chooses a creation of digital single market in EU as a first pillar (also one of the Slovak presidency priorities). Factors of DSM development are mentioned in more initiatives (Digital agency, Innovation union, Integrated industry policy and Program for new skills).

Specification of digital market should contribute to innovation development, economic and inclusive growth and to general growth of trust in economic environment and their actors.

On base of Digital Single Market – DSM strategy (EC, 2015), but also on Regulation of the European Council (EU) number 910/2014 from 23 July 2014, EK emphasize needs to achieve development in trust building as a key component of economic and social development, development of digital services and digital economy with long term growth potential based on interoperability and standards for e-business services and systems, development and understand of online platforms, development of "data economy" and development of new skill related with innovation environment in digital market development.

2.2. eProcurement development within DSM

Warner (2001) and other studies state that companies using e-procurement achieve significant savings of their expenditures, what is understood as a main benefit of e-procurement implementation (Dasgupta and Maskin, 2000; Caridad et al 2014; Maier, 2006; Dmitri, Piga and Spagnolo, 2006). Together, it provides more transparent environment, as all transactions can be easily controlled (Celentani and Ganuza, 2001). The aim of other studies was to study particular transaction mechanisms (e-tenders, e-auctions and e-catalogues), mainly their impact on the suppliers´ behaviour within selection procedures and the possibilities of their failures. Although some authors (Albano, Dimitri, Pacini a Spagnolo, 2006) discuss all transaction mechanisms, most of the authors analyze merely dynamic transaction mechanism – electronic auctions, but mainly in the area of selling e-auctions, for instance ones used on eBay. Ausubel and Cramton (2004), Hailu and Thoyer (2006) and Garratt and Wooders (2010) analyze different auction algorithms and their impact on sellers and buyers (consumers) behaviour in B2C environment. Other authors (Maasland and Onderstal, 2007; Albano, Buccirossi, Spagnolo and Zanza, 2006; Estache and Iimi, 2010; Lengwiler and Wolfstetter, 2010) discusses the conditions on suppliers´ market, their ability to make collusive agreements, and the implication of such agreements.

Better understanding of e-procurement processes is followed by more efficient utilization of organizational resources (Helfert, Doucek, Maryska, 2013). In academic and business environment, a complex research dealing with the suppliers' behaviour in e-auctions with respect to maximal number of potential parameters influencing the e-procurement efficiency, is still absent.

2.3. Transparency vs DSM

To make DSM applicable, it is necessary to understand practical problems and possibilities of its development and influence on transparency, markets structures changes, inter-organizational activities, trust and stability of market, asymmetric information, prices and utility. All these changes are induced but also caused by subject behavior changes on DSM market. Without understanding of these changes it is impossible to set practical implementation of DSM correctly from legislative, economic and technological aspect. Some specifications of this area are published in world studies. For example Turnes, P.B. and Ernst, R. (2014) claim in their article, that in near future it will be huge growth of standardized business processes. They will be determined by necessary of enormous increase of interoperability between systems. In area of transparency influence, Henze, B. Schuett,F. and Sluijs, J.P. (2015) suggest on the evidence from their experiment, that transparency is an effective tool to raise welfare and consumer surplus. In imperfect information surroundings, sellers manage to sustain prices substantially above marginal cost, allowing them to "rich on" buyers. It is better competition between sellers with using a transparency, because they can see prices and quality of each other and evaluate it. Veldkamp (2006) claims, that transparency is one of most important factors for keeping market stability. Reduce of informational asymmetries allows companies to re-allocate resources more efficiently when an internal or external shock occurs. Willmot (2003) and other authors (Dorčák et al, 2014; Szabo, Ferencz, Pucihar, 2013) considers, that transparency is important factor for trust building. On the other side according to Kitchin (2003) the relationship between consumers and companies is influenced not only by the transparent actions of the company, but also by the consumer´s subjective estimation of how the company is behaving in situations, where actions cannot be transparent. Kang, K. and Hustvedt, G. (2013) confirmed, that transparency is strong factor, which positively influence a trust.

According to other authors and studies (OECD 20012; Soh et al 2006; Zhu 2004, Ozcelik and Ozdemir, 2011; Gu and Hehenkamp, 2010; Szabo, 2013) increasing of transparency can leads to negative impacts, for example unwillingness of some companies to join into a transparent processes, requiring anonymity problems/ business secrecy, disruption of competition fight with high level of transparency, anti-competitive options of activities, decreasing innovation capacity, development of monopolization and other.

Based on these opposite studies, it is necessary to make a more detail review of DSM specifics and behavioral changes of market actors as well as indicators of market stability/growth and identification of DSM deploying components strategies to ensure effective transition of market environment to new form of market, which is based on productivity, fairness and trustworthy.

Several conflicting results from previous studies did not take account of the specific features and options that innovation of digital single market can bring. In the area of increased transparency has not yet been taken into account the different structure and level of transparency of the different elements of the market mechanism and environment.

Simultaneously the character of interoperability and standards of electronic business communication can cause sudden changes in the level of transparency of prices and benefit in the market which may lead to temporary market instability and inability to respond the following changes at the relevant time. This temporary market volatility can lead to negative expectations, acceptance of these innovations as well as the whole concept of the digital single market.

Research in the area of behavior of market entities in the digital environment will reveal potential dangers as well as opportunities for deploying various approaches and innovations in the area of

digital single market in international environment what will help to a suitable setting of legislation for the development of the electronic market stability and competitiveness of the internal market.

The pressure on standards, interoperability, trust and data economy development within digital single market is the pressure for achieving higher transparency on the market. These conditions are mentioned in two of DSM's three pillars – Environment and Economy&Society. According to following scheme, this initiative will have impact on transparency and related trust and economic indicators or behavior. Although, as mentioned above, this impact is quite tricky and fuzzy, and deeper understanding of what can happen is quite necessary. Present opportunistic behavior and unwillingness to make own behavior transparent can be on the one hand the barrier for wider deployment of DSM principle but on the other hand, it can cause some market deformities and instabilities due to low readiness/preparedness of economic subjects in the market.

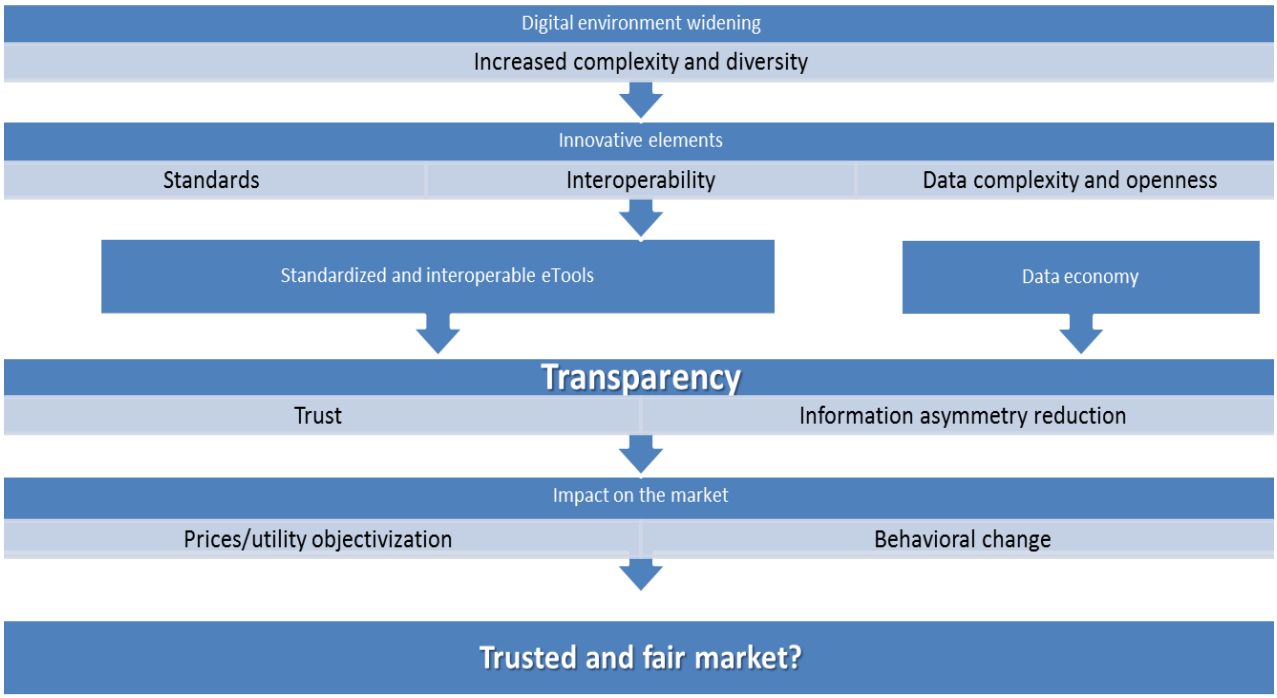

Figure 1 DSM impact on the market

3. Methodology

To examine what can happen on the market with DSM principle applied, we can follow different scientific directions. The most trusted research is based on evidenced based analysis above data from real business environment. Even though ICTs are widely adopted in business processes, e-standards, interoperability and esp. tools with wide and formalized impact on market transparency within global supply chain are still not sufficiently deployed. That's why, the experimental economy for behavioral research and validation of the impact is possible to conduct.

For the purpose of this paper, we will use one of the limited numbers of business data usable for this problem – data from electronic reverse auctions, which substitute really competitive market with full information. Although nowadays, electronic reverse auction software suffer still from not sufficiently suitable data structure and architecture for data mining and analytical services, we have obtained some data from not standardized environment and preprocessed it into one standardized form for our specific research.

On the base of literature survey, our research task or working hypothesis is to identify the impact of transparency level on prices negotiated and procured by using reverse auction (eRA).

Dataset used for our analysis are gathered from Slovak procurers, esp. from energy, building and construction and ICT sector. The sample description is provided in following table:

Description of sample			
Number of transactions	2579	Number of eAuctions (valid)	1233
Number of participants (Mean/Std dev)	15,48 / 13,06	Number of Sealed Bid transactions (valid)	957
Savings (Mean/Std dev)	12,85 / 56,97	Number of items	13942

Table 1 Description of dataset

It is needed to say, that validity of data was inconsistent and some data were missing or not valid. For our research, into each specific analysis, we have used only valid data.

4. Research and discussion

To analyze the impact of transparency level on prices negotiated within auctions we have to decide, what is the transparency level, and how we can identify and express different levels for our analysis. In the case of auction two basic dimensions how to look on transparency levels exist.

First, we can compare eRA, which is considered as transparent tool with sealed bid auctions (SBA) where participants has no idea about other participants and their offers. This dimension can differentiate the basic level between transparency (represented by auction) and anonymity (represented by sealed bid auction).

Second, we can analyze the complexity of transparency options within electronic reverse auction. It means, each eRA has option to set up the environment, where participants will compete, e.g. visibility of prices, rankings, criteria, etc. On this base, we can analyze different complexity or intensity of transparency within eRA or look for most efficient visibility settings.

Within our dataset, we have identified seven levels of transparency within eRA. It has to be said, that one price displaying was very similar to another type used in different version of eRA software. As some little difference was identified, we have used both types of price visibilities. In general, we have identified following types of transparency improvements within eRA:

- Price of participant – where each participant had visible his offer
- Ranking total – the rank of each participant was visible
- Ranking of items – in the case of bulk auction with several items, the rank of each item was visible
- Best (min.) price – two types of price visibilities were identified (because of different multicriterial evaluations), although very similar. It is the best or winning price for an item in specific time.
- Min. price total – in the case of bulk auction, where more items are negotiated, the total minimal or winning price is visible
- Criteria – criteria for selection and algorithmization is visible in the case, that criteria changing is allowed during negotiation.

Following box-plot graphs present comparison of different transparency levels within two transparency directions we have identified above.

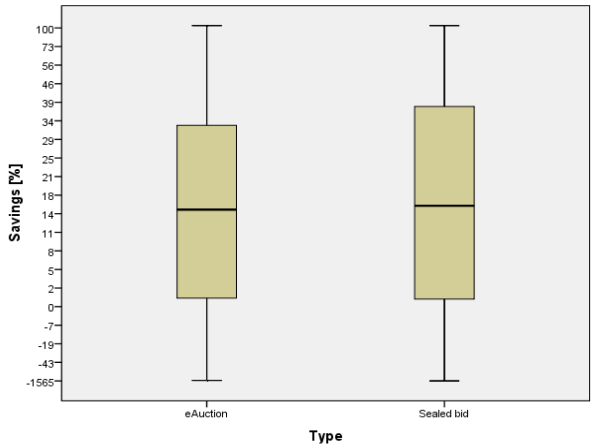

Figure 2 Comparison between eRA and SBA

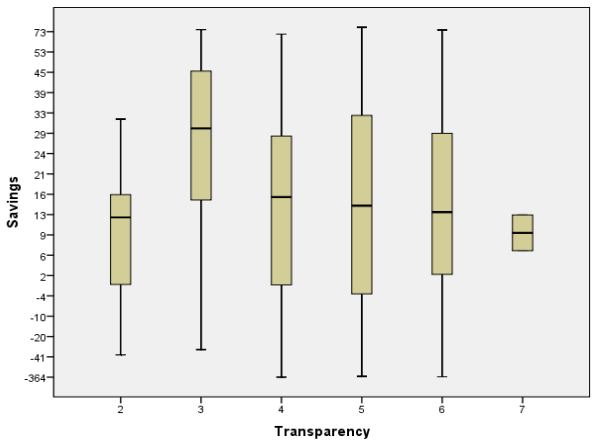

Figure 3 Comparison between different transparency settings in eRA

As we can see, the first comparison between eRA and SBA doesn't validate the presumption that SBA as anonymity based procurement tool provides higher prices. It can be explain in that way that also anonymity provides specific pressure on price offers as in non-transparent environment, suppliers can take non-rational decisions. It means, that eRA is not enough to take the advantage from more competitive and transparent tool. On the Figure 3 we can see, that also intensity of transparency represented by number of visibility settings is not enough to provide most efficient strategy. Different types of attributes visible in eRA have different weights and impact on price.

To analyze differences in correlation between visible attribute and price more deeply, we will use non-parametric correlation tests to analyze that. Non-parametric tests are necessary due to absolutely no similarity of our dataset to normal distribution. In following table we have included also other parameters, which can be considered as synergic driving factors for transparency efficiency. These parameters provide information about how many participants were invited, registered and active within eRA process. Motivation index is calculated as *registered participants / invited participant* and express the motivation of invited participants to register for the possible contract negotiation. Offers submitted is the number of participants submitting offers. Activity index presents the ratio of those who was active in submission of their offers against number of registered participants.

As we see from the table 2, no attribute transparently published in negotiation phase was strong enough at least on medium level. Very low levels of correlation strength can be caused by non-consistent data or some hidden structures and clusters of rules.

Parameter	**Savings**	
	Kendall's tau_b	Spearman's rho
Motivation index	,124**	,181**
Offers submitted	,262**	,362**
Activity index	-,002	-,002
Price of participant	-,003	-,004

Ranking total	,054	,066
Ranking of items	-,041	-,050
Best (min.) price	,071**	,087**
Min. price total	-,065*	-,079*
Criteria	-,088**	-,108**
Transparency Level	-,036	-,047
** *significant on 99% level*		

Table 2 Non-parametric correlation tests

That's why we tried to use also classification techniques to identify decision rules valid for different levels of savings. As distribution or savings is too inconsistent, as generally in the situation of similar data, we have binned savings into 5 percentile intervals with equal counts. For calculating decision tree model using C5.0 algorithm, we have used SPSS Clementine (IBM Modeller).

Calculated decision tree was too complex and deep and it was not possible efficiently to present it in graphical or ruleset mode. After deeper analysis, rules on lower levels of decision tree were not so significant so we have cut the branches to draw only most significant rules. In fig. 4, we can see the results of decision tree technique application. Best price is the attribute which represent the option to have this price visible or not. The value 0 means, that the price is not visible attribute, the value 1 provide the setting where all participants can see the price which in the current situation and time is the winning offer. The first significant classification rule is based on number of participants submitting offers in initial phase of eRA. We can call them active participants.

We have identified, that in the case we have at least 5 active participants with their offers submitted in eRA, the distribution of savings achieved is shifted in positive way.

Transparency level is significant in following branch, where for lower number of active participant the most important transparency setting is the visibility of best or minimum price. On the other hand, for auctions with higher number of participants, the most significant setting is the total ranking of participants. These results shows, that non-transparent prices and transparent rank can provide better pressure in the case of high number of potential suppliers or other words more competitive environment.

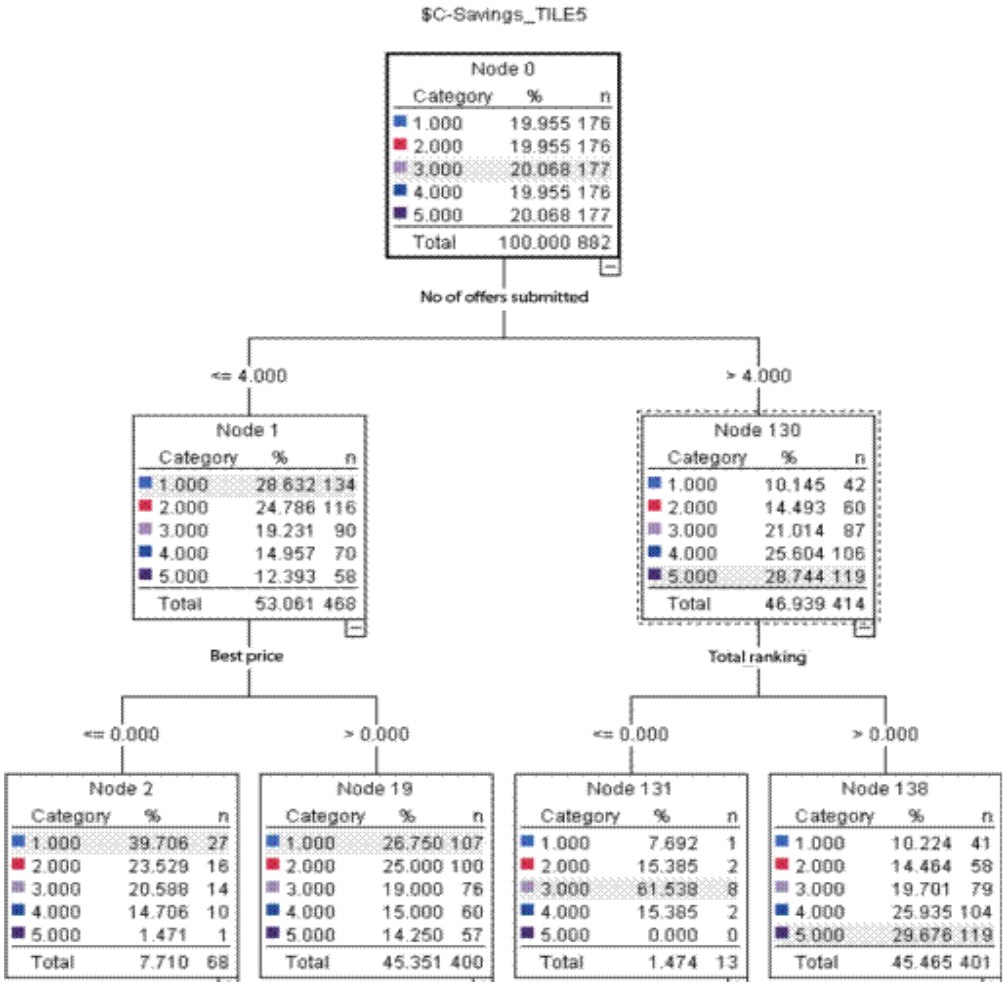

Figure 4 Decision rules for transparency efficiency

5. Conclusion

In current situation, the transparency is being considered as strong instrument for the fight against corruption and market efficiency. Although, the research results from past studies are not explicit and provide the space for disputes, open issues and distortion.

From our research, we have found that transparency is really not so simple issue. It is more complex and in different dimension can have different impact. The evidence from our analysis show, that electronic auction is not the tool automatically converting transparency and competition into better prices. On the other hand, transparency is more than the price visibility. In the situation, where open negotiation is eligible with high potential of competition, the more significant attribute to be visible is the rank of current winning situation as price by itself.

Our dataset is unique and initial for much deeper research. We have identified several constraints. Although, we have obtained quite large sample, a lot of data were missing or not valid. Together, it would be suitable to enhance dataset for more countries, procurers, types of organizations etc. to identify different factors influencing the transparency level efficiency for better prices or utility of product and services. One company with several procurement managers can have internal procedures determining results or usage of several settings in electronic auction process.

Very important results, we have realized, is that the necessity of data structure and eRA architecture software improvements is emerged. Better knowledge gathered from reverse auction processes and transformation into professional social procurement network learning can lead to higher readiness and awareness of procurers how to manage their purchasing by more effective and efficient way resulting into fair and more objective prices.

6. Acknowledgement

This work was supported by Scientific Grant Agency VEGA of Slovak Republic within the grant No. 1/0855/14 “Determinants of efficient purchasing supported by electronic solutions”.

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A LITERATURE REVIEW ON ONLINE DISPUTE RESOLUTION AND APPLICATION TO B2B E-COMMERCE

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Keywords

Online dispute resolution, B2B e-commerce, Literature review

Abstract

The rise in number of B2B e-commerce transactions inevitably leads to a corresponding rise in disputes over those transactions. Traditional methods of dispute resolution (litigation, arbitration or mediation) in the offline world, do not address the requirements of online users involved in disputes over online transactions. In response to the demand for dispute resolution procedures which recognize the online user's desire for a fast and flexible mechanism which has a global reach, various research have been performed worldwide. This literature review discusses studies on online dispute resolution. The results indicate four main topics – initiatives, methods, factors, effectiveness and effective system. The complexity of ODR and its implications for future research is discussed.

1. Introduction

Business-to-business (B2B) e-marketplaces bring great opportunities to the modern commercial world. For businesses, it means a huge number of potential partners that assist in e-procurement. They are mostly unknown companies, which can be a problem. Reputation is one of the most important parts of the image of a company (Dorčák, Pollák, & Szabo, 2014) and can help in choosing a business partner.

The rapid growth of B2B e-commerce increases the likelihood of disputes resulting from contracts (eg.: about prices, delays in delivery of goods, defects in goods, technical characteristics, etc.). The potential difficulties and costs to settle these disputes would greatly discourage both parties. The mechanisms of Online Dispute Resolution (ODR) could be useful to build trust with the participants because it allows efficient and effective law enforcement within the online business network or supply chain. Interpersonal trust plays a significant role for achieving prosperity through innovation (Szabo, Ferencz, & Pucihar, 2013). Especially, ICT innovations are the engine of growth of the entire economy and society (Doucek, 2004). Therefore, we can see connection ODR with trust and economic impact.

ODR is one of the core elements of trust building process, so it would be good to know how businesses are willing to implement the ODR into their services (Delina et al 2007). Delina, & Dráb (2010) through the questionnaire-based analysis of the trust building mechanisms showed that companies prefer limited trusted services for the low fee or free of charge. Acceptance of comprehensive specialized solution for the fee increases by increased e-skills. As main barriers which prevent companies to implement them are low skills of the new innovative tools. The solution may be to change education system with accent on tertiary education in order to prepare the ICT professionals in ICT business and for the roles of key users in public administration and in business corporations as well (Maryška, Doucek, & Kunstova, 2012). The research by Hanclova, & Doucek (2012) provided evidence that ICT-producers have the higher level of labor productivity growth.

The core business processes need to be supported by innovative but mainly effective ICT-based systems and tools (Delina, 2014). For this reason, the aim of this paper is to analyze findings on ODR in e-commerce to date in order to provide an overview of main research themes and methods, as well as implications for future research and practice.

2. Research method

A literature review was chosen as a method in order to identify and review how ODR, especially in B2B e-commerce, has been understood in academic research articles. Defining research questions is an essential part of this method. To achieve the objectives of this review, we identified the following three research questions.

RQ1. What are the main types and topics of ODR studied in research?

RQ2. What part of research is dedicated to ODR in B2B e-commerce?

RQ3. Which are the most significant gaps in the reviewed studies, and what are implications for future research of ODR in B2B e-commerce?

Initially, we chose Science Direct as a leading full-text scientific database offering journal articles from nearly 2,500 journals. This online academic research database covers important journals from various scholarly fields such as business, psychology, computer and decision sciences. The focus of this study was particularly in these fields because using of ODR in B2B e-commerce is linked to technical issues and issues of security and trust.

The database was scanned for relevant articles. In the first search stage, automated search was performed by applying the search string ‘online dispute resolution’ to the digital library. It included also phrase ‘online alternative dispute resolution’ (OADR) because some authors use this term. The search was conducted on all fields of the studies. We obtained 41 publications for ODR, many of which were irrelevant because the search was carried out only electronically. After that, studies were excluded based on the following four criteria:

1. Studies that are not related to the research questions;
2. Studies that are not in English;
3. Duplicated studies;
4. Other formats than journal papers.

As a result, a total of 19 papers meeting the inclusion criteria were selected for the review. The selected articles were drawn from the following journals in the years indicated in Figure 1. We can see that the most of these articles were published in Computer Law and Security Report, which

indicate that ODR is associated with application of law to disputes, but also the use ODR compared to traditional dispute resolution methods is linked to the security issues. Moreover, the most of journal papers were published after 2007, which means that attention to the issue of ODR has been growing at a rapid rate.

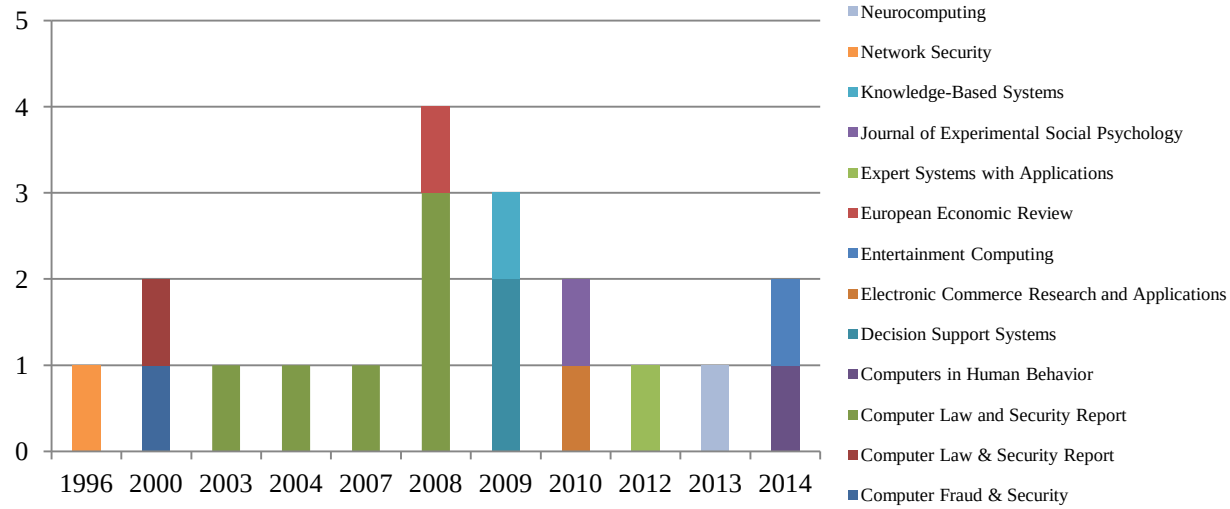

Figure 1: Selected articles and journals according to publication year

Each paper was placed in a concept matrix that contained the following headings: 'Research questions', 'Definition and types of ODR', 'Area of ODR (relationship to B2B e-commerce)', 'Methods', 'Main findings', 'Implications for future research', and 'Limitations'. In the matrix, the reviewed articles were classified and compared with each other in order to identify the most frequently occurring research topics and methods. The studies were also compared to identify differences. This way, we gained an overview of the reviewed studies and their main results.

3. Results and discussion

In modern times, judging cases should be performed in an online way due to speed of communication, and to handle the number of complaints adequately (Van den Herik, Plaat, Levy, & Dimov, 2014). On the whole, no specific definition is offered for ODR in the reviewed studies. Most commonly, ODR is a process whereby disputes are substantially handled via electronic networks such as the Internet (Xu, & Yuan, 2009).

However, there exist differences in types of ODR. Tang (2007) defined the effective dispute resolution system for e-consumer disputes as three schemes - the self-help communication mechanism, the alternative dispute resolution scheme (mediation, arbitration and chargeback), and the judicial procedure. The online version of these schemes she identified as ODR. According to Patrikios (2008) the term ODR was referred to the continuum encompassing OADR, online arbitration, and online litigation. Therefore, it is a point of view that the arbitration is regarded as ADR or not. Misunderstanding in research can also be caused by understanding the position of ADR in ODR. ADR methods to litigation in courts were adopted, which involve negotiation, mediation or arbitration. With the advent of the Information Society, these techniques are being considered of use in e-environments, leading to what is known as ODR (Carneiro, Novais, & Neves, 2013). Types of ODR are often not clearly defined. Xu, & Yuan (2009) mentioned four main forms: automated negotiation, assisted negotiation, mediation, and arbitration. Lai, Lin, &

Kersten (2010) claimed that e-negotiation could be in the types of negotiation support systems, ODR, complaint handling, case appraisal, online mediation, online arbitration.

Van den Herik, Plaat, Levy, & Dimov (2014) described a new type of dispute resolution, called Crowdsourced Online Dispute Resolution (CODR). They claimed that it have the potential to provide solutions that are cheap, fast, democratic, and relatively fair because it does not require a presence of a paid judge, arbitrator, or mediator, it can be designed to resolve disputes better than ODR, ADR or traditional litigation, and it will rapidly become popular. They mentioned also drawbacks such as concerns regarding procedural fairness, and difficulties in communication between the crowd and the parties.

Since disputes appear in various fields, topics of articles about ODR are different. The research on ODR can be categorized into four main research topics.

3.1. Initiatives

Especially in earlier years, the main topic was an overview of initiatives that undertaken in this area. The first rapid-response, ODR system designed to arbitrate was in 1996 the Virtual Magistrate project (Osen, 1996). In 1998, the Cyber$ettle has been used heavily by insurance companies who wanted a fast and cheap way to resolve disputes with claimants. The Cyber Arbitration programme was held at the IPBA and the scheme involved the use of video conferencing technology to communicate between disputing parties. Montreal University's CRDP developed the project CyberTribunal which offered mediation and arbitration (Ott, 2000).

In 1999, ICANN adopted the Uniformed Dispute Resolution Policy (UDRP) for conflicts concerning abusive domain name registrations. This is the development of transparent global ODR procedures (Weston, 2000). Diéguez (2008) recommended the steps in its reform. González (2003) described ODR in eBay. The firm started using ODR back in 1999 and found that ODR could be a considerable advantageous tool in solving disputes arising from eBay transactions, as customers in an online environment look for speed in resolution as part of the nature of e-commerce. eBay recommended the use of ODR services by the company called Square Trade.

There are currently some ODR providers who already use virtual environments for conflict resolution. The Mediation Room provides a virtual mediation space for parties trying to solve their disputes. The Smartsettle is an online negotiation system for decision-makers objectives who wish to reach a formal agreement. The Virtual Courthouse enables parties to submit disputed claims, responses and supporting material in digital form for resolution by a neutral provider. The MediateMe builds on the concept of mediation for the masses, making it easily accessible to everyone (Carneiro, Castillo, Novais, et al., 2012).

3.2. Methods

Attention was also paid to methods applied in the ODR. Many legal practitioners and academics consider the most common way of implementing ODR tools is by means of *expert systems*, which are a type of knowledge-based technology in the field of artificial intelligence (AI) and law. The use of *rule-based reasoning* (RBR) aims to encode the problem-solving expertise of human connoisseurs, which may be seen as a set of procedures guided by rules (TAXMAN, LDS, JUDITH). In the last years, however, the trend has been changing towards the use of a *case-based reasoning* (CBR) approach. It aims at capturing and using knowledge from past experiences (MEDIATOR, PERSUADER, SHYSTER). Some researchers have tried to use hybrid CBR–RBR systems (CABARET, Split-Up, Family_ Negotiator, AdjustedWinner and Family_Winner).

Xu, & Yuan (2009) claimed that currently most negotiation tools for ODR are based on utility theory. Their concept of a *principle-based* dispute resolution system is totally different from the loge-expert system. They showed that this approach can be applied in the real estate industry for consumer protection with fairness and justice. A major area for future work could lie in implementing a complete this approach. It is also necessary to define objective measurements such as cost/benefit analysis and subjective measurements such as user satisfaction and acceptance.

Carneiro, Novais, & Neves (2013) used *genetic algorithms* to generate solutions for the resolution of a conflict. The approach provides better results than a case-based approach since it is independent of the legal domain and it does not depend on the number and quality of cases present in a database. The results of the work were applied in a negotiation tool that is part of the UMCourt conflict resolution platform. Two disadvantages were identified. Sometimes the system was unable to generate information with enough quality for the parties to take good decisions and changes in the law are quite frequent, which may render past cases useless.

Web services (traditional programs or software agents) include commercial or technical services like processing power, storage space or goods delivery, but also negotiation frameworks, contracting protocols, reputation systems and representation or ODR (Bain, & Subirana, 2004). Gabuthy, Jacquemet, & Marchand (2008) presented an experiment as a *non-cooperative game* and derived equilibrium strategies for the plaintiff and the defendant. The main result showed that the settlement rule tends to create incentives for individuals to misrepresent their true valuations, which implies that automated negotiation is not able to promote agreements. If an agreement is not reached, authors of this experiment suggest to using OADR. The confidentiality which characterizes the ODR procedures creates important limitations to get field data. The experimental methodology offers the only way to obtain them. The implications of these results are used to discuss the potential role of public regulation, ADR and reputation mechanisms in Cyberspace.

3.3. Factors

The majority of the reviewed studies have focused on factors influencing on ODR. Lai, Lin, & Kersten (2010) explored the influence of *language familiarity* on online persuasion behaviour based on subjective measurements (the questionnaire) and objective actual negotiation behaviour (the numbers of submitted offers and messages, and the final utility). An online experiment was conducted using a text-based asynchronous e-negotiation system, with two groups of subjects negotiating in native (English) and non-native (Chinese) languages separately in purchasing negotiations. The analysis results showed that language familiarity has a greater effect on the buyer than on the seller and plays a critical role in inducing persuasion behavior in e-negotiations, with a higher language familiarity leading to higher language self-efficacy and negotiation self-efficacy. There are also the limitations of this research due to selection of languages, consideration of only asynchronous e-negotiation and missing different types of communication and decision support provided by e-negotiation systems, which would be remove in the future research.

Johnson, & Cooper (2009) examined the kind of relationships among different *media* (instant messaging versus telephone), communicated affect, concession making, and agreement. Though instant messaging can lower the cost of negotiation and increase its speed, this type of communication decreases concession. To overcome this problem, efforts must be directed at reducing the anonymity and depersonalization. Authors suggested the increased use of multiprotocol instant messaging applications with audio communication. External validity, and thus the generalizability of their study is limited to non-face-to-face negotiations between individuals that are strangers to each other, but in ODR services direct negotiation between strangers who make purchases and sales online is permitted.

The current ODR tools lose the context information regarding the context of interaction such as the level of stress, the level of escalation, the emotional state or the stress. Carneiro, Castillo, Novais, et al (2012) developed a prototype of this *stress*-aware virtual environment in the field of ODR. In fact, the UMCourt conflict resolution platform is being extended with a context-aware layer. For this purpose, AI techniques, namely machine learning and data mining were used. Their work defined a way to measure how each user is affected by stress and opened the door to defining personalized models to measure the influence of stress in the users.

Johnson, Cooper, & Chin (2009) were interested in *flaming* (the use of profanity to inflict harm) because it can significantly reduce the likelihood of negotiated agreements. They performed an experiment, where subjects were strangers to each other and they had to negotiate about the price for the lottery ticket. They provided suggestions that could help reduce anger and the associated incidence of flaming among negotiators through reinterpretation, managing provocation, and relaxation. It could increase the likelihood of a negotiated agreement. The results have implications for businesses that offer computer-mediated dispute resolution services.

A limitation of the prior research is that it has focused exclusively on single-shot interactions and ignored longer-term effects. However, people often negotiate on repeated occasions, so the *longer-term consequences of expressing anger* are important to know. Van Kleef, & Dreu (2010) used the emotions as a social information model (EASI) and performed experiments as two subsequent computer-mediated negotiations. Experiment 1 showed that participants demanded less in later negotiations when their partner in a previous negotiation had expressed anger. Experiment 2 showed that apologies reduce the negative effects of anger on impressions and desire for future interaction. In ODR, failure to reach agreement implied additional costs for mediation services, so responses to verbal expressions of anger are an important indicator. Furthermore, future research is needed to examine whether their findings can be replicated outside the laboratory.

3.4. Effectiveness and effective system

Despite the increasing use of e-mediated services to settle disputes, research on its *effectiveness* is limited. Bollen, Verbeke, & Euwema (2014) investigated the effectiveness of an asynchronous e-supported mediation. They use the objective indicator as the number of agreements reached and subjective perceptions of distributive, procedural, interpersonal, and informational justice with the help of a survey. Although, it was investigated mediation with mediator as a real person, it provides implication for future research because not only the number of agreements reached is an indicator for measuring the effectiveness of mediation, but also perceptions of justice linked to mediation satisfaction and compliance with the agreement.

Some researchers suggested the *effective dispute resolution system*. Tang (2007) defined such system for e-consumer disputes. She also suggested that further work could be done on the establishment of e-courts. Especially for disputes in B2B e-commerce e-court would be useful, but there exist also difficulties with the establishment of this platform. It requires a highly secure and confidential system for identification of the contractual parties and sending documents. Moreover, the contractual parties might doubt its quality and competence, so the trust rate of the e-court might be low. Patrikios (2008) recommended ODR centred on transnational online arbitration, which can form the basis of a decentralised, multi-stakeholder and multi-instrument co-regulatory system for *cross-border e-business*. The co-regulatory system may provide effective and efficient access to justice in terms of simplicity, efficiency, cost and time effectiveness, and may further enhance user confidence in cross-border e-business.

4. Conclusion

Several issues have emerged from the review to be considered in future studies. First of all, types of ODR are often not clearly defined, which can cause misunderstanding in research. For example, position of online arbitration as an alternative method. It is formed a new type of dispute resolution - CODR, which application to disputes in B2B e-commerce would be examined more. The reviewed studies focus more on consumer protection and, therefore, to disputes in B2C e-commerce, but some results should be useful also in B2B area.

According our review, we identified four main research topics. Firstly, the overview of initiatives covers from the first ODR system (Virtual Magistrate) to current ODR providers (Mediation Room, Smartsettle, Virtual Courthouse, MediateMe). Secondly, methods applied in ODR play the important role. Researchers use expert systems (rule-based and case-based reasoning), principle-based dispute resolution, genetic algorithms or game theory. There exist also limitations because the confidentiality which characterizes the ODR procedures creates important limitations to get field data. Thirdly, research of factors influencing on ODR can make it more effective. Language familiarity, media, but also the context of interaction such as the level of stress, the level of escalation, the emotional state or the flaming have longer-term consequences. Fourthly, the effectiveness of ODR can be measured by the objective indicator (the number of agreements reached) together with the subjective perceptions of justice. Sometimes researchers focus on the establishment of e-courts, another time on transnational online arbitration. In these areas, we detected the most significant gaps in the reviewed studies and recommended implications for future research of ODR in B2B e-commerce.

The main limitation of this review lies in the selection of publications. Some relevant studies may still have been left out of the sampling, making generalizations less reliable. Our review can be also shaped by subjective interpretation, but this review has approached ODR from a broad perspective, as the main goal was to gain a general view of the phenomenon.

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ANALYSIS OF ONLINE REPUTATION OF ELECTED E-COMMERCE ENTITIES OPERATING IN THE CENTRAL EUROPEAN MARKET

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Keywords

Reputation, electronic shopping, consumer

Abstract

The paper presents partial results of a comprehensive research of online reputation of small and medium-sized enterprises operating in specific market in Central Europe. More specifically it deals with the issue of online reputation of ecommerce entities operating in the relevant market. The objective of our analyses presented in this paper is to identify the main players from among the wide range of e-shops operating in the Slovak market, primary analysis of these entities reputation method Net Promoter Score (NPS), identify key factors for success in terms of customer preferences and review the extent to which changes in customer preferences are significant in relation to the reference studies undertaken in the relevant market in the past. Based on our findings recommendations for e-commerce entities with emphasis on preferences of their current as well as potential customers are formulated in order to improve competitiveness and increase efficiency.

1. The current state of the researched issue

Increased usage of the Internet led to fundamental changes in the way information is disseminated (Delina, Drab, 2010, Maryška, Doucek, Kunstova, 2012, Fischer, Vltavská, Doucek, 2013, Janke, Packová, 2013, Prídavok, Delina, 2013). In the traditional brick and mortar world the dissemination of information was based predominantly on spoken word (Soviar, Vodak, 2012). The virtual Internet space has contributed to a significant shift from speech toward written text by its very nature (Doucek, 1996). Written text naturally creates conditions for longer durability of information. In combination with a plurality of views of target and reference customer markets and almost instant access to information (Doucek, 2004, Lajčin, Frankovský, Štefko, 2012), this obviously results in a change of underlying assumptions for a successful management of marketing

activities (Doucek, Maryška, Nedomová, 2011, Saruc, Dorčák, Pollák, 2013). At the turn of the 20th and 21st centuries the issue of online reputation management of entities started to gain importance (normally for companies and organizations, but often even for individuals) (Kuncova, Doucek, 2011). Online reputation management is a process of assuring that the right information will appear in the right place at a time when customers are looking for a given company, brand or product, mainly through search systems such as Google, Bing or Yahoo, or using social networks such as Facebook, Twitter or LinkedIn (Randall- Stradman, 2012). Online reputation management (ORM) is a mix of marketing activities on the Internet. The purpose of the efforts of marketers is to protect the name of an entity in the online environment, primarily by preventing potential problems or their solution and elimination when incurred. These marketing activities are most frequently include monitoring, PR management and SEO (search engine optimisation). In literature ORM is also known as reputation management in search engines and includes the following activities:

1. Monitoring of the Internet and its users;
2. Communication with users;
3. Evaluation of monitoring results;
4. Crisis reputation management. (Sasko, Michálekova, Šulík, 2014).

As a result it can be argued that ORM is monitoring and management of Internet reputation of companies, brands, firms and individuals. The aim of this monitoring is to suppress or completely eliminate negative information acting in the name of an entity in search engines (Delina, Janke, Tkáč, 2011, Szabo, Ferencz, Pucihar, 2013, Delina, 2014). There are number of reasons why it is necessary to actively use these techniques (Maryška, Doucek, 2011, Maryška, Doucek., Novotný, 2012, Hanclova, Doucek, 2012, Koblen, Szabo, Krnáčová, 2013). To provide just few of them:

1. 90% of consumers trust recommendations of others;
2. 78% of consumers believe what others say about a company, product, brand or a person on the Internet;
3. 16% of people with a negative experience can affect group of up to nearly 10,000 people;
4. 92% of consumers stated that they consider information about goods or services they find on the Internet more reliable than those provided by a vendor. (Sasko, Michálekova, Šulík, 2014).

There is a wide portfolio of methods for quantifying reputation described in literature. Correct quantification reputation is necessary in the process of reputation management (Stec, Filip, Grzebyk, Pierscieniak, 2014). For the purpose of our research the method of measuring reputation through so-called NPS was selected. Net Promoter Score, or Net Promoter System (NPS) is a system for measuring reputation, which is based on the fundamental perspective that customers of each company can be divided into three categories, according to how much they are willing to recommend products or services of a company to their friends or family (Reichheld, 2011). The reputation ranking system uses direct questioning, relying on the so-called ultimate question: "How likely is it you would recommend us to your friends?“. Asking this question enables companies trace the three fundamental groups of customers, while this system produces pure measuring of organizational performance in terms of customers of the company. As already mentioned, the NPS uses direct questioning, while the process itself can be illustrated by the example of the question above: "How likely is it you would recommend us to your friends?". Respondents select answers to this question on a ten degree scale, with 10 representing extreme willingness to recommend the product, company, or service to their friends and 1 represents an absolute unwillingness to recommend this product further.

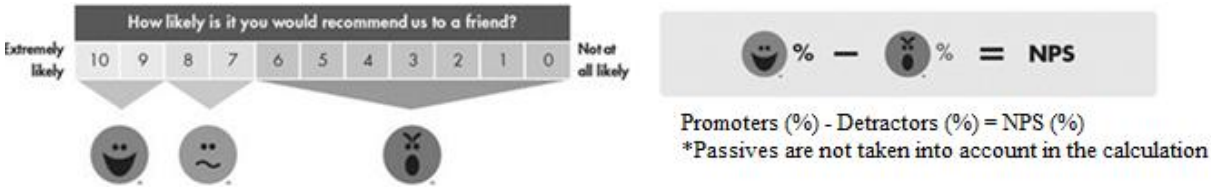

Figure 1: Net promoter score; Source: Reichheld (2011)

The scale is divided into three parts, where each part represents one group of customers.

1. 10-9: Promoters: this customer group is loyal and enthusiastic, and will always buy products of a particular company and will report on the quality of this company to their friends.
2. 8-7: Passives: a group of customers, which is satisfied with company's products, but is no longer as much enthusiastic as the previous group, their disadvantage is that they are vulnerable to competitive offers.
3. 6-0: Detractors: they are disgruntled customers, who can damage a brand of a company and there is a possibility that they will spread negative testimonials about products of a given company. (Reichheld, 2011)

2. Objectives and methods

The following chapter includes the description of objectives and methods used in the research.

2.1. Objectives of the analysis

The main objective is to identify key players among a wide range of electronic shops operating on the Slovak market. Then, using the Net promoter score (NPS) method, analyze the reputation of these entities to identify significant factors of their success from the perspective of customer preferences, and, last but not least, explore the extent to which changes in customer preferences are significant in relation to the reference surveys carried out on the relevant market in the past. Based on these findings the aim is then to formulate recommendations for e-commerce entities with emphasis on preferences of their current as well as potential customers.

2.2. Object and methods of research

The object of research are selected e-commerce entities / e-shops operating in the Slovak Internet market. Secondary as well as primary data are included in the analysis. Secondary data are the results of reference survey named "Internet shopping in 2009" carried out by TNS SK (TNS SK In: Rohošková 2012) on a sample of 1,171 respondents. Key players in the market are identified on the basis of the results of the Shoproku competition (2014) organized by Heureka and Naspres, and more specifically by the "Internet Users Award" category. As part of the competition more than 50,000 real unique customers select their favourite e-shops in the current year. Voting took place by means of a simple electronic form and lasted from the 1. August to 30. September 2014. One overall winner with the highest number of votes and nine finalists were declared. Primary data are based on the results of our own questionnaire investigation on a sample of 634 respondents. Respondents were approached nonrandomly by 60 evangelists. Evangelists' role was to query respondents of different ages, from different regions, or economic status. The data collection was carried out during March and April 2015. The questionnaire consisted of 28 questions, the introduction included general questions, which provided for basic sample classification. Another

part of the questionnaire included questions necessary for NPS calculation, and the last part included questions aimed at identifying customer preferences with the focus on the electronic shopping. The collected data were then subjected to a thorough analysis and statistical testing. For better authenticity and clearness the main findings were interpreted graphically through web charts.

3. Results and discussion

The following chapter describes results of primary research as well as its comparison with respect to a reference research conducted in 2009. In the primary questionnaire querying 634 respondents were interviewed – 44% of men and 56% of women. In terms of age the largest group were respondents aged 17-24 with more than 77% of all the respondents.

3.1. Net Promoter Score of selected e-commerce entities

As stated above, this reputation ranking system uses direct questioning, relying on the so-called ultimate question: "How likely is it you would recommend us to your friends?" Addressing this question enables companies to trace the three fundamental customer groups: promoters, passive customers detractors.

Ranking acc. to NPS	E-shop	Promoters N / %	Passives N / %	Detractors N / %	Results (NPS) %	Ranking acc. to Shoproku 2014*
1.	Martinus.sk	196 / 30.91	141 / 22.24	297 / 46.85	-15.93	4.
2.	Alza.sk	100 / 15.77	155 / 24.45	379 / 59.78	-44.01	2.
3.	Mall.sk	55 / 8.68	136 / 21.45	443 / 69.87	-61.20	1.
4.	Hej.sk	59 / 9.31	127 / 20.03	448 / 70.66	-61.36	3.

*Adjusted ranking - for subsequent comparison only e-shops with Slovak localization offering mainstream goods were considered for the ranking. The following e-shops have been excluded from the original ranking: nejlevnejsi-knihy.cz (formerly 3rd) and progamingshop.sk (formerly 5th place).

Table 1: Net Promoter Score of selected e-shops; Source: our own processing according to Reichheld (2011)

We learn from the literature that the NPS of an average company should be between 5-10 percent. This means that promoters of the company barely outnumber detractors. We can argue that many companies and even whole sectors of business have a significantly greater number of detractors than promoters. Even companies like Amazon are within the range of 50 to 80 percent, which means that even such large companies still have room for improving relations with their customers (Reichheld 2011). However, an interesting phenomenon can be seen on the researched market: not one of four finalists in "Internet Users Award," category of SHOPROKU 2014 competition has positive NPS. Thus, based on the information in literature, neither of the analyzed e-shops meets the "average company" level. The overall ranking is also interesting: except for the online store Alza, which maintained second position in both final rankings, all of its competitors saw significant changes in customer perception. In terms of the total NPS, online bookseller Martinus.sk ranked best when it moved from the last to the first place in the overall ranking. At the same time it has almost twice as many promoters in comparison to Alza which ranked second. In terms of real customers we can say, that analysed companies have a long way to go to even get close to the parameters that their competitors on the reference markets of Western Europe and North America achieve.

3.2. Key success factors of selected e-commerce entities

Based on the survey of 2009 we analyzed 2 key determinants of electronic shopping on the chosen market on a sample of 634 respondents. These included factors directly influencing the selection of an e-shop by consumers, as well as factors influencing the decision to make a purchase. We then

searched for statistically significant differences between factors analyzed in time by means of testing.

Selection of an e-shop

The most decisive factor for the selection of an e-shop in our as well as in the reference research was the length of delivery time. Based on the findings more than 72% of respondents also consider this to be an important aspect. Good reviews are important for more than 70% of respondents. Providing a sufficient amount of relevant information about products is a decisive factor for the selection of an e-shop for more than 60% of respondents. We can also see an increase compared to the reference survey carried out in 2009 by more than 15% for this category. Compared to the reference survey in 2009 the factor of multiple payment options saw a largest decline. This is, due to more frequent focus on direct benefits instead of focusing on the process, an expected phenomenon. After testing the measured values we can at the same time say that at a significance level of $\alpha = 0.01$ we chose, there is no statistically significant correlation between the current preferences when selecting an e-shop and customer preferences in 2009. Measured valuesare interpreted in the following graph:

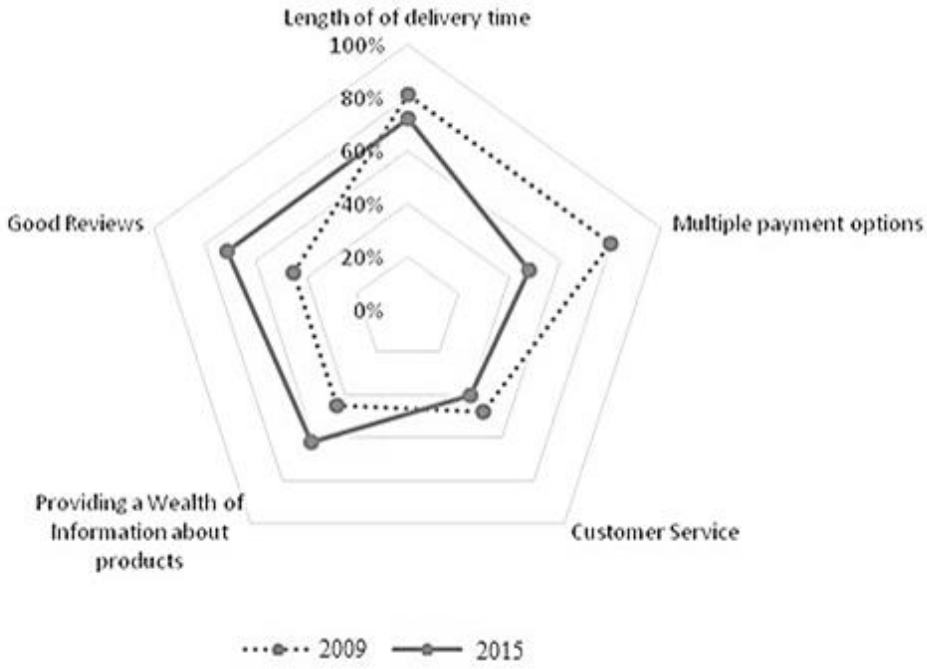

Figure2: E-shop selection; Source: our own processing

Deciding for online purchase

The most important factor in deciding for online purchase in our as well as in the reference research was the length of delivery time. Based on the findings more than 80% of respondents also consider favourable price to be an important aspect. In terms of customer preferences convenience and speed of purchase ranked second and no significant differences were observed in comparison to the reference survey of 2009. Wide range of offered products is considered important to more than half of the respondents. Compared with 2009 there is an increase of more than 15% which can be the result of various factors, were the ever increasing offer of online shops is certainly one of them. We consider the fact that comparing to 2009 the importance of good reputation of a shop increased by almost half, to be important, while this parameter has a direct association with the researched issue and only confirms the need to implement similar surveys over time. After testing the measured values we can at the same time say that at a significance level of $\alpha = 0.01$ we chose, there is a

statistically significant correlation between the current preferences when deciding for online purchase and customer preferences in 2009. In comparison to brick and mortar shops advantages of e-shops are obvious and clearly change only very slowly over the time. Measured valuesare interpreted in the following graph:

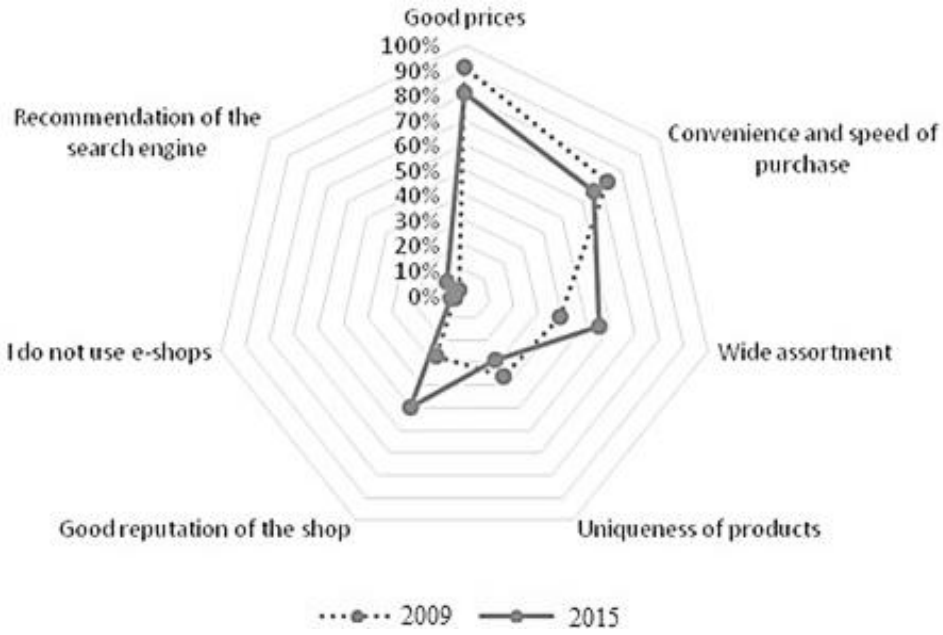

Figure 3: Deciding for online purchase; Source: our own processing

4. Conclusion

The paper presents partial results of a comprehensive research of online reputation of small and medium-sized enterprises operating in specific market in Central Europe. More specifically it deals with the issue of online reputation of ecommerce entities operating in the relevant market. The objective of our analyses presented in this paper was to identify the main players from among the wide range of e-shops operating in the Slovak market, primary analysis of these entities reputation method Net Promoter Score (NPS), identify key factors for success in terms of customer preferences and review the extent to which changes in customer preferences are significant in relation to the reference studies undertaken in the relevant market in the past. We verified changes in consumer preferences by testing. It can be concluded that factors influencing decision for shopping via the Internet are almost invariable over the time, on the other hand there was quite a significant shift in the factors influencing selection of an e-shop, and multiple payment options offered are no longer a key factor, whereas importance of good reviews of a shop increased. E-shop operators should place greater emphasis on factors such as reputation and good reviews of their shops, as well as a wide range and uniqueness of products offered. Information on offered products should be available in the greatest quantity and in the clearest way possible. The fact that more than a third of respondents regularly (at least on a monthly basis) purchase goods and services via e-shops is also positive.

5. Acknowledgement

This article is one of the partial outputs of the currently solved research grant VEGA no. 1/0145/14 entitled "Online reputation management (ORM) as a tool to increase competitiveness of Slovak SMEs and its utilization in conditions of Central European virtual market".

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TYPE OF E-AUCTION AS A FACTOR INFLUENCING ITS RESULT

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Keywords

Electronic reverse auction, Auction type, Measurement

Abstract

The choice of the proper type of an electronic auction has become an important part of the successful result from auction usage. Basic auction types are nowadays often extruded by the others because of their relevance in particular situation and different savings that bring to purchaser. The approach of Kruskal-Wallis ANOVA was used to determine whether the savings mean vary for different e-auction types. Results of this paper can supplement the existing research in the area of e-auction complexity settings.

1. Introduction

Recent economic and financial crisis showed us that nowadays it is still crucial to reduce the cost of external suppliers and search for innovative ways in purchasing and mainly in electronic purchasing. The implementation of dynamic tool of electronic procurement in purchasing process - electronic reverse auction has the potential to bring not only price savings but also many other benefits. As stated (Delina and Dráb, 2010) it is obvious that such electronic environment must be trustworthy. Many studies in this area deal with proper setting of electronic auction and the choice of the appropriate type of electronic reverse auction also seems to be very important. According to (Mabert and Skeels, 2002) electronic reverse auction (eRA) is a special case of electronic negotiation where several suppliers compete for the business to supply products or services and successively bid the prices down. As stated (Prídavok and Delina; 2013) the rapid adoption of eRA has undoubtedly contributed to the higher efficiency in procurement processes. One of the greatest benefits and advantages according to many authors (Kaplan and Zrník and kol., 2007; Janke and

Kubačka, 2013) are significant financial savings (first purchases-average savings of more than 15% from the originally offered prices and the maximum financial savings-more than 70%) and subsequently its transparency and the whole documentation of purchase. However as resulted from (Delina, 2014) transparency is not so clear dogma, it is much more complex phenomena and anonymity in eRA can push on auction participants to make more irrational decisions submitting better prices or utility for purchasers. Among other advantages of eRA belong: improvement the quality and supply guarantees and the implementation of effective and routine procedures for procurement. No less important part is also to choose the proper type of electronic auction. As stated in (AbuLaban and Qadah, 2006; Prídavok, 2011) we can distinguish a lot of types of electronic auctions for instance ERRMA (Electronic Reverse Multi-Item and Multi-Criteria Auction), NIPPON (Japanese Ticker Auction), HOLLAND (Holland or sometimes also called Dutch Electronic Auction), BRAZIL (Brazilian quantity-e-auction), YANKEE (capacitive e-auction) and also less used types in practice like Vickrey auction, The sealed first-price and second-price auction or The silent auction.

2. Theoretical background

In this section of paper are provided definitions and descriptions of types that are used in auction system proeBiz and will be the subject of our analysis. Those are: ERRMA, NIPPON, HOLLAND, RFX and e-auctions based on national legislations. We also focus on the topic of measuring e-auction performance.

2.1. Basic e-auction types

ERMMA (English Reverse Multi-Item and Multi-Criteria Auction) - The English Reverse Multi-Item and Multi-Criteria Auction is according to (AbuLaban and Qadah, 2006) auction where items are placed up for biding and the buyer generally sets a reserve price and auction duration. The reserve price is the maximum purchase price for the item and is generally not known to bidders. Participants bid openly against one another, with each bid being lower than the previous one. The auction ends when participants are not willing to bid further or when the auction duration is expired. If the auctioneer fails to raise a bid lower than the reserve price the sale will not be completed. In the NIPPON (Japanese Ticker Auction) the price increases incrementally and bidders are asked at every stage if they accept the current price level. If a bidder does not accept the price within some defined period of seconds he has to quit the auction at this stage. Bidders are not informed about the number of remaining bidders. The bidding process stops, when at least all but one bidder have quit the auction. In the case that all remaining bidders quit the auction at the same stage, the winning bidder is randomly drawn from the set of these bidders and has to pay the price of the last stage. (Ehrhart and Ott and Abele, 2008). HOLLAND (Holland Electronic Auction) is according to (AbuLaban and Qadah, 2006) in the Holland or also called Dutch auction the auctioneer offers up an item for biding at an arbitrary high price. The initial price is much higher than the item's value and therefore no seller expects to get that price for the item. Because bidders must know the amount of the bids, bids are not sealed as they are in some other types of auctions. The price is lowered in increments until a bidder is willing to accept the auctioneer's price; at that point the participant pays the last announced price. Shortage RFX (Demand) stands for Request for something (in case of system proeBiz X is replaced by Q) and it means Request for Quotation. The purchaser sends these requests to potential suppliers and they send him back through the auction system their bids. The special cases are e-auctions subject to the Law of Public Procurement in the relevant country (Czech Republic, Slovakia, Germany and so on).

2.2. Measuring the performance of e-auction

Measurement of e-auction performance is perhaps more complicated issue than it may seem. (Janke and Kubačka, 2013) conclude that the other benefits of e-auctions for the company than financial savings (such as the higher efficiency of the market or time savings) are very hard to measure. Therefore, they highlight the financial savings as the most comprehensive method. Generally speaking, financial savings in e-auction are understood as lowering of the purchase price through competitive bidding achieved through the e-auction (Klézl and Vašek, 2015). In addition to that, there is more than one way of computing them – savings based on estimated price and savings based on the initial price. The estimated price is usually based on the purchase price of the goods before the e-auction, or is set as an expert estimation of the purchaser, or a combination of these methods. The initial price is the lowest price after the first round of e-auction, where all the potential suppliers independently submit their bids, which are then lowered in the second round of the auction. Authors (Janke and Kubačka, 2013) conclude that these two variables are highly correlated and basically substitutable. However, in this article, we use both of these ways of calculation to highlight how the different mechanisms underlying each type influence the result of the e-auction.

3. Research methodology

Our study is based on real e-auction data from Czech software provider NAR marketing conducted in their e-auction tool PROebiz. Our dataset includes all the e-auctions in this software by Czech and Slovak institutions in the year 2014. The institutions include private companies of all sizes from local branches of multinational companies to small local firms, and also public institutions (municipalities, hospitals, government organizations…). It was necessary to clear the sample and eliminate e-auction cases with missing data. The main objective of this article is to prove whether the type of e-auction has the influence on its result. Our goal is then to analyse both types of savings (as specified in chapter 2.2), therefore all the auctions that lacked estimated price were cleared. Also, type of e-auction was sometimes not specified, and this variable is obviously crucial for our analysis. The cleared dataset consists of 6061 e-auction cases. Analysis of variance (ANOVA) was chosen to test the results of e-auctions amongst the respective e-auction type. To use this research method, two criteria have to be met – normal distribution of the data (both quantitative variables for savings) and homogeneity of variances. Kolmogorov-Smirnov test was conducted to test whether the data are of normal distribution (see Appendix X), and it was found the data are not of normal distribution. Therefore, non-parametric variation of the ANOVA test (Kruskal-Wallis ANOVA) had to be used.

3.1. Kruskal-Wallis ANOVA

The non-parametric equivalent of ANOVA is Kruskal-Wallis one-way analysis of variance (also known as Kruskal-Wallis ANOVA). It is a test that uses ranks instead of values. It is used for comparing more than two samples which originate from the same distribution. Generally, it is an extension of the Mann-Whiteny U test, which tests only 2 groups. The test statistic is given by:

$$K = (N-1)\frac{\sum_{i=1}^{g} n_i(\bar{r}_i - \bar{r})^2}{\sum_{i=1}^{g}\sum_{j=1}^{n_i}(r_{ij} - \bar{r})^2} \quad (1),$$

where n_i is the number of observations in the group i, r_{ij} is the rank of observation j from group i, N is the total number of observations across all groups, and $\bar{r}$ is the average of all r_{ij}. The K value is

then corrected of ties (this is usually a small difference). If the statistic is significant, then there is evidence of differences between the samples.

4. The influence of e-auction type on its result

In this section of the article, we take a look at the savings from e-auctions divided by their type. First, we examine the descriptive statistics (share of e-auctions by their type, average savings…) and then perform statistical testing with Kruskal-Wallis ANOVA to determine whether the savings mean vary for different e-auction types.

4.1. Descriptive statistics

As seen in Table 1, ERMMA is by far the most widespread e-auction type amongst Czech and Slovak institutions, with more than 75% share. It is due to the relative simplicity (both sides – purchasing and selling – can understand this type well and have experience with it), and its versatility when it comes to auctioned items (type of item and also the number of items). Other e-auction types have taken up less than 10 % share, with e-auctions based on Slovak legislation coming second with 8.23 % share, as opposed to Czech legislation e-auctions taking only 2.31 %. This could be explained by the legislation itself – Slovak law is more strict in requiring e-auctions to be done in procurement cases by public institutions. RFx and NIPPON auctions have around 5 % share, with sealed bids taking the 2.28 % share. Those types are relatively marginal for now, but NIPPON auctions are gaining attention and their share could be on the rise in next few years. Please note that after the data clearing mentioned in Chapter 3, our sample does not include any HOLLAND auction. This type, while being one of the most described in theory, seems to be unpopular amongst Czech and Slovak institutions.

ERMMA	Based on Legislative 25/2006 (SK)	RFx - Quotation	NIPPON	Based on Legislative 137/2006 (CZ)	Sealed bids
76,54%	10,93%	6,49%	4,12%	2,31%	2,28%

Table 1: Relative frequencies – e-auction types

Mean for Savings based on estimated price is 12.72 %, and mean for Savings based on initial price is 8.06 %. This is due to the fact that the Estimated price is usually higher than the Initial price – when potential suppliers know they're going to compete in an e-auction, they usually make the initial offer lower. Standard deviation is also almost twice as high for Savings based on estimated price (23.05% to 12,86%) – this is probably due to the fact that the Estimated price can vary much more from the Final price, as the methods for its computation is not set in stone and might be different for each institution or procurer.

4.2. Savings and e-auction type: KW ANOVA

As mentioned in Chapter 3, we use Kruskal-Wallis ANOVA to determine if the savings differ for e-auction types. We have set the following hypotheses for comparing the savings amongst e-auction types:

H_0: there are no differences between the median Savings based on estimated (initial) price of the samples based on e-auction type; H_a: there is a statistically significant level of difference between

the median Savings based on estimated (initial) price for at least two e-auction types. Then, we analysed both of the savings separately using KW test.

4.2.1. Savings based on estimated price and initial price

Based on the result of KW test, we reject the null hypothesis and conclude that the Savings based on estimated price vary for the e-auction types (see Appendix X). In other words, each e-auction type has different average savings. In Figure 2, we can see the boxplot graphs for each type of e-auction and the savings. The highest median savings is for the Sealed bids, while the most popular type – ERMMA – is second lowest. For specific values, see Chapter 4.3. In the case of initial price we again reject the null hypothesis (Appendix X) and accept the alternative hypothesis saying that the savings based on initial price vary across the e-auction types. Again, the most used type is amongst the lower medians when it comes to savings. Surprisingly, the Sealed bids tend to have highest savings. It is also interesting to see the differences amongst Czech and Slovak legislation based auctions. For specific values, you can see the Chapter 4.3.

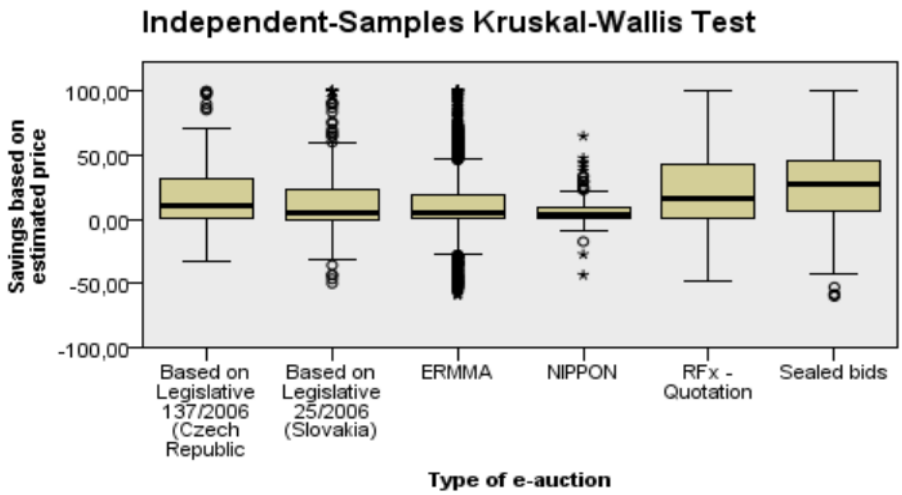

Figure 1: Savings based on estimated price: Kruskal-Wallis test results

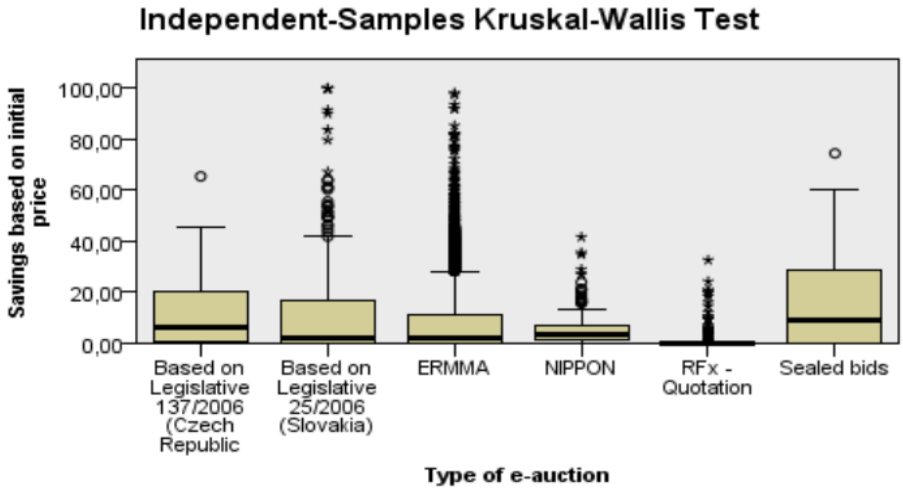

Figure 2: Savings based on initial price: Kruskal-Wallis test results

4.3. E-auction types: descriptive statistics

We've concluded in Chapter 4.2 that the e-auction types vary in their result, now we can take a look at the descriptive statistics. We've chosen Median, Mean and Standard Deviation for each e-auction type. Quite surprisingly, the least used e-auction type (Sealed bids) achieved the best results on average (highest Mean and Median for both methods of savings) with high Standard Deviation – the results of this type are very diverse. On the other hand, e-auction type that is gaining popularity in recent years – the NIPPON auction – has relatively the lowest average savings and quite low std. deviation, meaning that all the auctions of this type tend to have lower savings. The most used e-auction type by far – ERMMA – is very close to the values of the whole dataset, and generally is around the middle of the dataset. Standard Deviation is also close to average values and relatively high, as the result of the auction can vary depending on other influencing factors.

Type of e-auction		**Savings based on estimated price**	**Savings based on initial price**
Based on Legislative 137/2006 (Czech Republic	Median	10,93%	6,49%
	Mean	20,21%	12,62%
	Std. Deviation	26,19%	14,12%
Based on Legislative 25/2006 (Slovakia)	Median	5,46%	1,94%
	Mean	14,88%	10,92%
	Std. Deviation	23,98%	17,48%
ERMMA	Median	4,55%	2,40%
	Mean	11,39%	8,12%
	Std. Deviation	22,36%	12,51%
NIPPON	Median	4,15%	3,57%
	Mean	6,42%	5,48%
	Std. Deviation	10,38%	6,53%
RFx - Quotation	Median	16,00%	0,00%
	Mean	22,28%	1,00%
	Std. Deviation	26,11%	3,57%
Sealed bids	Median	27,58%	9,46%
	Mean	26,27%	15,72%
	Std. Deviation	31,25%	17,79%
Total	Median	5,22%	2,15%
	Mean	12,72%	8,06%
	Std. Deviation	23,05%	12,86%

Table 2: Descriptive statistics for e-auction types

5. Conclusion

The goal of this article was to prove whether the assumption that the type of e-auction influence its result (Teich et al, 2004) can be confirmed on real data. We've used data from e-auctions done in Czech and Slovak institutions, with the sample of 6061 e-auction cases. Our data shows that the e-auctions types indeed influence both measured types of savings. The most used e-auction type with almost 75% of cases, ERRMA, is performing quite averagely, while some of the lesser used types (Sealed bids, RFx) performing somewhat better. There could be several reasons for the differences amongst results: firstly, the ERMMA type is very well known by both suppliers and purchasers. The suppliers know, how high the initial price needs to be and what they can expect to happen in the auction, and similarly, procurers know how to set the estimated price. It could be advisable for procurement teams to occasionally use different e-auction type to break the habit and force the suppliers to change their behaviour in favour of reaching higher savings. However, further research needs to be done in this area. Auction type is only one of the factors influencing the result of the e-auction, and the factors often complement of contradict each other (Wagner and Schwab, 2004). E-auction type could be related with the item auctioned, as some categories of items could achieve better results with certain types. The factor of organizational infrastructure and expertise of the procurement team (Smeltzer and Carr, 2002) could also influence the choice of e-auction type – the more experienced and capable teams are more likely to choose the right type of auction to achieve the best results. Szabo et al (2013) also prove that skill and experience are key determinants of successful e-procurement application. This procedure could be a subject for future research activity.

6. Acknowledgement

This research was supported by the national project VEGA 1/0855/14 „Determinants of efficient purchasing supported by electronic solutions" financed by Ministry of Education, Science, Research and Sport of the Slovak Republic.

This paper is supported by Student Grant Competition of the Faculty of Economics, VŠB-Technical University of Ostrava; project's registration number is SP2015/93. All support is greatly acknowledged and appreciated.

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THE ANALYSIS OF PRICE OFFERS IN CONSTRUCTION INDUSTRY FROM PARTICIPANT'S POINT OF VIEW

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Keywords

Tender, e-auction, biding, construction, offers, Slovakia,

Abstract

In construction industry process of creation of bids and offers is the only way, how to attract customers. It is a very specific industry, where company must compete for every product, that it want sell. The presented paper use Slovak construction company as a case study to analyses the process of creation of offers and bids from participant's point of view. It analyses how method of procurement or amount of money estimated in the request for proposal influences money saved due to reduction of winning price, or how e-auctions and tender mechanism influence the cost of proposal preparation.

1. Introduction

Because of very specific and unique product, which is characterized with extremely small standardization, companies in construction industry use process of offers' and bids' creation as a main way to attract their customers. Rowlinson and McDermot (1999) called procurement in construction industry as process of the allocation of resources in order to realize construction project. The procurement actions in construction can be divided into three sections: sourcing, direct procurement and indirect procurement. Indirect one focuses on procurement of daily used supplies. Direct procurement is also known as supply chain management and it's focused on obtaining goods and managing tasks to manufacture products. As Kim and Shunk (2003) claimed, sourcing penetrates both of previously mentioned forms and it involves four stage process based on: 1. information, 2. negotiation, 3. Settlements and 4. After-sales actions). In construction industry sourcing is done on behalf of client through the process of choosing a construction company, which involves first three phases of previously mentioned model. (Eadie et al., 2012)

In Slovakia the process of choosing a construction company have usually two forms, form of tender (electronic or not) and form of electronic reverse auction (further known as e-auction). According to Liu (2015) the tender process is focused on procurement an outstanding contractor to ensure the construction quality and control the construction investment. The same can be said also for process

of procurement contractor via e-auction. In order to differentiate these mechanisms we use Delina and Vajda (2006) which explains that tenders are based on competitive offers or public competitions, where administrator (proposer) setting the rules and conditions, and participants sending their offers. In the end the best offer is chosen. The tenders usually represent RfQ (Request for Quotation) and RfP (Request for Proposal) models. The basic characteristic of tender is that it is a onetime offer only. That is the reason why, scientific literature describe tender, as ineffective method to gain optimal winning price. Apart from tender, there is electronic reverse auction which Carter (2004) defines as ''an online, real-time auction between a buying organization and two or more invited suppliers, where suppliers can submit multiple bids during the time period of the auction, and where some degree of visibility exists among suppliers regarding the actions of their competitors.'' Lots of author (such as Prídavok and Delina, 2013; Eadie et al., 2012; Kim and Shunk, 2003; Szabo et al. 2013; Rowlinson and McDermot 1999) argued that used of e-procurement method such as e-auction will saved hiring company a lot of money due to efficient optimization of winning price. Other authors (such as Hartley et al. 2004, Teich et al.) also suggest that use of e-auctions lower the transaction and administrative costs.

There is also other problem regarding the prices estimated in the RfPs. According to Best and Meikle (2015) "acquiring true purchaser price for construction project is all but impossible, as final account (i.e. out-turn price) information is seldom available." Volatility of the price is causes by delays, changes in design and by many other factors, which mean that that the final sum is not the same as estimated, even if there are available data from same project, which is built in new location, or in the same location but in different time. (Best and Meikle, 2015). These discrepancies motivate clients to estimate proposal price with a reserve. Biding companies in construction industry probably use these estimated prices presented in RfPs as starting point and form their own offers/bids. Question is how far are these companies willing to reduce these reserves in order to produce winning offer/bid. Is there a relationship between proposed price and money saved by minimization of winning offer/bid.

Regarding to all these problems we proposed three research questions, which were tested in chosen Slovak construction company. These are the questions:

1. How procurement method influence money saved due to lower winning price
2. How amount of money estimated in the request for proposal influences money saved due to lower winning price
3. How procurement method influence cost of proposal preparation

2. Methodology

2.1. Description of the sample

The research in this paper is based on case study of Slovakian medium sized construction company from eastern Slovakia. Study provides an analysis of all requests for proposal and offers which company identified and submitted during the years 2009-2013. Although the company operates in the building industry for more than 25 years, the reason why this particular start year was chosen is that the company started to be involved in e-auctions from 2009. According to provided data during this five year period company obtain 139 requests for proposals (RfPs) where tender or e-auction was requested as procurement method. This number also represents all RfPs, which were proposed to company's management and considered for offer preparation. The archived RfPs which were rejected are also included in dataset.

2.2. Variable selection

Based on the analysis of provided RfPs we identify several characteristics, which are essential for proposed research questions. They represent the general characteristics, which can be found in every RfP. On the other hand, the costs of proposals are estimated from accounting data of the company. These variables together with their values are presented as variables in Table 1.

Variable name:	Variable description:	Variable values:	Variable type:
Procurement type	The type of procurement method which were defined in the proposal by investor.	0-"Tender", 1-"E-auction"	Nominal
Price of RfPs (PRfPs)	The price of construction project estimated by investor listed in RfPs	Prices in €	Continuous
Proposed price (Pp)	Last price of the offer/bid proposed by company	Prices in €	Continuous
Offer	This variable represent if the proposed offer win loose or management decide not to participate on the contest and cancel RfPs.	0-"No participation" 1-"Loss", 2-"Win"	Nominal
Proposal costs	All costs (labor costs, operational costs, fees and charges) that company declared for creation of offer proposal	Prices in €	Continuous
Price change	The difference between Price of RfPs and Proposal price calculated as percentage of Price of RfPs: $\text{Price change} = \frac{\text{PRfPs} - \text{Pp}}{\text{PRfPs}} \times 100 \quad (1)$	Percentage	Continuous

Table 1: Description of the variables used in the study

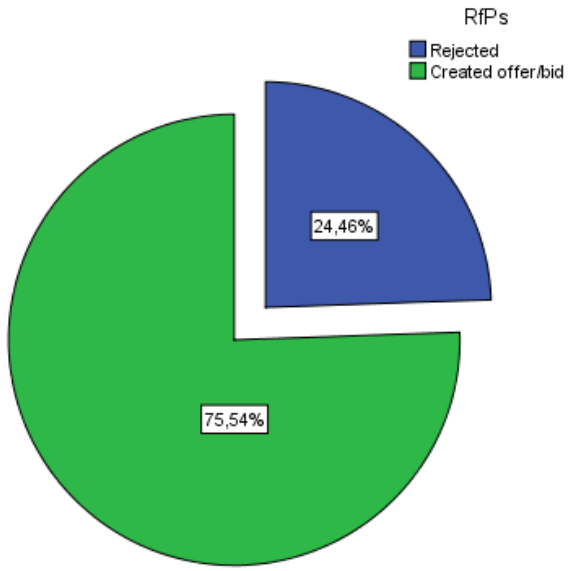
In order to provide answers to proposed research questions the distributions of these variables and relation between them had to be determined. For this purpose we use the scatter-plot analysis, and boxplot analysis. Because of non-normal distribution of few variables, the non-parametrics measurements of association known as Spearman's rho coefficient and Kendall's tau-c are also used.

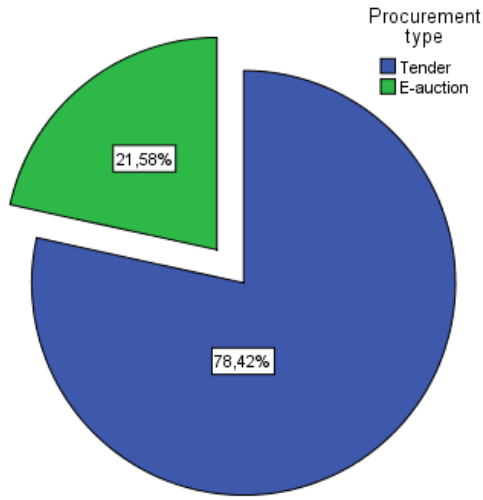
3. The results

3.1. Company profile

As was stated in the methodology part, the tested sample is based on 139 RfPs identified by sales department of the construction company during the five year period. As can be seen on Figure 1, only less than one quarter of RfPs, which were presented by sales department to management of the firm for consideration were rejected. The rest of the RfPs, were transformed into the offers/bids to take part in tender (78,42%) or e-auction (21,58%). The winning rate of company and archive of

RfPs, which is pretty detailed, are the reasons why this company was chosen for a case study. From all 139 requests company create and win 55,4% of offers/bids and lose only 20% of them. Results like these lead to conclusion, that company understand the construction market in region and know, which RfPs should be selected to prepare offers/bids.





		Offer					
		No participation		Loss		Win	
		Count	Row N %	Count	Row N %	Count	Row N %
Procurement type	Tender	21	19,3%	21	19,3%	67	61,5%
	E-auction	13	43,3%	7	23,3%	10	33,3%
	Total	34	24,5%	28	20,1%	77	55,4%

Figure 1: Description of companies RfPs

3.2. The impact of type of procurement on reduction of estimated price

The first research question deal with impact of two mostly used types of procurement methods on minimization of estimated price. It reflects how different type of bidding mechanisms influence difference between estimated and winning price. To measure these differences we established variable called price change. This variable determines the percentage of estimated price which was saved by lower winning price and its calculation is presented in methodology. The research question was analyzed by boxplot analysis presented in the Figure 2. Here the distribution of price change variable for tender offers and winning e-auction bids are presented.

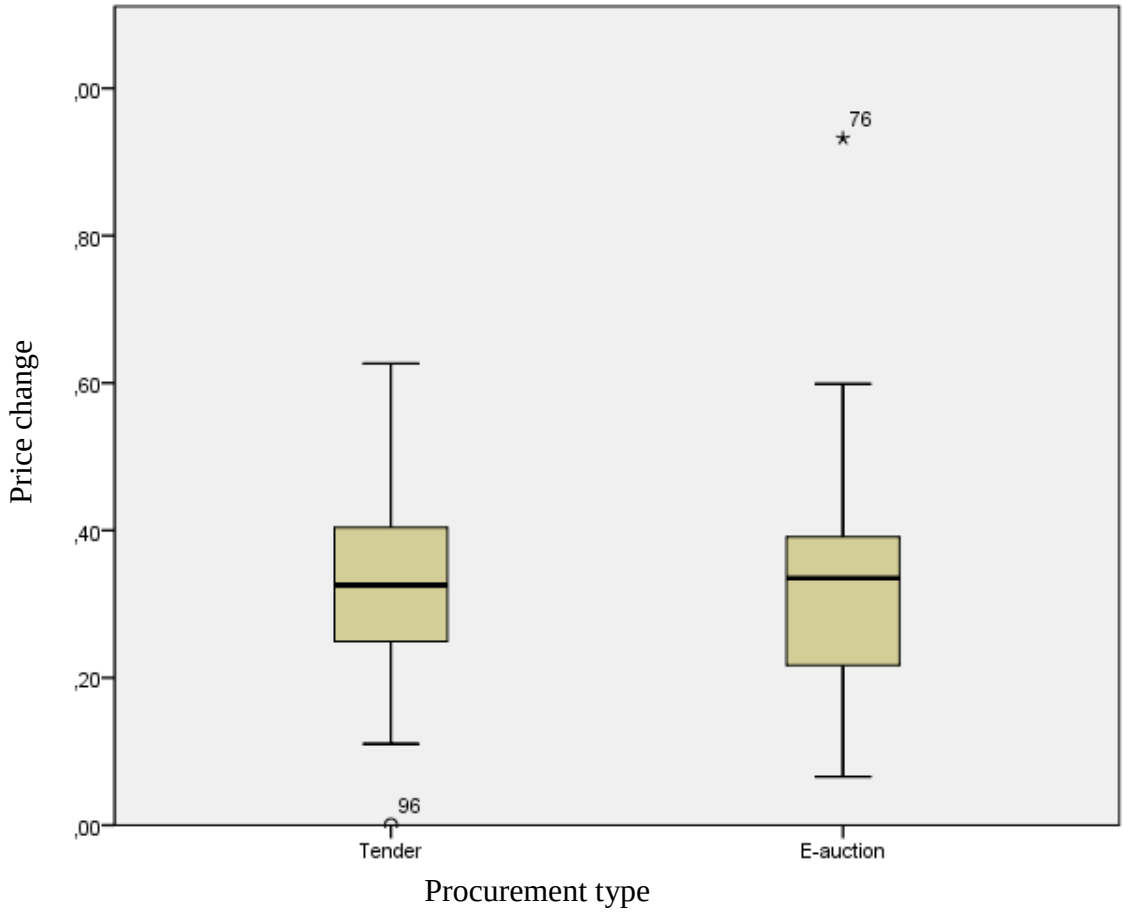


Figure 2: Boxplot analysis of price change distribution across various procurement types

As can be seen on the Figure 2, the price change distribution of tender offers is not very different from price change distribution of winning bids of e-auction. However there are some differences between them. Firstly, the median (horizontal line in the boxes) is slightly higher in e-auction boxplot than in tender one, which means that the proportion of higher savings by use of e-auction mechanism is bigger than in tender one. On the other hand, as boxplot analysis showed e-auction winning bids represent more variability and has lower first quartile than tender ones. This discrepancy shows that saving from tender bids are less volatile and the proportion of lower price saving is more probable by use of e-auction mechanism than by use of tender one.

3.3. The impact of estimated price on price change

The second research question dealt with dilemma whether amount of money estimated on the proposal price influence the difference between estimated and winning price, known also as savings. To analyses this relationship, we decide to use the scatter plot analysis. In the analysis, the proposed price was chosen as dependent variable and as in the previous research question, also here we use price change as independent variable. The results of the analysis are presented in Figure 3.

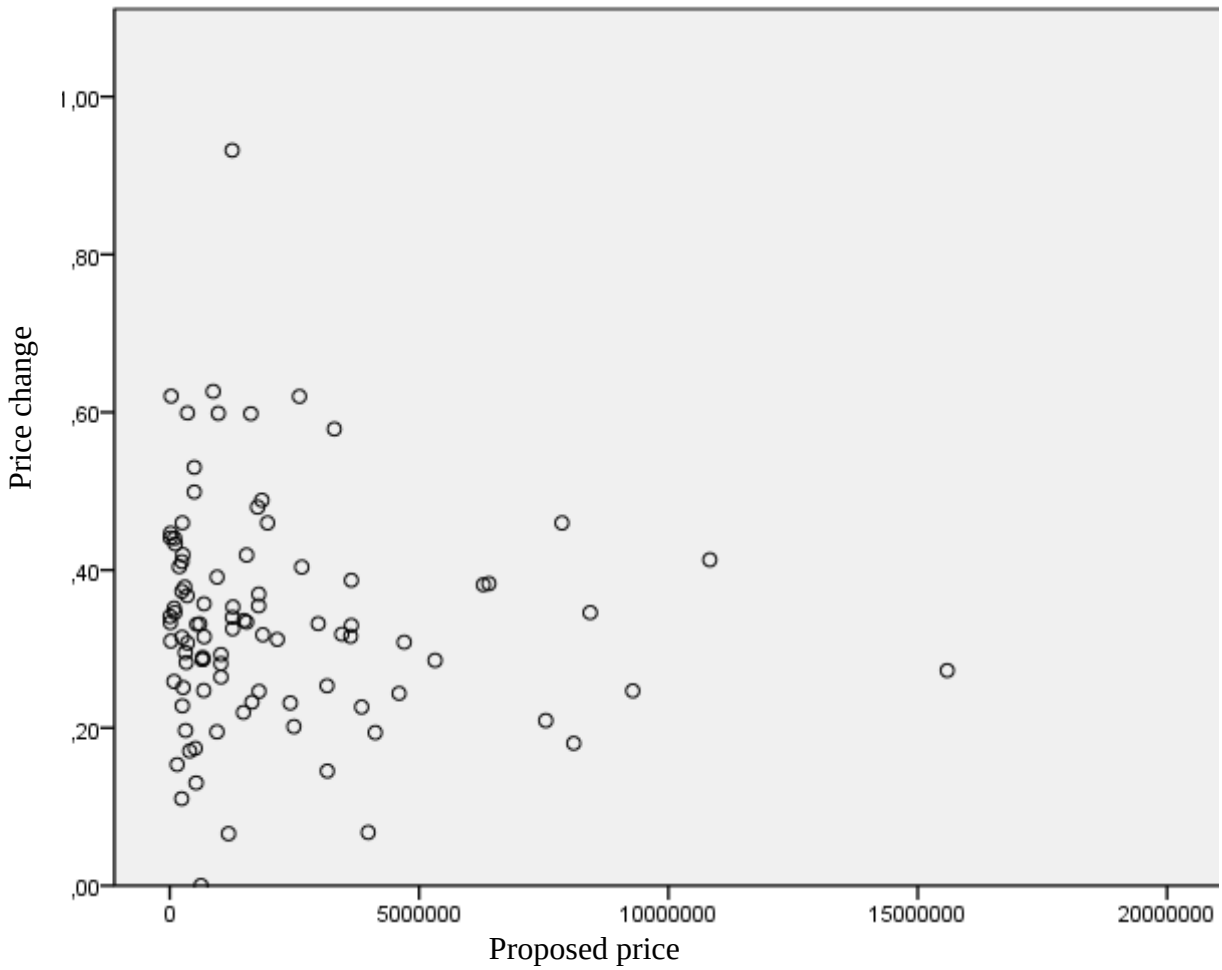


Figure 3: Scatter-plot analysis of proposed price and price change

According to the Figure 3, it can be seen than amount of money prosed in RfPs doesn't influence the volume of the money saved by lower winning price. The Relationship between these variables was tested by correlation analysis. The essential assumption for choosing correct characteristics is normal distribution of the dataset. We test it by use of Shapiro-Wilk's test. This test operates under null hypothesis of normal distribution and its results are presented at Table 2. At 5% level of significance the normal distribution was rejected for both variables.

	Shapiro-Wilk's Test of normality			Proposed price vs. Price change		
	Statistic	df	Sig.	Measure	Value	Approximate Significance
Price change	0,950	95	0,001	Spearman's rho	-0,382	0,144
Proposed price	0,715	95	0,000	Kendall's tau-c	-0,300	0.093

Table 2: Test of normality and association analysis

Based on the results of normality test, we used two non-parametric measures Spearman's rho and Kendall's tau-c to confirm level of association between selected variables. Both measures show week relation between these variables and their statistics are determined in Table 2.

On the other hand scatter plot analysis presented in Figure 3 showed that the bigger savings are presented where low prices are proposed. This lead to a conclusion, that construction costs of small projects (represented by small proposed prices) are more overvalued than large projects which costs more.

3.4. The impact of type of procurement on cost of proposal

Last research question analyze how type of procurement method specified in RfPs influence money spent on creation of offer. To provide answer to this question we decided to determine two (one for e-auction offers/bids, another for tender offers/bids) distributions of variable proposal costs, specified in methodology section. These distributions were transformed into boxplots and are presented in Figure 4.

Boxplot analysis showed differences in distribution of proposal costs between various procurement types. According to Figure 4, the costs of offer creation for e-auctions are usually higher than costs of offer creation for tender.

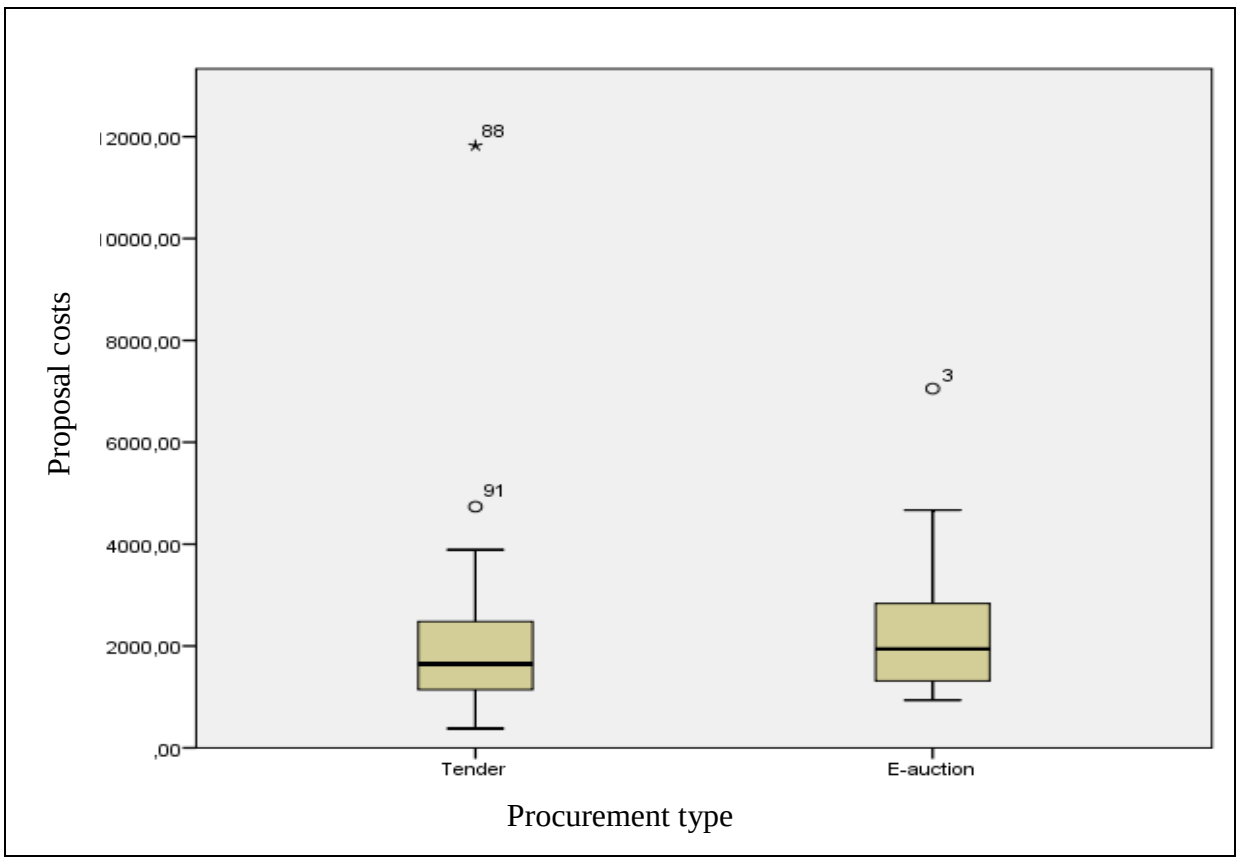


Figure 4: Boxplot analysis of proposal cots across various procurement types

4. Conclusions

The presented paper dealt with analysis of offers/bids of chosen Slovakian construction company. The motivation for this study was to analyze offer/bids from participant's point of view and provide

some tribute to on-going discussion regarding procurement. According to the results it can be said that there is no big difference between use of e-auction and tenders in term of savings due to lower winning prices. However tender offers show relative less volatile and slightly better results than e-auction winning bids. Moreover, other analyses discover that preparation cost for offers which use e-auction mechanism are higher, than preparation costs for tender offers. The study also showed that higher savings due to lower winning prices are usually possible in small projects, which are usually badly evaluated and because they are overvalued they also have high estimated prices. In the end, it has to be reminded, that this study analyses company within very specific industry where every offer/bid is very unique and specific, so these results has to be interpreted with the great cautiousness.

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SESSION G: DO WE NEED INFORMATION AND COMPUTER ETHICS?

ETHICS FOR A GLOBAL SUSTAINABLE INFORMATION SOCIETY

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Keywords

Ethics, morals, naturalistic fallacy, spiritualistic fallacy, postmodern fallacy, emergentist ethics, global challenges, socialisation, individualisation, Is-Ought-relationship, means-end-relationship, Great Transformation

Abstract

Starting point is the résumé of a systems theoretical analysis of the information age as an age of global challenges. A second part deals with ethics and the basic question ethics seeks to answer: how are Is and Ought related to each other? According to the different answers possible, a picture of trendy moral approaches can be concluded that either prolong the current crises or are conducive to the shaping of ICTs for a global sustainable information society.

1. Ethics in the information age

The information age is an age in which information, in particular, wisdom, conscience, ethics, morals as its manifestations, is needed to underpin the course of civilisation towards a global sustainable information society. It is needed to cope with the global challenges that are an expression of increased interdependencies of the partitions of humanity. These interdependencies signify a rise in complexity that longs for a new step of integration to be caught up with (Hofkirchner, 2014b).

1.1. Integration and differentiation

Any system shows a dialectic of integration and differentiation. Agents that differ from each other bring about the formation of a structure that integrates; this structure catches up with the differentiation at hand and, at the same time, conditions a new differentiation of the agents which brings about a new integration: ever more differentiated agents bring about the formation of an ever more integrated structure that conditions the formation of ever more differentiated agents. There is divergence and convergence in one. That is the line along which evolution can make progress. As long as the increase in divergence is for the sake of convergence and the increase in convergence for the sake of divergence, a system does not fall apart; evolution can lead to ever more complex systems (the higher the differentiation, the higher the integration). This is the most fundamental dynamic in self-organising, evolutionary systems. It accounts for development and evolution. After the festschrift for Ludwig von Bertalanffy, it may be called unity through diversity (Gray, 1973).

1.2. Socialisation and individualisation

The dialectic of unity through diversity appears in social systems as dialectic of "socialisation" and "individualisation".

At the highest resolution, social agents, actors, members of societal systems are different individuals. Through their action, interaction, and co-action they bring about the formation of societal relations that condition the generation and utilisation of commons in an integrated way, which allows the individuals to differentiate: the more individuals are "individualised", the better they produce the common good; the better the common good is "socialised", the more individuals can become individuated. That is, socialisation and individualisation precondition each other.

Being social is the result of socialisation, and being individual is the result of individualisation. The more the individuals contribute to the commons and the more diffused are the commons, the more social is society; the higher creativity and the more open the access to the commons, the more individual are the individuals.

What has been said of individuals, holds for composite social subjects too, and what has been said of society, holds for component systems of society too. It holds for every element that takes part in the self-organisation of a social system.

1.3. An Age of global challenges

Since the second half of the last century the dominant way of using technological, environmental and human resources has turned out to be increasingly incompatible with a peaceful and harmonious future of societies. There are forceful impediments on the path to establishing sustainable international as well as intra-national relations (which exclude the use of military violence and other technological means that are detrimental to the good life); to establishing ecologically sustainable relations to nature (which excludes overuse of resources and their abuse as sinks for harmful waste); and to establishing sustainable relations amongst humans in the cultural, political and socio-economic context (which includes all producers and users in a fair production and usage of whatever is commonly produced). It is an age of global challenges that human civilisation had entered. Global challenges are global because they affect humanity as a whole and because it is only humanity as a whole that can deal with them successfully.

Global challenges are due to an exaggeration of the socialisation/individualisation dialectic. Individualisation has been hurrying ahead. In the course of evolution, a state of higher individualisation needs a state of higher-ordered structure if the social system is to relink individuals back to the community they build. In the case of global challenges societies can fall apart. The enclosures of the commons have been aggravated to such a degree that all of them morphed into global challenges. As long as social systems could externalise the negative effects, their self-organisation was compatible with the enclosure of commons; now that they are interconnected as they are, the enclosure of the commons is not tenable any more.

1.4. The Great Bifurcation imperative

Global challenges have a 'dark' and a 'bright' side. The dark side is the imminent danger of the breakdown of interdependent societies with the possibility of exterminating civilised human life. The bright side marks a possible entrance to a new state of civilisation that brings about a peaceful, environmentally sound and socially and economically just and inclusive world society. This is the Great Bifurcation that lies ahead of humanity. World society, humanity as one whole, as a unity through diversity, is in *statu nascendi*. The crises of today are the heralds of that change never seen

before – of a possible and needful meta-system transition in which a supra-system is on the point of emerging. This supra-system would be a real world society that turns the current systems into its components. But the actors might fail to face up to that complex challenge.

A Global Sustainable Information Society (GSIS) is the new social formation that might emerge. It is an overall framework consisting of three conditions that need to be fulfilled, rather than a detailed blueprint.

1. It needs to exist on a planetary scale, that is, it needs to be global.
2. It needs to be capable, by establishing its organisational relations, of acting upon the dangers of anthropogenic breakdown, that is, it needs to be sustainable.
3. It needs to be capacitated, by means of ICTs, to create requisite wisdom, knowledge, data, that is, it needs to be informational (Hofkirchner, 2014a; see also Hofkirchner, 2011, and Hofkirchner, 2013).

Being global implies being sustainable which, in turn, implies being informational. Informationality means there is information needed for sustainability; sustainability means there are sustainable relations needed for globality.

2. Ethics accounts

Ethics accounts can be qualified along the four ways of thinking promoting reduction, projection, disjunction or integration. In contradistinction to those accounts that fall prey to the so-called naturalistic, spiritualistic or postmodern fallacies, it is only the last account that avoids problems of justification and the practical implications of universalism and relativism that are societally not desirable. Since 2010 I'm calling that account Emergent(ist) Ethics (Hofkirchner, 2012).

2.1. The naturalistic fallacy

The naturalistic fallacy is only one kind of inferences that do not hold. It is based on a reductionist way of thinking. It tries to derive prescriptions from descriptions, norms from facts, Ought from Is, thus levelling down a norm or an evaluation that is related to a fact to a proposition that only describes facts without making prescriptions or evaluating the facts (which is an implicit prescription). Reductionism, in general, reduces phenomena of higher complexity to those of less complexity. Insofar norms or evaluations are not only, directly or indirectly, prescriptive but relate to facts they are more complex than descriptions of facts that lack the prescriptive moment.

2.2. The spiritualistic fallacy

Another fallacy is wishful thinking, called here the spiritualistic fallacy. It pretends that Is follows from Ought and projects the higher complexity given in prescriptions onto descriptions that are less complex. That is, projection presumes the existence of something in an area where it cannot be found.

2.3. The postmodern fallacy

A third fallacy might be called the postmodern one. As it is a feature of postmodernity to accept only that great narrative that says there are no great narratives any more, postmodern thinking deconstructs consistency provided so far; things fall apart and so do Is and Ought. From that

follows there is no dependency of one on the other at all and every norm or value is as justified as any other. That is an expression of a way of thinking that disjoins things that are connected.

2.4. Emergentist Ethics

However, there is another possibility for conceptualisation: emergentist ethics. It is possible to look upon Is as necessary, but not sufficient condition of Ought. In that way Is can be integrated with Ought. They are not made completely identical nor completely different. They are conceived of as being related by a certain connection that opens room to move. "Ought" can emerge as contingent on a given basis. Thus reductionist, projectivist and disjunctivist ways of thinking are negated. Values, guidelines for actions, morals are emerging in a historical context; they are originating from, and dependent on, history.

This is very like modern views of laws of nature. Laws of nature that govern natural processes are not predeterminants that are given from outside nature or are unchangeable. Physical laws seem to emerge along with matter and energy. So seem morals to develop with the circumstances in which they are embedded. System goals are construed on the basis of the actual interaction of the elements of that system. The former depend on the latter, but cannot be reduced to them.

Goals need to be realistic in that there is a chance to realise them. Emergentist ethics starts from her stating that for the improvement of a social system one has to take into consideration that which is not only possible but also desirable and, in turn, not only what is desirable but also possible. This approach includes not only an account of the potential that is given with the actual but also an evaluation of the potential that sorts out the desired. Thus it embraces an ascendance from the potential given now to the actual to be established in the future as well as an ascendance from the less good now to the better-then, which altogether yields the Not-Yet in the sense of Ernst Bloch (1985).

3. Morality in crisis

The current crises across all areas of social life, including the ecological and the technological infrastructure, go hand in hand with a deep ideological crisis, a crisis in morals, due to an actualisation of a plethora of different morales that do not form a coherent guidance for conduct.

The state of morals can best be demonstrated by an analysis of the role of morals in dominant means-end relationships, of concomitant interests and of the underlying kind of reflexivity.

3.1. Means and ends

A categorisation of means-end relationships can be based upon the categorisation of Is-Ought relationships. The end is a kind of Ought, because it presents a desired state; the means is a kind of Is, because it presents a state of possible dynamisms the initialisation of which might bring about the desired state.

The end has a moral dimension, since what is desired is good, more or less good, or evil.

The means as a means has, at first glance, no moral dimension, since the dynamisms work in one way or another. It is appropriate to reach the end, or it is inappropriate or it is even counterproductive, which is a matter of fact. As such the means is right or wrong in relation to the end.

However, the means is not only a means for an end but has also independent existence. As an imperative to act it is subject to moral judgements. For the required action in itself is good, more or less good, or evil, and this property is depending on the consequences. Those consequences can be close-range or long-range effects, short-term or long-term effects, or side effects, and they can be intended or unintended, and, most importantly, they can be desired or undesired. If the consequences are desired or undesired, that is, if they can be evaluated with regard to goodness, then that degree of goodness can be conferred from the consequences to the action that causes the consequences, and the means acquires a moral dimension.

If the end is the only consequence of the action, and if the end is good and the means is proper, then goodness can be conveyed from the end to the means. As a matter of fact, actions usually do not have one single consequence only. They have several ones. And each of those would need an evaluation and all of them an overall weighing up against each other in order to find a substantive moral judgement.

That's the means-end relationship seen from a moral perspective.

3.2. Pragmatism: Amoralisation tendency

Now, the naturalistic fallacy yields a tendency of amoralisation.

The moral end is camouflaged and reduced to pretended real necessities, to the "Sachzwang" of technocracy, of punditocracy (German "Expertokratie"), of bureaucracy, that represent mere means. The norms are stripped off their moral values. That kind of pragmatism has a universal claim. Since capitalism has penetrated the economies of almost all cultures and countries, that claim has a self-evident basis. Capitalism, and its current neoliberal development, seems to be the only possible economic reality.

The pursuit of neoliberal, capitalist interests goes without saying. There is no need to say that those interests are neoliberal, capitalist ones. The behaviour is in no need of justification. The superficial reality suffices.

The ruling out of questioning the ends, the moral load of the ends and of the positions that are provided by the social relations and make the incumbents of those positions inclined to behave in the way they behave characterises a state of restricted reflexivity, that is restricted cognitivity, communicativity and co-operativity, restricted to individual self-concern and suppressing any third concern.

3.3. Fundamentalism: Hyper-moralisation tendency

The spiritualistic fallacy turns into a hyper-moralisation tendency.

A particular moral end is preached in a fundamentalist way and projected onto particular measures such that the end justifies the means. That's particularism. In any of such cases the actors deem themselves to be the good ones such that whatever they do cannot be other than good too, even in case of doing bad things. But in every case it is particular moral values that are passed off as universal.

Accordingly, it is particular interests that are pursued. As long as positions are antagonistic and fight for the prevalence over those that contradict them, they cannot be generalised and cannot become valid in a universal sense.

The reflexive quality connected with values and interests that are with fundamentalism as particularistic as with pragmatism – albeit not disguised but unveiled – is a restricted one too. The quest for commonness of interests is extraneous.

3.4. Indifferentism: A tendency towards a moral disconnect

The postmodern fallacy at large tends towards a secular disconnect.

That is the disconnect of means and ends, of norms and morals, of the micro and the macro (see Douglas Porpora, 2013). The argument here is that morals of the ends (macro) are neither reduced to nor projected onto the norms of the means (micro) but that either side is disjointed from the other. Norms are without morals and morals without norms. Norms are not grounded in morals and morals don't support norms. Neither norms nor morals can be criticised by reference to the other. The change of norms or morals becomes a matter of accidental or arbitrary action. That fosters overall indifference, because the disconnect leads inevitably to pluralism – a diversity of zero or equal moral values. Any norm or morals go.

In any case those decisions again are subject to individual interests, to interests that are particularistic, to parochialism.

And reflexivity faces restrictions again, since there is no corrective against the pursuit of short-sighted interests.

3.5. A new cosmopolitanism

Given these three tendencies, the overall picture is like that: all of the three positions are ventilated by late modernity, and in the case of neoliberalism even taken to extremes. On the micro-level, there is growing fluctuation, whereas on the macro-level we have, at large, the same social system. What all that fluctuation could not yet achieve is a qualitative system change.

However, amidst all those tendencies of a- or hyper-moralisation or towards a disconnect, there is a step-by-step convergent tendency too that orients towards the formation of a global conscience as part of a global consciousness, a tendency that comes along with a cosmopolitanism up to the requests of what starts to be called anthropocene. This tendency is integrativism based upon the emergentist ethics approach.

Regarding the means-end relationship, a permanent adjustment of the means to the end and of the end to the means is assumed as feasible and mandatory. The means is open to critique, if it does not lead to the desired moral end, and the end is open to critique too, if it turns out to frustrate a higher moral end.

Interests are compelled to replace short-sightedness by long-sightedness. Individual interests need not to be particularistic. They can be coherent with social relations that are concerned with, and care for, all individuals.

And reflexions are compelled to make reference to commonalities. Those urges qualify the reflexivity in question, the interestedness in question, the morality in question and the view of means-end relationship in question as apt for a new cosmopolitanism.

In contradistinction to pragmatism and fundamentalism that yield unity without diversity, and in contradistinction to indifferentism that yields diversity without unity, new cosmopolitanism is defined by yielding unity through diversity.

Though the ideological hegemony is given to the trinity pragmatism–fundamentalism–indifferentism, a new cosmopolitanism is *ante portas* – an idea whose time has come.

Thus the fluctuation on the micro-level, given the presence of instantiations of all categories of reduction, projection, disjunction and integration, might be an indicator for preparing the grounds for another Great Transformation. The revolution needed for the formation of a Global Sustainable Information Society would be a reflexive revolution. What is needed is individuals, social subjects, social systems, whose concerns are with civil society, with values, and with the future of society.

3.6. Informatisation needs to serve informationalisation

In the course of that second Great Transformation that relies upon meta-reflexive social subjects (Archer, 2012), informatisation is requested to, above all, facilitate informationalisation.

Informationalisation is the process of raising the problem-solving capacity of the nascent world society to a level that allows for successfully tackling the problems that arise from society's own development. Informationalisation can, and needs to be, based upon informatisation, that is, the spread of information and communication technologies that makes society more and more responsive to information, but is not entailed by informatisation per se.

The penetration of society with ICTs is not a “mechanism” that leads to information society. “Mechanisms” are rooted in self-organisation. Far from being mechanical, they are contingent dynamisms. They are not based upon a one-to-one mapping of causes and effects. In spite of designing technological means serving particular social interests, supervenient features accrue in the shape of the designed technology and open the space for possible impacts on society different from those intended. This is an ineluctable property of the complexity of real-world systems. These impacts can add value to the system, can be neutral, or can be partly or overall detrimental to it. Detrimental impacts occur because social actors who are accountable behave as if they were autonomous systems, that is, restrict their focus to themselves and do not extend it to the social relations that assign to them the limits of positions they hold and of the roles they play.

The social system is characterised by a certain structure containing dysfunctionalities or not. The techno-social system can reinforce particular dysfunctionalities, quantitatively; it can spawn new dysfunctionalities, qualitatively; and it can support the mitigation, and even elimination, of those dysfunctionalities and the advent of new functionalities.

Because there are contingent ways in which the “mechanism” of mutual shaping of ICTs and society can work, informatisation has to be tamed such that it can be harnessed for informationalisation.

The dialectic of informatisation and informationalisation is the generic dynamism in information society. As it is a manifestation of the dialectic of "socialisation" and "individualisation" characteristic of any social systems evolution, antagonisms hinder proper informationalisation and turn informatisation into a perverted form. They reflect the tension between the opportunity to digitalise technology and the whole world and the risk of increasing the vulnerability of civilisation; the tension between the opportunity to manage sustainability and the risk of computer-aided colonisation of nature; the tension between the opportunity to liberate knowledge and the risk of its economic monopolisation; between the opportunity to empower the people and the risk of ubiquitisation of surveillance and information warfare between nation states; between the opportunity to enhance one’s way of life and the risk of being manipulated by new media through disinfotainment.

It’s the task of information and computer ethics to address those issues to help solve the problems that need to be solved, if a Global Sustainable Information Society shall come true.

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DO WE NEED INFORMATION ETHICS?

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Keywords

Ethics, information ethics, public good, private good, relationship marketing

Abstract

The article deals first with the definition and then the motives for the development of information ethics. It shows the area of information ethics is complex and its solution requires sophisticated thinking. The article also proves there are many motives for the information ethics development.

1. Information ethics

The question in the title of this contribution begs the question of what information ethics is. We should know what we need in order to be able to decide if we need it. I´d like to concentrate on the concept of information ethics proposed by L. Floridi. In fact we can find two approaches defining information ethics. One is from L. Floridi, the other one from R. Capurro. It is noteworthy they don´t understand one another and especially from Capurro´s side we can trace a lot of critique towards Floridi´s conception. We´ll use Floridi´s conception as it is clearer and illustrates the issues where information ethics may be helpful. The study of other approaches would lead to similar results.

Floridi claims technology changes processing of information and thus have moral implications. Technology has been developed by man and that is why we can ask if he should or shouldn't develop it as it changes the world´s status quo. That implies that technology can be evaluated from the ethical perspective.

Regarding information technology Floridi thinks we shouldn´t concentrate on specific technologies (such as computers), but concentrate on the concept of information and its life. The main concern of information ethics should be in his opinion the well-being of the infosphere.

In his famous article (2006) L. Floridi complains about the ambiguity of information ethics for different researchers in different disciplines (computer ethics, business ethics, medical ethics, computer science, library science etc.). The reason can be according to Floridi found in the novelty of the discipline. To rescue the situation Floridi suggests a unified approach towards information ethics focusing on the moral agent.

The moral agent A uses some information as a resource to generate other information as a product and affects the information environment as a target. The fragmentation of information ethics resulted according to Floridi from the study of just one or another of the three information arrows.

1.1. Information as a source

Let´s go through the three arrows. We´ll start with the information as a resource. "A" may be expected to strive for the best information because it would thus be able to make better decisions and actions in the given situation. We may expect that better information would help in the decision making. From the ethical point of view it can be concluded that some morally deficient decision stems from deficient information. The responsibility of the moral agent is proportional to his degree of information. The less information he has the less is he morally responsible. We speak of informed decision, informed consent, informed participation. From this perspective the moral agent needs as much information as possible. But we can´t make of the sufficient amount of information a basic moral rule. There are cases like anonymity protection, fair treatment, unbiased evaluation. Being informed is not always morally positive. Within the sphere of information as a resource information ethics may be described as the study of moral issues related to availability, accessibility and accuracy of resources of information. Floridi includes into this sphere the issues of digital divide, infoglut, reliability and trustworthiness of information resources.

1.2. Information as a product

The production of information is subject to various limits, constrains and opportunities. That is why problems regarding accountability, liability, testimony, plagiarism, advertising, misinformation etc. occur. We can´t say what we´d like as our acts of information production affect many people around. Information production is an act and the agent is responsible for his activities.

1.3. Information as a target

The third area of activities concerns activities which affect the information environment. Floridi includes into this area activities like privacy breach, confidentiality, security, vandalism, piracy, intellectual property, censorship, filtering, contents control or hacking. The difference from information as a source consists in the breaking of information environment, not the use of illegally obtained information.

The model suggested above may be criticised for its simplicity as the moral problems concern often more than just one information arrow. Responsibility depends not only on the information one has, but also on the information one produces. Censorship affects both the producer and user of information. Another line of critique may concern the inclusive nature of the model. Many ethical problems are established from the interaction of the information arrows. Examples may be copyright regulation which affects users, producers and the information environment. Mason´s PAPA model faces similar difficulties.

The model thus serves as a useful simplification, but a more general approach is necessary. Floridi suggests an ontological approach where entities would be discrete, self-contained, encapsulated packages containing data structures and operations, functions and procedures which are related to various interactions or stimuli. Floridi calls such an approach a macroethics. Information ethics as a macroethics supports the existence and flourishing of all entities and their environment. What harms the entities and their environment is entropy which can have the form of destruction, corruption, pollution and depletion of information objects. It claims that being and information have an intrinsic worthiness. Any informational entity has the right to persist and improve its existence. Moral agents have the duty to contribute to the growth of the infosphere. The ethics claims the ontological equality principle according to which any form of reality has the equal right to exist and develop on a way which is appropriate to its nature (Floridi, 2006, p. 26).

Any moral agent should contribute to the development of the infosphere. The four laws define who a moral agent is. They are ordered according to their moral value. To avoid misunderstanding Floridi denies that he develops an ethics of e.g. emails, news etc. His ethics is for beings like animals, plants, artefacts etc. This ethics provides some concepts and tools for the solution of ethical problems even though it doesn´t give any easy solutions to specific problems. Floridi applied it to deal with "tragedy of the digital commons" (Greco and Floridi, 2004), the digital divide (Floridi, 2002)), game cheating (Sicart, 2005) and the problem of privacy (Floridi, 2005). Floridi´s information ethics is a minimal and overridable (Floridi, 2006, p. 33) ethics. The general rule is to fight against entropy. At the same time information ethics is not conservationist and doesn´t inhibit any modification of the given state of affairs.

To conclude we may say we need information ethics in whatever kind in order to solve the ethical problems regarding the information as a source, information as a target, as a product and their combination. Information ethics may be used to study and solve ethical dilemmas.

2. Types of information ethics

In accordance with Kitzmueller and Shimshack (2012) who dealt with the economic analysis of the corporate social responsibility we may distinguish two big types of information ethics: One is market driven and the other is driven by social or environmental or cultural factors. It means information ethics may be a strategic organizational feature, but it is not the only reason for its existence. It follows we may need information ethics in order to improve the reputation or to fulfil the requirements of the culture and society we live in.

An important question deals with the state intervention in public good provision. From the economical point of view ethics is a public good, which means it is non-excludable and non-rival. From that it follows ethics can´t be supplied through market mechanisms only and it is difficult to charge for its consumption. And this type of goods tends to be provided in sub-optimal amounts because many individuals use free riding. Samuelson in his article (1954) formulated a famous condition $\sum_{i=1}^{n} MB_i = MC$, where MBi is the marginal benefit of each person consuming one more unit of the public good and MC is the marginal cost of the public good production. In case of two products (one private good and one private good) the condition can reformulated as $\sum_{i=1}^{n} MRS_i = MRT$, where MRS is the marginal rate of substitution and MRT is the marginal rate of transformation. As public good is non-excludable every individual will try to hide his marginal benefit form public goods in order not to pay for its provision. Only state can ensure Pareto optimal provision of public good, but it would have to know everybody´s preferences which is also problematical.

A related point of view would be the tradeoff between information ethics provided by companies and as a state regulation. Let´s look at an example from Kitzmueller and Shimshack (2012). Companies produce private good x together with a type of information ethics y. The public good is provided at lower than optimal level. State requires uniform regulation. Society contains agents preferring public goods, not preferring public goods and groups preferring public goods if consuming. Without regulation the market is at equilibrium. Some firms provide information ethics and charge higher prices to their caring customers due to competition, other companies don´t care for information ethics and charge lower prices to their not caring customers. The government is usually influenced in the elections either by the group preferring information ethics including a part of the group preferring public goods if consuming or the group not preferring information ethics including the other part of the group preferring public goods if consuming. Either a regulation is imposed on all market subjects or on none of them. If the government doesn´t impose any

regulation information ethics means an improvement which will benefit both those preferring information ethics and those preferring it if consuming private goods including any free riders. Those not preferring won´t be harmed. If a regulation is imposed, those not preferring information ethics will be forced to pay more for private goods or stop consuming it. Money are distributed from those not preferring to those preferring information ethics who now pay lower prices.

The society welfare under regulation can be only evaluated if we weight the benefits of groups B, E, F (those preferring information ethics and part of those preferring only if consuming) against the part of those not preferring information ethics (D). The groups not consuming x (A, C) are not affected by the government regulation in contrast to head tax. We may not conclude that the state will provide sufficient balance on the market. Its failures justify companies themselves in the information ethics provision. The following chart illustrates the situation. From this perspective we would need information ethics in order to decide what role the state should have in the ethical issues and who should pay for the ethical provision.

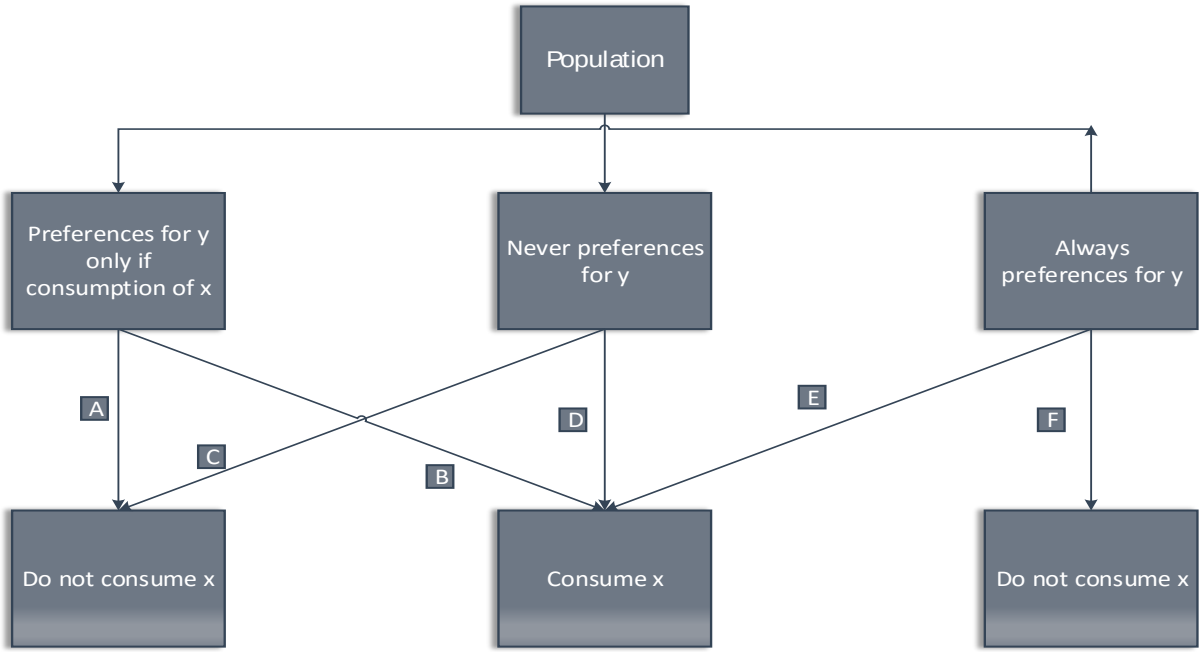

Figure 1: Market situation in public good provision, Kitzmueller, Shimshack, 2012

3. Motives for information ethics

If we look at information ethics not as a dichotomy between state regulation and private provision of information ethics, but look at the motives for its occurrence we may find reasons for its occurrence. We may understand information ethics as a form of investment that results in negative costs or benefits in time. However given the dynamic character of the economic environment it is not possible to evaluate the results beforehand. Another approach sees information ethics as a pure company´s expenditure. We may then ask why do companies voluntarily increase their costs. Information ethics as a component of business ethics can be part of company´s strategy. This behaviour needn´t be rewarded on the market and then it is a sacrifice of profit in the interest of the society. Another reason may be negative preferences for profit distribution. Owners of the company may not want to spend money for other purposes than bonus payments of the management.

Another reason consists in the profit maximalization as some stakeholders may have preferences in information ethics. Information ethics may be also be introduced as a precaution against future

regulation or activities of non-governmental organizations. Such forms of information ethics are motivated by outside parties and the companies´ management is reactive only. There are also companies not looking for profit only and they may survive if their owners have sufficient funds for ethical expenditures. In many cases it may also happen that ethical behaviour has positive economical effects, e.g. providing information accessible may be costly, but may bring advantages because customers would now the information better, the communication will be flexible etc. and their reactions will be better targeted, they won´t need so much support etc. Following principles of information ethics may lead to attracting employees who would be contented with lower wages in exchange for the opportunity to work for a company which supports ethical behaviour. Their social status would be improved.

For customers information ethics may serve as a source of differentiation and may build brand loyalty.

4. Types of preferences

The preferences of various stakeholders may be money, social services or reputation. This is important for incentives for ethical behaviour. People using monetary incentives may be considered greedy. Another preference may be for the warm glow (Andreoni, 1989) which is connected to the ethical behaviour. Some motives for ethical behaviour may be influenced by the education, family background, culture etc.

An important self-centered motive for information ethics could be the deception of customers that the company can be trusted. Customers would then provide their data in exchange for some additional services, e.g. personalized supply of services and the company gets a lot of valuable data which can be analysed and customers can be influenced.

Information ethics is motivated on the victim´s side, too as a way of protection against the harm caused.

5. Relationship marketing and management

To illustrate the fact that information ethics is not only an academic discipline and that it has relevance for the business sphere we can turn our attention to the concepts of relationship marketing and management where these ideas have their relevance.

Relationship marketing consists according to Buttle (1996) of concern, trust, commitment and service. The concern of marketers is welfare and wellbeing of their customers. Meeting and exceeding customer expectation is their objective. Trust and commitment prefer long relationship to short term alternatives. Commitment tries to maintain a relationship and trust is the confidence in another partner´s reliability and integrity. Confidence is related to consistency, fairness, responsibility, helpfulness, benevolence etc. Concern, trust and commitment should result in reliable, empathic and responsive service.

Relationship marketing focuses on stakeholders. According to Bourne (2009) “Stakeholders may be groups or individuals who suwho supply critical resources, or place something of value at risk through their investment of funds, career or time in pursuit of the organisation’s business strategies or goals. Alternatively, stakeholders may be groups or individuals opposed to the organisation or some aspect of its activities. Stakeholders are defined as ‘individuals or groups who will be

impacted by, or can influence the success or failure of an organisation's activities'." Their stake may consist in an interest, right, ownership or contribution as knowledge or support.

Information ethics promotes the relations with the stakeholders as it is based on trust and respectful behavior. Stakeholders are affected by the information in all its three forms (information as a source, as a product and as a target) and their combination. Following the principles of information ethics, i.e. respecting Floridi´s four principles of information ethics and decreasing their entropy may help not only to improve the relations with the stakeholders, but also to improve the society and give sense to activities in it.

6. Conclusion

I think the article has shown we need information ethics to help us analyze and solve issues related to problems with information. The content of information ethics deals with these issues and people have anough motives to be interested in them. The relationship marketing is an example and proof that these issues are getting more respect in the business sphere.

7. Acknowledgements

This article was processed with contribution of long term institutional support of research activities by Faculty of Informatics and Statistics, University of Economics, Prague.

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ETHICAL ISSUES IN CYBER SOCIETY

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Keywords

non-ethical exploiting of information and computers – facts, motives and reasons, solution potentialities of ethical problems in cyber society

Abstract

"The threat from cybercrime is increasing, targeting citizens, businesses and governments at a rapidly growing rate" (Europol, 2015). The information and communication technologies (ICT) rapid development brings for society not only many benefits, but many threats too. ICT nature, especially the speed, convenience and anonymity of the Internet commit a diverse range criminal activities and new trends in cybercrime that threaten business processes, eroding the employees integrity, and damages the organizations reputation. The paper deals with two problems in cyber society. Initially gather facts about non-ethical exploiting information and computers in society. On the other hand deals with motives that lead to unethical activities. Final thesis section is looking at potential solutions to ethical problems in cyber society.

1. Introduction

Cyber threats are no longer just in the movies. Area and acts of unethical conduct in the context with information and information and communication technologies increases. Public awareness about the negative phenomena, threats and risks types associated with the severity of their impacts and possibilities of defense against them is not high. Is this society ethically mature?

What is unethical behavior? It is conduct that is contrary to morality and can involve individuals, groups of people, institutions and organizations and societies. In context with ICT it can be an information theft, data manipulation, data falsification, misuse of power, or technology. Ethics and ethical behavior is related to so-called man-made disaster, characterized according WCPT as "an event caused by humans and caused by human influence." Unethical behavior sharp rise in recent years in working with information and ICT is not related just to individuals. There are involved organized groups (also at national levels), acting, often on the order in favor or against someone or something. Biggest business scandals recent years have followed a similar pattern: „The ethical behavior of those involved eroded over time. When moral standards are unclear or unenforced, it's easy to engage in non-ethical behavior, it is necessary to discover problems in time, to stop them in advance" (Gino, 2014).

Unethically human activity is usually based on bad faith. It is implemented so, that cannot be simply detected. All unethical conduct and behavior types caused deliberately by man, have a negative impact (psychological, medical, economical, etc.) on other people, consequences in economic and social costs, and it usually leads to the disruption of an organization (or society)

functioning. Unethical acts must be prevented and as well must be removed their causes and consequences. These problems give the basics of developing international, national and local organizations. E.g. in the Council of Europe was founded in 2001 "Convention on Cybercrime" that provides a modern and flexible means of international cooperation and expresses the desire to harmonize rights related to the crimes in combating cybercrime and misuse of computer systems.

2. Do we need the information and computer ethics in contemporary society?

This part is focused on cases of unethical conduct involving abuse or personal data theft and information manipulation through computers.

The need to address the information and computer ethics is evident from some recent headlines:

- Internet crime is increasing, police set up a new department. From 2011 to 2014 number of Internet crimes increased from 1500 to 4300 (Editors ZET. 2015)
- Every tenth Bohemia met the misuse or personal data theft (Editors ZET. 2014)
- Cyber attacks are increasingly using mobile devices, focusing mainly on Android (Editors ZET. 2014)
- Cyber attacks soon endanger not just technology but also human lives. (Honus, 2014).

Information and computer ethics. Information processing, transmission and storage has always been people and organizations focus. Information and communication technologies and automated information processing systems currently dominate many areas of life. ICT efficiently process information and provide processes optimization and this leads to their widespread use. In contrast, thanks to ICT raises a number of areas that are vulnerable to the human factor. With the increasing ICT application we also meet with higher rates of information abuse. Ethics behavior in cyber society is therefore directly linked to the problem at work with information and ICT, thus with information and cybercrime.

Facts about cybercrime. According Leitersdorf (2014) „Nobody was safe in 2014“ – hacked were large retailers, media companies, financial institutions, technology companies, government organizations, health service institutions. Damages estimation caused by Internet crime are huge. According Honus (2014) amounts to $ 300 billion annually. Gartner estimates (in Leitersdorf, 2014), that the global cybersecurity market can grow from USD 67 billion in 2013 to USD 93 billion in 2017. Based on a survey by PWC 4,000 organizations in 78 countries (including the Czech Republic) was found (Qureshi, Withers. PriceWaterhouse. 2011), that 30% Czech companies are worried about corruption, computer crime and information abuse in business, 27 % organizations are concerned about asset misappropriation and 8% were worried about accounting fraud. The statistics for 2014 also shows that in Czech Republic each one of the ten organizations met with the misuses or theft of personal data (Police, 2015).

Unethical use of information and computers. Cybercrime includes activities where the computer is a tool or unethical goal for crime (Musil, 2000 Council of Europe):

- deliberate attack against the computer and the data on it with the intent to destroy,
- theft of data, programs or machine time,
- illegal manipulation of computer data or software,
    - misuse or data falsification,

  - data or programs damage,
  - computer sabotage, including an attack against HW,
  - unauthorized access or penetration to the data through the unauthorized use of computer communication networks (hacking - overcoming protective software elements of different databases and to amend certain data - damage to information provided by the network),
  - unauthorized copying - Software piracy,
  - change data or programs with the consequences of the processing personal data, etc.,
  - cyber espionage (aimed to stealing corporate secrets and intellectual property for resolding to competitors and governments interested to the strategic know how),
  - Copyright Infringement - use software for their own use, illegal software distribution, unauthorized use of copyrighted work program, software misuse for business purposes,
  - hactivism – groups of computer hackers going beyond nation´s borders (blocking access to websites, defacing web sites, identity theft, virtual sit-ins, website hijacking (Paganini. 2012),
- penetration into information system or the Internet and changing data networks provided damage information (without a physical presence at the scene),
- information gained from mobile systems – sensitive information gained from mobile´s (contacts, e-mails, phone numbers, mobile pickpoketing – SMS/call fraud, steeling bank account credentials, appointments, position, customs and tradition, etc.),
- penetration into smartphones and consumer products connected to the Internet (Honus, 2014),
- cybertripes - pressure to buy in fraudulent e-shops,

cyberstalking - repeated, long-term, systematic and intensified harassment - a form of psychological terror via SMS, e-mails, phone calls using instant messenger (ICQ), chat via VoIP technology, social networking, etc. - discussion forum, in which stalker, based on false identity, tries to contact the victim or obtain information about victims from other Internet users (Kopecky, 2010)

- cybergrooming is a type of mental manipulation carried out through the Internet, mobile phones and other related technologies - instant messengers, social networks and advertising portals (offer various career options and earning to children eg. in modeling),
- but also, for example propaganda dissemination, pedophile images on the Internet, extremist movements and groups and their activities on the Internet; e.g. extremist movements who see violence as a legitimate means to promote political objectives using web presentations, discussion forums, blogs and social networks for the distribution and promotion materials and mobilizing support to upcoming events (MVČR, 2012),
- ransomware (type of malware), who blackmails the user and asks ransom,
- SPAM – every day is in the world sent 29 billion spam, phishing and infected messages.

According to Czech National Security Team (Computer Security Incident Response Team) statistics it was solved in the years 2008 to 2015 a total 13,236 cyber crime incidents. There has been successfully resolved 5540 incidents related mainly to phishing, spam, malware (in 2015

almost two-thirds of the total), and others (CSIRT.CZ). From all economic crime types amounted computer crime 13% and misuse of information in business 13% (PWC 2011). Increase in cyber crime has been since 2009 a full 13% stake, information misuse increase 8%, total more than 20%. In comparison asset misappropriation increase was 15%. The study also indicates that respondents ranked cybercrime in some cases as the item "financial fraud". Organizations in Czech Republic are most worried about the intellectual property theft - including data theft (71%), damage to company reputation (72%) and personal information theft (74%). As excessive risky departments are designated IT departments (51%). The reason is staff professional knowledge and opportunities for computer fraud. As medium-risky are designated marketing departments (31%) and finance departments (20%). The least risky are designated human resources departments (7%) and legal departments (4%). No more than 20% of Czech companies evaluates the cyber crime risks more than once per year; and 6% of them are not addressed. Nearly 38% respondents from the Czech Republic who in the past 12 months met with fraud, said that the total cost exceeded 100,000 USD. A total of 8% victims suffered even a loss exceeding $ 5 million. 67% companies that have been victims of economic crime in the past 12 months, was cited as the most significant non-financial impact of the deterioration in staff morale. Furthermore were mentioned business relationships damage (38%) and damage to reputation or brands (25%). (Qureshi, Withers, PriceWaterhouse 2011).

Methods for unethical behavior (cheating) detection in Czech organizations were: Corporate control systems - Internal audit 17%, risk management systems 21%, automatic reporting of suspicious transactions 4%, corporate security8%, personnel rotation 4%; Corporate Culture - internal warnings 8%, External warnings, anonymous hotline 4%; Outside control of management – by chance 13%, authorities notification law enforcement / investigative media 4%, otherwise 4%. (Urban, 2011).

2.1. Motives for unethical activities in cyber society

Generally, people want to act in an ethical manner and see themselves as ethical people (Guillen. 2013). Why, then, some of them are "ethical fading" losing ethical view to problems solving, have limited perception of ethics and ethical threats are becoming part of everyday life? Unethical activity by using ICT "is highly lucrative and far less risky than any other ordinary crime like old-fashioned bank heist." (Paganini, 2012).

Mankind motives for unethical conduct were always especially power (acquisition of resources, territory, domination, etc.), economical (obtaining funds or competitive advantage). Usual motives also include "something to prove" (hacker), "earn" (hired hacker - cracker), "highlight" of errors in the system, "harm" someone out of anger, "highlight" the opposition to something / someone.

However, the reasons for unethical acting may be different. E.g. Guillen (2013) and others have dealt with reasons that led to the facts, that right people do bad things:

- psychological pressure - situational behavior when people act against recognized values,
    - person does not perceive a problem relating to ethics, he does not notice that problem has an ethical dimension and is "automated" based manner on the preconceived opinions (preconceptions) or prejudices basis in other situations,
    - load stress or emotional trauma, which causes it, that the brain does not pay attention to relevant context,
    - in order to achieve success, progress, meet deadlines and expectations, both on their own volition or by pressure from managers, co-workers, customers or suppliers, but

also from family or friends (even if it is known, that it is morally unacceptable the abuse of power by ashing others to do unethical things),

- uncertainty about what is the right thing to do,
- misguided loyalty to managers or organization.

Chen (2012) defines unethical behavior context with the degree of a man moral development as follows: “Preconvention level - a person’s choice between right or wrong is based on personal consequences. Conventional level, ethical decisions rely on living up to the expectations of others. Principled level, individuals define moral values apart from the authority of the groups society in general”.

Cyberethics. Ethical behavior is acceptable in everyday life - respect for others, honesty, fairness, integrity, etc. This is acceptable in cyberspace too. What is cyberethics? By (Chen, 2012) “Cyberethics is a set of moral choices individuals make when using Internet-capable technologies and digital media."

In cases of unethical conduct in cyberspace, people act consciously and reasonably internally (have a selfish interest, personal goals, ambitions, are greedy). An example may be the drug manufacturer or distributor, who never deal ethical values, never think about what is good and what is bad. Their thinking goes through “what do I get” and “can I get out of it”. Such human beings have strong focus on economic values and high need for personal power to satisfy their own interest. These people aim is usually to acquire either technology and / or strategic information from systems of organization. The purpose is then single or multiple hardware, software and data (information) sales, their transfer to another entity for professional use (usually for payment or other benefit), use for their own commercial activities or for other criminal activities (blackmail, misinformation, etc.). As well ICT professionals can have the temptation or the urge to unethical conduct. But they just “try their skills” without benefits or wealth. It is usually one-time mistake and conscious return to ethical conduct. In practice nearly every IT professional ever attempted in the course of working life at least once.

Other motives of unethical behavior in cyberspace:

- anonymity - in the last century eg. Diener dealt with (Diener et al, 1976); nowadays is particularly associated with the Internet and social networks; unethical behavior is usually based on an assumption, that the offender cannot be detected,
- role conflict that was resolved unethically and the resulting revenge protest against someone or something, dissatisfaction, etc. and is resulting in bad emotional state of a person,
- "climate" and culture in an organization (or in society at large) - respect for the law, and respect for organizational (nationwide) rules,
- role relationships and conflict of interest - an employee is forced to do something by unethical manager with the comment: “Just Do It” , “I don’t want to know how you do it.” or “I don’t care about the details“, or manager demands the result not achievable through ethical means” (Sharifzadeh, 2009).

3. Options for a "solution"

Ethics define socially acceptable behaviors and plays intricate role in the modern cyber society. Ethical theory is necessary because general rules are not always sufficient. Ethical theories provide categories and procedures for determining what is ethically relevant. But it is not universally

accepted way of deciding if something is ethically acceptable or not. (Johnson, 1985) We can meet several different ethical frameworks – right and duties, maximizing the amount of good in the world, respecting people´s autonomy in decision making and leading a virtuous life, because it is not consequences making an action right or wrong, but motivation on which it is based. From ethics are drawn laws. The key difference is, that laws carry the authority of a governing body and ethics is based on cultural mores (McCarthy, 2013).

Investigation causes of unethical information and computer use shows that information in many cases have not been published, not on the Internet, either in the media. Organization conceal incidents or damages caused to them by unethical behavior in cyberspace. The public learns from media just "sensational stories". Facts about unethical events are scattered across a range of subjects and even fields, and often leads to focus on numerical data rather than on the causes. For these reasons, we consider IT necessary to apply consistently the following measures at least:

- continuing education and training (from an early age, but in the whole population spectrum), not only to ethics, but also to the responsibility for behavior and actions - including the use and work with information and ICT - to the rules and the consequences of their abuses - both in daily life and in work for an organization or society as a whole,
- create and enforce effective strategy for risky behavior prevention in schools, organizations, institutions and states,
- improve and implement safety measures and monitoring the employees activities in organizations and in the State apparatus, on the basis continuous monitoring new information, for the possible preventing disparities between reality and its realization,
- accept and improve legal measures (eg. Cyber Law adopted in July 2014 and valid in the Czech Republic from 1.1. 2015),
- unify legislation in European countries in interrelation to cybercrime,
- by all means inform the public truthfully and in time about "cases" and developed actions,
- create an organization that supports safety development when working with ICT (including the Internet), for example Police Internet Helpline for reporting illegal and harmful content on the Internet, the National Centre for Safer Internet, etc.,
- identify and prioritize values to guide behaviors in the organization, to establish associated policies and procedures to ensure that behaviors are conducted,
- at SW - use antivirus protection, firewall, legal software, and other protection means,
- reassess the safety functions and preparedness organizations for cybercrime cases, assess risks, identify possible gaps in the system, to adapt the procedures and processes,
- increase cybersecurity vendors cooperation – e.g. establish cyber threat alliances,
- to clarify norms, values, responsibilities and expectations for managers and employees and examine their effects,
- put the code of conduct known and to demand its implementation,
- raising awareness in the media, schools and organizations for understanding the current, and emerging computing environment, and gaining awareness of threats present ethical dilemmas and ask for reaction,

- identify and allow the emergence of new professions / occupations - field / education fields, focusing on cyber attacks from different angles – so-called cyber warrior expert.

Unethical behavior is difficult to isolate, because it is easy to spread. On issues related to ethics and cyberethics it is therefore possible to seek a solution through multidisciplinary cooperation. The reason is, that problems of ethics and cyberethics concern many areas - legal issues, management issues, education, health, cooperation among organizations and others at all society levels – international community, states, public and individuals.

4. Conclusion

The idea of freedom as absolute freedom to any act or action is ethically questionable and unacceptable. In the mankind history there stood always against each other those who wanted power to gain wealth, resources, territory and those who have faced these attacks and were forced to defend themselves. Over (in retrospect) cumbersome transfer and information retrieval, information flows were engaged people - the countries leaders, their "spies" traitors in their own ranks, the church, but also eg. birds, horses, etc. At present, it is enough to obtain and disseminate information on computer or mobile connections, or technology, such as drones. The more the society should be ready on the unethical behavior possibility and response. Preparation includes - plans, exercise / training, warning systems, communications systems, information and public education. For plans is essential the anticipation of possible unethical conduct and information accessibility, but also revealing the degree in which we are able to use the information in various situations. Of the many surveys is noticable that people (and sometimes other subjects) do not consider essential about these matters and are not acquainted with them or are not interested in them. The consequences are removed "ad hoc" according to the plans, which most people have never seen or never been aware of them. If moral standards are unclear or unenforceable, it brings some people to problematic behavior. It is therefore necessary to create an environment and conditions that allow to prevent unethical problems before they get out of control. Therefore, we consider as essential education, enlightenment and systematic informing people both in school and in the media, including the Internet and from the society's view, the use of technological tools available for the early detection and prevention unethical intentions. Great importance is the determination appropriate consequences for unethical acts actors.

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MULTICULTURAL WEB DESIGN: A REVIEW

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Keywords

Culture, Website, Webdesign, Website localization

Abstract

This paper presents a comprehensive view of the current state of website localization for different cultures. The main objective of this text is to review the literature focusing on the most prominent articles written on the topic. The literature overview was carried out on more than 60 articles found in the most important databases, nevertheless this paper considers on the most relevant studies. The aim of this study is to describe the present state of knowledge within this area, outline progression and current trends and consequently highlight the main research gaps to be further explored. Additionally the study includes a broader view on the topic combining the main methods with complex concept of culture. This seems to be indispensable for the proper cultural understanding and subsequent quality localization of a website.

1. General

Internet is a space with a great amount of data and potential information, which makes the websites the most important source of information for more and more people. Websites are thus nowadays the first and the most important place where users research any business and service. A large number of companies are no longer content with the local market. There is also an increasing necessity to get established on foreign markets. It appears that the most important cause of this phenomenon is increasing competition, which is connected with the pressure on decreasing prices. Under these circumstances the only method to keep the quality of service is to attain large volumes of sales. However this usually proves to be impossible to achieve on a small market.

Since the beginning of this millennium studies are concerned with the question of achieving successful transfer of the company and its brand to foreign cultures (or countries). With increasing role of globalization and rapid development of the Internet the importance of this issue increases. This article aims to examine the current state of knowledge in this field. Besides the literature overview, the outline of the main approaches, used in the context of our subject, comparison of the results and determination of current gaps in knowledge as well as main trends in the context of researched area are also part of this article.

2. Methodology

Current status within the study area was investigated through an extensive literature review. The most important studies based on a citation rate and relevance to the selected phrases were found. As the main database were selected Web of Science, Scopus, Proquest and Ebsco. This means that the search has been made over all important and reputable databases.

As the main search phrases were selected cultural adaptation + website, cultural differences + website, website + culture and ecommerce + culture. First articles were searched on the basis of these key phrases. Additionally, these articles were used as a source to find more major articles. More than 60 articles were thus searched and explored. Some of them concerned with the issue only marginally (eg. a primary focus on the cultural dimension, cultural differences or focus on different types of media), and others were too narrowly focused (e.g. the area of semiotics, development or UX). After filtering out these articles, there left over 20 relevant articles that show the current state of investigated field.

3. Multicultural web design

Question of website localization to the foreign culture is examined from many angles. The scope of science is of course also developing within time, ie. the first studies dealt with other issues than the current ones. In the following chapter we will try to introduce the problematics in a broader context and show that current issues have their continuities. This should give us enough information to describe the current state of the researched problematics, and simultaneously we will be able to point out existing gaps in knowledge.

3.1. Culture and fields of exploration of cultural differences

The world, environment in which we operate, communication, society and another phrase now so widely used, becoming increasingly connected with adjective global, international, intercultural, international, etc. These are nicknames that are associated with the interconnection of different areas, states or simply cultures. With an expanding international trade and cooperation between countries across the world can be since the second half of the last century observed efforts to define culture, respectively major cultural symbols and attempts to describe cultural differences in order to minimize misunderstanding in communication between partners from different cultural areas.

These efforts focused from the beginning primarily on topics actual for a given period. It is a whole range of themes that change over time. We can mention for example the article dealing with the difference of cultures and races and problematics of racism (Bock, 1957). Authors Stewart et al. (1967) examined the influence of culture on study results in secondary schools. Rosen (1955) studied the cultural differences in the context of health care. Tomeh (1970) examined the influence of culture on recognized moral values. Well known is study (Segall, et al., 1963), where the authors show different perception of geometric illusions among people from different cultures.

Differences in perception of color and optical illusion were also examined in study (Bornstein, 1973). Kobayashi (1980) dealt with the differences in advertising between the US and Japan. Differences in adolescent negotiations between the US, India and Argentina were studied in (Druckman et al., 1976). Ekman (1987) wrote about cultural differences of facial expressions of emotions. Henderson (1979) described the problems associated with cultural differences when doing business abroad. McGovern (1983) dealt with a different management style of American and Japanese managers. Differences in the management are also handled in article (Ashton, 1984).

Rodgers (1986) pointed out the possibility of using the knowledge of cultural differences as significant advantage in a highly competitive environment in the context of management, negotiation and decision making.

This short list of articles dealing with themes of cultural differences serve mainly the illustration of the fact that cultural differences is important issue and that they are the subject of interest to academics and experts from many fields of science. Every age has its phenomena, some issues are topical and more important than others. These cycles are naturally reflected in the texts that emerged at particular time. Even this is from the previous paragraph clearly visible. Thus, newer articles examine the impact of cultural differences in the context of the media, web design, or graphical user interface in general.

With the rapid development of the Internet since the end of the last century has increased the importance of the media to such an extent that nowadays it is practically the most important medium at all. The preceding paragraph is important also because it shows how broad and complex the culture is. There exist accredited ways to handle quickly and effectively with the problematics of culture and enable its comparison. It is necessity for a quantitative comparison of two cultures. However, it is important to remember that culture, ie. people, society, rituals, ethical values, etc. can not be completely narrowed to few dimensions. These dimensions, respectively. descriptions of culture based on the dimensions should be supplemented by qualitative analysis, which should aspire to illustrate the entire complex look at the culture.

3.2. Website localization

The influence of culture on the internet, respectively websites or web design began to be the subject of academic interest since the end of the last century. One of the first texts on this topic is the article (Marcus and Emilie, 2000) and Marcus (2003). The authors come with the question of cultural differences reflected in web design. They use Hofstede's cultural dimensions to answer this question. Based on the characteristics of Hofstede cultural dimension they try to identify the characteristics of website appropriate to cultural features. This started the first phase of research. The authors try to answer particularly the question whether the website is a culturally sensitive medium and if it is possible to explore cultural differences within the website. The main object of interest is the question of cultural sensitivity of website. Ie. whether websites vary across cultures, whether users from different cultures have different expectations and hence whether it is appropriate to adapt the site for different cultures.

Among the best works in this field belong articles of author Singh and his colleagues. Singh is interested in this issue for over a decade. Singh studies confirm the difference of websites from different cultures and simultaneously confirm that these websites reflect the values (mainly used Hofstede's cultural dimensions) of these cultures. There is obviously development in Singh’s studies and the results are continually improved and shifted up. From the beginning can we see the effort to verify the cultural sensitivity of websites and especially to create a framework that would assist with the localization of websites into different cultures.

Contribution of this author is especially in his comprehensive approach. His scope is not limited to comparison of two or three states. In his studies, for example Singh (2002), Singh (2003), Singh (2003b), Singh (2004) are sequentially compared cultures of more than 10 countries from three different continents. From his studies emerge a framework that provides a list of website elements which are connected with Hofstede's cultural dimensions. Thus they have partially defined reflection of Hofstede's cultural dimensions in websites produced in different cultures. As an example could be presented dimension of individualism, which should be reflected by these characteristics: emphasis on privacy, uniqueness and personalization. More specifically, for

example (Singh, 2003b) uses content analysis to explore the cultural values contained on the websites of the US, Germany and France. The subject of content analysis were 98 websites with an emphasis on 23 cultural categories in six cultural dimensions. The study confirms the cultural sensitivity of websites.

In a study (Singh, 2006), the author moves to investigate user perspective. The study investigates the influence of the cultural adaptation of a website to the level of satisfaction with the use of the site. The results confirm the important role of cultural adaptation from the user perspective. Study (Singh, 2009) offers a framework allowing to measure the degree of website localization. The authors propose framework based on four constructs: content localization, cultural customization, local gateways and translation quality. Thus, it offers an overlap and important perspective within a given topic. Study (Singh, 2013) specializes on B2B websites in the US and South Korea. The results of content analysis shows that the current state within the localization focuses almost exclusively on the mere translation of the website. The study therefore proposes a comprehensive framework for measuring the degree of localization. It includes context localization, content localization and cultural customization. Cultural localization is divided to the web page structure, graphics, colors and translation quality.

Study (Al-Badi et al., 2009) compares the possibilities of localization and internationalization. The result is a general framework for website localization, which unfortunately does not offer a more specific list of elements. The benefit of this study is that it shows how web design affects the rate at which the user is willing to use the web. The importance of proper user interface is confirmed also by other studies, e.g. (Evers and Day, 1997), (Davis, 1993).

Ahmed et al. (2009) provides instructions (simple framework) to create a website for culture with a high contextual level and high power distance.

Li et al. (2009) examined the influence of national cultural values on user acceptance of websites in the US and China. Users from these countries evaluated specific websites from both countries. The authors used TAM (Technology Acceptance Model) based on TRA (Theory of reasoned action). On that model the authors examined the influence of cultural values on the user acceptance of website. The results show the important role of cultural congruence of website with the culture.

Study (Karacay et al., 2010) is based on a content analysis of 88 companies from the USA and Turkey. Sites were examined with respect to the reflection of Hofstede and Hall cultural dimensions. Based on the literature review authors determined 14 website properties that correspond to the cultural dimensions. The results confirm the differences within websites corresponding to the cultural dimensions.

Vyncke and Brengman (2010) provide an overview of research of an efficiency and a quality of websites that correspond to a given culture. The study provides an overview of an entire decade of research on this issue. The results confirm the hypothesis that websites corresponding to a given culture are more effective than websites that ignore cultural values.

Study (Yalcin, 2011) contains slightly more specialized perspective of this issue. It addresses the issue of standardization versus localization. Specifically, the study focuses on the empirical verification of the extent to which companies from North America, Europe and Asia localize their website for Russia and Turkey. The results empirically confirm the intention of website localization.

Daryanto (2013) offers wider view on the problematics. The study uses the WAM (extension of TAM) and its use within the perception of a company in foreign environment. Study identifies a network of main points that interact with each other. Culture is a part of this network. Results

shows the importance of website localization, as well as entire approach of a company in the context of operation within a foreign culture.

Shneor (2012) provides information about an influences of the decision to create a localized website in a foreign country. It is thus an example of expanding view of our issue.

Study by Calabrese et al. (2014) shows the constant topicality of the examined subject. Results confirm that website is not culturally neutral medium and the website localization is one of the most important success factors.

Explored studies confirm the positive effect of website localization and indicate that the site is culturally sensitive medium. A more detailed comparison offers the following chapter.

4. Discussion

For clarity and the ability to draw results from the literature overview was drafted the following table. It clearly summarizes the most important of the described articles according to the importance for the possibility of analyzing the current situation and outlining future trends.

Study	**Methodology**	**Cultural dim.**	**Culture/county**	**Focus**	**Artefact**
Singh, 2002	Set of values by Pollay Content analysis	Hofstede	USA, Japan	Website elements and features	Framework to analyse the depiction of cultural values on the web
Singh, 2003a	Content analysis	Hofstede Hall	USA, China	Website elements and features	Framework + recommendations
Singh, 2003b	Content analysis	Hofstede Hall	USA, Germany, France	Website elements and features	Framework + recommendations
Singh, 2004	Content analysis	Hofstede	USA, Mexico	Website elements and features	Framework + recommendations
Singh, 2006	TAM , Questionnaire	Hofstede	USA, Japan, Germany, Brazil, Taiwan	--	Extended TAM model (Cultural Adaptation)
Ahmed et al., 2009	Content analysis	Hofstede, Hall	Malaysia, China	Website elements, website content	Specific guideline for w. localization
Al-Badi et al., 2009	TAM Literature overview	--	--	Factors affection website usability	Framework
Li et al., 2009	TAM, survey	Hofstede	USA, China	--	Model connecting Hofstede's c.d. and TAM
Singh, 2009	Content analysis	--	USA, Hispanic people	Website categories and features	Framework for measuring localization
Vyncke and Brengman, 2010	Literature overview WebQual	Hall, Hofstede	--	Comparison	W. localization concerning website efficiency
Karacay et al., 2010	Content analysis	Hofstede Hall	USA, Turkey	Website elements	Recommendation for w. localization
Yalcin, 2011	Content analysis	Hofstede Hall	Russsia, Turkey, USA, Europe, and Asia-Pacific	Website elements	Recommendation for w. localization
Daryanto, 2013	Questionnaire survey, TAM, WAM	--	UK, China	Factors affection website usability	Conceptual model
Singh, 2013	Content analysis	--	USA, South Korea	Website categories and features	B2B web site localization framework
Calabrese et al., 2014	Literature overview, Content analysis	Hofstede	Brazil, Portugal, Angola and Macanese people	Website elements	Framework for w. localization

Table 1: An overview of studies concerning the problematics of website localization

The table shows that analyzed studies agree in some aspects and differ in others. The most important aspects were used as parameters of the comparison (see a heading of the table). If we start with the methodology, we can find that most studies have used a content analysis or some form of a questionnaire in combination with statistical evaluation of data. Further studies often combine these methods with some already proven model that seek to expand on a surveyed issue. In terms of examining of the reflection of culture within a website is the most common approach a use of Hofstede's cultural dimensions. Some studies contain extension of Hall's dimensions.

Among the most frequently compared cultures or countries belong the United States and Asian countries. It is a logical approach because these cultures vary in a lot of aspects and thus can the differences can be well-presented. The most interesting results provide comparisons of the focus of studies and their results. The table shows that the authors principally concerned with two main issues. The first is how to create a website to suit a given culture - it is called website localization. The results of these articles are mostly some kind of recommendations or an attempt of framework that would facilitate localization. A part of these studies is a list of website elements corresponding to the cultural dimensions.

The second issue is a user perspective. For exploration of this question is used TAM model complemented by features allowing to investigate the influence of culture. There is also the third group, which is the smallest. This group includes mainly recent articles. The main issue of these articles is an effort to look at the culture in a wider context, these studies are not limited to the cultural dimension. If we take into account how complex culture is, it is very welcome approach. These articles try to foster the ideas from older studies. It is for example consideration of colors, structure of language, symbols, graphics, navigation models and so on. (Singh, 2003a) (Sing, 2004)

5. Conclusion

The results of the literature overview show that the problematics of localization and adaptation of websites for different countries and cultures is still a current topic. New studies dealing with the topic of optimal localization a website for different cultures are still written. It is important to realize that proper localization of website in its true sense does not lead only to the fact that the site will be translated and slightly adjusted, but also to the respect for the culture in its broadest sense possible. That means primarily respect for values, religious traditions and customs of the country and culture. Our main concern should not be strictly financial, but the ethical problematics of the field should be also taken in consideration. We can see a lot of ethical problems concerning this issue. The most important is the question of values. There are values that are common, but there are also values that differ a lot across cultures. Many of these values (mainly connected with religion and traditions) can not be included in any of cultural frameworks and therefore we should extend usage of pure cultural frameworks by general (at least) knowledge of the foreign culture.

The most important task now seems to be the development of a steady framework, which will be able to facilitate guidance on how to effectively localize a website for a different culture. This framework should ideally combine both of the aforementioned approaches (list of website elements and user perspective) and thus offer a comprehensive and coherent solution for this problematics. With the respect of the ethical view, this framework should be also supplemented by the third of the aforementioned attitudes. We should try to consider a culture in its broader context and try to grasp its qualitative aspects, which are not possible be taken in account with the quantitative approach.

Thus we will be able to create web sites that really resonate with the culture and will have the ability to reach users on the very basic level of their perception. There is consequently much higher chance to avoid any culture misunderstandings.

Another major trend is a further specialization of the subjects of research, which is mainly more detailed focus on the issue of localization in terms of individual countries, emphasis on specific business areas as well as linking the area to other scientific disciplines. This should lead to acknowledgment of other perspectives and to a greater degree of knowledge. In the future, this trend will certainly continue and new studies will pay attention to the fulfillment of scientific research in terms of specialization of the field.

6. Acknowledgement

This paper was prepared with the financial support of the research project VSE IGS F4/18/2014.

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EXPLANATION OF MULTIMEDIA COMMUNICATION USING CATWOE ANALYSIS

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Keywords

Soft systems methodology, CATWOE, Multimedia, Communication, Model, Education

Abstract

Multimedia are widely used communication tool with specific features. Multimedia communication, as a type that use them, should be deeper explained to achieve findings that make its user to be able to better design and analyze the communication. Findings from classic communication theories provide the framework for closer define of communication cases that are typical by a specific transmission element (medium). Effective way of this situation explanation is the use of conceptual model. Due to presence of human factor, it is suitable to use soft systems methodology and especially its method CATWOE, which identifies basic features and mechanisms from different participants' perspectives. This paper focuses on describing basic model of multimedia communication by said method. Created model will be usable tool for study multimedia communication and production, understand the ethical dimension and also for further research of the multimedia communication process.

1. Introduction

Multimedia are widely used communication elements in human activities and interactions like entertainment, advertising, art or informatics. Benefit of using multimedia came from its comprehensibility that arises from synergic effects of its elements if multimedia is proper used (Vaughan 2008). Classic example of this effect is combination of pictures and sound, which touches together two human senses. Another example is combination of picture and text, which is not such intensive like first example, but still more effective than a plain text. After digitalization of media tools and transmission techniques, the multimedia creation has become very accessible and its use has widened. In connection to these possibilities the demand for multimedia communication products and services has also raised. By this expansion, important topics and issues also have arisen like media literacy, education and ethics. These aspects of using multimedia make demand to multimedia literacy and education of both initiator and recipient of communication. They would ask how to use suitable tools for creating effective outputs and also how to resist persuading pressure of multimedia communication. This trend is confirmed by new study fields or whole new faculties in higher education. Elementary school level is also trying to establish media education as a part of actual study contents. Requirements of education are not only about skills of how to use the tools (how to design?). It is also about understanding the concept, the mechanism and the background to

be able to design the communication which meets its goals on one hand (how to design effectively? when is suitable to design specific kind of multimedia?). On the other hand, the aim is to be able to reveal communication tricks and to be prepared recipient of communication.

For better understanding of the multimedia communication as the process in social system we considered to describe it by methods of soft systems methodology. The reason was that it studies different participant perspectives, roles and context of social systems, worldview and superior influences in one to describe and enhance situation in real world by conceptual model. This paper shows specific application of CATWOE analysis on the multimedia communication process. Presented use of soft systems methodology is modified. It is because we do not work with real case on input but with conceptual findings that arisen from real cases, so we need to synthesize them into one model. Analysis is focused on its part systems thinking about real world (Checkland, Scholes 1990). Goal of the analysis is to make multimedia communication process model which makes this specific kind of communication more understandable. Main practical output of this work is to use the model for explaining the process, for optimization of creating multimedia communication and for teaching about the multimedia production. By knowing the concept and mechanics of multimedia communication we should design effective procedure to reach the communication goals without previously determined kind of multimedia. We should base on analysis, creative processes and project management and on the second stage add the specific multimedia tools and delivery systems. In use by recipient of communication, we can clearly identify, which communication should be constructed as overpromise or tinsel on the worthless thing.

2. Multimedia communication

The inputs of the analysis in this paper are models from classic transmission theories of communication. They have been choose by finding, that multimedia do not offer the possibility of change after release to communication space. Only change is possible by replacing multimedia content by new or within setting of media pre-defined interactivity. First two used are Shannon-Weavers' mathematical model (Shannon 1948) and Lasswell's model of communication (Lasswell 1971). These models identified basic elements, processes and relationships of the elements. By their findings, we can point out elements as communicator/source, message, medium, channel, receiver/destination, effect and the noise. Between these elements, there are processes of coding, transmission, decoding and reacting. Shannon-Weavers' model was primarily defined for measuring the information in hard systems but later it was developed and applied it in social systems by Schramm (Schramm 1954) or Berlo (Berlo 1960). Schramm's approach to communication brought the explanation that the transmission of the message is not made just by its contents or meaning, but also by its form. By previous findings we can derive that the message, medium and the channel are elements that are defining one complex communication tool, which will be further in this paper called media type or multimedia product. Jacobson's model of communication (Jakobson 1960) should be in some case remotely understood as the non-exact continue of ideas of communication noise brought by Shannon-Weaver's model. It pointed out context as another element of the communication process which affects interpretation/decoding of the message and by this also its creation/coding. By the context the meaning of the message should be fundamentally changed. In Schramm's model context was represented by personal features and knowledge. Modern communication studies are developing theories in more detail or specific approach focusing on social phenomenon like theory of gatekeepers (Shoemaker and Vos 2009) or the magic bullet theory (Berger 1995). These approaches can be mixed together during study of specific cases to get multidimensional perspectives (Craig 1999). New concept of communication

was presented as the transactional model of communication and it is still developed as the actual model of communication (Barnlund 2008). Innovation of this model is in understanding communication as the series of transactions (connected pieces) that are reacting on receiver's behavior and contrary communication and its transactions. In case of multimedia, application of this principle is limited. Multimedia used to communication between participants in different time or different place inhibits the possibility of instant transactions' reactions. They give the opportunity of communication but in limited conditions. Multimedia is also used in presence of both participants but in this case the limitations of transactional principle are based on their prefabrication that they cannot be changed instantly.

If we go back to multimedia communication analysis, the analysis of the models and theories defined that multimedia should be explained as the kind of multiple media holding the message and transmitting it in specific channel that as a whole makes effect on the receiver. For the purpose of this paper, multimedia is defined by the cognitive theory of multimedia learning (Mayer 2009) which is derived from the dual coding theory. In these findings multimedia are understood as the combination of pictures and text or narrations, that are oriented to pictorial and verbal human senses, working memory and knowledge, which all allow their integration, interpretation and understanding. Model of dual coding theory modified by cognitive theory of multimedia learning is shown in Figure 1.

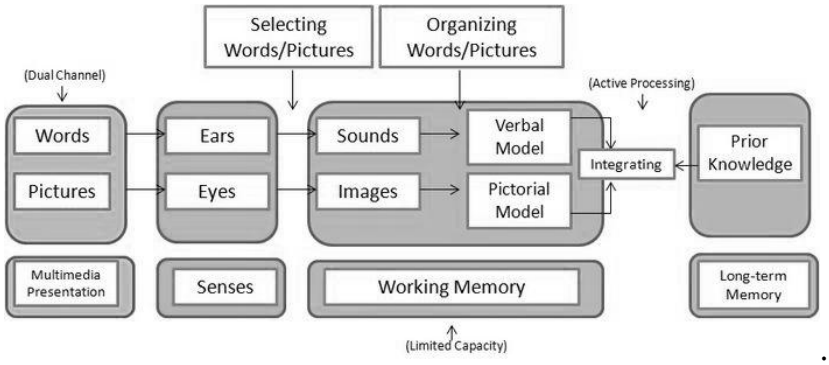

Figure 1: Cognitive Theory of Multimedia Learning (Mayer 2009)

Cognitive theory of multimedia learning defines three basic views to understand multimedia (delivery, presentation, sensor modalities). Delivery media view focuses on technical realization. Presentation modes view focuses of designing the content. Sensor modalities view is centered on target group and its cognitive processes. Each of these three views is reflected by different actors in the process of creating the communication and helps understand the roles and interests of actors in CATWOE analysis. Cognitive theory works with concept of cognitive capacity and load of target group/receiver that define the ability of each of the two channels to income the communication. Amount of load taken by the channel defines the used and resting cognitive capacity. In accordance to working memory and process of integration with prior knowledge, it describes if the communication makes the receiver active or passive. It means if he is just taking the contents from communication like it is or if he is enhancing or modifying it by his own imaginations or meanings. If we summarize the elements derived from multimedia communication definition, we have:

Elements

- communicator/source – will be split to initiator and provider
- message, medium, channel
- receiver/destination – target group

- effect
- noise, context

Transformations

- coding
- transmission
- decoding
- reacting

Environmental constraints

- message meaning is connected to form
- media views = approaches
- cognitive capacity = activity or passivity of reception

3. Soft systems methodology and CATWOE analysis

Mnemonic word CATWOE is the shortcut made from words defined in Soft systems methodology (Checkland, Scholes 1990) for naming the particles and principles of the system. Soft systems methodology in general is the framework for solving problems in systems with impact of human in real world. It consists of seven stage model, measures of performance and options how to make models of problem situations (systems). Methodology is suitable for analyzing and solving problems for the purpose of organization design or education. CATWOE is the method chronologically used in methodology after expressing the problem situation by the root definition to identify relevant system's conceptual model. Basic principle of the CATWOE is connection of transformation and weltanschaunung (worldview) followed by the rest elements. Letters in CATWOE mean:

- C: Client (victims or beneficiaries of transformation)
- A: Actor (those who do transformation)
- T: Transformation (the conversion of input to output)
- W: Weltanschaunung (the worldview which makes this transformation meaningful in context)
- O: Owner (those who could stop transformation)
- E: Environmental constraints (elements outside the system which it takes as given)

4. CATWOE analysis of multimedia communication

For now analysis is focused on the one way linear multimedia communication, which normally refers to video (motion picture and sound) or printed materials (combination of picture and text). This means we do not comprise interactive or non-linear multimedia communication that will be part of future analysis. Following the Soft systems methodology we mentioned the problem situation in the introduction of this paper. Once again our goal is to deeper understand the process and mechanisms of multimedia communication to gain ability of better teaching, optimizing or

revealing tricks or excessive persuasion in the process. Our root definition was formulated after more than three years of targeted observations focused on this problem. Observations were made in three different fields, where the multimedia communication is used. These sectors are commercial advertising (both small and big agencies), art (performances, scenography and intermedia installations) and generally beneficial aim of presentation of cultural heritage.

Root definition of our problem is:

Realizing communication targeted to specific recipient by use of multimedia made and delivered to recipient by professionals (educated persons) will help to meet initiators communication and superior chained goals. Goals of communication are transformed by creative and delivery service into appropriate set of media types (containing message, form and delivery procedure strategy). Set of media types is received by the recipient in conformity with his cognitive skills analyzed by professionals.

CATWOE analysis is then:

C: Client (victims or beneficiaries of transformation)

- Recipient / target group (is victim, who receive the communication and is prompted to reaction)
- Initiator (have the goal, which is met by the reaction of recipient to communication)

A: Actor (those who do transformation)

- Initiator
- Communicator/provider (advertising agency, freelancer or production group, who made the message to meet the goal)
- Mediator/provider (media agency, owner of media channel, who manage the transmission)
- Recipient

T: Transformation (the conversion of input to output)

- Initiators goals -> fulfilling the goals by recipients reaction

W: Weltanschaunung (the worldview which makes this transformation meaningful in context)

- Proper made content and form of communication persuade recipient to expected reaction

O: Owner (those who could stop transformation)

- Initiator
- Mediator/provider (in some cases can also stop the transformation)

E: Environmental constraints (elements outside the system which it takes as given)

- Initiators resources (he pays)
- Initiators communication limitations (corporate identity, cultural or art barriers, primary ideas of content)
- Accessible technology (media limitations)
- Positioning of communications on the market
- Political, economic, social, cultural context

- Habits and knowledge of target group

By the analysis we are able to form the model (in Figure 2) that shows the principles and connect processes of definition of communication goals, selection of creative and delivery services, designing the message and form into the set of deliverable media types, transmitting the media types, receiving of media types and reaction. Both communication theories and cognitive theory of multimedia learning define communication principles of transmission and form (delivery and presentation views). They can be in future considered as delivery and presentation systems. Sensor modalities or cognitive view from multimedia learning theory is represented in the communication content meaning and in the setup of whole process (goals, recipient's reaction, state of success). It is about goals and their reaching by initiator and actions he do or services he takes, so than about monitoring media type nature, monitoring process of delivery and reaction, defining the measures of performance and taking control actions. It can be in future considered as the directional or control system. CATWOE analysis showed and confirmed three perspectives and role of participants in them.

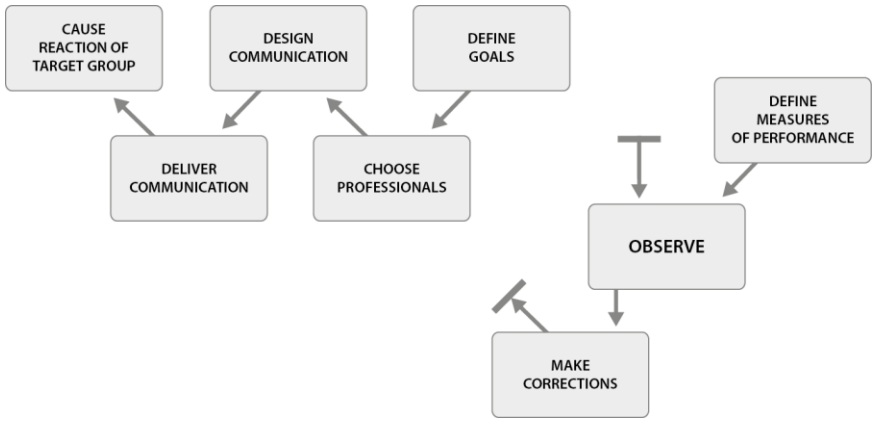

Figure 2: Operational model of multimedia communication

For further explanation of the multimedia communication process depicting connections with previously mentioned theories and observations from practice, we enhance the imaging procedure and form the operational model of multimedia communication in Figure 3. Figure is inspired by communication theories models and model of dual coding in cognitive theory of multimedia learning. For now there is excluded monitoring control system. In the figure, there are all three perspectives mentioned in layers of professional, multimedia product and recipient part. Initiator and recipient's reaction parts are defined only in way of directional perspective. Arrows show transformations (processes).

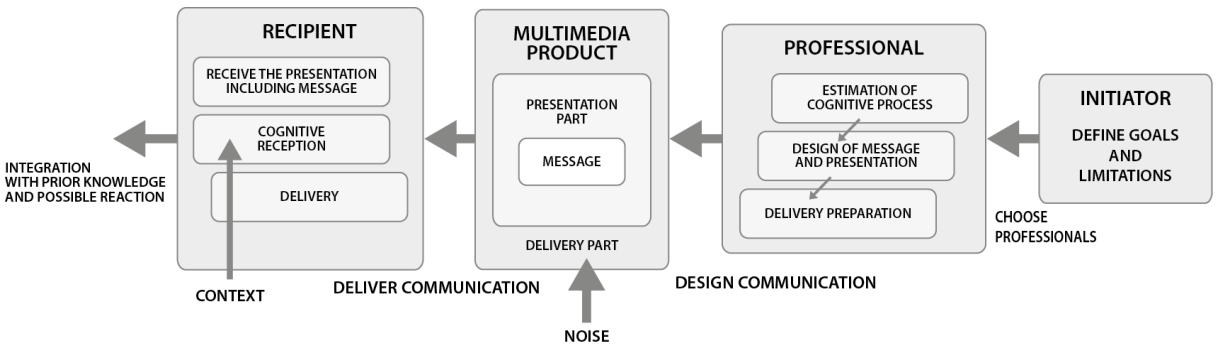

Figure 3: Enhanced operational model of multimedia communication

5. Discussion

Model depicted in Figure 3. shows that principles from the cognitive theory of multimedia learning stand in the significant place of the whole process and divide the multimedia communication perspectives. Cognitive abilities of recipient containing senses, prior knowledge, cognitive capacity, and ability of recognizing and integration pictures and narrations are the key step in decoding the delivered media type message. This indicates that the first guideline to design communication content during setting up the whole process goals is analysis of recipient's profile. In practice this is confirmed by using surveys, user experience testing, eye tracking, heat maps, neuro marketing and focus group methods before any content is designed. On the other hand, prior knowledge, focused on communication process parameters and production principles is the best defensive system to avoid unwanted persuasion. This competition of initiator and recipient of communication matches to popular principle of evolutionary arms race (Dawkis and Krebs 1979). Both subjects in communication process are enhancing its position by knowledge.

If we will try to relate the model to practice again, we find out, that commercial and art communications are at first very different, but after the analysis, we found, that in case of multimedia nature they are same. Different are just the goals. In case of commercial use goals of communication are connected with business plans. In case of art goals are about expressing ideas, reflection or asking new questions. This confirmation is connected with definition arisen from observations in different fields of multimedia communication use mentioned above. The difference in connection to the models and analysis findings is in prioritization of certain perspective (delivery, presentation, cognitive).

Both models depicted in Figure 2 and Figure 2. show specific features of multimedia communication in part of control system. Repair actions in phase of delivering (after release) are very limited. The multimedia content is standardly previously prepared on specialized equipment and is unable to naturally change or improvise. Its change or repair take time that should stops delivering or change the meaning of whole because of the noise in the content caused by modification and then disintegration. Other problematic factor would be change of context by the time of making corrections. By this, the phase of preparation is underlined as the key process, which needs a lot of insights to predict future situation to avoid bigger changes after the release of communication. Careful and conscious preparation in accordance to communication goals is then the key to success. From the communication recipient's point of view, there is an advantage in preparation demands. Recipient can act in this match just using his knowledge, which underlines the need of media literacy. Ethical issues caused by over pulled advertising would have lesser impact if the media literacy in society will be on higher level.

6. Conclusion

Model arisen from CATWOE analysis is showing the principles of multimedia communication in perspectives according to cognitive theory of multimedia learning. At this stage, it is useful for explanation and understanding how is basically designed the communication using multimedia in accordance to fulfil the communication goals. It is showing the importance of recipient analysis and careful preparation of the content (if the goal is communication effectivity). By this it is prepared for use in education for explanation of principles and correlations in the mechanism. Next planned steps of the research will be making model more detailed by studying the particular parameters of each element. These will be categories of communication goals, details of cognitive mechanism, design procedures and technical parameters from delivery systems affecting the design of

multimedia product. Next steps will be also integrating the non-linear and interactive media into the model to make it more universal. After integration of these it will open the possibility for detailed optimization of the production chain of multimedia communication by modelling the production process and study the inner principles that should be modified. Gained knowledge would also improve media education and make recipients more understanding and selective. These two effects are against each other. Who will gain the most in this will be organizations with generally beneficial aim like presentation of science or cultural heritage. Therefore outputs of these findings will be primarily used to develop methodology of multimedia presentation of cultural heritage (Vondra 2014).

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A MATH FOR INFORMATION ETHICS

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Keywords

Biased derivative, dynamical systems, information ethics, mathematical modelling, moral agents

Abstract

A new frame for mathematical modelling in field of information ethics is proposed. A concept of the so called biased derivative is introduced. It has a potential to investigate dynamical properties of information processing systems where rules of ethics are used.

1. Introduction

Information ethics is used as a general label to discuss issues regarding information (or data) confidentiality, reliability, quality, and usage (Floridi, 2008). There are attempts to introduce information ethics more formally (Bawden, 2014, Dodig--Crnkovic, 2006). Furthermore, the young generation prefers a new approach towards digital content (Sigmund, Pavlickova, 2015).

As known to the author, there does not exist an attempt to use formal tools of dynamic systems in information ethics modelling until now. In this paper, a basic mathematical concept is designed in order to model moral agents. For this purpose, a specific kind of derivative (so called biased derivative) is introduced and used. Motivation for using this kind of derivative is given by inherent part of these agents: a feedback path given by the moral--based information processing beyond the agent activities.

The paper is organized as follows. Section 2 introduces concept of moral agents. Section 3 explains, how the model method works. Section 4 presents a few illustration examples for being motivated in principles of moral agent modelling. In Section 5, the biased derivative as a specific tool given by subjective instants of moral agents is introduced. Mathematics of moral agent models is proposed in Section 6. Section 7 has illustrative character given by a simple case study.

2. Moral Agents

One of the valuable mainstream tools will be moral agents. These are single blocks having one input and one output. Agents process some information from related infosphere (information as the block input) to generate some other information (information as the block output) and, in so doing, affect related infosphere (Floridi, 2008). Agents carry out activities that are, in many aspects, information--intensive; and as part of living in this extraordinary network information environment,

they have begun to manifest many features and actions that are the domain of highly moral human beings.

There are two paths inside a single moral agent: feedforward path and moral path. The information input of the block is fed by the feedforward path to compare with the built in moral path values (reference) and the "difference" is fed to the block output. By comparing reference with input and using the difference as a mean of "control", the single moral agent tends to maintain a specific relationship between the input and the output of the agent.

3. The Model Method

It has always been the purpose of science to make models (Richalet, 1981). A mathematical theory which seeks to explain and to predict the events always deals with a simplified model, a mathematical model in which only things pertinent to the behaviour under consideration enter (Pierce, 1980).

The moral agents are considered to be mathematically modelled in the following. It enables to more understand their behaviour and to predict what their action will be, if submitted to a known stimulus. The simplest method for representing the behaviour of a dynamical system (or agent) is to mimic it with a mathematical description in the form of differential equation, for example: $Tdy/dt + y = Ku$, where u, y are the system input and output, respectively, and K,T are the significant structural parameters.

At beginning, the modelled system is excited to learn its behaviour. Immediately, two behaviours will be compared, that of the real system and that of the mathematical representation, the model. If the behaviour of the real system and the model is equal, for example, responses to the known stimulus are the same, it is possible to state that a model of the real system is identified. Note that this procedure is indeed that of experimental science advocated by G. Galilei providing a "closed loop" experimental discovery opposed to the deductive path of mathematics. Unfortunately, real systems are not so simple to totally encompass them by a mathematical description. Therefore, models mostly tend towards a similarity of behaviour with real systems being represented.

4. On Models of Moral Agents

Our experience indicates that the behaviour of actual human moral beings is neither as determined as that of the economic man nor as simply random as the throw of a die or as the drawing of balls from a mixture of black and white balls (Pierce, 1980).

Due to their information--intensive activities, moral agents have an inherent tendency to evolve over time. Hence, they can be thought of as a dynamical system (Sheinerman, 1996). When growing, dynamic systems self-enhance the initial deviation from the mean. Output of moral agents grows since attracted by input information similarly as cities grow since they attract more people. Based on intensity of moral path values, self-enhancing processes evoke inhibiting reactions similarly as the increasing noise and traffic may discourage people from moving into a growing city. Furthermore, if the moral reaction follows with some delay, the self-enhancing reaction can cause an overshoot.

Imagine the functioning of a moral agent by the sand dune paradox. Naively, one would expect that the wind in the desert (feedforward path) causes a structureless distribution of the sand. However, wind, sand and surface structure together represent an unstable system where dunes are formed.

Sand accumulates behind the wind shelter. Dune begins to grow increasing the wind shelter which self-enhances the deposition of sand. But the sand, once settled in the dune, cannot participate in dune formation. Hence, the inhibiting reaction results from removal of sand able to participate in dune grow. In this way, the growth of dunes is reduced. This leads to stable dune patterns (Meinhardt, 2003).

The model scheme of a moral agent is composed of an activator and an inhibitor part. The activator represents the self-enhancing (native) "substance" of the agent whilst the inhibitor relates to the inhibiting (moral) activity. The concentration of both parts participates in a steady state as well as the stable behaviour requires specific inhibiting reactions.

5. The Biased Derivative

Describing mathematical dynamical systems include a function (i.e. a rule) which tells, given the current output, what the output of the system will be in the next instant of time. Typically, it is provided by equations which contain derivatives such as $Tdy/dt + y = Ku$. Here, derivative is defined by the ratio $dy/dt = [y(t + \Delta t) - y(t)] /\Delta t$ for an infinitesimally small Δt. I. Newton called it fluxion.

Moral values are connected with entities such as feeling, emotion, illusion which concern a piece of fantasy to the actual value y(t). It becomes biased. The latter is reflected in "egofluxion" or biased derivative, algebraically

$$d\hat{y}/dt = [y(t + \Delta t) - (1 - \varepsilon \Delta t)\, y(t)] /\Delta t, \qquad (1)$$

where ε is a moral coefficient given by the subjective feelings, emotions, illusions … It results in a bias of the derivative. If positive, then the derivative tends to be overestimated, if negative, then the derivative tends to be underestimated, if zero, then biased derivative becomes the ordinary one, if proportional to y(t), then the derivative can tend to create bubbles, if proportional to square of y(t), then the derivative can tend to have chaotic behaviour.

In normal society development, fluxions and egofluxions are mixed to reproduce a given structure faithfully. The diversity in egofluxions indicates that it is possible to modify the society pattern deeply. By other words, society allows to play.

6. Mathematics for Moral Agents

Due to the difficulty of understanding dynamical systems, a relative simple model will be studied in the following. An inherent inhibiting property of biased derivative is given by the following theorem.

Theorem: If ordinary derivative dy/dt is known, then biased derivative $d\hat{y}/dt$ is determined by

$$d\hat{y}/dt = dy/dt + \varepsilon\, y(t). \qquad (2)$$

Proof of this rule is given by a simple rearrangement of (1). By the method of (2), differential equation $Tdy/dt + y=Ku$ is represented in the form of $d\hat{y}/dt = Ku/T$, where $\varepsilon=1/T$. It well illustrates the concept of biased derivative since response to a unit step input is $y(t) = K(1 - e\text{-}t/T)$ for the zero initial condition $y(0)=0$ and $t \geq 0$. It results in a self-regulating system in which inhibiting ("moral") mechanism is automatically included.

Concept of biased derivative, among others, covers self-regulating scheme of known logistic equations and predator-prey interactions. Logistic equations are the most popular models for the

concept of saturation in grow of population y(t) with the carrying capacity K and multiplicative factor σ. They are expressed by $dy/dt = \sigma y (1-y/K)$. The latter becomes $d\hat{y}/dt = -\sigma y2/K$ by a use of biased derivative, where $\varepsilon = -\sigma$.

Similarly, consider the set of coupled double population y1,y2 equations of the form (Kahn, 1990) $dy1/dt = \varepsilon 1\ y1 - \gamma 1\ y1\ y2$, $dy2/dt = -\varepsilon 2\ y2 + \gamma 2\ y1\ y2$, where ε1, ε2, γ1, γ2 are multiplicative factors. With a use of biased derivatives it follows that $d\hat{y}1/dt = -\gamma 1\ y1\ y2$ and $d\hat{y}2/dt = \gamma 2\ y1\ y2$, where $\varepsilon = -\varepsilon 1$ (first equation) and $\varepsilon = \varepsilon 2$ (second equation).

As for moral agents, it is useful to arrange the feedforward and moral paths of input processing according to their effects and to combine moral agent block factors to an equation. Based on the inherent moral tendency of agents to inhibit, the combination leads to input--output relationship of the form

$$d\hat{y}/dt = f(u), \qquad (3)$$

where f denotes a function of the input. In the single linear form, the model becomes $d\hat{y}/dt = Ku$, with constant K in a role of moral agent "gain". A more complex form of moral agents is expressed by $d\hat{y}/dt = f(y,u)$ where the function f includes two independent variables.

7. A Case Study

Naturally, every society creates chains of variable length, which are difficult to predict. Biased derivatives are aimed at indexing society processes that are inherently unpredictable. Their indexing (or simply constructing (ε,K) graphs) helps to measure effects of rational/irrational decisions in order to model movement of societies, for example. It is based on the fact that the moral path of an agent is associated with irrational activity in a subjective measure. A self-regulating force is needed, for example, in uploading some "free" however copyrighted information when does not realize it. An opportunity to get or to keep an employment can inhibit moral effects of normally moral agents or groups of them for a short time (Ariely, 2008).

The latter book describes experimental research results which will be identified with models of the form (3) in the following. A control group of students was asked to find twins having sum equal just to 10 in a set of number series and to record time spent with searching. An example of such number series is represented by 1.69, 1.82, 2.91, 4.67, 4.81, 3.05, 5.82, 5.06, 4.28, 6.36, 5.19, 4.57.

Suppose searching of 10 twins. Whilst the control group is continuously supervised in their searches, another groups are not supervised. Unsupervised groups tend to overestimate results. They recorded 1.32 times faster time of twin searches in average. It indicates two dynamical models of the form $d\hat{y}/dt = 10u$, first with $\varepsilon=1$ and the second model with $\varepsilon = 1.32$. Unit step responses of these models are in the following Figure. Faster curve represents less moral unsupervised agents. Indeed, no supervision leads to less moral behaviour of agents (Ariely, 2008).

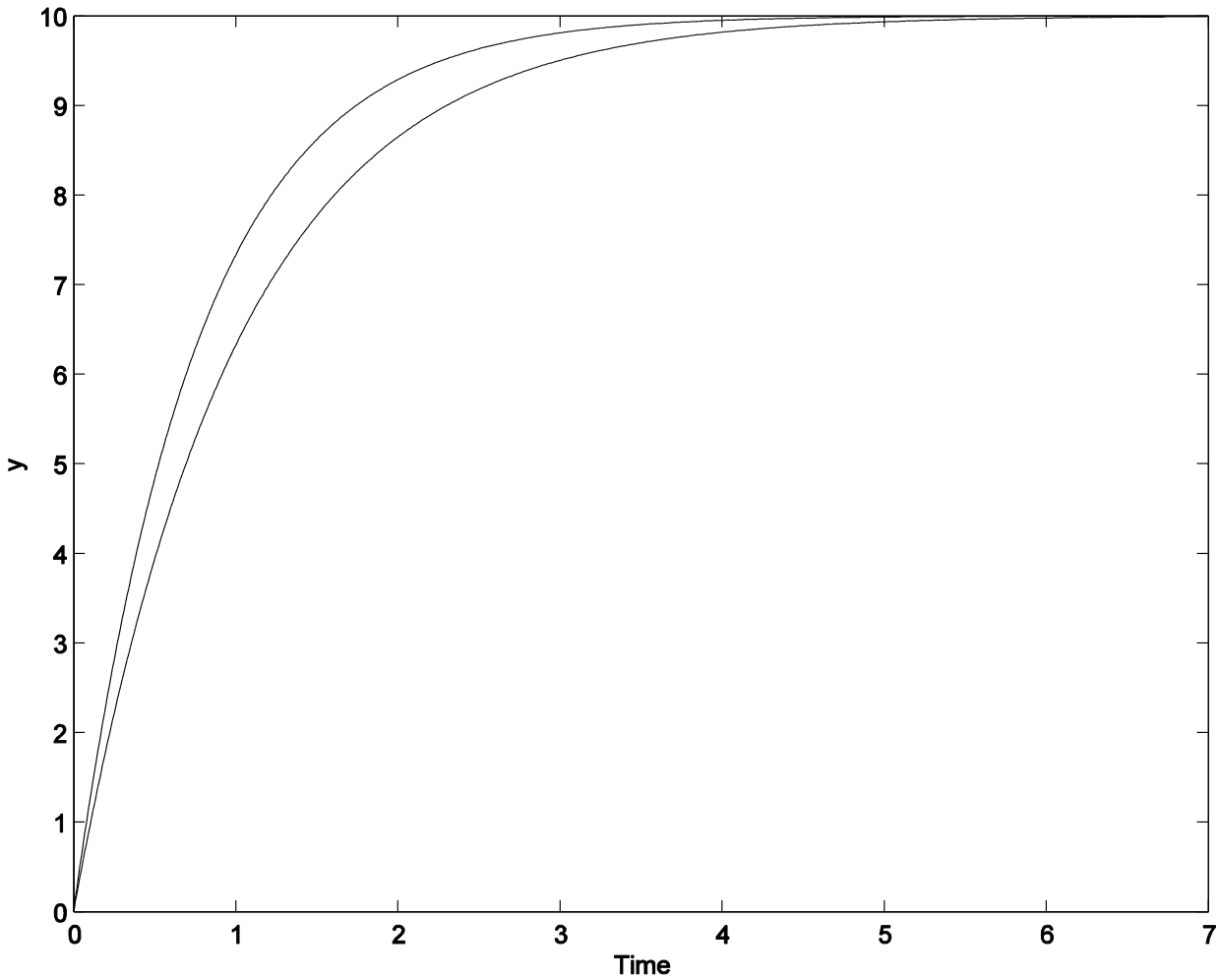

Figure 1 Unit step responses

8. Conclusion

In this paper a specific kind of derivative is used to describe dynamic properties of moral agents. Simple equations applied this derivative are introduced and used. They allow to model moral agents and to investigate their dynamic behaviour. A simple case study is added. It illustrates basic idea of method, which is proposed.

Information processing and namely processing of information content in societies have dynamic background. The latter is associated with gains and time delays which would lead to unstable behaviour or to chaotic oscillations. In this paper, a first attempt is realized how to better understand information and moral processes in societies.

Main contribution is twofold. First, the frame for mathematical modelling of processes connected with information ethics is given. Biased derivatives serve the description of moral agent dynamics. Second, a way for indexing information ethics in societies is opened. Without information ethics-based mathematical models, understanding of moral facts in general would be less complete.

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THE HISTORY OF COMPUTER ETHICS AND ITS FUTURE CHALLENGES

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Keywords

Computer ethics, Information Ethics, virtual personal assistants, Internet of Things, Linked Data, Big Data, virtual currencies, Bitcoin.

Abstract

This paper presents an overview of the history of computer ethics, a discipline that has been in existence for more than a half century and which is now experiencing exponential growth, and a few predictions concerning the ethical issues of forthcoming computer technology. The paper begins with the ethical issues introduced in Cybernetics by N. Wiener, then describes the so called the First and the Second Generation of Computer Ethics, the "uniqueness debate" of the late1980s, the Górniak Hypothesis and the Johnson Hypothesis. The paper also provides a short description of the ethics of the process of the development of information systems and project management. A basic overview of Information Ethics theory, which purports to be the general foundation of computer ethics, is included. The last part of the paper lists a few new and potentially ethically questionable areas: Internet of things, new sensors and devices, virtual crypto-currencies, linking data, and advanced artificial intelligence.

1. Introduction

Computer ethics is a new discipline and it may be considered premature to discuss its history. But a close look reveals that its history, which has lasted for more than a half century, is not only inspiring but also provides the necessary foundations for dealing with the present and forthcoming ethical issues of computer technology. We follow in the footsteps of Rogerson and Bynum (1996) who tried to summarize the development of information ethics from the mid 1970s to the 1990s. They believed that it was possible to identify "two generations" of information ethics: the first started in the 1970s when Walter Manes coined the term "computer ethics", and the second began in the mid 1990s when the first efforts to elaborate on the conceptual foundation of information ethics emerged.

Bynum (2000, 2008, 2014) later localized the beginnings of computer ethics to much earlier, to the years just after the World War II and he connected them to works of American scholar Norbert Wiener. Norbert Wiener did not use the terms "computer ethics" or "information ethics" but his ideas were very influential in later development of information ethics.

The rest of the paper is organized as follows: Section 2 provides a basic characterization of the ethical issues analyzed in *Cybernetics* of N. Wiener. Section 3 describes so called the First Generation of Computer Ethics – it summarizes the pioneering works of W. Maner and J. Weizenbaum and several other important figures. Section 4 describes the so-called the Second Generation of Computer Ethics – it describes D. Johnson's textbook *Computer Ethics* and the beginning of the "uniqueness debate". Section 5 provides an overview of the Górniak and Johnson Hypothesis. Section 6 deals with the introduction of ethics to the process of the development of information systems and project management. Section 7 provides a description of the *Information Ethics* theory of L. Floridi. Finally Section 8 discusses the future of computer ethics and the ethical problems linked to forthcoming technological innovations. Section 9 provides conclusion and acknowledgements.

2. Norbert Wiener and Cybernetics

There is no exact date for the foundation of computer ethics. However, Bynum (2000) believes that computer ethics as a field of study was founded by Norbert Wiener during World War II while he participated on the development of antiaircraft cannon. The need for the implementation of feedback loops between the part of the system that tracked the aircraft and the part of the system that fired the shells required specific scientific challenges. These challenges later led to development of a new science dubbed "cybernetics" by Wiener. This new science dealt with information feedback systems and relied on inspiration from animals or living organisms.

In Wiener's (1948, p. 28) first book, *Cybernetics* (which deals mainly with technical aspects of cybernetics), he is clearly already aware of the ethical importance of this new discipline. Later, when he wrote the book *The Human Use of Human Beings* (Wiener, 1950, 1954) his writing was completely devoted to the ethical issues of new technology and applied ethics were framed in discussion of a number general ethical questions concerning issues like the purpose of human life or justice. Similar topics were also analyzed in his later book *God and Golem, Inc.* (Wiener, 1963), which also includes discussion of computer security, artificial intelligence, and robotics. Bynum (2014) points out that this book also presents the first discussion of the relation of information technology to the social environment. It deals with issues connected to unemployment, religion, globalization, teleworking, virtual communities, and enhancing of human bodies with computer technology.

3. The First Generation of Computer Ethics

The term "computer ethics" was coined decades after Wiener's pioneering work. Walter Maner created the term to refer to a specific branch of applied ethics focusing on ethical problems created, transformed, or exacerbated by computers or computer technology. He was the first to develop and present university courses that dealt with this topic, as well as publishing many relevant materials and documents that influenced the subseuent development of computer ethics as an academic discipline (Maner, 1980).

Rogerson and Bynum (1996) identify Joseph Weizenbaum as another key thinker who is considered to be part of the first generation of the computer ethics movement. Weizenbaum (1976) suggested that there should be some strict limits to the computerization of human life. He considered such limits to be necessary in order to protect important social values form the negative influence of computer and information technology. Bynum (2000) points out some specific examples of such relations between individuals and computers that had already been documented in

the 1970s: at MIT some students and staff became emotionally involved with a computer and shared their intimate thoughts with it. This was connected to experiments with computerized Rogerian psychotherapy performed by a computer program called ELIZA, which was created by Weizenbaum (1966). Some scientists became convinced that computers coul replace humans in psychotherapy and there is still ongoing research about such a possibility with some researchers continuing to suggest it as viable alternative (see Plutchik and Karasu, 1991). This implies that the ethical questions raised by Weizenbaum's research are still important today.

Bynum (2000) also observes that during the 1970s the first instances of computer crime occurred and the invasion of privacy by electronic technology became a public worry. This led Donn Parker to work on a specific ethical code, which was adopted in 1973 by the Association for Computing Machinery and later updated several times (ACM, 1992). The experiences from developing the ethics code for the Association for Computing Machinery were later summarized in a volume edited by Parker, Swope and Baker (1990).

4. The Second Generation of Computer Ethics

During the 1980s several influential publications in the field of computer ethics appeared. Deborah Johnson published the first major textbook on the topic, entitled *Computer Ethics* (Johnson, 1985). The book deals with the problems related to the ownership of software and intellectual property, questions concerning privacy, the responsibilities of computer professionals, and issues related to the fairness of the distribution of resources. Revised editions (Johnson, 1994, 2001) added discussion of topics such as computer technology and politics, hacking, and use of computers by people with disabilities.

The late 1980s are also marked by the beginning of the “uniqueness debate”. Maner suggested and still defends (Maner, 1996) the idea that computer ethics is a specific and autonomous academic discipline dealing with specific issues connected to computer technology. From this point of view, computer technology created ethically unique problems that have no correlation in thehistory of ethics. Johnson, on the other hand, maintained that while computer technology presents new ethical challenges and problems, these problems are new versions of standard moral problems and moral dilemmas. While computer technology may exacerbate traditional ethical problems or present them in new context, they are merely the disguised classical problems of ownership, power, responsibility and privacy.

Maner's work inspired many followers including Terrell Ward Bynum who also later developed a university course and became editor of a special issue of the journal *Metaphilosophy*, entitled *Computers and Ethics*. Perhaps the most influential article in this issue was written by James H. Moor and is entitled *What is Computer Ethics* (Moor, 1985). Bynum also published a number of articles describing historical development and the specific issues of computer ethics (Bynum, 1999, 2000, 2008, 2014).

5. Górniak and Johnson Hypothesis

In the mid 1990s Krystyna Górniak-Kocikowska (1996) presented a theory (“Górniak Hypothesis”, see Bynum 2000) that developed Maner's idea even further, arguing that computer ethics is now just a brand of applied ethics will become universally applicable to the global ethical system. Górniak-Kocikowska believes that major historical ethical systems like Bentham's and Kant's were developed as a response to major technological innovations but were limited by their foundation in

their local cultural context. Computer ethics developed as response to the computer revolution, but because this revolution has global character computer ethics is also going to have global character.

Johnson (1999) argues for the opposite prediction ("Johnson Hypothesis"), which is that the computer revolution will not lead to the creation of new universal ethical system which would replace Bentham's or Kant's but that computer ethics will continue to develop as a specific branch of applied ethics while still remaining on the foundation of general ethics and its systems.

A different point of view was presented by Donald Gotterbarn (1991, 2001), who states that computer ethics should be primarily understood as professional ethics focusing on developing codes as well as the standards of ethics for computer professionals and specialists.Similarly, Walsham (1996) claims that traditional ethical systems and mainstream research in ethics will still provide necessary foundation for research on the ethical issues of information technology. He describes ethical theories drawn from philosophic literature and uses these theories to critique aspects of the ACM Code of Ethics (1992).

Many authors agree that since the 1980s the field of computer ethics has experienced exponential growth (Kenneth and Herman, 2008, p. 39). In 1987 the Research Center on Computing and Society (RCCS) at the Southern Connecticut State University was created and in the late 1990s the Software Engineering Ethics Research Institute (SEERI) at East Tennessee State University was established. Additionally, several conferences on computer ethics were organized during this time.

6. Information Systems Development and Project Management

Rogerson and Bynum (1996) also mention the introduction of ethics to process of development of information systems and project management. They propose moving from a "techno-economic" view to a "techno-socio-economic" approach for project management and this view is shared by several other authors (Avison 1995, Wood-Harper et al. 1995) who analyzed existing development methodologies which propose more ethically responsible approaches to decision making, which in turn is inspired by Aristotelian theory (Rogerson and Bynum 1995).

In an effort to alleviate the deficiencies of traditional methodologies a few proposal have been made (see Checkland 1981, Avison and Wood-Harper 1990). The most notable of these was the ETHICS methodology developed by Mumford (1983a, 1983b). Mumford emphasises the importance of job satisfaction that can be derived from the five fundamental fields of needs for an employee: knowledge (learning new things), psychological (need for recognition), efficiency (need for support and control), ethical (fairness), and task structure. The needs of the employee and the needs of the employer should, in the end, be equally satisfied.

7. Information Ethics

Floridi (1999) claims that standard ethical theories cannot be adapted to deal with the problems of computer ethics because computer ethics requires a conceptual foundation as an ethical theory. He therefore advances the development of *Information Ethics* to be understood as the philosophical foundational counterpart of computer ethics. The fundamental moral question of *Information Ethics* is "What is good for an information entity and the infosphere in general?" Floridi argues that apart from traditional elementary ethical concepts such as life or pain there is also something even more fundamental: being understood as information. This places information entity to the center of moral discourse and makes it an object of recognition that presupposes any necessary regulation to any morally legitimate action.

Floridi (1999) formulates the following fundamental principles and concepts of Information Ethics: 1) Uniformity of becoming – all processes, operations, actions and events can be treated as information processes. 2) Reflexivity of the information process – any information process necessarily generates a trail of information. 3) Inevitability of the information process – absence of information is also an information process. 4) Uniformity of being – an entity is a consistent packet of information. 5) Uniformity of agency – an agent is defined as an entity capable of producing information phenomena that can affect the infosphere. 6) Uniformity of non-being – non-being is an absence or negation of any information. 7) Uniformity of environment – the infosphere is the environment constituted by the totality of information entities.

Floridi (1999) also defines 27 fundamental information properties of the infosphere, providing regionalization of the infosphere. Based on this foundation he proposes the four moral laws of Information Ethics: 1) Entropy ought not to be caused in the infosphere (null law). 2) Entropy ought to be prevented in the infosphere. 3) Entropy ought to be removed from the infosphere. 4)Information welfare ought to be promoted by extending (information quantity), improving (information quality) and enriching (information variety) in the infosphere.

Furthermore, Floridi (2008) later developed the RPT model (resource-product-target) that explains the "life of information" and therefore provides important moral implications for any moral agent.

8. Future of Computer Ethics

Contemporary computer ethics deals with traditional themes such as computer crime, privacy and anonymity, freedom, intellectual property, professional responsibility, and globalization in relation to new ethical issues. Technological development leads to a) new problems in mentioned areas and b) completely new types of problems. Technological innovation usually presents ethical questions not in just one but in several areas. It is also possible to distinguish between a) issues of computer ethics in the traditional sense of the term, as they relate to interaction of men and computer, and b) issues related to computer based devices, new peripherals, wearable computers, robotics, etc.

We present a list of issues which is not to be considered to be exhaustive, but which emphasizes problems that we believe to be the starting points of the future research efforts in the field of computer ethics.

8.1. Internet of things, new sensors and devices

Some of the new ethical considerations are linked to the *Internet of Things* (IoT) initiative that advances the idea of the universal addressability of physical things and of connecting most of them to the Internet. Van Kranenburg and Bassi (2012) claim that the challenges posed by *Internet of Things* are impossible to manage with the existing policy tools and research programs, as these are too slow and too instrumental. Similarly Popescul and Georgescu (2014) emphasize the ethical issues of IoT related to the sensitivity of transmitted data, information and knowledge. Closely related to the IoT initiative is the wide usage of sensory devices. Electronic sensor systems (cameras, passive infrared detectors, etc.) are relatively common in security systems, however for a long time these were not connected to Internet or other networks.

We can distinguish between 1) static sensory devices, which are installed on a fixed location and 2) mobile sensory devices, which are personal devices that move together with the user. We can also distinguish sensors for 1) location / position (GPS etc.), 2) environment (video / audio, weather, temperature, light conditions etc.), and 3) health and biometric data.

Alongside traditional sensors there are new types of network connected sensory devices installed even into living rooms - e.g. Microsoft Kinect. The widespread availability of these devices raised new questions concerning privacy. Sottek (2013) even compared them to Orwell's Telescreen from the novel *Nineteen Eighty-Four*. On the other hand, there are works like that of Zhang et. al. (2012) that proposes a new privacy using an automatic fall detection method which would facilitate the independence of older adults living in the community.

There is also a growing number of new mobile / wearable sensory devices and most of them are somehow connected to internet, either directly or via a networked mobile phone or personal computer. These wearable sensory devices register health related and biometric data (e.g. a growing number of "fitness bands"), or they continuously capture audiovisual data like Google glass or "action cameras".

Related to the new sensors is the new hardware and issues of robotics. One of the most discussed contemporary issues is the emerging technology of drones. The majority of ethical research relates to military use of drones. For example Brunstetter and Braun (2011) analyze the use of drones in the context of the "just war" tradition for their foundation. Coeckelbergh (2013) analyzes that drone warfare not only creates physical distance, but also moral distance that makes it easier to kill one's opponent. Civil use of drones haven't been ethically analyzed as complexly.

8.2. Virtual crypto-currencies

Emerging virtual currencies like Bitcoin also present unexplored ethical issues. Krugman (2013) charges this entire payment system with being "evil". Angel and McCabe (2014) compare forms of payment – paper, plastic, and virtual currencies – and conclude that there is often an asymmetric power relationship between payer and payee and question the fairness of these forms of payment. Payment tools as such are in their view ethically neutral, but can be used in an ethical or unethical manner.

Bergstra and Leeuw (2013) go beyond Bitcoin in their analysis. They classify Bitcoin as technical informational money (TIM) and explore a more extreme notion of informational money that may be developed: exclusively informational money (EXIM). They present a thought experiment that contemplates Bitguilder, a hypothetical copy of Bitcoin that qualifies as an EXIM. Their paper also provides a business ethics analysis of Bitcoin and it reveals a number of issues.

8.3. Linking data and advanced artificial intelligence

There are also ethical challenges related to the *Linked Data* initiative that purports to publish structured data in a standardized format that can be interlinked and utilized with common web technologies and ultimately made standard like HTTP, URI or RDF. This initiative is related to the concept of *Big Data* (technologies developed to deal with extremely huge amounts of data) and advances in machine learning algorithms. Complex ethical research in this area is still lacking.

Related to the growing amounts of data available online and linked together in the cloud is the renewed focus on artificial intelligence and the increasing awareness of its possible ethical issues. Astrophysicist Stephen Hawking famously stated that "the development of full artificial intelligence could spell the end of the human race," and similarly the business executives such as E. Musk from Tesla Corp. or B. Gates, the founder of Microsoft, consider artificial intelligence a threat. J. Tallinn from the Centre for the Study of Existential Risk and the Future of Life Institute considers contemporary artificial intelligence unlikely to pose a threat, but future systems called *artificial superintelligence* may present considerable danger. (Greenwald, 2015)

Artificial intelligence systems like Amazon's Alexa, IBM's Watson and Google Brain, are just few of these emerging systems that combine cloud technology, vast amounts of data, and advanced machine-learning algorithms. The introduction of virtual "personal assistants" in the form of software embedded in mobile phones (e.g. Apple Siri, Microsoft Cortana, Google Now) presents substantial technological innovations but also implies severe ethical questions. Some of the potential issues like the infringement of rights of people who were used as the models for virtual personalities were discussed by Wassom (2014). But there also ethical problems related to the cloud based nature of these services: each user interaction is sent to the central computing hub of the provider, analyzed, and results or responses are sent back to the device. Such architecture presents considerable privacy and security risks, however proper ethical analysis and assessment has not been yet made.

9. Conclusion

Why do we need computer ethics? Computer ethics facilitates discussion about contemporary ethical issues that cannot be solved easily within existing ethical theory but which are still important for the everyday lives of computer users. Such discussion may result in the formulation of ethics codes that present voluntarily and widely accepted regulatory principles, or may even lead to new laws that embody what is ethically important.

As a starting point for such discussions the presented paper provides an overview of the history of computer ethics, a discipline lasting for more than a half century, which is now experiencing exponential growth, and a few predictions concerning the ethical issues of forthcoming computer technology. We mentioned the ethical issues first introduced in *Cybernetics* by N. Wiener, then we described the so called the First and the Second Generation of Computer Ethics, the "uniqueness debate", the Górniak and Johnson Hypothesis, and the introduction of ethics to the process of the development of information systems and project management. We also provided a basic overview of the *Information Ethics* theory of L. Floridi. The final Section focused on the future of computer ethics and established the basis for our future work.

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SESSION H: CORPORATE PERFORMANCE MANAGEMENT

FACTORS INFLUENCING DESIGN AND OUTCOMES OF PERFORMANCE MANAGEMENT SYSTEMS

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Keywords

Performance Management, Performance Measurement, Management Control Systems, Management Accounting, Contingency Theory, Intangibles.

Abstract

Performance Management Systems (PMS) – also termed as Business Performance Management (BPM), Corporate Performance Management (CPM) or Enterprise Performance Management (EPM) – represents an often topic of debate in academic journals. The literature consists of two highly overlapping categories of research. The first category is research on Performance Measurement, which primarily addresses the question of appropriate measurement how company proceeds towards its performance goals. The second stream of research deals with Management Control Systems (MCS) and focuses more on the purpose of performance measurement and its specific context. The aim of this article is to address the following three basic research questions that each scholar starting research in PMS has to answer. Namely these are: RQ1. How to define contemporary PMS? RQ2. What are the key factors that influence the design and outcomes of PMS? RQ3. Which methods best reflect the interdependences among factors, PMS and performance?

The article reveals that despite 50 years of research, the terminological inconsistencies persist involving the definition of the term PMS itself, its subcategories and last but not least the list of factors with impact on PMS. These contingency factors are briefly introduced and the final framework mapping their relationships is presented as well. Because traditional statistical methods coping with the standalone relationship are not sufficient, the quantitative studies in the intertwined nature of contingency factors, PMS and its outcomes usually employ the technique of Structural Equation Modelling (SEM), which represents the answer to the third research question.

1. Introduction

It is evident in all sectors of industry and commerce that some companies outperform the other ones. "Business performance was explained by factors of industry structure and the conduct of firms within the industry." (Pettigrew et al. 2002, p. 462). It means that sustainable competitive advantage, as the source of outstanding performance, was supposed to lie in positioning a company and its products on the market, because all companies were assumed to be similar inside. The change in strategic thinking came with resource based theory in mid 1980s. This approach to

strategic thinking emphasizes the internal resources and distinctive firm capabilities that determine how effectively the firm can compete with its competitors not only in the same, but even in different industries.

Barney (2007), big advocate of resource based theory, draws distinction between real resources and second-order (usually intangible) resources that serve as a catalyst and intensify the impact of the real ones: "*Numerous components of a firm's organization influence its ability to exploit the full competitive potential of its resources and capabilities, including its formal reporting structure, its explicit management control systems, and its compensation policies. These components are often called complementary resources and capabilities as they have limited ability to generate competitive advantage in isolation. However, in combination with other resources and capabilities they can enable a firm to realize its full potential for competitive advantage.*" (p. 67) The quoted paragraph documents that management control system (considered almost identical with performance management system, PMS) is expected to be resource with a potential to contribute to better performance of the firm and consequently to its value. That is why corporate PMS have been under sustained attention and development in the companies. Figure 1 shows such an evolution.

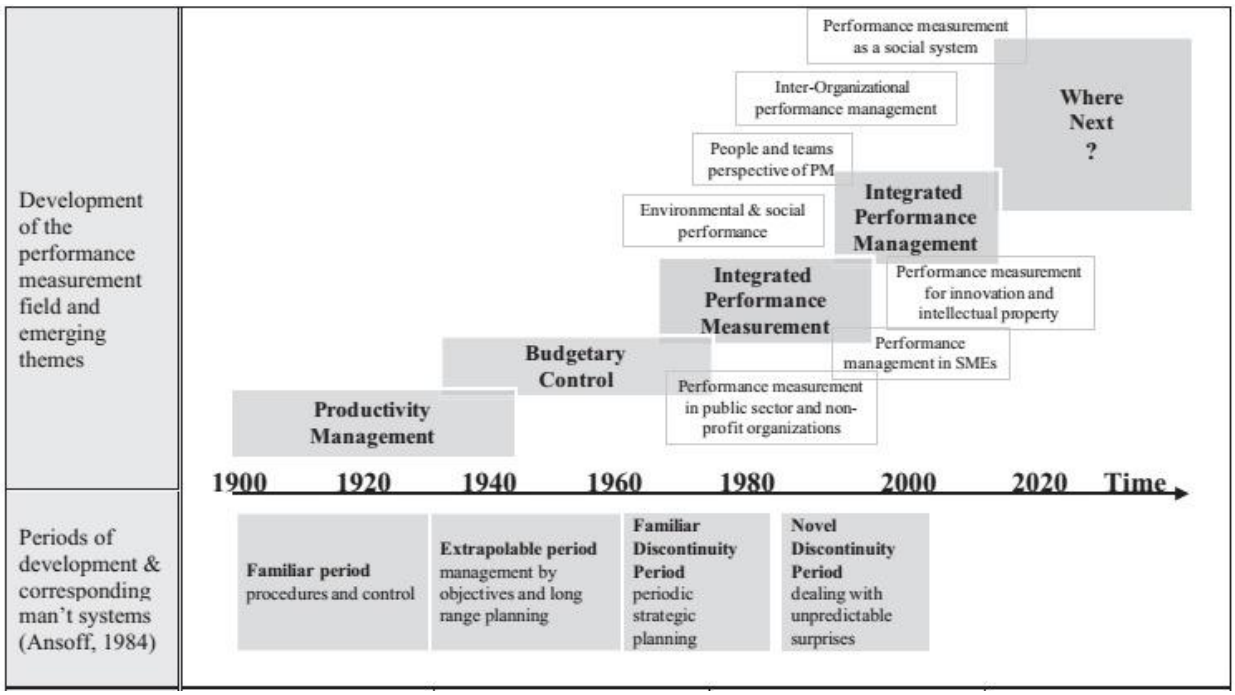

Figure 1: Evolution of PMS; Source: Bititci et al. (2012, p. 312)

In figure 1, the grey rectangles above the timeline portray the changes in scope and nature of PMS. Starting with relatively simple productivity management and cost accounting at the beginning of the last century and adding predetermined costs in 1930s, the PMS got more complicated during last quarter of the 20th century, above all due to the absorption of nonfinancial measures and informal controls. Around millennium, scholars began to speak about performance management instead of performance measurement. The reason was finding that structure and design of PMS depend on many factors, especially on the way how the PMS serves as a tool in hands of company's managers in achieving the performance objectives.

The latest stage of the outlined evolution explains main objectives of this article, which aims at explanation of the main factors influencing PMS design, outcomes and the research tools used for such analysis. Three research questions were stated:

RQ1. How to define contemporary PMS?

RQ2. What are the key factors that influence the design and outcomes of PMS?

RQ3. Which methods best reflect the interdependences among factors, PMS and performance?

The remainder of the article follows the research questions. The second section introduces the concept of PMS and compares that with the other similarly used terms. In the third section, the main contingency factors are introduced and the possible answers to the second research question are presented. The fourth section focuses on searching for answer to the third research question concerning methodological issues how to treat mutual relationships and mediations among factors, PMS and/or performance in quantitative studies. Finally, the last section summarizes the article.

2. Definition of Performance Management System (PMS)

The majority of researchers in the field does not explicitly define what they are referring to when they use the term Performance Management System (PMS), for which Pour (2008) also enumerates synonyms like Corporate Performance Management (CPM), Enterprise Performance Management (EPM), or Business Performance Management (BPM). Franco-Santos et al. (2007, p. 795) even concluded: "*After conducting a methodical literature review and reading over 300 documents (including journal articles, books, conference papers and working papers), we found only seventeen definitions of the BPM system concept*."

Garengo et Bititci (2007) shed a little light on the content of the terms of PMS/BPM when they recognized two most relevant perspectives in the literature:

- the performance measurement system perspective and
- the management control system (MCS) perspective.

Taylor et Taylor (2014) define the first named perspective: "*A performance measurement system is a system that provides a concise overview of performance through sets of (financial and/or non-financial) metrics that guide and support the decision-making processes of an organisation. This is done by gathering, processing and analysing information about its performance, and communicating it in the form of a succinct overview to enable the review and improvement of strategy deployment and alignment of key business processes*" (p. 848). Cheng et al. (2007) hold that "*contemporary performance measurement systems, such as the balanced scorecard, advocate the use of an array of financial and non-financial performance measures*" (p. 221). In the same way, Franco-Santos et al. (2012) define: "*a contemporary performance measurement system exists if financial and non-financial performance measures are used to operationalize strategic objectives*" (p. 80). She complements this basic definition with a number of assumptions, such as that performance measurement system involves specific processes of information provision, measure design, and data capture, or that it comprises a supporting infrastructure ranging from a simple method of data collection and analysis (e.g. MS Excel) to a sophisticated information system facilitated by enterprise resource planning platforms or business intelligence (BI) solutions. Practically oriented authors Yeoh et al. (2014) reconcile these assumptions in the same manner: "*Corporate performance management system comprises a combination of performance management practices and business intelligence (BI) technologies that helps managers to better set and monitor business-performance metrics and to know what is happening in the organisation and why it is happening. It also includes such BI functionalities as real-time monitoring, performance reporting, and support for exploring the solution space with statistical models and visualisations*" (p. 105). The two latter named definitions already bear the stamp of performance management more than measurement when they emphasize not only measures themselves but their objective as well.

Regarding the definition of Management control system (MCS), the term itself was first outlined in the seminal work of Robert Anthony (1965), who defined management control as "*the process by which managers assure that resources are obtained and used effectively and efficiently in the accomplishment of the organization's objectives*" (p. 17, quote from Ferreira, Otley, 2009, p. 264). Malmi et Brown (2008) offer more contemporary and eclectic definition of MCS: "*systems, rules, practices, values and other activities management put in place in order to direct employee behaviour*" (p. 290). Chenhall (2003) admits that terms MCS, management accounting (MA), management accounting systems (MAS), and organizational controls (OC) had been used interchangeably, but corrects that "*MCS is a broader term that encompasses management accounting (MA) and also includes other controls such as personal or clan controls.*" (p. 129) Influential MA textbook written by Drury (2012) confirms that MCS is a broader term than management accounting because more controls are involved and the classification of controls involves action (behavior) controls, personnel/cultural controls, results/output controls. Langfield-Smith (2007, p. 754) offers more detailed categorization of controls distinguishing "*formal and informal controls (Anthony et al., 1989), output and behavior controls (Ouchi, 1977), market, bureaucracy, and clan controls (Ouchi, 1979), administrative and social controls (Hopwood, 1976), results, action, and personnel con- trols (Merchant, 1985a), bureaucratic and organic controls (Chenhall, 2003), and diagnostic and interactive controls (Simons, 1995)*". Textbook in MA written by Atkinson et al. (2012) combines MCS and MA together, writing about "*management accounting and control system (MACS)*" (p. 342).

The previous paragraphs briefly illustrate the overlap between the terms Performance Measurement Systems and MCS, which usually are put together under one umbrella of Performnace Management system (PMS) or Business Performance Management (BPM). At general level of analysis, performance measurement literature stresses measures, their financial/non-financial character and how suitable they are for measuring goal achievement. On the contrary, MCS literature prefers controls to measures. Controls are understood in broader sense than measures including e.g. rules, standards, operating procedures, budgeting systems or other management accounting techniques, and even shared values or unwritten policies (Langfield-Smith, 2007).

3. Contingency factors of PMS design and outcomes

Contextual factors influencing the design of PMS are also known as contingency factors because they are effective only under specified conditions. Chenhall (2003) offered one of the first comprehensive reviews regarded to generic contingency factors:

- external environment (competition and uncertainty of the environment),
- technology (complexity, task uncertainty and interdependence),
- advanced technologies like Just in Time (JIT), Total Quality Management (TQM), or flexible Manufacturing (FM),
- organizational structure and decentralization (formal specification of different roles for organizational members),
- size and growth of the company,
- strategy and
- culture (above all national).

Henri (2006a) tested the cultural factors in more detail. He found the relationships between organizational culture and two attributes of PMS, namely the diversity of measurement and the nature of use. One of his conclusions was that top managers of firms reflecting a flexibility dominant type tend to use more performance measures than top managers of firms reflecting a control dominant type.

Garengo et Bititci (2007) were looking for contingency factors in Scottish SMEs. They concluded that corporate governance structure is the most important factor influencing performance measurement adoption and use, followed by information practices, then by strategy (referred to as firm's business model) and, finally, by an authoritative management style.

In her exhaustive review, Langfield-Smith (2007) paid close attention to quantitative studies of strategy as contingency factor. Although she admits that due to differences in research design, it was difficult to integrate the results of the reviewed studies where, she identified trend: "Recent studies have tended to turn away from a focus on identifying the specific design characteristics of MCS, toward examining how controls are used and implemented to reinforce strategic thinking and strategic change." It was Simons who started this trend in the series of research studies culminating with Levers of Control (LoC) introduced in Simons (1995). The concept of LoC was successfully empirically tested by Widener (2007). Cadez et Guilding (2008) emphasized type of strategy, whether it was intended or emergent one, and its impact on strategic management accounting usage in Slovenia.

Albu et Albu (2012) found foreign/domestic origin of capital and the size of the company to be dominant factors forming management accounting practices in Romania.

Taylor et Taylor (2014) based on their study among 349 companies established six factors enabling effective performance measurement system implementation. These factors are depicted in Figure 2. After their reanalysis controlling for the size of the responding company, they found significant differences in contingency factors concerning large enterprises and SMEs.

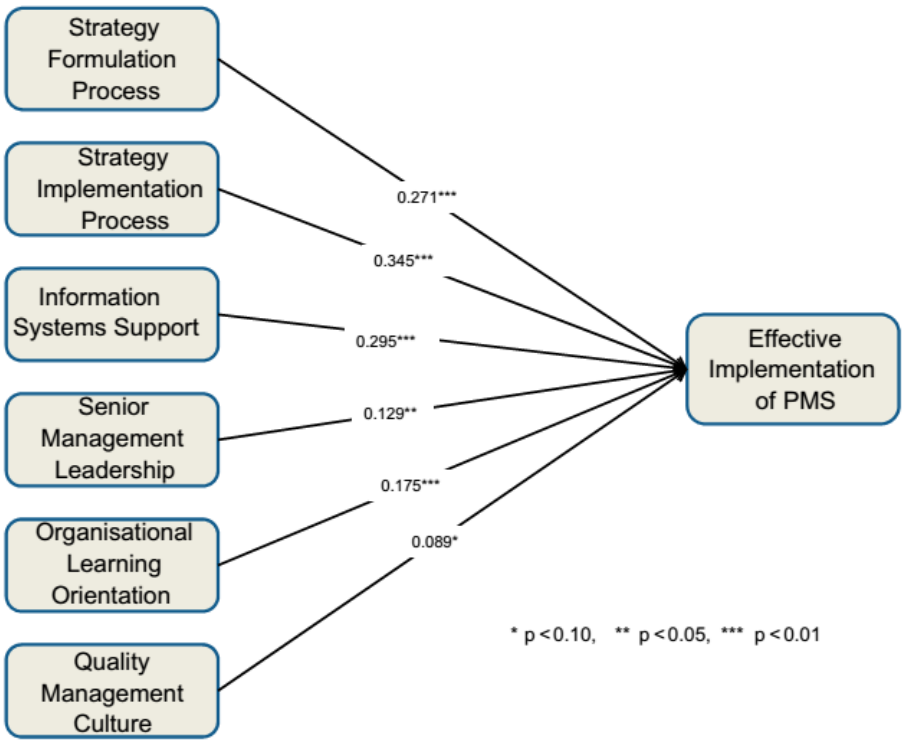

Figure 2: Contingency factors according to Taylor et Taylor (2014); Source: Taylor et Taylor (2014, p. 856).

Contrary to stream of research on contingency factors, Franco-Santos et al. (2012) conducted quite exhaustive review focusing on PMS outcomes, often labelled as roles, purposes or consequences of PMS too. The ultimate goal of PMS is naturally performance, although Tessier et Otley (2012) suggest two basic objectives of PMS: performance and compliance. Franco-Santos et al. (2012) documents that the relation between PMS and performance is not straightforward but mediated through people's behavior and creations of organizational capabilities.

The relationship among PMS and four organizational capabilities leading to strategic choices (market orientation, entrepreneurship, innovativeness, and organizational learning) was addressed by Henri (2006b). His results suggest that an interactive use of PMS fosters the four capabilities, but the diagnostic use of PMS puts negative pressure on them. Finally, some evidence was found, too, for the influence of dynamic tension resulting from the balanced use of PMS in a diagnostic and interactive fashion.

The optimal balance between exploration and exploitation organizational capabilities interested Uotila et al. (2009). They found an inverted U-shaped relationship between the relative share of explorative orientation and financial performance. Koufteros et al. (2014) even write about resource orchestration theory and confirm - based on cross sectional study from 386 Italian firms - that the use of PM systems leads to improved capabilities, which then impact performance. They found evidence that high levels of both diagnostic and interactive types of PMS use generated extraordinary high levels of capabilities.

Su et al. (2015) conducted a survey in 343 Australian manufacturing business units in order to test the influence of organizational life cycle stages (birth, growth, maturity, and revival). The results indicate that the interactive approach was positively associated with performance in the growth stage and negatively with revival stage of life cycle. As far as the use of the diagnostic approach is concerned, this was positively associated with performance in the revival stage and negatively with maturity stage.

4. Quantitative methods for testing contingency factors

Preparing research in PMS it is necessary to address the interdependence of analyzed concepts (RQ3). As a consequence of interdependence, the concepts (variables) cannot be classified as either dependent or independent. In addition, there is no single relationship between the analyzed variables; more likely, the chain of intertwined connections can be expected resulting with one of its ends in the concept of "performance". That is why traditional statistical techniques such as multiple regression and bivariate correlation analysis are too narrow and the application of the Structural Equation Modelling (SEM) is expected. The upper part of figure 3 delineated by dashed line shows example of such a model represented as a path diagram. There are one exogenous variable $\xi_1$and two endogenous variables η_1 and η_2. The relationships are depicted in arrows complemented with parameters γ for relationships between exogenous and endogenous variables and β for relationships between endogenous variables. Using LISREL notation, all linear relationships can be universally expressed by equation:

$$\mathbf{B\eta} = \mathbf{\Gamma\xi} + \boldsymbol{\zeta}$$

where $\mathbf{B}$ is an $(m \times m)$ coefficient matrix ($\beta_{ij} = 0$ means that η_i and η_j are not related), $\mathbf{\Gamma}$ is an $(m \times n)$ coefficient matrix ($\gamma_{ij} = 0$ means that η_i is not related to ξ_j), $\boldsymbol{\eta}$ is an $(m \times 1)$ column vector of endogenous variables, $\boldsymbol{\xi}$ is an $(n \times 1)$ column vector of exogenous variables, $\boldsymbol{\zeta}$ is an $(m \times 1)$ column vector of errors in the structural equations, $\boldsymbol{m}$ is the number of endogenous variables and $\boldsymbol{n}$ is the number of exogenous variables.

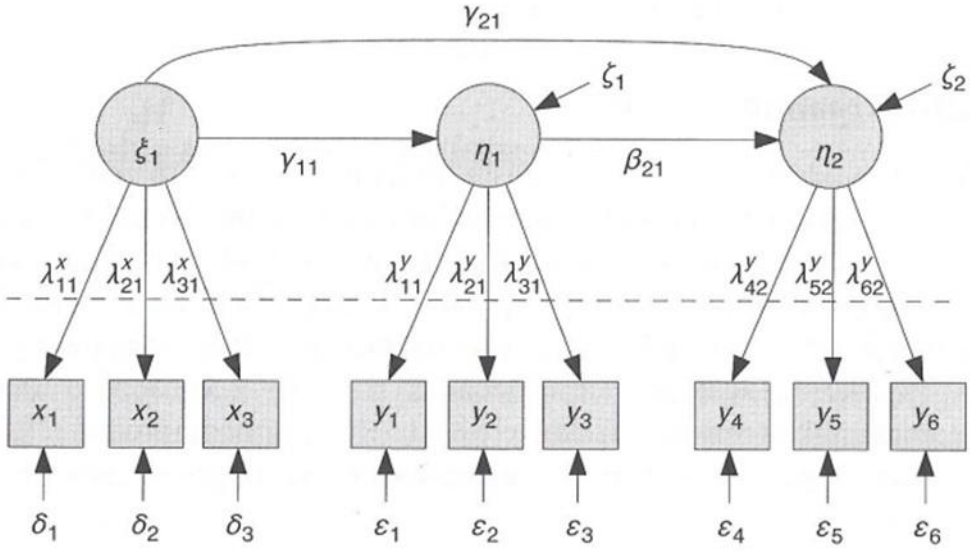

Figure 3 Structural model; Source: Hendl (2009, p. 554)

Apart from the intertwined relationships among variables (concepts), their multidimensional aspect has to be taken into account too. For example, Hamman et al. (2013) found in similar way four dimensions of the concept of "performance". That is why the analyzed concepts are usually hypothesized to be latent variables (a.k.a. latent constructs) that can be represented by observable measured variables, sometimes referred to as manifest variables, or indicators. In figure 3, indicators are represented in the lower part under the dashed line by the rectangles labeled x_i for indicators of exogenous latent variables ξ and y_i for indicators of endogenous latent variables η. It should be apparent from figure 3, that latent variables are linear combinations (variates) derived from indicators. Thus so called "measurement model" in the lower part of figure 3 may be universally expressed by equations:

$$\mathbf{x} = \mathbf{\Lambda}_x \boldsymbol{\xi} + \boldsymbol{\delta}$$

$$\mathbf{y} = \mathbf{\Lambda}_y \boldsymbol{\eta} + \boldsymbol{\varepsilon}$$

where $\mathbf{x}$ is a $(q \times 1)$ column vector of indicators constructing exogenous latent variables ξ, $\mathbf{y}$ is a $(p \times 1)$ column vector of indicators constructing endogenous variables η, $\mathbf{\Lambda}_x$ is an $(q \times n)$ matrix of factor loadings, i.e. regression coefficients between indicators *x* and exogenous variables ξ, $\mathbf{\Lambda}_y$ is a $(p \times m)$ matrix of factor loadings between indicators *y* and endogenous variables η, $\boldsymbol{\delta}$ is a $(q \times 1)$ column vector of errors in measurement in x, $\boldsymbol{\varepsilon}$ is a $(p \times 1)$ column vector of errors in measurement in y, $\boldsymbol{q}$ is the number of all indicators used for construction of exogenous variables and $\boldsymbol{p}$ is the number all indicators used for construction of endogenous variables.

The indicators (manifest variables) are to be gathered through the survey asking respondents for expressing their perceptions on the Likert scale. Than the confirmatory factor analysis (CFA) follows to evaluate the construct validity of the concepts and quality of the whole measurement model. Close attention has to be paid to conceptual justification of the nature and direction of the relationships between constructs and indicators addressed by Bisbe et al. (2007), especially whether the analyzed concepts are in fact of a usually assumed reflective nature or whether the formative measurement model should be hypothesized.

After CFA, the whole SEM model is simultaneously calculated resulting, on the one hand in estimates of coefficients matrices and error matrices outlined above, on the other hand in an estimation of the covariance matrix $\boldsymbol{\Sigma}$. For the model fit assessment, the comparison of estimated

covariance matrix $\boldsymbol{\Sigma}$ and the actual covariance matrix $\mathbf{S}$ between each pair of indicators x, y is applied. For this purposes, e.g. Hair et al. (2010, p. 672) summarizes the commonly used fit indices (namely χ-square, CFI, GFI, RNI, SRMR, RMSEA) and their cut-offs values. The changes in fit indices serve as foundation for comparison of the competing models developed in further stages of research.

SEM belongs to the tools of theory-driven empirical research. It means that the statistical methods has to be preceded by the thorough systematic literature review resulting in formulation of theoretical concepts and their hypothesized relationships verified by SEM afterwards. In addition, the SEM methodology requires the sample size in hundreds of respondents. As a "rule of thumb", 20 and more respondents per 1 estimated parameter are recommended. Kline (2011) admits as the least ratio 10:1, but only in case of sufficient communalities of indicators.

5. Conclusions

The following sections are organized based on the findings and their implications for further research and practice.

5.1. PMS definition

The literature review revealed that Performance Management Systems (PMS) are sort of complementary intangible resources that organizations use for building their competitive advantage, which helps them to outperform their rivals.

There are many synonyms for PMS such as Business Performance Management (BPM), Corporate Performance Management (CPM) or Enterprise Performance Management (EPM). PMS consists of two highly overlapping subcategories of research. The first subcategory is research in Performance Measurement concerned primarily with the question of appropriate, often non-financial, measurement of company's progress towards its performance goals. The second stream of research deals with Management Control Systems (MCS) and focuses more on the purpose of performance measurement and its specific context. In simplified words, both approaches are looking at the same phenomena of performance from different perspectives: performance measurement concentrates on the question of "how" and MCS on the question of "why".

As far as the definition of PMS and the answer to the first RQ1 are concerned, PMS is defined as array of controls (or measures), which are viewed in the broadest sense of the word. The list of controls ranges from accounting techniques, scorecards and other measurement tools, through organizational rules, procedures, manuals and recipes to unwritten policies and behavioral patterns perceived by and even expected from the employees. The ultimate purpose of controls (and PMS itself) is to get the organization under control. Tessier et Otley (2012), who revised popular concept of Levers of control (LoC) from Simons (1995), are more specific and suggest two basic objectives of PMS: performance and compliance. Both of them can be viewed from strategic and operational viewpoints and predetermine the selection of appropriate controls (measures) and the ways how they are used.

5.2. PMS research implications

In regard to the RQ2, the current literature (especially in its MCS stream) reveals many contingency factors that influence design of PMS. The left-hand side of figure 4 exposes the typical factors in rectangles. The hypothesized basic linkages among them are depicted with arrows. Although the relationships are deliberately simplified, the concentration of arrows aiming at the

interactive/diagnostic use corresponds to currently often highlighted importance of the intended purpose of PMS. In the right-hand side of figure 4, there are the typical consequences connected with PMS deployment. The arrows outline the fact that PMS does not impact firm's performance directly but through some mediation variables like people's behavior or organizational capabilities.

Finally, the tangled web of arrows in figure 4 depicts many interdependences among factors, PMS and performance. Such relationships are difficultly treated by traditional conventional statistical methods. That is why researchers have to employ more complicated statistical tools such as Structural Equation Modelling (SEM) which is able to handle relationships among latent variables and their observed operationalizing manifestation variables concurrently. The Bisbe's et al. (2007) warnings about the reflective and formative nature of the concepts have to be taken into account as well.

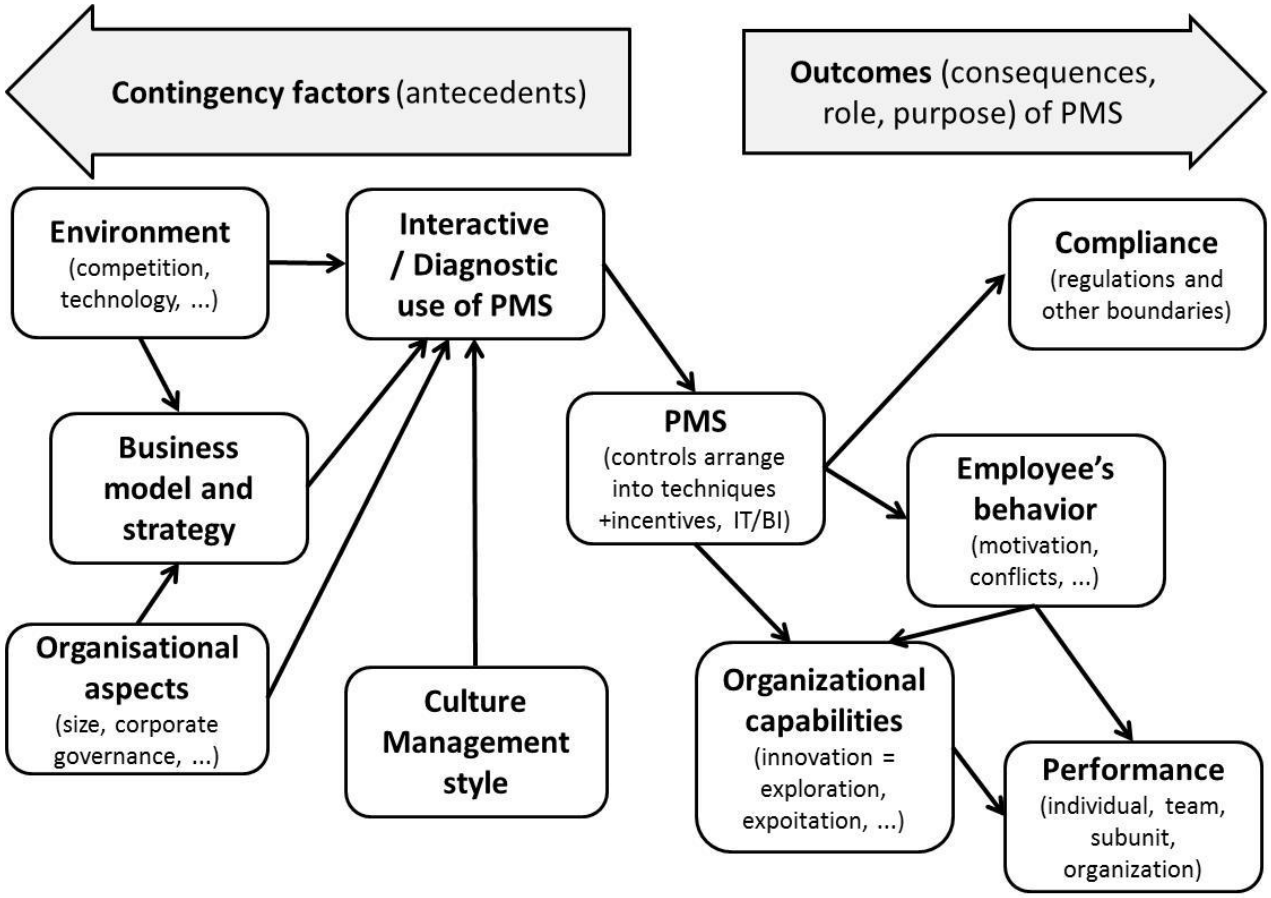

Figure 4 Framework of PMS contingency factors and outcomes; Source: Author.

5.3. Managerial implications

Despite of its general and abstract nature, the findings of the contingency theory research affect managerial practice as well. Sousa and Voss (2008) summarized the reasons adequately: "Contingency knowledge is also important for practitioners, because the failure to acknowledge the limits of applicability of practices may lead to their application in contexts to which they are not suitable. This reduces the chances of success, with the risk of discrediting practices whose validity, although not universal, might certainly hold in appropriate contexts" (p. 711).

6. Acknowledgement

This paper describes the outcome of the research financed by the Internal Grant Agency of the University of Economics, Prague, Grant No. F1/13/2015 and institutional research support.

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ADVANCES IN PERFORMANCE MANAGEMENT USING CUSTOMER EQUITY

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Keywords

Corporate Performance Management, Customer Equity, Customer Relationship Management, Customer Lifetime Value

Abstract

Forward-looking discounted customer metrics like Customer Lifetime Value and Customer Equity have found their direct relationships to performance management of a company on various levels. This paper examines several of these relations both in theory and in practical analysis of a real-world dataset. Discussed connections range from the obvious marketing management and Customer Relationship Management links, through links to Shareholder value, even into financial reporting and management complements of firm's financial statements.

Empirical case study from an online retailer from the Czech Republic demonstrates a practical usage of Customer Equity within non-contractual business-to-consumer settings. The results reveal important managerial insights when using Customer Equity Statement as a clear form of measuring the value of a customer base.

1. Introduction

Customer Lifetime Value (CLV) is defined as the present value of the future net cash flows associated with a particular customer (Fader, 2012). Customer Equity is the sum of the customer lifetime values across a firm's entire customer base (Fader, 2012). More definitions were broadly researched in (Gupta et al., 2006).

Both concepts of Customer Lifetime Value (CLV) and Customer Equity (CE) originated from marketing science, yet with important relations to management accounting and corporate performance management. The purpose is therefore not only for the management of marketing and Customer Relationship Management (CRM) activities, but also for strategic performance management of a company.

Researchers have identified various links of Customer Equity to (1) financial reporting and management accounting, (2) Shareholder Value (SHV), and strategic marketing management and Customer Relationship Management in particular. Part 2 goes into better detail of these links. The aim of this paper is to analyze the first described link and after generalization of the CE method as a performance tool analyze Customer Equity Statement as one of the possible managerial outputs.

The empirical part uses a dataset from an online retailer and, as can be seen in Part 3, exemplifies the studied method and its managerial impacts on customer acquisition and retention.

A brief remark on Brand Equity (BE) should be made in the context of CE. Fader (2012) discusses that for concepts like Brand Equity, which considers a brand as an measurable asset, there is far greater backing for the formalization than for CE, yet without doubting the fact of enormous value in a powerhouse brand, Fader is convinced that BE is: "often not quite as important or as valuable to a company's overall equity as is the last piece of our equity puzzle, customer equity". Fader also mentions that finance positions in a company (the CFOs, the accountants, the auditors) are already more comfortable with the ideas behind CE than they are with those ideas behind brand equity. More suitable role of BE instead of CE is for companies in non-contractual settings, companies selling highly specialized offerings, high-end product companies, firms with powerful intermediaries standing between them and their end users, and of course companies that can't easily obtain customer-level data.

2. Customer Equity as a Performance Metric

Wiesel, Skiera & Villanueva (2008) state that Customer Equity: "…contributes to the discussion about marketing accountability and might support marketing's re-entry into the boardroom because it aligns customer management with corporate goals and the investor's perspective." (p. 12).

There are many possible links between forward-looking customer metrics and performance measures for a company management. Gupta et al. (2006) provide simple framework (to be seen in Figure 1, left) demonstrating relations of marketing management and Customer Relationship Management activities with the value and performance of the whole firm. Hogan, Lemon & Rust (2002) proposed a conceptual model of how the firm can employ its stock of physical, intellectual, and customer-based assets to maximize the value of its Customer Equity and achieve above-industry-average profits (Figure 2, right).

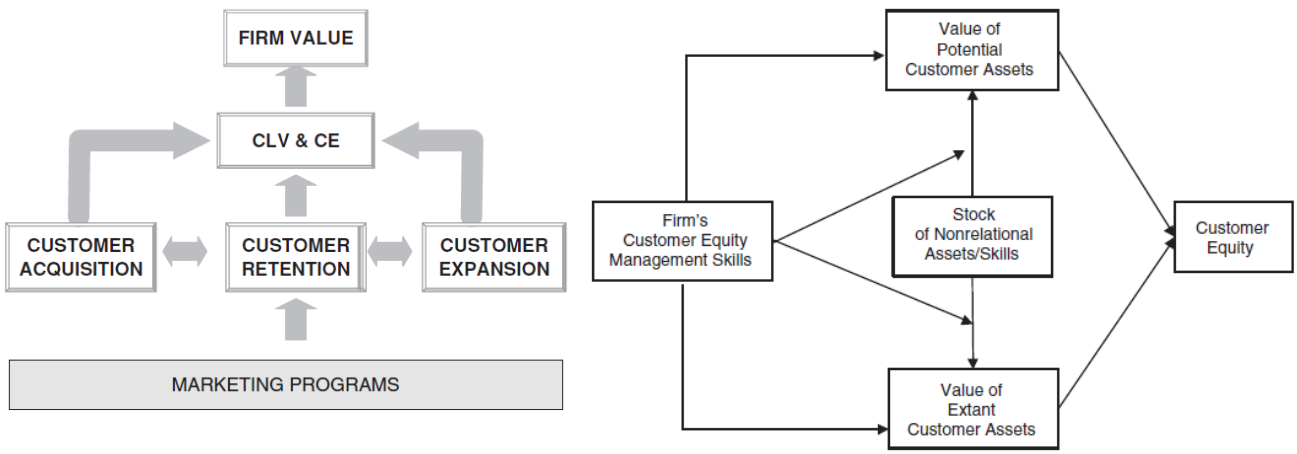

Figure 1 (left). Conceptual framework for modeling CLV. Source: (Gupta et al., 2006). (Right) Conceptual Model of CE Management. Source: (Hogan, Lemon & Rust, 2002).

Researchers have identified various links of Customer Equity to (1) financial reporting and management accounting (Wiesel, Skiera & Villanueva, 2008), (2) Shareholder Value (SHV) (Gupta, Lehmann & Stuart, 2004; Berger et al., 2006; Bauer, Hammerschmidt & Braehler, 2003), and strategic marketing management and Customer Relationship Management in particular (Rust,

Lemon & Zeithaml 2004; Berger et al., 2002; Bolton, Lemon, & Verhoef, 2004). Following part of this paper discusses these links further.

2.1. Integral Part of Financial Reporting

Wiesel, Skiera & Villanueva (2008) conclude that forward-looking customer metrics are necessary and useful as a managerial tool and thus should also be reported in financial statements to enable investors to understand clearly the firm's capability to generate shareholder value. Customer Equity and other discounted metrics of future value of customer base suit the demands of the "Management Discussion and Analysis" ("MD&A") part of financial statements required in the United States (Securities and Exchange Commission 2003) and the "Management Commentary" (IASB 2005) for complementation of firm's financial statements, and the information should be future oriented, understandable, relevant, reliable, and comparable and should provide an "analysis through the eyes of the management". Current profitability lacks the forward-looking approach. As a result, Wiesel, Skiera & Villanueva (2008) proposed several following metrics that would provide valuable information to investors:

1. customer metrics (e.g., customer retention, customer cash flow),
2. the value of the customer base (usually operationalized as customer equity),
3. components of customer equity (e.g., customer equity before marketing expenditures, total lifetime retention expenditures, total lifetime acquisition expenditures),
4. changes in customer equity and components of customer equity over time, and
5. the effects of changes in customer metrics over time.

2.2. Customer Equity Statement

Customer Equity should be reported in a single, clear display that reveals the value of the existing customer base. Wiesel, Skiera & Villanueva (2008) took very innovative approach and constructed such clear report from the publicly available information about Netflix, as in Figure 2.

The correctness of this approach was supported by Gupta, Lehmann & Stuart (2004) that used publicly available data from five firms to estimate customer equity and the estimates of CE were reasonably close to the market value of three of these firms. Also to mention, the research by Wiesel et al. point out this approximation is fundamentally different for non-contractual relationships where it is hard to determine the number of existing and lost customers at a particular point in time.

For internal purposes, Rust, Lemon & Zeithaml (2004) require these models to be more detailed in order to diagnose the reasons for particular changes in customer metrics.

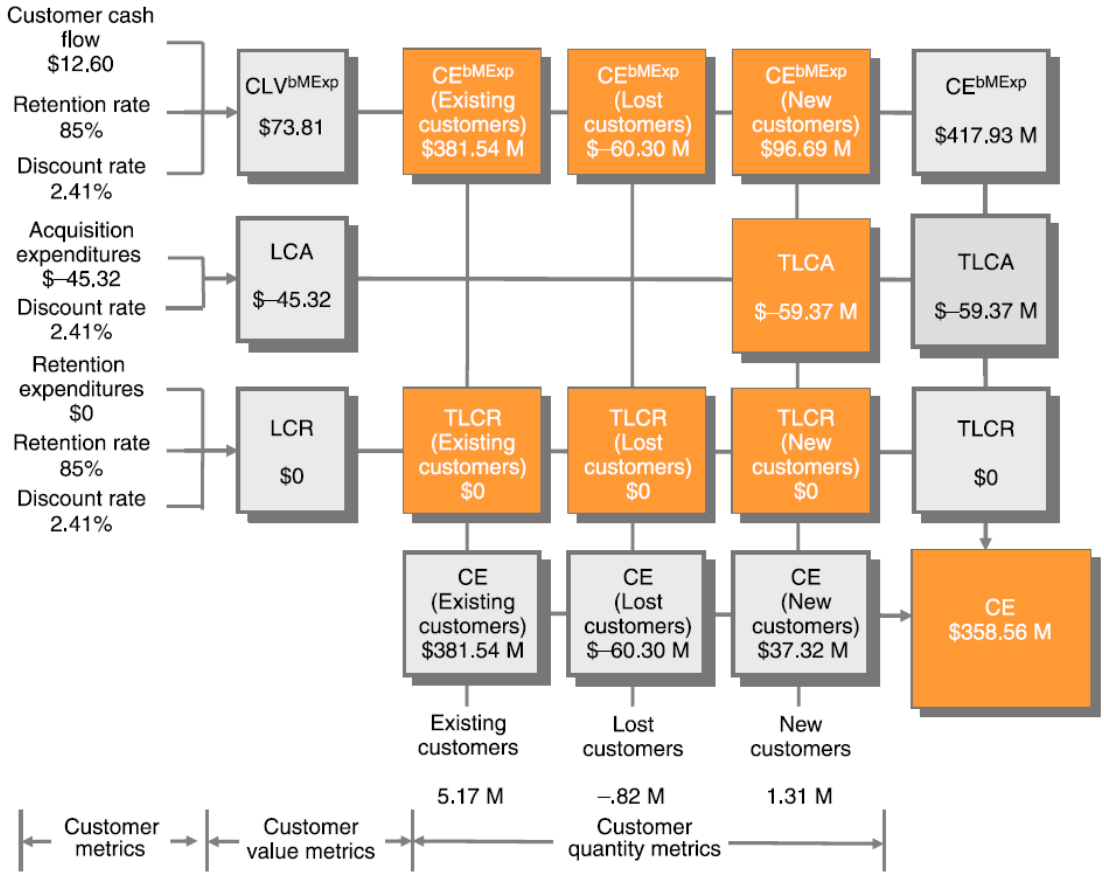

Figure 2. Netflix's Customer Equity Statement (Q3 2006). CE = customer equity, CLV^{bMExp} = customer lifetime value before marketing expenditures, LCA = lifetime acquisition expenditures, LCR = lifetime retention expenditures, TLCA = total lifetime acquisition expenditures, and TLCR = total lifetime retention expenditures. Source: Wiesel, Skiera & Villanueva (2008).

2.3. Shareholder Value

Skodakova (2009) lists SHV and discounted cash flow metrics as one of the examples of value based management. Bauer, Hammerschmidt & Braehler (2003) support such representation of marketing for value creation and see that the more widespread the CLV concept becomes as a controlling tool in the operative sphere, the more easily corporate valuation efforts via CLV can be undertaken. According to Bauer et al., a comprehensive CLV-based corporate valuation is more complex than traditional SHV procedures, and propose a formal synthesis of CLV and SHV concepts in Corporate Value metric, where CE forms the base of such calculation.

2.4. Marketing management and CRM

Research on links between CRM and business performance can be divided into technological aspects of CRM and business aspects. As for technological aspects, findings by Reinartz, Krafft & Hoyer (2004) strongly suggest that mere implementation of CRM technology will not lead to the desired effect; it may even have a negative effect. Despite that, the same research indicates that the implementation of CRM processes is associated with better company performance in two of the following three stages: the strongest effect is for relationship maintenance, followed by relationship initiation, yet the effects for relationship termination were either low or not significant. Their

research also motivate the use of marketing automation, as at the termination stage, it may be cost efficient to manage low-value relationships with technological support systems. This point is highly relevant in context of CLV and cost-benefit analysis of relations with customers.

A study by Pechova & Zajarosova (2014) ranked and analyzed several factors of CRM performance measurement. The most important are factors regarding customer (customer satisfaction, customer value, customer retention, customer equity). The least important factors are infrastructure factors (internal processes).

Rozek & Karlicek (2014) concluded their research with finding that CLV approach brings the marketing focus back to the customer and highlights the overall long-term profitability of customers. Customer relationships, similar to other company's assets, require an investment which should produce respective revenues, both happening over multiple accounting periods.

With these foundations, the role of CLV and CE has direct links to CRM performance measurement and marketing management.

2.5. Actionable use of Customer Equity

Kumar & George (2007) differentiate between two approaches to measure CE according to data requirements, metrics computed, underlying assumptions and level and type of aggregation, as these yield different methods to maximize the value of customers:

1. in the disaggregate-level approach, customer lifetime value is maximized by implementing customer-level strategies such as optimal resource allocation, purchase sequence analysis and balancing acquisition and retention spending,
2. at the aggregate-level, improving the drivers of customer equity maximizes customer equity.

Customer Equity Statement presented in (Wiesel, Skiera & Villanueva, 2008) also helped with exposing such drivers as lifetime value estimates, acquisition expenditures and retention costs are clearly distinguished and available for management decision making.

3. Customer Equity Implementation for an E-commerce

In this part a practical demonstration of Customer Equity is done on a real-world data from one health & beauty online retailer from the Czech Republic. The data provided consist of 48 thousand transactions by 35 thousand identified, yet anonymized, customers within a period of 232 weeks (18 quarters). The business is clearly non-contractual with business-to-consumer relations. The dataset includes purchase data, but no acquisition and retention costs, therefore some of the values had to be estimated according to a business knowledge.

When discussing Customer Equity for e-commerce companies, the approach taken in part 2.2 by Wiesel, Skiera & Villanueva (2008) is not suitable as those models are appropriate for contractual settings (e.g. telco, utilities, financial services etc.). For majority of e-commerce companies at business-to-consumer market, more convenient models should be selected. Kumar & Shah (2015) warn that customer 'death' is unobserved (and unobservable) in non-contractual settings. Some companies thus exchange retention rate metric for repeat-buying rate or repurchase rate, although the fact that a customer has not made a purchase in a following period does not mean they are 'dead'.

One viable solution uses latent attrition approach (or 'buy till you die' framework) that is also implemented in the statistical computing language R by Dziurzynski, Wadsworth & McCarthy

(2014) in BTYD package. This framework uses negative binomial distribution model for customer's purchasing behavior and Pareto Type II distribution for the unobserved customer lifetimes. Figure 3 demonstrates such implementation by estimating probability of customers being 'live' at the end of calibration period.

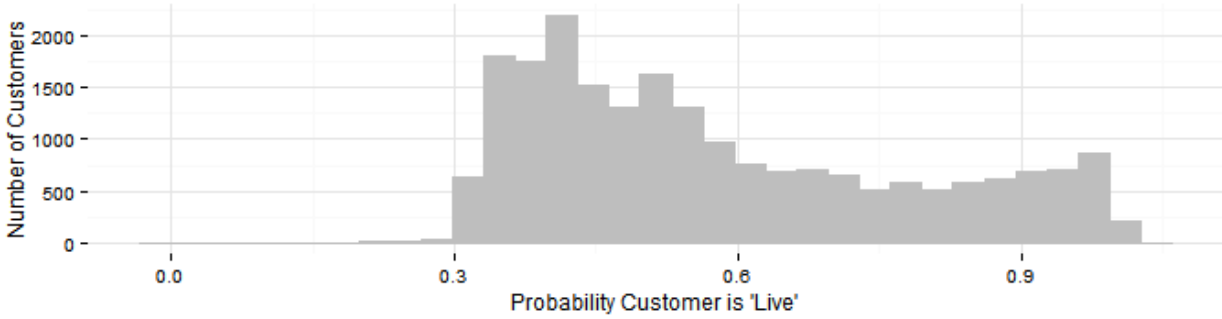

Figure 3. Number of customers by their probability of being live at the end of 2013. Processed on analyzed dataset with R and BTYD package by (Dziurzynski, Wadsworth & McCarthy, 2014). Source: author.

In contradiction to the approach of Gupta, Lehmann & Stuart (2004), this analysis could be built upon internal data, thus more accurate than using public figures. In a similar way as (Wiesel, Skiera & Villanueva, 2008) on Figure 2, this paper presents Customer Equity Statement for the specific e-commerce dataset in Figure 4.

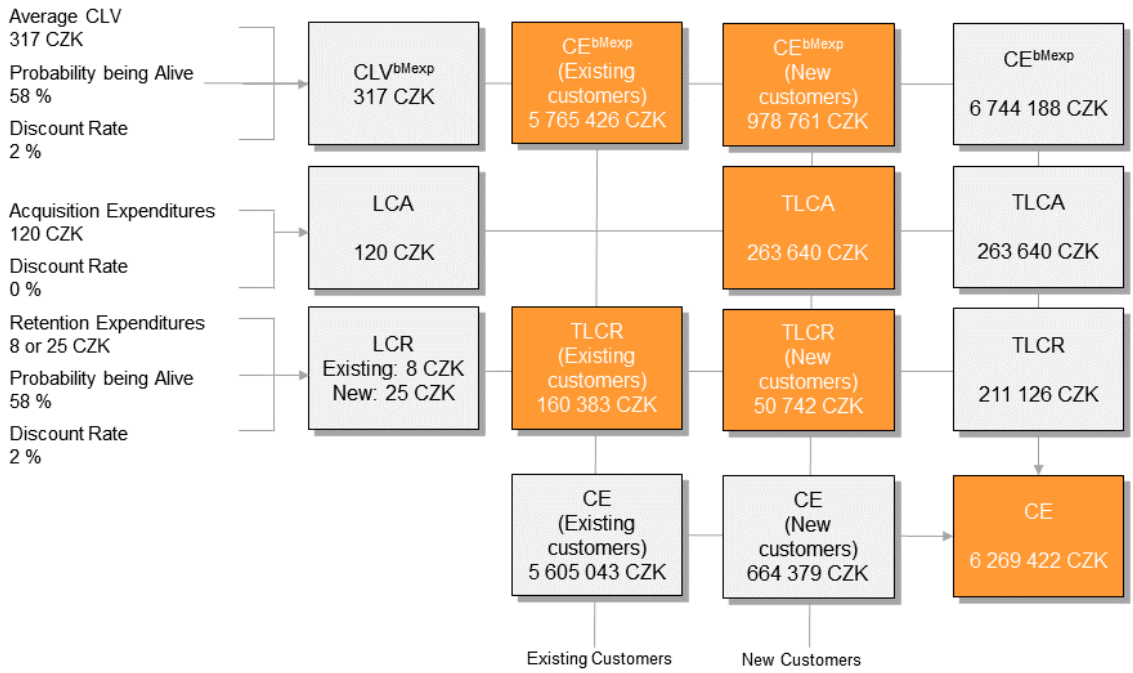

Figure 4. Customer Equity Statement for Q4 2013 data of analyzed dataset of an online retailer. CE = customer equity, CLV^{bMExp} = customer lifetime value before marketing expenditures, LCA = lifetime acquisition expenditures, LCR = lifetime retention expenditures, TLCA = total lifetime acquisition expenditures, and TLCR = total lifetime retention expenditures. Adapted from (Wiesel, Skiera & Villanueva, 2008). Source: Author.

Expressions in Figure 4 deserves more explanation as several approximations and assumptions were made. Discount rate was set to 2% accordingly to internal accounting principles of the studied company. CLV was estimated for up to 3 years with respect to current management strategy of the

company. Acquisition expenditures were obtained at average level of 120 CZK and held with no discount rate. There were 2 197 new customers in specific quarter. For retention expenditures an estimation of 8 CZK per customer was used to send e-mails to an existing customer for following 3 years (7.5 CZK discounted), and 25 CZK to a new customer for following 4 years (23.1 CZK discounted). There were 21275 customers in the database at the end of 2013. In contrast with Figure 2, lost customers were not included in the schema as non-contractual model already counts with the customer's probability of being alive.

Customer Equity Statement shown in Figure 4 clearly describes current situation as of the end of the fourth quarter of 2013. The average CLV for new customers is 445 CZK i.e. 40% higher than the overall average CLV. Customer Equity for new customers equals to 11% of total CE. There are clear links to high acquisition and retention costs for new customers.

4. Conclusion

This paper reviewed very important links of progressive customer metrics like Customer Lifetime Value and Customer Equity to performance management of a company on various levels: (1) financial reporting and management accounting, (2) Shareholder Value (SHV), and strategic marketing management and performance measurement of Customer Relationship Management. One of the finest outputs was a Customer Equity Statement that serves as a managerial tool for decision making on all customer acquisition, activation and retention activities on a strategic level.

The empirical part of this paper used a dataset from an online retailer and adapted the Customer Equity Statement to non-contractual settings, where customer relationships can't be calculated in such a predictive manner as in contractual settings like in the case of Netflix (Wiesel, Skiera & Villanueva, 2008). For this adaptation a statistical model with Pareto/Negative Binomial Distribution was successfully implemented. The results reveal important managerial insights of importance of new users despite higher acquisition costs, all this by using Customer Equity Statement as a clear form of measuring the value of a customer base.

Further research should elaborate on the problems faced while using Customer Equity in non-contractual settings: (1) lack of pure retention metrics, (2) absence of some key financial data regarding marketing activities, (3) tests on assumptions stated by used statistical models.

5. Acknowledgements

This paper was processed with contribution of long term institutional support of research activities by Faculty of Informatics and Statistics, University of Economics, Prague and supported by the IGA grant F4/18/2014.

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UNDERSTANDING SUSTAINABILITY BY LARGE CZECH COMPANIES

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Keywords

Understanding sustainability, sustainability-related initiatives, motivation for sustainable behavior, infrastructure for sustainability, key stakeholders

Abstract

In our paper we present results of our research aimed at understanding sustainability by large companies domiciled in the Czech Republic. The findings show that concept of corporate sustainability is well known among these companies, nevertheless there are substantial differences among companies both in breadth and depth in which they address sustainability.

Based on our research question we in interviews identified several key dimensions, specifically existence of a vision related to sustainability; understanding sustainability in general; specific activities in the area of sustainability; motives for and against involvement in sustainability-related activities; outset of sustainability-related initiatives; key stakeholders; highlighting the importance of going over and above the legal requirements of corporate sustainability management.

Consequently we addressed these key dimensions in detail and obtained results that to a large extent confirm findings from the previous literature. Interestingly, analyzed organizations relatively often emphasized social dimension of sustainability and especially the importance of education (both of internal and external subjects). By these activities organizations hope to increase their reputation and persuade civil society about their usefulness and thus justify their existence. Nevertheless economic dimension of sustainability is still considered of extreme importance and activities in the other traditional dimensions of sustainability (environmental, social) are understood as a support for ensuring sustainability of an organization per se.

1. Introduction

The importance of corporate sustainability is according to numerous authors and consulting companies increasing (KPMG, 2013; Roca & Searcy, 2012).

Quite interestingly, there is no agreement upon definition of the term "sustainability" neither among scholars nor among organizations. Very often used definition of sustainable development is the one, which was proposed by the Brundtland Commission in year 1987: ''Sustainable development is development that meets the needs of the present without compromising the ability of future

generations to meet their own needs.'' (WCED, 1987), nevertheless this definition is not sufficiently operational from the viewpoint of corporations.

Within corporate environment exists a broad variety in understanding the term "sustainability". In a narrow sense, "sustainability" is related to the corporation per se. Nevertheless more usual are broader definitions, which often utilize Elkington's (1997) triple bottom line approach. For example Holton, Glass, and Price (2010, p. 152) defined corporate sustainability as "improving corporate social, environmental and financial performance in a balanced and integrated way". Pojasek (2012, p. 93-94) highlighted that in practice is the term "corporate sustainability" often interchangeably used with terms "corporate social responsibility", "social responsibility", "corporate citizenship", "corporate responsibility", "environmental sustainability", and "sustainable development" and that there are countless definitions of these terms that organizations can choose from. We would like to mention that some authors differentiate among these terms (and e.g. understand corporate social responsibility to be a subset of sustainability). Finally, Pojasek (2012, p. 94) suggested the following definition: "Sustainability is the capability of an organization to transparently manage its responsibilities for environmental stewardship, social wellbeing, and economic prosperity over the long term while being held accountable to its stakeholders".

Corporations have various motives for addressing sustainability and implement diverse initiatives related to the sustainability. Lozano (2012) suggested that corporate leaders and employees increasingly recognized their role in contributing to sustainability. Obviously, these findings are in majority based on research conducted among companies domiciled in advanced economies.

Understanding sustainability is addressed in numerous articles, nevertheless in-depth qualitative research from the Czech Republic is not available. The key goal of research presented in this paper is therefore to find out to which extent large companies domiciled in the Czech Republic address issues related to sustainability. More specifically we examine understanding of sustainability, motives for dealing with sustainability as well as key initiatives.

2. Literature review

There are numerous articles dedicated to the discussed problems. We attempted to select such ones, which we consider critical from the viewpoint of our study and for higher transparency we classified them into conceptual and empirical.

2.1. Conceptual articles

Understanding sustainability is in detail addressed in a review article by Aguinis and Glavas (2012), where is provided a literature review on the basis of 588 journal articles and 102 books and book chapters.

Interesting discussion aimed at prioritization of sustainability dimensions can be found in Hahn, Pinkse, Preuss, and Figge (2015), where is stressed the need for a framework enabling simultaneous integration of three traditional dimensions of sustainability (economic, environmental and social) without, a priori, emphasizing one over any other. Such an integrative view on corporate sustainability is based on the idea that organizations need to pursue different sustainability aspects simultaneously and thus goes beyond traditional triple bottom line approach.

Implementation of sustainability practices may have form of numerous and diverse voluntary initiatives. Lozano (2012) provided an analysis of strengths and weaknesses of the most widely implemented initiatives (cleaner production, corporate citizenship, corporate social responsibility,

design for the environment, eco-efficiency, ecolabelling, environmental management systems, environmental and social accounting, factor X, green chemistry, industrial ecology, life cycle assessment, sustainable livelihoods, sustainability reporting, the natural step and the triple bottom line). Lozano (2012) concluded that all these initiatives have strengths and weaknesses and when used in isolation, may lead to narrow view of sustainability. As solution Lozano (2012) suggested CIVS (corporate integration of voluntary initiatives for sustainability) framework, which should help to implement sustainability into the organization with the least effort and maximum results.

2.2. Empirical articles

Very comprehensive research on sustainability in business environment was conducted by Berns, Townend, Khayat, Balagopal, Reeves, Hopkins, and Kruschwitz (2009). The research was conducted among 50 global thought-leaders (interviews) and among more than 1,500 worldwide corporate executives (survey). This research deals e.g. with questions how managers understand the term "sustainability", what are key drivers of sustainability and which benefits businesses obtain in case of sustainable behavior. It was found that there was no single established definition of sustainability; some companies understood sustainability narrowly (e.g. only as environmental issues), other companies had broad view of sustainability. Survey respondents who claimed to be sustainability experts, tended to understand sustainability more comprehensively than novices and usually mentioned Brundtland Commission's definition or the triple bottom line definition of sustainability. Experts also believed more strongly in the importance of engaging suppliers across the value chain. Unlike global thought-leaders, majority of survey respondents (i.e. corporate executives) claimed that government legislation is a driving force in sustainability. Thought-leaders mentioned situations in which businesses influenced regulatory framework. Another difference between thought-leaders and corporate executives was in the area of assessing the influence of customers, which were considered to be stakeholders with significant impact by executives, while thought-leaders considered more important factors like climate change etc. Last but not least, employee interest in sustainability was by executives considered as the third most important driver of corporate sustainability investments (after government legislation and consumer concerns), while thought-leaders did not consider this factor to be important. In regard to benefits of addressing sustainability, executives considered improved company or brand image to be by far the most important benefit. Other important benefits (in decreasing order of importance) were cost savings; competitive advantage; employee satisfaction, morale and retention; product, service or market innovation; business model or process innovation; new sources of revenue or cash flow; effective risk management and enhanced stakeholder relations. On the other hand, according to Berns et al. (2009, p. 24-25) there are three important barriers that hinder decisive corporate action in the area of sustainability-related issues. First, insufficient understanding what sustainability is (missing integrative view of sustainability); second, businesses struggle with creating a business case for sustainability (especially because of short-term planning horizon, issues with identification, measurement and control of impacts of sustainability-related initiatives, and high uncertainty connected with sustainability-related decisions); third, businesses have difficulties with effective implementation of sustainability-related initiatives.

Case study approach to exploring sustainability management practices was applied by Holton, Glass, and Price (2010), who concluded that managing for sustainability in each company began with a compliance approach (especially ISO 14001 certification), which led to continuous performance improvement culture. Consequently, studied companies broadened their sustainability focus and next to eco-efficiency added better utilization of their human capabilities. For the successful implementation of sustainable approach, support from senior management and cascading commitment to sustainability throughout the company, was very important. Last but not least,

Holton, Glass, and Price (2010, p. 160) suggested that companies should after implementation of ISO 14001 broaden their sustainability focus (wider spectrum of environmental issues, internal social issues, local community etc.).

A literature review and especially very detailed research into motives for social initiative of Norwegian corporations can be found in (Brønn & Vidaver-Cohen, 2009). In this study motives were classified into three groups. First, legitimacy motives, which strive to build reputation by taking part in social initiatives and thus creating impression of legitimacy in the minds of organizational stakeholders. These motives are according to the results of the study very important. Second, profitability motives (belief that participation in social initiatives can yield direct financial benefits for the firm); nevertheless this factor according to this study received far less agreement from study participants than other two motives. Finally, sustainability factor (belief that corporations have a moral obligation to invest in making the world a better place for future generations), nevertheless also this factor was not considered to be very important.

Specific initiative (by some authors considered as "buzzword") in the area of sustainability is implementation and utilization of sustainability accounting, which can be defined as "new information management and accounting methods that attempt to create and provide high quality, relevant information to support corporations in relation to their sustainable development" (Schaltegger & Burritt, 2010, p. 377). Nevertheless content and function of sustainability accounting is not settled yet and the term is not much used in practice.

3. Methodology of empirical research

In this chapter we discuss selected research methods in general, procedure for selecting organizations and interviewees, approach to conducting the interviews and method used for analysis of obtained data.

3.1. Character of selected research method

For investigation into the understanding sustainability in general and into drivers, motives and benefits of participation in sustainability-related initiatives we utilized in-depth interviews. We therefore had to restrict our research to a limited number of respondents and statistical analysis and generalization of our results would be largely irrelevant. Guthrie and Farneti (2008) noticed that responses obtained from in-depth interviews are difficult to analyse. To identify the key themes in our interviews we therefore used thematic analysis including coding of our data. Methodologically we followed recommendations given in relevant literature (e.g. Gibbson & Brown, 2009; Berg and Lune, 2012; Schreier, 2012). Because of the qualitative character of our research we also utilize a qualitative style of presenting our results as described e.g. in Schreier (2012).

3.2. Selection criteria

We prepared our interviews in several steps. First, we utilized a ranking of the 100 largest companies domiciled in the Czech Republic "Czech top 100", which is available from (http://www.czechtop100.cz). Consequently we tried to contact all these businesses by phone and obtain an email contact to the person responsible for sustainability issues. Consequently we sent e-mails with request for interview.

3.3. Interviews

In the end we were able to realize 13 interviews; in Tab. 1 can be found job titles of our interviewees.

The interview questions were focused on understanding sustainability, motives for participation in sustainability-related activities, benefits of addressing sustainability issues and especially on sustainability reporting (but in this paper we do not primarily deal with reporting practices).

Two "interviews" were structured ones because these organizations asked us to send them our questions and answered them in a written form. The rest of interviews were conducted face-to-face and were semi-structured (i.e. interviewees were allowed to relatively freely express their views on sustainability-related issues and practices, without any strict restrictions, nevertheless interviewers were instructed to ensure that all key questions were asked).

Organization	**Job title**	**Organization**	**Job title**
A	country and cluster sustainability manager	H	HR Marketing
B	director of communication	I	director of strategy and communication
C	chief of controlling department	J	sustainable development manager
D	chief financial officer	K	controller
E	corporate social responsibility expert	L	senior manager of corporate communication
F	controlling specialist	M	director of endowment fund
G	chief accountant		

Table 1 Positions (job title) of interviewees

The interviews were conducted by research associates (students, who were in detailed manner instructed about the interview), firstly under supervision of researchers, and consequently independently. All interviews were recorded by digital voice recorder. The average length of interview was 45 minutes, the shortest one took 18 minutes and the longest one 90 minutes.

The interviews were conducted from February till April 2015.

3.4. Coding and analysis

All interviews were fully transcribed and transcriptions were checked by researchers. Consequently researchers coded the transcripts using both apriori and empirical codes. For automation of these tasks was used software NVivo 10.0.

Coded parts of the interviews (selected were passages relevant to the research questions discussed in this paper, i.e. excluded were parts related solely on detailed issues of sustainability reporting) were analyzed again and key themes were identified.

4. Results

In this chapter we present results of our analysis of the interviews. Our research questions, which served as a filter for selection of relevant data for this article, were aimed at understanding sustainability in general and at drivers, motives and benefits of participation in sustainability-related initiatives. After collapsing of codes we ended up with the following key themes: existence of a vision related to sustainability; understanding sustainability in general; specific activities in the area of sustainability; motives for and against involvement in sustainability-related activities; outset of sustainability-related initiatives; key stakeholders; highlighting of importance of going over and above the legal requirements.

4.1. Existence of a vision related to sustainability.

Only minority of our respondents indicated that they use comprehensive definition of sustainability and / or have sustainability included in their vision. Their answers confirmed that understanding sustainability differs among organizations, but there are some common features, e.g. (definitions were slightly changed because of anonymity):

“We are looking far into the future, we want our country and its people prosper not only today or in ten years, but in ten years, twenty years, in future generations”.

“Our organization understands sustainable development as such type of doing business so that the organization is involved in harmonic compliance with its surroundings, with culture, with society, with the people, but also with the environment where it operates. So that it bequeath something for the future, something that will be useful for the lives of future generations”.

“We are aware that the more successful we become, the greater our responsibility towards the environment, our employees, the locations where we are based and all the places in the world where our products are sold. We are therefore committed to fulfilling our responsibility consistently worldwide. Based on the firm belief that only those who act responsibly can be successful over the long term, the company adheres to the principle of sustainability and gives economic, social and environmental aspects equal consideration”.

Quite interestingly, some organizations with “official” definition of sustainability are reluctant to use such definition in internal communication because they are afraid that such practice could turn sustainability into an empty phrase. Representatives of these organizations explicitly mentioned that they prefer “humane approach” to sustainability.

4.2. Understanding sustainability in general

Second key theme found in interviews were broad dimensions of sustainability. On the one hand, we can conclude that our results are not surprising. We identified three key dimensions of sustainability – economic (sometimes only implicitly included in the interviews), environmental and social. We suppose that occasional omission of the economic dimension of sustainability during interviews was caused by the fact that organizations consider this dimension so obvious that they do not mention it. This assumption is supported by the fact that from interviews was clear that majority of companies understand economic dimension as the most important (which is logical). Activities in other dimensions of sustainability are not primarily understood as a kind of “philanthropy”, but as tools for enabling sustainable existence of the organization itself.

Next to three traditional dimensions, several companies highlighted the long-term aspect of sustainability. Long-term character of sustainability was highlighted also by the fact that

representative of a company, which addresses sustainability in a very narrow way, suggested that insufficient interest of this company in sustainability-related issues was caused by instability of its management, which consequently caused short-term orientation of managerial decision making and therefore underestimating sustainability-related issues.

4.3. Specific activities in the area of sustainability

Our respondents named numerous activities related to sustainability and we summarized the key ones in Tab. 2.

Code	**Description (paraphrase / example from interview)**
economy	circular economy; cost saving programmes
environmental-related activities	CNG cars (in fact, utilization of CNG cars is also cost-saving); recultivation; biodiversity
socially related, internal	
employees education	education of managers in the area of sustainability, soft skills; providing employees educational materials useful for their work; education centers for employees, which can be used also by external subjects; training on health and safety
employees benefits	provision of various benefits increases loyalty of employees, decreases fluctuation
employees various programmes	prevention of breast cancer
employees diversity	employing disabled; cooperation with sheltered workshops
employees career planning	care about development of employee, helping employees with solving their problems
socially related, external	
voluntary work	increasing of reputation of an organization; strengthening relationships among employees; team building (but must be based on voluntary decision of employees)
endowment fund	centralization of donation activities support of interesting projects
education of civil society, students etc.	explaining people operations of an organization, gaining trust, educating toward responsible behavior; inducing interest about work in a company
partnership with educational institutions	trainee programs; employing absolvents; grants
partnership with research institutions	cooperation in the area of research and development
support of small enterprises	supporting small enterprises from coffee bars to family farms
support for region	various activities in region in order to be accepted as a

	responsible partner
implementation of new sustainability reporting practices	driven especially by legislation or by parent company, e.g. "we expect to be influenced by EU directive and we want to be well prepared, we implement a large pilot project reporting according to GRI G4"
risk management	across all activities
health & safety	health and safety was often mentioned as an important part of sustainability-related initiatives

Table 2 Specific important activities

4.4. Motives for and against involvement in sustainability-related activities

We identified the following key motives for involvement in sustainability related initiatives: legislation (legislation has to be respected and so may enforce companies to behave responsibly); prestige, image; justification of existence; increasing of customer trust and loyalty; cost savings (e.g. CNG cars); transparency and reliability (specific for reporting); becoming attractive employer; differentiation; pride oneself on being responsible.

On the other hand there are also some important drivers that are against participating in sustainability-related activities, e.g.: increase of costs (for example because of support of community, non-profit organizations etc.; need for specialists; motives specifically against sustainability reporting (increased costs; potential abuse of information by competitors or media; no pressure from stakeholders; reporting is not obligatory).

4.5. Outset of sustainability-related initiatives

Our research showed that sustainability-related initiatives are not new for our respondents. Only one respondent did not indicate when their sustainability-related initiatives started. All other respondents indicated that their sustainability-related initiatives started "from the beginning" of their existence, respectively more than 5 years before our interviews.

4.6. Key stakeholders

Our research identified several groups of important stakeholders, especially: owners, customers, suppliers, customers, employees, government, municipalities, civil society, media, non-for-profit organizations, potential customers, ranking agencies, students, educational institutions, research institutions.

Majority of companies is aware of the importance of dialog with these stakeholders and strives to communicate with them via various communication channels.

4.7. Highlighting the importance of going over and above the legal requirements

An interesting key topic, which was highlighted by minority of companies, is "going over and above the legal requirement". One of these organizations stressed that thanks to voluntary initiatives in the area of health and safety several lives were already saved. Another organization has voluntary sustainability-related initiatives included in vision – "Our organization is committed to its vision to contribute to increased quality of life in all its forms. This decision relates to the safe

and thoughtful production and trade, and the voluntary adoption of sophisticated internally as well as externally oriented commitments over and above the legal requirements.”.

We consider such approach as highly responsible and in fact, organizations which mentioned this issue belonged among leaders in the area of sustainability.

5. Conclusions

In our interviews we identified several key themes relevant from the viewpoint of our research question.

First, existence of a vision related to sustainability. We found that leading companies in the area of sustainability have such “formal” definition/vision of sustainability nevertheless they are in several cases reluctant to use it in internal communication and prefer more humanistic approach.

Second, understanding sustainability in general. In this regard our findings confirmed that companies understand sustainability in the sense of triple bottom line or in a more narrow sense.

Third, specific activities in the area of sustainability revealed a huge amount and diversity of activities and these are outlined in chapter 4.3.

Fourth, in the area of motives for and against involvement in sustainability our research in comparison with Berns et al. (2009) displayed numerous similarities, but also some differences. As regards to motives for sustainability related initiatives, it seems that among our respondents employees’ interest in sustainability is by majority of our respondents not considered to be an important driver of corporate sustainability investments. Reasons for this fact may be grounded in a different mindset of people in the Czech Republic (in comparison with people in advanced economies, who may consider sustainability related issues more appealing), but this assumption would need more detailed investigation. The most often mentioned motive for engaging in sustainability was (in accordance with Berns et al., 2009) increase of reputation.

Fifth, we explored when companies began with sustainability related initiatives and our interviews revealed that at least some initiatives were employed more than 5 years before our interviews by nearly all respondents. On the contrary, relatively new is for majority of companies reporting on sustainability issues.

Sixth, we identified key stakeholders without any surprising findings. Nevertheless it seems that companies more and more accept the fact that for their sustainable existence is necessary dialogue with key stakeholders and behave accordingly (via internet, brochures, educational activities etc.).

Finally, only minority of companies explicitly mentioned the importance of systematically going over and above the legal requirements in the area of sustainability initiatives. Nevertheless there are leading companies that are aware of the importance of such approach and actively conduct pilot projects in this area hoping to differentiate from their competitors.

Last but not least, no one of our respondents mentioned sustainability accounting as an important tool for information support of sustainability management and reporting. Further research is needed to explain this observation. We suppose that functions, which are in literature ascribed to this system, are in the businesses domiciled in the Czech Republic conducted by other departments/functions or are just differently named.

6. Acknowledgment

This paper describes the outcome of research financed by the Internal Grant Agency of the University of Economics, Prague, Grant No. F1/42/2014 (IG107014).

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IT PROJECT PERFORMANCE MANAGEMENT

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Keywords

Governance, GEIT, project governance, project performance management, project performance attributes, project performance measures, total project value

Abstract

Everyone seems to agree that we need to invest in IT to grow the business, but we can notice very little advice on how to identify the right investments to make. The paper provides positioning of the IT project performance management within the enterprise governance of IT. It presents examples of guidelines for this problem solution (PMBOK, MIT, Val IT, Cobit 5). The difficulties with the total project value setting are summarized and model of project performance metrics is introduced together with the comments about its infrastructure (practices, responsibilities, tools).

1. Introduction

Looking into the history, Enron scandal in 2001 became not only a well-known example of wilful corporate fraud and corruption, but in the same time it brought into question the accounting practices and activities of many corporations all over the world. Thus it initiated the new era in corporate management system that highlights next principles:

- Rights and equitable treatment of shareholders
- Interests of other stakeholders
- Role and responsibilities of the board
- Integrity and ethical behaviour
- Disclosure and transparency

Despite the fact that in the documents accompanying the introduction of these principles into practice, there is no word on IT, one of the biggest changes occurred just in this area, more precisely in the performance management aspects of IT.

The main aim of the paper is to introduce the model of system for IT project performance management. Firstly the mutual relationships between the Governance of Enterprise IT (EGIT), project and performance management are discussed. Next the different approaches and best practices on project performance criteria/metrics are introduced. On the base of this short survey a model of the project performance system is presented. Last part of the text focuses on the infrastructure issues of the whole system.

2. Performance Management as an Inherent Part of GEIT and Project Governance

The terms ‘governance’, ‘enterprise governance’ and ‘GEIT’ may have different meanings to different individuals and enterprises depending on (amongst others) the organisational context, e.g., maturity, industry and regulatory environment, or the individual context, e.g., job role, education and experience. In each case it should not be understood as a new approach for IT management but rather enhancement of the existing approaches.

(ISACA, 2012, p. 13) defines governance as:

Governance ensures that stakeholder needs, conditions and options are evaluated to determine balanced, agreed-on enterprise objectives to be achieved; setting direction through prioritisation and decision making; and monitoring performance and compliance against agreed-on direction and objectives.

GEIT is not an isolated discipline, but an integral part of corporate governance (EGIT, 2009, p.3). (ISO 38500, 2008, p.6) sets out six principles for good corporate governance of IT (Responsibility, Strategy, Acquisition, Performance, Conformance and Human Behaviour). Performance means:

IT is fit for purpose in supporting the organization, providing the services, levels of service and service quality required to meet current and future business requirements.

While the need for governance at an enterprise level is driven primarily by delivery of stakeholder value and demand for transparency and effective management of enterprise risk, IT thanks to its importance for business, still growing expenditures and associated risks call for special but at the same time integral focus on GEIT. GEIT elevates IT from a pure managing level to governance level, which is concerned with objectives that focus on such areas as: alignment of IT with business, value and benefits of IT to the business, management of the risks associated with IT and performance measures for IT services to the business.

With significant increases in investments in IT by the business, it has become very important and necessary to ensure that tangible benefits for the business are derived from these investments. Owing to the fact, that great majority of IT investments are provided through projects and related project management it was necessary to adopt the same GEIT principles to project management. This new additional view over project management is called project governance. Project governance refers to the practices that must be in place for project success. Governance includes aspects like accountability for project outcomes; project guidance and critical decision points; stakeholder involvement; and oversight of project performance, issues and risks. The more complex a project is, the more important project governance becomes for achievement of envisaged outcomes (Transnet, 2015, p.1).

Project governance should not be confused with project management. Project management is essentially concerned with ensuring that the implementation is done within the planned time frames and within budget without sacrificing any of the key requirements, including quality, training and ensuring the defined coverage in terms of functionality and locations.

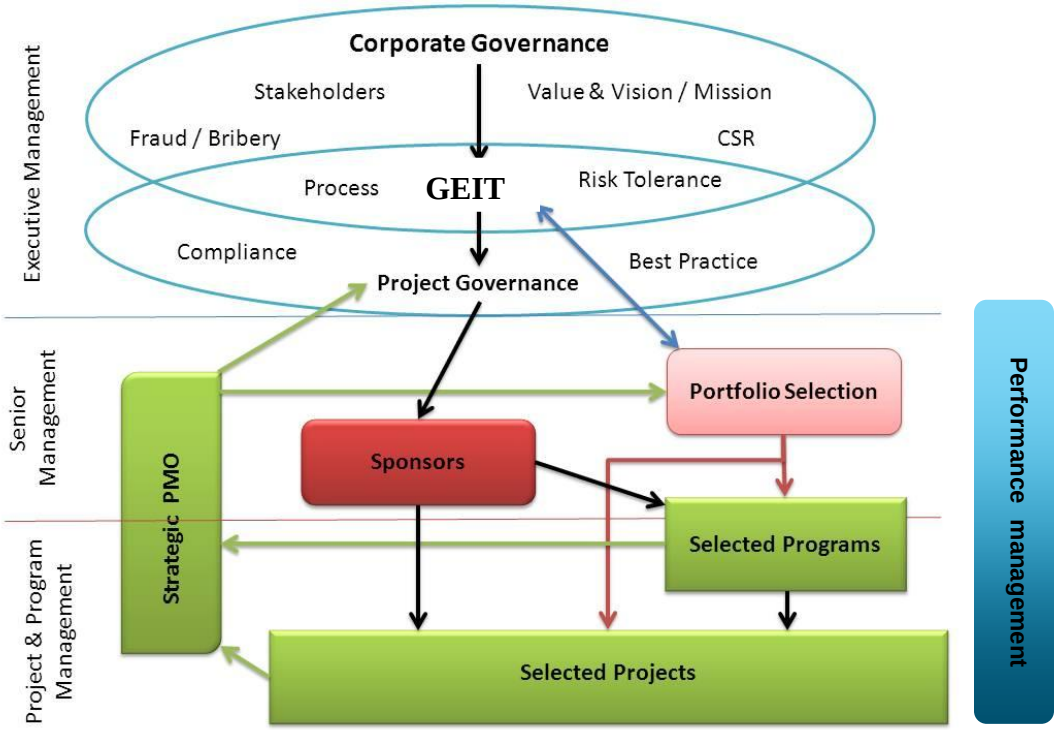

Figure 1: The framework for effective project governance (modified according to (Wordpress, 2011))

Project governance has emerged as one of the most vital corporate responsibilities. IT encompasses the project, program and portfolio governance and the governance of supporting management systems such as PMOs and project control boards (PCBs). It focuses on overseeing the management systems that ensure the right projects and programs are selected by the organization to achieve its strategic objectives, and that the selected 'few' are accomplished as efficiently as possible within the policy framework. This main focus encompasses the term project performance management and the introduction of the metrics/measures in order to be able to provide good decisions through the whole lifecycle of IT projects.

3. Criteria/Metrics of Project Performance Management

One of the main feature of project governance is the fact, that it forces the executives to focus on the pre-project management stages, i.e. on stages within which the decisions about where to invest money (what projects have the highest potential to bring value for business) and then how to manage the mutual relationships between the projects in order to balance the resource spending. These responsibilities cannot be provided without distinguishing between the three levels of project management: project portfolio management, program management and project management.

The relationship among portfolios, programs, and projects is such that a portfolio refers to a collection of projects, programs, sub-portfolios, and operations managed as a group to achieve strategic objectives. Programs are grouped within a portfolio and are comprised of subprograms, projects, or other work that are managed in a coordinated fashion in support of the portfolio. Individual projects that are either within or outside of a program are still considered part of a portfolio. Although the projects or programs within the portfolio may not necessarily be interdependent or directly related, they are linked to the organization's strategic plan by means of the organization's portfolio (PMBOK, 2013, p. 4).

Portfolio management refers to the centralized management of one or more portfolios to achieve strategic objectives. Portfolio management focuses on ensuring that projects and programs are reviewed to prioritize resource allocation, and that the management of the portfolio is consistent with and aligned to organizational strategies ((PMBOK, 2013, p. 5).

Performance management and related metrics should follow the same project management levels. Hereafter for simplicity will not be discussed the program level.

(Heiskanen, 2012) states, that „portfolio criteria are measured as expressed by an organization's strategy or as estimated variables. Portfolio criteria are suited to classification and evaluation; they can be financial, strategic or tactical. Portfolio criteria change with strategic changes. The criteria should be sufficiently comprehensive, but at the same time universally applicable to facilitate the satisfactory depiction of all types of programs". As a consequence there exist many different models of portfolio criteria.

One example is Massachusetts Institute of Technology. (Weill, 2004) lists four main criteria for IT programs imported to the project portfolio:

- Infrastructure programs, which develop an organization's information and communication technologies (ICT) infrastructure and target, for example, the advantages of scale, standardization and integration.
- Operational process/transactional programs, which develop business processes and their information management while cutting costs and increasing productivity
- Informational programs, which generate solutions related to management and communications that also aim at, for example, improved information quality and availability
- Strategic programs, which management has specified as a strategy and that create, for example, a competitive advantage or market growth4

(Val IT, 2008, p. 37) gives example of next investment portfolio categorization:

- Mandatory
- Continuity or sustaining
- Discretionary
    - Strategic (to create new products/services and enter new markets)
    - Transformational (to gain competitive advantage or major innovation)
    - Transactional (to process transactions more efficiently)

Another possibility how to classify programs and projects is BSC perspectives utilization (financial, customer, process and personnel and growth) (CBP, 2005, p.5).

(Val IT, 2006, p.16) states, that the core document in portfolio decisions is business case, which should specify next criteria, each separately for three layers (technical, operational, business):

- Outcomes (intermediate and end)
- Alignment - document addresses the two types of alignment:

[4] According to CIO Gartner survey from 2009 data percentage of each category (total IT spending) are the next: Infrastructure: 36%, Transactional 27%, Strategic: 18%, Informational: 19%.

  - Assuring that the IT-related investments are optimised to support the strategic business objectives
  - Assuring that the IT-related investments are aligned with the target enterprise architecture
- Financial benefits
- Non- financial benefits
- Resources and expenditures
- Risk drivers
- Assumptions and constrains

Probably the most complex approach to portfolio, program and project performance management provides (ISACA-EP, 2012). The document Cobit 5 Enabling processes introduces the IT process framework that identifies 37 processes situated into the 5 domains. One domain includes governance processes (Evaluate, Direct and Monitor) and four domains cover management processes (APO: Align, Plan and Organize; BAI: Build, Acquire and implement; DSS: Deliver, Service and Support; MEA: Monitor Evaluate and Assess). Two processes deal with the problem of project performance management: APO 05 – Manage Portfolio and BAI 01 Manage Programmes and Projects. Table 1 represents an excerpt of main objectives and related metrics for portfolio management.

Level	Goals	Metrics
GEIT	Alignment of IT and business strategy	Percent of enterprise strategic goals supported by IT strategic goals Level of stakeholder satisfaction with scope of the planned portfolio of programmes and services
	Realised benefits from IT-enabled investments and services portfolio	Percent of IT-enabled investments where benefit realization is monitored Percent of IT services where expected benefits are realized
	Delivery of programmes delivering benefits, on time, on budget, and meeting requirements and quality standards	Number of programmes/projects on time and within budget Number of programmes needing significant rework due to quality defects Cost of application maintenance versus overall IT cost
Portfolio management	An appropriate investment mix is defined and aligned with enterprise strategy.	Percent of IT investment that have traceability to the enterprise strategy Degree to which enterprise management is satisfied with IT´s contribution to business
	Sources of investment funding are identified and available.	Ratio between funds allocated and funds used Ratio between funds available and funds allocated
	Programme business cases are evaluated and prioritised before funds are allocated.	Percent of business units involved in the evaluation and prioritization process
	A comprehensive and accurate view of the investment portfolio performance exists.	Level of the satisfaction with the portfolio monitoring reports
	Investment programme changes are reflected in the relevant IT service, asset and resource	Percent of changes from the investment programme reflected in the relevant IT portfolios

	portfolios.	
	Benefits have been realised due to benefit monitoring.	Percent of investment where realized benefits have been measured and compared to the business case

Table 1: The goals and related metrics at the two levels of project governance (modified according to (ISACA-EP, 2012, p. 73))

4. Portfolio and Project Measurement System

The chosen examples of approaches to the criteria/metrics categorization declare, that even to the fact, that the enumeration of the total project value is the core information in project governance, we are not able to figure it up. The reasons are the next:

- Each project has many different values for different stakeholders. Therefore the project metrics should cover the whole range of different project attributes (from different stakeholder´s point of views)
- The project value is not static, it changes though the main project lifecycle stages (project initiation, execution and completion)
- The project value is not an absolute value, but relative value that must always be related to some other value (plan vs. reality, the percentage of the whole, evolution from the previous period)
- From business point of view there is a need to differentiate the project value and portfolio value. The total project value can be assessed by the help of outcome measures (lag indicators); when taking in account portfolio management level, the KGI at project level are becoming performance indicators for portfolio value assessment (lead indicators).

The design of effective and efficient portfolio and project measurement system is thus extremely difficult problem. Table 2 is an attempt to provide basic framework for solving this problem.

The model is based on three basic stages of project management: initiation, execution and completion. For each stage the table states examples of the most common attributes and related measures. Project initiation attributes are viewed as goal measures, project execution attributes as performance measures and project completion attributes as portfolio measures (portfolio value depends on both the project goal measures and performance measures).

Total project value	
Project initiation attributes (goal measures)	
Costs	Project budget, funds allocated, impact on operating costs
Time	Delivery date, number of men/days
Quality	Number of milestones, number of user acceptance tests, number of outputs needing significant rework due to quality defects
Outcomes	Description of the project goal, project outcomes
Strategic alignment	Identification of the project category
Financial benefits	Value of planned benefits
Non-financial benefits	Level of user satisfaction, better image
EA alignment	Project adheres to defined state of EA

Risks	The value of associated risk
Project execution attributes (performance measures)	
Project management process performance	Level of adherence to standard project methodology, maturity level of project management
Team collaboration	Level of satisfaction, project team members fluctuation
End-user collaboration	Percent of stakeholders effectively engaged, percentage of business people participating in project
Actual and planned values comparison	Number of performance targets met, percentage of budget utilization vs. approved budget, percentage of time spend vs. output delivery
Project completion attributes (portfolio measures)	
Satisfaction with portfolio	Percentage increase in portfolio value over time, level of the satisfaction with the portfolio monitoring reports, percent of certified or trained project managers,, percent of projects following project management standards and practices
IT contribution to business	Percent of IT investment that have traceability to the enterprise strategy, degree to which enterprise management is satisfied with IT´s contribution to business,
Resource utilization	Ratio between funds allocated and funds used, ratio between funds available and funds allocated , percent of stakeholders participating in projects (involvement index), TCO
Changes and deviations	Percent of investment where realized benefits have been measured and compared to the business case, percent of changes from the investment programme reflected in the relevant IT portfolios
Financial benefits	ROI, NPV, payback period, percent of investment where realized benefits have been measured and compared to the business case
Portfolio mix	Percent of portfolio spend in different project categories (e.g. infrastructure, operational, informational, strategic), percentage of portfolio in Short/Medium/Long-term projects or in Large and Extra Large Projects

Table 2: Examples of portfolio and project attributes and measures

On the base of the model project portfolio evaluation can be provided and decisions can be done. The resulting structure of project portfolio can follow the next categories (Heiskanen, 2012):

- Active projects:
  - Terminate, Suspend, Mothball
  - Continue with changes
  - Continue as planned
- Project proposals:
  - Discard, Mothball
  - Start with changes
  - Start as proposed

5. Conclusion

The above description of the approaches to project performance criteria/metrics setting declares the fact, that currently there is no problem to identify the usable performance metrics of different

aspects of project management. The main problem is to choose the right mixture of them and thus balance the costs of their implementation, operation and resulted benefits.

The mixture of mandatory attributes can be further supplemented by weights, which sets out the priorities for each attribute.

Before system starting there is a need to specify the whole infrastructure enabling performance system operation. This infrastructure includes:

- Processes/practices description at the portfolio management level (e.g. establish the target investment mix, determine the availability and sources of funds, valuate and select projects/programmes to fund, monitor, optimise and report on investment portfolio performance., maintain portfolios, manage benefits achievement
- Process/practices at the project management level (e.g. maintain a standard for project management, start up and initiate projects, plan projects, manage project quality, manage project risks, manage project resources and work packages, close a project or iteration)
- Setting responsible and accountable roles at the portfolio management level (there should be shared responsibilities between the board members, CFO, CEO and Strategy Executive Committee)
- Setting responsible and accountable roles at the project management level (Steering Project Committee, PMO, project managers)
- Supporting tools either in the form of Excel tables or more sophisticated software packages enabling all the stakeholders easy communication and data sharing.

We can conclude that implementation of the project performance system as an important part of project governance is not easy and it meets itself all the characteristics of the project management. But does it have chance to become one project of accepted project portfolio while before its approval there is no objective evaluation system?

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REFERENCE MODEL FOR COST ALLOCATION AND PROFITABILITY MANAGEMENT AND INFLUENCE OF INTERNATIONAL NORMS

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Keywords

Corporate Performance Management, International Norms, Reference Models

Abstract

The proposed model deals with cost allocation and profitability management in business informatics. This paper provides information about relations among proposed reference model for cost allocation and profitability management and national and international norms, methods and models that should be taken into account during design phase. This paper identifies the most important norms that influence proposed models, their relationship to designed model and their applicability in dimensional view.

1. General

Economy, their changes and overall behavior of companies and national and international governance caused changes in internal company management. Influence of governance is visible especially in increasing number of international norms that are not yet mandatory but we can expect, that at least some of them will be mandatory in future times.

Measuring results and performances have a long tradition. Rapid development in this area is visible especially in last ten years and this development can be split into two groups. The first group is especially about development in the area of norms and processes how the measuring should be realized and the second group is about development of tools for measuring results and performances with the support of information and communication technologies (ICT).

This paper aims to present a conceptual Reference Model for Cost Allocation and Profitability for efficient management of corporate informatics (REMONA) based on the principles of Corporate Performance Management (CPM) and the most important international norms that had to be taken into account during design phase of designing REMONA model. Through this paper, a discussion about norms and their general impact into economy and into the REMONA should be started and to obtain feedback and opinions if it is really necessary to implement these norms into similar models. The REMONA model is proposed as part of an academic project of the Faculty of Informatics and Statistics at the University of Economics in Prague in association with the companies Profinit, s. r. o., Lodestone Management Consultants, A.G., AM-Line, GmbH.

2. State of the Art

Research done in the last decade (Muhammad, 2010; Remenyi, Bannister, Money, 2007; Maryska, Wagner 2013; Maryska, Novotny, 2013) shows that performance management is difficult and solutions with support of ICT can improve their solution. (Variana, Farrel, Shapiro, 2004; Remenyi, Bannister, Money, 2007; Cookins, 2009).

Management of the economy of business informatics is an area which has to be addressed in detail in the context of the management of an entire company. (Chen, 2004; Hanclova, Doucek, Fischer, 2015)

Cost allocation, pricing, and profitability that are the most important task solving by the model, is growing in importance. Thanks to the growing importance of these tasks, managers demand detailed, accurate and up-to-date information about all individual parts of the company. (Kral, 2010; Dimon, 2013; Lomerson, Tuten, 2009; Pridavok, Delina, 2013; Dorcak, Delina, 2011; Svatos, 2014).

National and International Norms are not new but their importance and their number is increasing and national and international governance are mentioning their importance. We can expect that these norms will be mandatory in near future and we have to take into account selected norms in proposed models.

3. The REMONA

The aim of the model is to offer a technical solution that support cost allocation, planning, profitability management and workflow related to these tasks. All of these tasks are closely connected not only with definition of dimensions and metrics but also with taking into consideration of selected IT and non-IT norms.

The proposed model is based on basic requisites, limitations and requirements which must be fulfilled to ensure that REMONA can be easily and quickly implemented in a company. The most important information about model are provided in paper (Maryska, Doucek, 2014)

The design of the model is based on answers to crucial questions. What are current and expected main problems in company's economics and what the priorities of the solution? Do we use for management the approach of services and service level agreements? What key metrics are required for the management of the economics of the system for corporate informatics? Is there documentation of the management of corporate informatics and database management from which data can be obtained? How high a level of detail will be necessary for analytical tasks in the management of economics of corporate informatics?

The proposed REMONA model is designed to permit easy and quick adaptation (modification) of the solution according to the character of the answers to these questions by parametrization without high costs of additional alterations.

4. National and International Norms

We have plenty of methods and standards in current times and these methods and standards are very heterogeneous. The impact of this heterogeneously are problems with totally different terminologies, mutual overlapping of these methods and standards and in several cases we are facing with their inconsistencies.

Methods and standards even though they are not prepared for the area of information technologies directly, they are in plenty of cases use in the area of information technologies as an informal standards.

A prerequisite of satisfaction with the company's enterprise informatics is, that business informatics provides services that meet the requirements of business users of these services, both in terms of quality and price. One of the approaches needed to achieve this goal is the establishment of internal control systems and frameworks that all important parameters of services checked and compared with expectations of business customers. (ISACA, 2007) The introduction of such checks is already closely linked to the introduction of IT Performance Management System allows to control both the enterprise and business intelligence. (Lagsten and Goldkuhl 2008)

4.1. Methods and Standards of Management

Methodologies and management standards, which is addressed in this part, affect the design, operating and management of enterprise informatics. Although the methodologies and standards set out in this part are the key element that affects the draft the REMONA, taking them into account when building the model is significant.

We have plenty of Standards ISO / IEC (International Organization for Standardization / International Electrotechnical Commission). In the context of the goals and objectives of the REMONA model we will focus only on the most important that should be reflected in the model. Their selection was based on:

- their relationship to the corporate informatics and design of business information systems,
- current emphasis societal demands on their implementation in enterprises,
- their influence and relation to financial management,
- their relationship to ensure the quality of products and services provided by business intelligence.

As the most important standards and methods were identifies:

- ISO 9000 – Quality Management,
- ISO/IEC 20000 – IT Service Management,
- ISO/IEC 26000 – Social Responsibility,
- ISO/IEC 38500 – IT Governance,
- ISO/IEC 27000 – Information Security Management Systems (Basl, Doucek, 2012; Doucek, 2008),
- CobiT Framework 5,
- ITIL - IT Infrastructure Library.

In the context of the limited length of the paper we will not describe these norms and we will mention references (Maryska, Doucek, 2014) that describes all of them in high detail.

4.2. Models, Methods and Frameworks for Performance Management

Cost Allocation, cost Optimization, profitability and management of the economic situation of the whole company is one of the highest companies' priority over the world.

The importance of this area is supported by the interest of Analytical companies like Gartner, IDC, Ernst and Young etc. And also academic institutions that are analyzing this are from scientific point of view. The importance of this are can be proved by increasing amount of papers and books that handle this topic over the world.

Specific part of the management of cost and cost Allocation that are used in management of business Economics, are traditional and modern systems of cost calculations. One of the most important in current days are Activity Based Costing.

Attractiveness of this topic is from models point of view proved by the plenty of models that are supporting and helping managers to be able to analyze and manage company's economic situations. During design of our model we analyze plenty of international models, methods and frameworks. The most important that provides us new ideas and thoughts were:

- Management of Business Informatics (MBI),
- Framework for Cost Optimization in Business Informatics,
- Program for Cost Reduction,
- IT Governance & Performance Management Framework,
- Framework for Business Performance Management (FBPM),
- Other models:
    - Total Economic Impact (TEI),
    - Rapid Economic Justification (REJ),
    - Total Value of Opportunity (TVO),
    - IT Balanced Scorecard.

In the context of the limited length of the paper we will not describe these norms and we will mention references (Maryska, Doucek, 2014) that describes all of them in high detail.

5. Discussion

Figure 1 expresses a comparison of selected methods, models and frameworks through two view" dimensionally-economic point of view, i.e. through the multidimensionality and economic management. Models that are the most supported from both point of view are FITPM, MBI and ITGPMF. These models are in the right upper corner. These models differ only slightly in the level of support in the dimensional and management view. On the other side is standard ISO / IEC 9000 that is not focused on the area of the economy and also not prepared for targeted support of multidimensionality. For this reason, together with ISO / IEC 26000 is located in the lower left quadrant. Other norms as displayed on the picture are usually more concerned on measurement of economics or on support of multidimensionality.

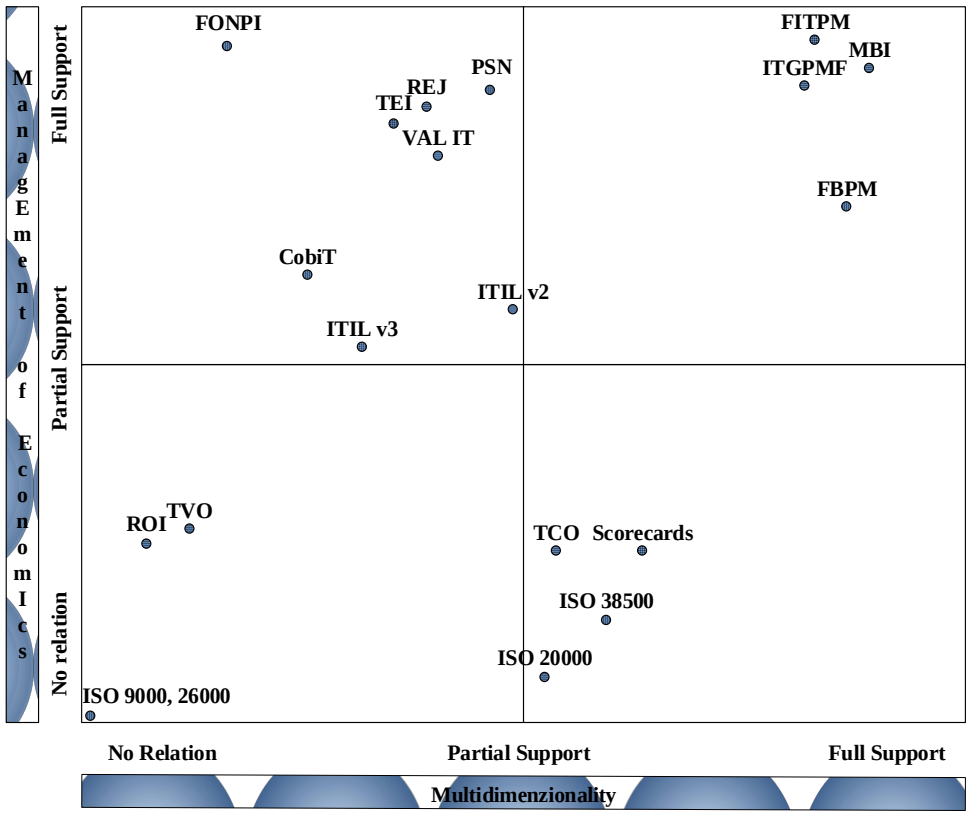

Figure 1: Readiness of methods, models and framework on multidimensional view and management of economics, Source: author

A second look at the models for the management of the economy is a dimension of support (orientation) on the management of ICT. This view is shown in Figure 2. This figure shows that the models MBI, ITGPMF, VAL IC and ITIL v2 / v3 are looking management support informatics very balanced and the differences between them are mainly focusing on economic governance. At the opposite end of the spectrum is similarly as in previous figure ISO 9000 and 26000, which are of a general nature and not supported by financial management, and are not focused on the area of informatics. Specific placement point Scorcards, which in its original form does not have the support of IT management, but in its modified form (IT Scorecard), this support is included. For this reason Scorecard placed in partial support.

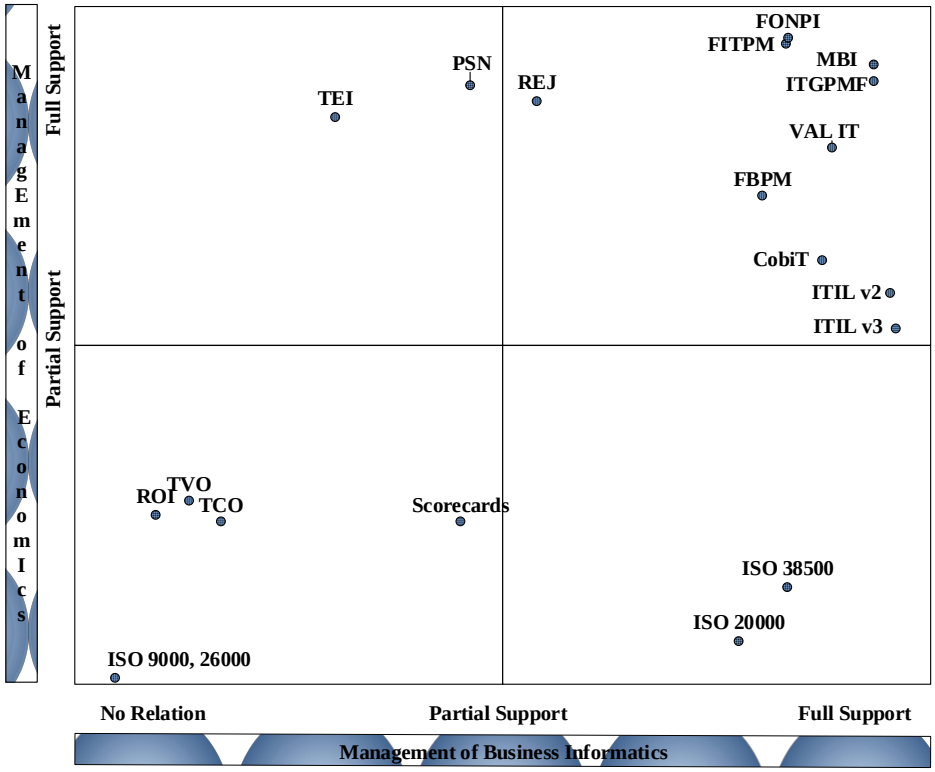

Figure 2: Readiness of methods, models and framework on from the view of management of economics and management of business informatics, Source: author

Figure 3 analyzes the selected methodologies and standards in the context of the model MBI, respectively how are (beige and red) or may be (green), these models within MBI covered. Marked yellow part is the field of economy of enterprise informatics, which is addressed under the habilitation thesis.

As shown in FIG. 3 Obviously, MBI model is proposed very comprehensive and covers a wide range of existing methodologies / standards. In the field of economy of enterprise informatics it is then mainly focus on management, respectively cost reductions that will be in the context of this habilitation thesis extended the area of a new perspective on cost allocation and profitability management.

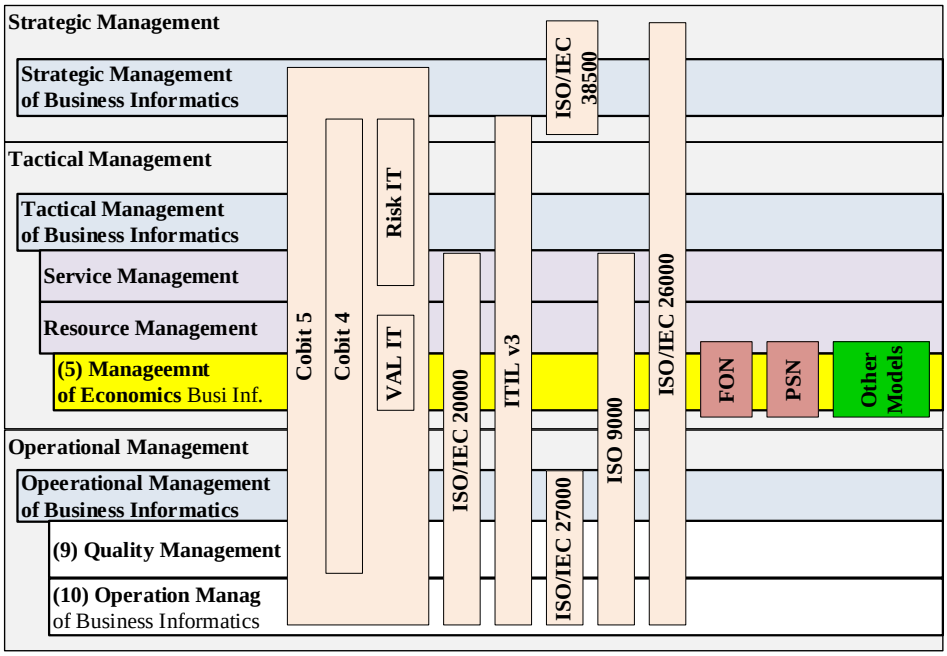

Figure 3: Methods, Standards and Frameworks in the Context of Reference Model for Management of Business Informatics, Source: author

6. Conclusions

There are a large number of approaches that are more or less intertwined. For this model were chosen those which the author considers the most important. In the context of our model can be analyzed all methodologies, standards, frameworks and models divided into two groups. The first group covers the methodology and standards. The second group focuses more on models and frameworks for management. Partial overlapping between two groups is presented by CobiT and ITIL, which can be classified into two groups.

For designed model REMONA is an important model MBI, which is part of his management of the economy Business Informatics expanded this work. MBI is specifically mapped on standards analyzed and identified areas in which mingles with them or is / will be adjusted in their context.

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CHALLENGES FOR BUSINESS PROCESS MODELING IN CONTEXT OF THE CPM

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Keywords

Corporate Performance Management, Business Process Modeling, Methodologies

Abstract

In this paper we focus on business process modeling which we consider as an important part of the Corporate Performance Management (CPM). The methodologies connected with the CPM are built on business processes and although they all built on the basis of the same business processes, their business process models differ as their requirements do. We see this as a challenge for the business process modeling since the efforts, connected with a redesign of business process models according to individual requirements of different methodologies, are high. In this paper we try to define what these challenges are and what issues it is necessary to overcome in order to be able to minimize the necessity to redesign the business process models for individual methodologies.

1. Introduction

As the pressure on business performance efficiency throughout the different businesses grows, the businesses try to implement different measures according to different methodologies. The gradually growing effort to manage the corporate performance, enabled by the possibilities the ICT offers, revealed a need for consolidation of different initiatives done or running in the businesses; often according to different methodologies. The Corporate Performance Management (CPM) approaches this issue as a relay race (Figure 1) consisting of processes, methodologies, metrics and applications required for measurement and management of corporate performance (Chandler, 2007; Maryska, Helfert, 2009; Maryska, Wagner, 2013).

As the figure suggests we can consider the business processes as the foundation for the following metrics, methodologies and applications and as such the importance of their solidness is crucial for the rest of the components. Any distortion in them may lead to questioning the reliability of results delivered by the other CPM components. This would not only lead to the reanalysis of the reality and necessary redesigns of the existing business process models, but also to reviews and redesigns in the other CPM components.

In this paper we go by the hypothesis, that there are challenges the business process modeling has not dealt with yet and that these challenges keep the CPM components from taking full advantage of the created business process models without necessity of their substantial redesigns.

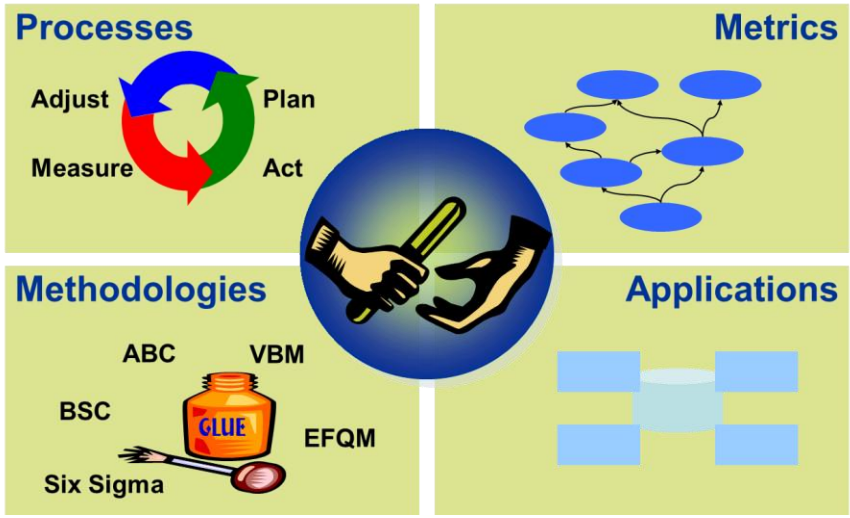

Figure 1: CPM as a Relay Race (Chandler, 2007).

2. CPM and Business Process Modeling

As the Figure 1 depicts, the methodologies related to CPM are based on business processes and their management. Some work with the business processes at general level some in detail. The figure presents just a sample of methodologies one can encounter in the CPM related literature. In this paper we will focus on those that not only recognize the importance of the business process management but also work with the individual business processes and their basic elements i.e. activities. Such methodologies, we have encountered, are Six Sigma, Lean Six Sigma, Activity Based Costing (ABC), Theory of Constraints and Total Quality Management. All these work with the business processes in detail and it is important for their correct application to have the business processes well mapped.

The business process modeling becomes very important in this case as the process of mapping of the business processes into models defines the basic elements and structures. The business process models are abstract vision of the reality the methodologies then work with. The abstraction is helpful in order to be able to conceive the reality, on the other hand it disconnects one from the reality – the models become the perspective the reality is viewed from. Since every methodology has different requirements or accents on abstraction, it is a real challenge for business process modeling languages and business process modeling methods to take all these differences into consideration when mapping the business processes.

3. Challenges

Looking into the methodologies, we have listed above, we have identified two main challenges, with which one has to deal with when mapping business processes in context of these methods: at what level of detail the business process models should be made and how business process modeling should work with activity attributes, which the methodologies use.

3.1. Level of Detail

Authors like Bahnub (2010) and Cokins (2001) generally agree on importance of the appropriate level of detail of a business process model, but the guidelines they provide are very loose. The

methodologies itself do not provide the readers with a clear method. Mostly they leave it up to the analyst and specify what all aspects should one take into consideration when setting the appropriate level of detail. These recommendations, of course, among the methodologies differ as their goals differ.

Generally too high or too low detail is not appreciated. Too high detail increases exponentially model's complexity and the benefits of the higher precision of the model are outweighed by the costs of the complexity – complicated maintenance of the model and complicatedness of its interpretation. Too low detail on the other hand may harm model's precision significantly and that would strongly limit its usage and applicability.

The methodologies like Six Sigma (Gygi, Williams, DeCarlo, 2012) or Lean Six Sigma (Morgan, Jones, 2012) do not deal with the business process modeling in detail. They leave it up to different methodologies and focus on what one should do when managing or redesigning them. As the origin of these methodologies is in manufacturing and the methodologies are usually presented on simple stream line business processes, it is not surprising then that the need for some complex business process modeling methodology is not the primary issue for them. And yet business process models made at appropriate level are required by these methodologies as the following chapter on activity attributes shows.

Some discussion (Cokins, 2001; Maryska, Novotny, 2013; Maryska, 2014) on the appropriate level of detail we can find in context of ABC as it usually has to deal with the complexity of the whole company and not just one business process. In the ABC the appropriate level is dependent on the activity cost drivers (Figure 2). The appropriate level is set when each activity has an activity cost driver assigned (which in general fits the activity) and it does not make sense to split the activities in further detail as it would introduce further activity cost drivers but with insignificant effect on accuracy of the cost allocation model.

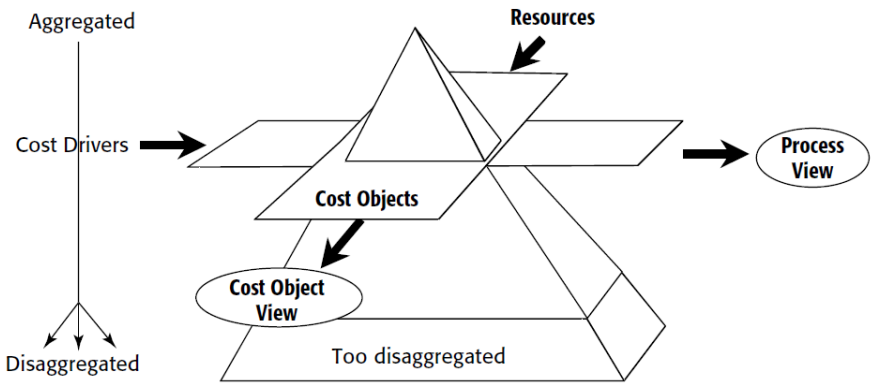

Figure 2: Three-Dimensional View of the Level of Detail in ABC (Cokins, 2001)

As some methodologies appreciate the detail, some on the other hand appreciate global overview too. Theory of Constraints (Cox, Schleier, 2010), for instance, tries to find bottlenecks in a process throughput and unlike the ABC, for instance, which focusses on activity cost allocation and management in individual processes, it focuses on the global level too. Searching for a constraint, one may realize that the source of the constraint is a resource in some supporting process and therefore the global overview, mapping the relations among business processes, is necessary.

Different detail appreciated by a different methodology can causes troubles with usage of business process models if modeled according to one methodology only. One model, which was created for

the purpose of one methodology, would be either too detailed or too rough for another methodology and the analysis would have to be done again.

The appropriate level of detail issue is strongly interconnected with the activity attributes issue as the following chapter notes.

3.2. Activity Attributes

Throughout the application of business process management and implementation of above listed methodologies, there has developed quite useful feature bound to activities that is called activity attributes (Cokins, 2001, p. 87). It is not surprising that most of the methodologies have developed their own activity attribute sets.

Six Sigma primarily differentiates either value adding (VA) or non-value adding (NVA) activities (Gygi, Williams, DeCarlo, 2012), which can be extended by business value adding (BVA) activities (Martin, 2008). On contrary Cockings (2001, p. 90) suggests that it is better to discard the VA versus NVA dichotomy with a different set of words that scale along a continuum and better describe levels of importance (e.g., critical, necessary, regulatory, or postponable.). Further on Six Sigma also uses attributes capturing each activity processing time in form of parameters of normal distribution (Martin, 2008). This can be extended by another set of activity attributes brought by the Lean Six Sigma (Morgan, Jones, 2012) such as cycle time, changeover time, lead time, takt time, which we can find in a value stream map.

The ABC works with different activity attributes (Cokins, 2001): allocated activity costs, individual activity cost drivers, differentiation of fixed/variable costs, or production, batch and sustainable costs. In case of the Time Based ABC (Kaplan, Anderson, 2007) there are collected processing times of individual activities or other allocation factors.

Total Quality Management through the Cost of Quality Classification (Campanella, 1999) suggests hierarchy of activity quality attributes presented in Figure 3.

The presented overview shows that there are many attributes used and usually each set is specific for individual methodology. What they have in common are the activities, which we can find in the business process models. In order to support these methodologies the business process modeling should be able to somehow incorporate the activity attributes into the mapping process. The ability to work with the activity attributes is not only important for the individual methodologies, but, as Cockings (2001, p. 88) suggests, they bear a great potential for the business process management too:

“Some practitioners of ABC/M believe it is the use of “attributes” that really brings power to ABC/M analysis. This implies that the attributes information may be more important than the traced and assigned cost data that are so fundamental to what ABC/M is doing.”

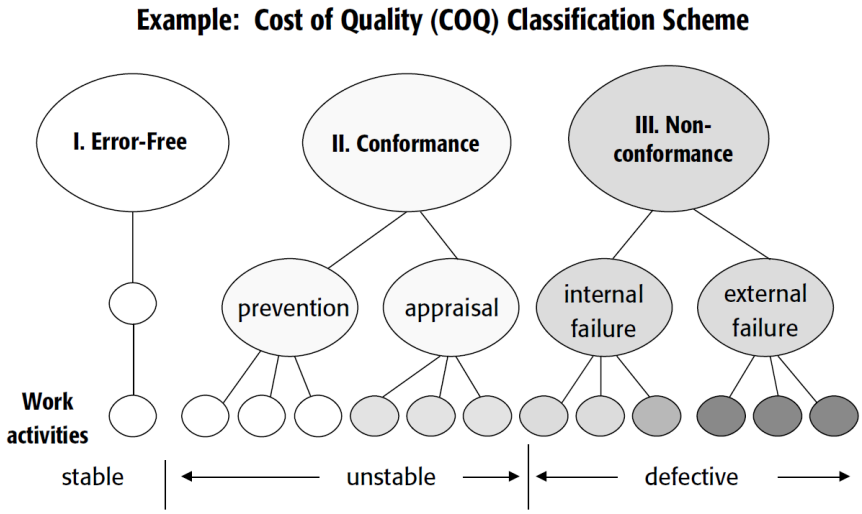

Figure 3: Quality Activity Attributes (Campanella, 1999).

The activity attributes have also an impact on the selection of appropriate level of detail since the attributes also require appropriate level of detail at which it makes sense to use them. Obvious example is the ABC's activity cost driver attribute mentioned above (Figure 2), but also others, like the quality attributes for instance that make sense to use only at certain level of detail.

4. Current State of the Art

If the business processes are modeled for each methodology separately, the produced models are likely to be unusable for each other due to the two described challenges and the business process modeling process has to be performed again. In order to avoid that there should exist a business process modeling method which would be aware of these two issues and so it would minimalize the necessity of reanalysis of the business processes. Looking into the contemporary business process modeling we don't see one.

First we have looked at what modeling tools and methods the managerial literature, for the methodologies listed above, suggests. There are generally two modeling techniques referenced: the flowcharts and value stream maps (VSM). The flowcharts are used as the main tool for business process modeling (Arthur, 2010), but the mapping method is supplied individually by the general rules in the individual methodologies. The value stream maps are specific abstractions of usually production processes focusing on measuring of process output delivery time and the factors which are important for smooth process flow. This perfectly fits the Lean Six Sigma needs. The VSM, in a single view, provides a complete, time-series representation of one stream of activities - from beginning to customer (Sayer, Williams, 2007).

Either of these techniques does not provide us with a solution for the challenges stated above. The flowchart is a modeling technique, which is unaware of activity attributes and setting the appropriate level of detail leaves upon individual methodologies. The value stream map is a specific model for specific methodology and, although, it is aware of some of the activity attributes, its usage is very limited outside the "lean" world. We cannot consider it as generally usable tool for business process modeling.

If we look at the business process modeling standards used in the business process reengineering branch like the EPC, BPMN, or UML activity diagrams, we can see that their approach is more

general, like the flowcharts', but the challenges pointed out are still outside of the scope of their standards.

4.1. Level of Detail

Throughout the standards it holds true that the purpose of a business process model is the core parameter, which defines the appropriate detail a business process model should be modeled at (Object Management Group 2013a, 2013b).

In general there are two levels of detail used in business process modeling (Řepa, 2007). For the global overview there are global diagrams like the Eriksson-Penker UML extension used and the detailed models are captured in standard business process modeling languages like the BPMN, EPC or UML activity diagrams. Global business process models provide users with a business overview from the business process perspective and they also capture the important intra-process relations. The detailed models provide then detailed information for the analysis and management of the individual business processes. In detail one may work with unlimited number of levels of abstraction (i.e. detail) and it is upon the analyst to decide what the appropriate level is. Common sense and the target usage of the business process model are the measure for setting what the appropriate level is (Object Management Group 2013a, 2013b). The standards itself do not set the level. Methodologies that surround these modeling languages may set the detail level, for instance the MMABP (Řepa, 2007), but they always name the purpose of the models, this level is appropriate for. We have not encountered a business process modeling methodology that would be aware of most of the CPM related methodologies listed above and that would incorporate the required level of detail of individual methodologies into one that we could call as the definition of the common appropriate level of detail for these methodologies.

4.2. Activity Attributes

Standards like the BPMN and UML activity diagrams are not aware of any activity attribute we have discussed above. If there are being introduced extensions, they are focused on one methodology only and the activity attributes are captured as artifacts i.e. activity annotations (Lourenço, 2013), (Wynn, Low, Nauta, 2013).

EPC is used as a business process modeling language in the ARIS platform, which is aware of process cost accounting and ABC (Davis, Brabänder, 2007), but only in data tables outside the EPC diagrams. These are then used for cost evaluation and process cost simulation. Other attributes, discussed above, are outside of the ARIS's scope. EPC itself, same as the UML activity diagrams or BPMN, is not aware of the activity attributes and one can use only the general text comment artifacts to assign them (vom Brocke, Recker, Mendling, 2010).

The business process modeling standards do not provide an analyst with guidelines what attributes to collect and how. They leave the management of activity attributes up to the individual methodologies and so the activity attributes keep piling up in different tables, as different projects are executed, instead of being part of one business process model.

5. Conclusions

In this paper we have shown that the business process modeling languages and standards are generally applicable, but for modeling in context of the CPM there is necessary to extend their abilities in order to be able to take full advantage of the development, which has been done in different business performance management methodologies. We have identified two problematic

areas for the contemporary business process modeling methodologies in context of the CPM which keep the other CPM components from taking full advantage of the created business process models without necessity of their substantial redesigns. We have shown that there is a business process modeling method and possibly also a business process modeling language extension missing, which would be able to incorporate the following identified missing features:

- Awareness of the purposes of individual methodologies relevant for CPM and an ability to set the appropriate level of detail which would fit these methodologies in general.
- Guidelines on:
    - What activity attributes to collect.
    - How visually present the collected attributes and their values in a business process model.
    - What evaluations can be done already on the basis of modeled business processes and collected activity attributes.

Figuratively speaking, the modeling method should somehow glue together (as illustrated in the Figure 1) the individual processes of business process modeling which take place during implementation of the individual CPM relevant methodologies so that the created business process models would have the appropriate level of detail for all of the CPM relevant methodologies and a model redesign would have to occur only rarely in some details.

Further on the method should state what activity attributes are in what case reasonable to collect, when doing the business process mapping, and what requirements they have on the level of detail of a business process model. Activity attributes should not just keep piling up in different tables, as different projects are executed, instead the method should make them a part of the visual presentation of the business process models i.e. the diagrams.

Activity attributes and their values, when collected during the initial business process modeling stage, may become very useful for the initial business process analysis. Our ability to work with them in this initial stage may lead to different decisions than if not collected. This extension of the initial analysis may also help to identify a need to start other projects in order to investigate and resolve performance problems. The business process model would work as common starting point for the individual methodologies and would be valuable source for decision what methodology implementation is reasonable.

As the business processes are a core component of the CPM we see as vital for further adoption of the CPM related methods and methodologies to provide analysts and developers with a method that would incorporate the requirements on business process models and modeling, the different methodologies have. The goal should not be to substitute the methodologies with one all covering methodology, but to provide a business process modeling method which would be able to help to build firm foundations, the individual methodologies can build on. This is what the future research, in our opinion, should focus on.

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APPLICATION OF WINGS METHOD IN CRM PERFORMANCE MEASUREMENT

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Keywords

Customer relationship management, CRM Scorecard, performance measurement, WINGS

Abstract

Customer relationship management (CRM) is the core element in relationship marketing that is considered more and more essential for a successful company. Companies manage their own customers´ databases and according to segmentation of the customers, the company can adapt the communication process forming the relationship with them. The advantages, which CRM strategy provides, are for example higher revenue, bigger market share or higher loyalty of customers. This research examines the application of the WINGS method for the CRM performance measurement. WINGS method identifies mutual influence and relations among factors and also determines the central (key) factors with respect to the importance of the factors. WINGS method belongs to MADM methods while pairwise comparison is used for factors evaluation. The aim of the paper is to identify possible relations among factors measuring CRM performance. The sub-aim is to determine key factors for successful CRM strategy for the company. In the first part of the paper, theoretical base is described considering CRM performance measurement. Research methodology introduces the WINGS method. The following part of the paper deals with the application of the WINGS method in CRM Scorecard model (one of the possible model used for measuring CRM performance). The results show the organizational performance factors as the most important factors, they are receivers of effects. It means that these factors are affected by the others - process perspective, customer perspective and infrastructure factors, too. As the key factors we can identify profitability, customer satisfaction, customer retention, management attitude and clear goal setting.

1. Introduction

According to Blattberg et al. (2001), Customer Relationship Management (CRM), a management philosophy that focuses on the nurturing of customer relationships, emerged as a response to decreasing customer loyalty and increasing competition. An understanding of how to manage relationships with customers effectively has become an important topic for both academics and practitioners in recent years. Companies want to calculate CRM implementation success, quantify the level and performance of the CRM concept, for example in comparison with competition or in time. It must be said, there is no one and only concepts that is the best for every company. CRM systems are designed mostly individually and that's why their performance measuring differs too and is very flexible. Different authors describe several methods or possibilities how to measure

CRM performance, for example Balanced Scorecard (Kaplan & Norton, 1992) or CRM Scorecard (Kim & Kim, 2009), CRACK model (Chlebovský, 2005) or quantification of monitored factors without using any concrete model. These methods are mostly general, so we have to adapt them in the concrete situation, for a concrete market or company.

The main aim of the paper is to identify possible relations among factors measuring CRM performance. The sub-aim is to determine key factors for successful CRM strategy for the company. This research is based on application of the WINGS method within CRM Scorecard model. We use CRM Scorecard model for its coherence and possibilities of adapting to any company. The WINGS method is used to construct interrelations between factors and to find the key factors considering the importance of established factors.

Firstly, the CRM Scorecard model is specified in the next chapter. Secondly, as the research methodology, the WINGS method is described. In this chapter the procedure of usage WINGS is shown. The following part of the paper deals with the application of the WINGS method in CRM Scorecard model. In the conclusion results and future research steps are summarized.

2. CRM Scorecard model

Kim and Kim (2009) worked with Balanced Scorecard model (Kaplan & Norton, 1992) which they adapted for customer oriented companies. They developed the CRM Scorecard model. The CRM Scorecard model evaluates contemporary CRM performance level and readiness of the company for future implementations. The model operates with factors influencing CRM performance and factors influencing successful CRM system implementation. This model is more comprehensive, it is focused on the customers and company's CRM strategy. Factors are divided into four groups, see Table 1. Each group of factors contains several specific measurable variables, by which managers can evaluate the CRM performance level. By applying a multiple criteria decision making method (MCDM), we can calculate importance indices of the factors and we can modify the CRM Scorecard model for the individual company.

Kim and Kim (2009) applied the CRM Scorecard model for the Korean bank institution. Authors Shafia et al. (2011) modified the concept as fuzzy CRM Scorecard model for Iranian industrial market. Soeini, Jafari, and Abdollahzadeh (2012) adjusted the factors into the specific CRM Scorecard model for Iranian governmental corporation.

Group of factors	**F1: Organizational performance**	**F2: Customer perspective**	**F3: Process perspective**	**F4: Infrastructure**
Measuring factors	F11: Shareholder value	F21: Customer loyalty	F31: Customer acquisition	F41: Employee behaviour
	F12: Profitability	F22: Customer satisfaction	F32: Customer retention	F42: Employee satisfaction
	F13: Customer equity	F23: Customer value	F33: Customer expansion	F43: Management attitude
				F44: Partnership
				F45: Market orientation
				F46: Explicit goal
				F47: IT
				F48: Organizational alignment

Table 1 Structure of factors within CRM Scorecard model

3. WINGS method

WINGS (Weighted Influence Non-linear Gauge System) method developed by Michnik (2013) belongs to MADM methods. WINGS is based on DEMATEL method, actually WINGS is enhanced DEMATEL. WINGS (as well as DEMATEL) can identify mutual influence and relations among factors and also determine the central (key) factors but with respect to the importance of the factors. DEMATEL is not considering the importance ranking. Further text introduces DEMATEL method and the procedure of factors' importance evaluation within WINGS.

3.1. DEMATEL method

Decision-making Trial and Evaluation Laboratory method (in short DEMATEL) was originally developed by Fontela and Gabus (1976) to analyse complex problems. It is a mathematical procedure suitable for a determination of interrelations between criteria (factors) and subsequently it is used for an identification of a subset containing the effective criteria (factors) only. In comparison with the traditional methods such as Analytic hierarchy process assuming that criteria are independent, DEMATEL focuses on a depiction of causal relations among the elements of a considered system through an impact – relation map (IRM) and an evaluation of influences between criteria (Sumrit and Anuntavoranich, 2013). DEMATEL is based on pairwise comparisons and is comprised of these following steps:

Firstly, a group of *m* experts are supposed to assess a degree of a direct influence of criterion *i* on criterion *j* denoted as x_{ij} using the scale $\langle 0; 4 \rangle$. Value 0 means "no influence", number 1 goes with "an insignificant influence", 2 "a medium influence", 3 "a strong influence" and 4 "a very strong influence". Assuming *n* criteria, an *n x n* non-negative matrix is constructed for each expert and is denoted as $X^k = [\mathrm{x}_{\mathrm{ij}}^{\mathrm{k}}]$, where *k* is a number of experts participating in evaluation processes, while $1 \leq \mathrm{k} \leq \mathrm{m}$. Thus, $X^1, X^2, X^3, \ldots, X^m$ are the matrices from *m* experts. To aggregate opinions from *m* experts, the average matrix $A = [\mathrm{a}_{\mathrm{ij}}]$ has to be computed according to a formula:

$$a_{ij} = \frac{1}{m} \sum_{i=1}^{m} x_{ij}^{k}. \tag{1}$$

Secondly, the normalized initial direct – relation matrix $D = [\mathrm{d}_{\mathrm{ij}}]$ has to be calculated:

$$D = \lambda \times A, \text{ where} \tag{2}$$

$$\lambda = min\left[\frac{1}{max_i \sum_{j=1}^{n} a_{ij}}, \frac{1}{max_j \sum_{i=1}^{n} a_{ij}}\right]. \tag{3}$$

Thirdly, the total relation matrix *T* has to be derived from the equation (4), where *I* represents the identity matrix and *D* is the direct – relation matrix.

$$T = D(I - D)^{-1} \tag{4}$$

The sum of rows and the sum of columns in the total relation matrix *T* are represented by vectors *r* and *c*:

$$r = [r_i]_{n\times 1} = \left[\sum_{j=1}^{n} t_{ij}\right]_{n\times 1}, \tag{5}$$

$$c = [c_j]'_{1\times n} = \left[\sum_{i=1}^{n} t_{ij}\right]'_{1\times n}, \tag{6}$$

where $\mathrm{r_i}$ denotes the sum of i-th row in the matrix *T* and shows a total (direct and indirect) effect of criterion *i* on the other criteria. Similarly, $\mathrm{c_j}$ denotes the sum of j-th column in the matrix *T* and shows a total (direct and indirect) effect received by criterion *j* from the other criteria. In addition,

when i = j, $(r_i + c_j)$ denotes the total effects given and received by a criterion *i*. It indicates the degree of importance that element *i* plays in the whole system. On the other hand, $(r_i - c_j)$ means the net effect that criterion *i* contributes to the system. If $(r_i - c_j)$ is positive, element *i* is a net cause that affects the other criteria. If $(r_i - c_j)$ is negative, element *i* is a net receiver (result) that is influenced by the other criteria (Kashi and Franek, 2014; Shieh, Wu and Huang, 2010; Tzeng, Chiang and Li, 2007).

Fourthly, a threshold value α has to be set in order to filter out minor effects. In doing so, only the effects exceeding the threshold value will be chosen and shown in a chart called IRM. The threshold value could be either estimated by the experts or computed as the average of the elements in matrix *T* (Lee et al, 2013).

3.2. Factors' importance evaluation

The difference between WINGS and DEMATEL is in importance of factors evaluation. DEMATEL does not consider similar importance. In this research, we wanted to examine deeper relations among factors so we assessed the importance of factors. An expert appraised firstly group of factors and secondly each factor within the group among themselves. For the evaluation similar scale was used, from 0 (equal weight) to 4 (the strongest difference of weights).

4. Results

The research was conducted among 6 experts from marketing area (2 academics, 2 managers, 2 company owners). The experts were face to face interviewed by the author, data was collected in structured questionnaire.

For the CRM factors (F1 – F4) the threshold value α = 0, 0847 was computed. According to $(r_i + c_j)$ values meaning a sum of given and received effects (an overall importance) the CRM factors can be ordered as follows: F1 > F2 > F3 > F4. The organizational performance (F1) is considered to be the most important one with the value of 1,0223, while the infrastructure (F4) is the least important field in that case, reaching the value of 0,5345. Based on $(r_i - c_j)$ values the customer perspective (F2) and Infrastructure (F4) are net causes, whereas the organizational performance (F1) and process perspective (F3) are net receivers. According to Figure 1 the organizational performance (F1) and process perspective (F3) are mutually dependent on one another. It means they affect each other. What is more, the customer perspective (F2) and infrastructure (F4) influence the organizational performance.

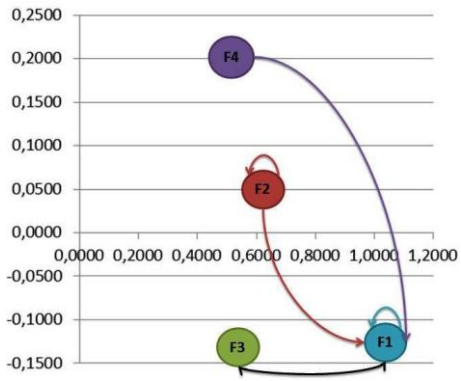

Figure 1 Engagement-position map for CRM factors

For the organizational performance factors (F11 – F13) the threshold value α = 0,1666 was calculated. According to $(r_i + c_j)$ values depicting an overall importance, the organizational performance factors can be ordered as follows: F12 > F11 > F13. The factor concerning profitability (F12) is considered to be the most important one with the value of 1,1238, then the shareholder value (F11) follows, while the customer equity (F13) is the least important criterion in that case, reaching the value of 0,8829. Based on $(r_i - c_j)$ profitability (F12) and the customer equity (F13) are net causes, whereas the shareholder value (F11) is a net receiver.

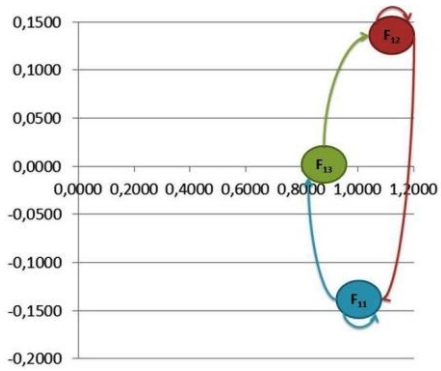

Figure 2 Engagement-position map for Organizational performance factors

According to Figure 2, the shareholder value (F11) affects the customer equity (F13) that is in relation with profitability (F12). Finally, profitability (F12) influences the shareholder value (F11). It is obvious that these factors form a network with loops connected with the shareholder value (F11) and profitability (F12).

For the customer perspective factors (F21 – F23) the threshold value α = 0,1652 was calculated. According to $(r_i + c_j)$ values depicting an overall importance, the customer perspective factors can be ordered as follows: F22 > F23 > F21. The factor dealing with customer satisfaction (F22) is considered to be the most important one with the value of 1,1560, then the customer value (F23) follows, while the customer loyalty (F21) is the least important criterion in that case, reaching the value of 0,8537. Based on $(r_i - c_j)$ values the customer satisfaction (F22) and customer value (F23) are net causes, whereas the customer loyalty (F21) is a net receiver.

According to Figure 3, the customer satisfaction (F22) and customer value (F23) are mutually dependent on one another. What is more, the customer satisfaction (F22) influences a level of customer loyalty (F21). Each factor has a significant loop which means inner dependence among sub-factors.

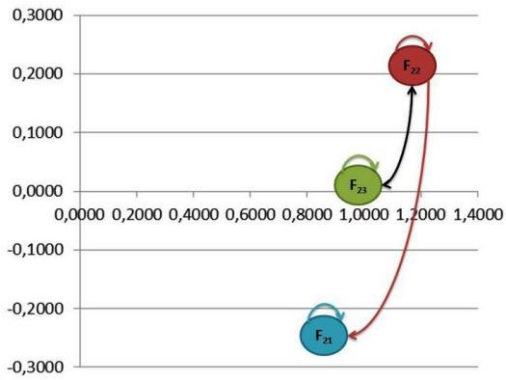

Figure 3 Engagement-position map for Customer perspective factors

For the process perspective factors (F31 – F33) the threshold value α = 0,1597 was computed. According to $(r_i + c_j)$ values depicting an overall importance, the process perspective factors can be ordered as follows: F33 > F31 > F32. The criterion connected with customer expansion (F33) is considered to be the most important one with the value of 0,9992, then the customer acquisition (F31) follows, while the customer retention (F32) is the least important criterion in that case, reaching the value of 0,8891. Based on $(r_i - c_j)$ values the customer retention (F32) is a net cause, whereas the customer acquisition (F31) and customer expansion (F33) are net receivers.

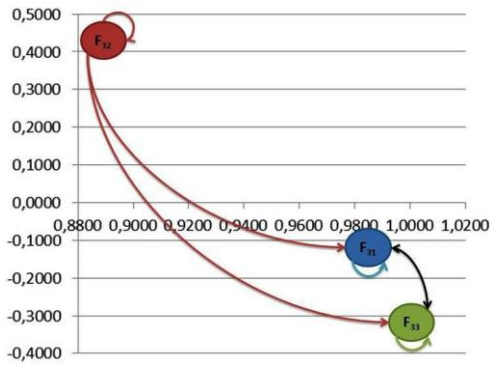

Figure 4 Engagement-position map for Process perspective factors

According to Figure 4, the customer acquisition (F31) and customer expansion (F33) are mutually dependent on one another. It means they affect each other. What is more, these factors are influenced by the customer retention (F32). Each factor has a significant loop which denotes inner dependence among sub-factors.

For the infrastructure factors (F41 – F48) the threshold value α = 0,0200 was determined by an expert. According to $(r_i + c_j)$ values depicting an overall importance, the infrastructure factors can be ordered as follows: F46 > F48 > F43 > F41 > F44 > F47 > F45 > F42. The criterion dealing with explicit goal formulation (F46) is considered to be the most important one with the value of 0,3775, while a level of employee satisfaction (F42) is the least important criterion in that case, reaching the value of 0,2257. Based on $(r_i - c_j)$ values management attitudes (F43), partnership (F44), market orientation (F45) and explicit goal setting (F46) are net causes, whereas employee behaviour (F41), employee satisfaction (F42), IT (F47) and organizational alignment (F48) are net receivers.

According to Figure 5, explicit goal setting (F46) and market orientation (F45) are mutually dependent on one another. What is more, explicit goal setting (F46) significantly affects employee behaviour (F41), management attitude (F43), IT (F47) and organizational alignment (F48). Employee behaviour (F41) is influenced by employee satisfaction (F42) and management attitude (F43). Partnership (F44) is in relation with market orientation (F45) that affects organizational alignment (F48). Finally, organizational alignment (F48) influences partnership (F44) and IT (F47).

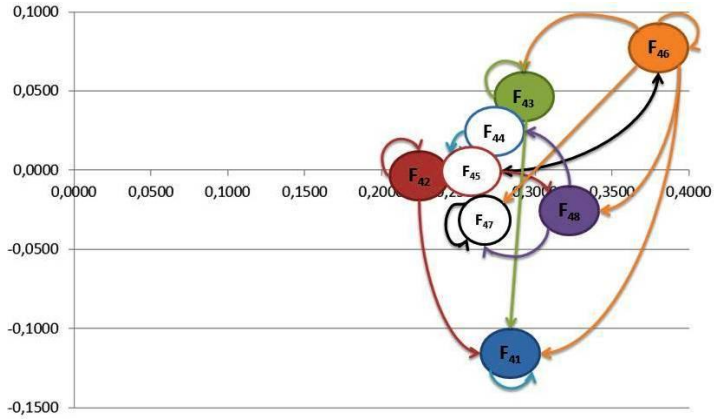

Figure 5 Engagement-position map for Infrastructure factors

5. Conclusion

The main aim of the paper was to identify possible relations among factors measuring CRM performance. The sub-aim was to determine key factors for successful CRM strategy for the company. According to our research the organizational performance factors are the most important for CRM performance measurement. These factors receive effects from the rest, this means these factors can be affected by another ones. Organizational performance factors can be considered as an indicator of successful CRM strategy. Factors such as profitability, shareholder value and customer equity are rather external factors, these create the image of the company on the market and in public.

As the key factors we can identify profitability, customer satisfaction, customer retention, management attitude and explicit goal setting. Profitability shows us directly whether the company is successful or not. Customer satisfaction is connected with customer retention (and loyalty too), satisfied customer is foundation for prosperous company. Management attitude cannot be omitted. Because managers and owners are creators of the company, they decide about CRM strategy and manage the CRM process. Their decisions are reflecting in every action and explicit goal setting (the last key factor) is not an exception.

This research was conducted among experts from different areas. The results could have been influenced by their differing opinions and experience. The research can be adapted for a specific company to explore its internal structure and processes in CRM and results can be helpful to better CRM management.

6. Acknowledgement

This paper is supported by Student Grant Competition of the Faculty of Economics, VŠB-Technical University of Ostrava (project registration number: SP2015/93 „Application of Hybrid MADM Methods in the Field of Business Administration, Management and Marketing“). All support is greatly acknowledged and appreciated.

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SESSION I: SMART-HOME SECURITY

SMART-HOME SECURITY

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Keywords

Smart-home, security, elements of security, security model

Abstract

Smart-homes are becoming increasingly popular, and many manufacturers improve their products to be "smart", "connected", or "cloud-enabled". While it is not always clear what they actually mean with these terms, communication with other devices and the ability to being controlled at least partially from somewhere else are part of it. But this increasing trend also introduces security problems: what can be controlled from a single mobile device might also be manipulated from anyone on the Internet, if no security measures are present or those existing are faulty. This paper explores these security issues and discusses what countermeasures should be present in a smart-home system to ensure security in its various aspects.

1. Introduction

Smart-home technology consists of many aspects, and sometimes it is used merely as a marketing buzzword. In practice this results in formerly individual elements of a home (or office, factory…) communicating with each other and providing some additional value, like increased convenience, through this. Therefore merely replacing the normal lighting system (switches turns on/off the power to the lamp) with an electronic one (like a WLAN controlled light bulb) should not be considered as a smart-home on its own. However, this is a required initial step, before the "smart" can be added to it, for instance controlling several lamps and the shutters together to set one of several predefined lighting scenes (unless the windows are open – sensors), increasing the room temperature (or starting cooling in summer) and turning on the music to a specific volume and with a random song of a predetermined category.

Although such a system might be very comfortable or even helpful (reducing energy consumption through automatic regulation of temperature, hot water production, or starting washing machines; alarm systems against burglars etc), there are many dangers associated with it. The first one is privacy: for the system to be helpful it needs to know a lot about the users. This might be programmed explicitly (see music category above), or determined through observation (remembering the light setting from previous uses and recreating them), potentially including other information (associated with persons: location of the user, or statistical usage profiles from other users of similar systems; or anonymous ones, like the weather forecast). A second aspect of privacy is the data transmitted (commands, sensor values etc), which may disclose information about the person(s) currently present and their activities [Robles/Kim 2010]. While privacy is interesting and important, this paper focuses on security aspects: if the door lock is not controlled by a physical key

but through a network, an intrusion into the network, the locking device, or any other device might be sufficient to unlock the door. And while all methods of physical unauthorized entry leave traces (some only accessible through dismantling the lock, however), this might remain completely unnoticed or even be attributed to someone else (e.g. the owner who should be able to unlock his door). Usability and safety aspects are excluded here too. Smart-home security in the sense of securing a smart-home system must also be distinguished from security systems integrated into a smart-home, like video surveillance or alarm systems [Zhang/Zhao/Zhang 2009]. Security here is therefore the security of the smart-home system and not the security of its users or the environment.

Because of this, smart-home security has to fulfil the typical aims of security: Confidentiality, integrity, availability. Confidentiality implies that information about the current state as well as any commands and sensor values should be accessible only to authorized persons/devices. Integrity requires that any messages cannot be altered undetected and that the state of each element changes only according to the defined stimuli. Availability is then present, if all intended users can employ all functions of the system at their discretion whenever they want.

1.1. Attacker model

When investigating security, an attacker model is required. Otherwise an identification of countermeasures is impossible even on a general level. Regarding a typical smart-home system within a private home or a small business building an attacker must be assumed to possess complete knowledge on the following elements: model and manufacturer of all elements (might be openly visible or can be obtained through observation), their properties and functions (they can be openly and cheaply bought and inspected; datasheets are probably available for free online), and at least limited knowledge about their placement and interconnection (sniffing for wireless devices and observation/logical assumptions for physical wiring). In addition it must be assumed that all normal devices are commercially available and most of them can be modified (hardware changes as well as software) or replaced by custom implementations (normal computer connected to a potentially specialized communication device). Access to the communication medium must be assumed, which is obvious for wireless communication. But for all other communications at least at some remote point access can be obtained too (“evil maid” attack, accessibility from the outside at some point etc). Also, rogue devices might be introduced e.g. by guests, so while internal attacks are unlikely, they cannot be ruled out completely [Mantas, Lymberopoulos, Komninos 2011].

It should be noted that we assume here that a smart-home system is employed for a “single entity” only. I.e., multi-tenant buildings are assumed to possess completely separate systems for each flat. Otherwise additional precautions (see e.g. segmentation below) will be necessary to ensure strict separation between devices of the separate owners. While this is a reasonable assumption, it will be incorrect in many cases, as e.g. door communication systems might connect all separate networks together, if integrated into them. Another limitation is that we focus solely on the control functions of a smart-home, but not on the individual devices themselves. If e.g. a TV decides to send some collected information (like ambient audio for speech recognition [Zeit.de]) to a cloud service directly via its internet connection, this is not covered here. Instructing the TV to do this, or determining the target of this delivery is however within the scope.

2. Elements of Security

Based on the attacker model, several security aspects need to be taken care of (see also [Changmin et al 2014] and [Enisa]).

2.1. Physical security

Preventing access to the "bus" or communication medium is typically much harder than it seems. All wireless networks are accessible by default, and even wired networks are not necessarily secure. Often at least one device can be found "outside", e.g. lights, shutters, weather stations, sirens, locks etc and if they haven't been mounted very carefully and connected to an alarm system, their communication wires will be accessible from the outside. If cryptographic keys (see below) are used, physically getting hold of a device might disclose the key rapidly, as today this is typically not tamper-resistant hardware. Therefore physical security is desirable as far as possible, but cannot be relied upon to secure a smart-home system. Some elements, typically those responsible for security functions, need to be at least partially physically secure, i.e. located in the inside and protected against normal access. It should also be noted that it is often easy to introduce rogue devices into the internal network, e.g. through giving them as a present or obtaining partial – but too extensive – rights as a guest or visitor [Kim et al 2011].

2.2. Power security

Cutting electrical power is an option to circumvent security. First, some functions will not work without power or they may possess safe (but insecure) failure modes. Secondly, when reconnecting power an insecure default value might (for some time) exist. Uninterruptible power supplies are not necessarily a help here, as they might be bled dry through introducing artificial load within a short time (or just expire through waiting). While UPS exists, not only for central servers resembling normal PCs but also for e.g. bus systems, power loss must always be taken into account and cannot be neglected. In many cases even a partial "power loss" must be considered: While the individual devices are already working again, some infrastructure elements might not (yet), e.g. because they need more time to boot or have to re-provision many devices, which cannot take place in an instant.

2.3. Password/key security

Configuration and introduction of new devices is cumbersome, if (especially in the case of cryptographic) keys must be distributed. Even more problematic are regular key updates – these would only be possible if they work fully automatic without service interruption and a fall-back solution in case of problems exists. The system developed for DNSSec could perhaps serve as a model (obviously not identically, but especially regarding key rollover). Knowledge of keys can typically not be assumed for attackers, except when physical access to a device allows its extraction (printed on label, extraction from RAM/flash/…). This means that for individual devices a compromise must be assumed, unless specific security precautions are taken. Chipcards are looking promising in this regard, as they are small, cheap, and physically rather secure.

2.4. Interconnection security

This seems to be the most difficult problem. Often (apart from large industrial buildings built from scratch) the smart-home will not consist of a single medium/system alone. Rather lighting, shutters, and radiators may follow one system, while the heating itself might be proprietary, the power generation (e.g. solar panels) might be based on another system, and integration with yet another system for media distribution (audio/video servers) could be necessary. Other elements like security systems (smoke/gas detectors, but also glass breaking sensors, door/window sensors – also important for heating, sirens, telephone alarm systems), door communication (including fingerprint sensors/keycards/tokens for unlocking), household appliances (dish washer, laundry machine, refrigerator) and information gathering (video surveillance, utility metering – electricity, water,

gas…) must be integrated too. While large parts may come from a single manufacturer and are therefore compatible, most will not work together out of the box (e.g. bought later or from a different vendor).

The result from this is that either no communication takes place, which is obviously secure but undesirable, or interfaces are needed. These can connect two individual systems directly like a media converter or interface, or provide information and receive commands from a central system responsible for integration of all sub elements. In practice, the first solution will be useful only where few elements need to interact in specific and rare cases (and protocol translation is simple), as connecting each pair of systems requires many more interfaces than connecting every subsystem to a single "master". For attackers this results in additional opportunities, as some systems might be less protected than others and interconnection devices might be used to facilitate attacks. For instance introducing a command into the AV-subsystem might be harmless because it will be ignored there completely (incorrect format, unused address etc.), but when transformed by an interconnection device and passed on it could be dangerous (and directly injecting it there might be physically impossible or might have been prevented by a security device – introducing malware by the back door instead of the front door).

2.5. Security architecture and requirements

Form a security point of view this leads to a star architecture with a central computer which can be compared to an IP LAN network: individual subnets are connected together with a router. Such routers typically possess at least some filtering options and are often full firewalls, providing extensive filtering of messages when forwarding them to other subnets (here: communication systems). But while a router normally passes messages just on, a central smart-home system often interprets all incoming messages, stores some data, and generates new and independent outgoing messages. This distinction is important from the security viewpoint. While routers pass on messages by default and filter out things deemed not acceptable, a central server does not pass on anything and generates outgoing messages only in response to a concrete configuration. Rules of the kind "pass all messages from X on to Y" should therefore be strictly avoided and transformations should never happen automatically, explicitly generating a new message instead. This has however some consequences on the overall architecture of the system. While many individual systems are fully distributed, i.e. any sensor knows to which actor it has to send commands (and in reverse actors know on which events to start their activity), this leads to a central system where all sensors report to and all actors receive commands from. Properties of systems following this paradigm strictly are therefore:

- The central server is a single point of failure: If in a distributed system a switch is no longer working, the light can still be switched from another switch and other systems are not affected at all. But if this central server has any problem, nothing will work at all. It is therefore a prime target for denial of service attacks to bring down the whole system. Similarly disrupting a communication system close to the central server will affect a large number of devices. Regarding power supply attacks this is however an improvement.
- Centralized trust: The central system issues commands to all actors, so all actors have to trust it fully. If the server is compromised, every single potential activity can be started or stopped. Physical security for it is therefore a must.
- Reachability: As every command goes through the central server, it must be able to reach all other devices and vice versa. Especially for wireless communication systems this can be complicated or may require large signal strength or amplifiers/intermediaries. However,

passing on of encrypted messages (without any ability to inspect their content) can reduce this problem. But from a security point of view this opens up new possibilities for attacks, e.g. denial of service through flooding such intermediaries with arbitrary (incorrectly signed, but this is not discoverable for the node passing it on!) messages or posing as a very well-connected system, but not relaying any messages at all.

- Unidirectional communication only: As every element communicates solely with the central system, an individual key can be used for each communication link, i.e. all sensors receive their "own" and different password. This can be used for both authentication and signature (if encrypted correctly, it must come from the other partner; complex public key cryptography can be avoided through this). Breaching a single device then does not affect other devices. Conversely this also means that a much higher communication bandwidth is required, not only at the server but also through the individual communication systems, as no multi-/broadcasts are possible any longer and commands affecting several devices must be duplicated.
- Known counterpart for incoming messages: The central server knows each device and its type, allowing it to do extensive filtering. Whenever a message is received, it can be authenticated (individual key, see above) and checked whether this device is expected to send such information (e.g. the light sensor sending the information that the fingerprint was verified and the door should be unlocked can be identified as an attack).
- Known counterpart for outgoing messages: All clients know their central control system and can refuse commands coming from anywhere else or not correctly authenticated.
- Unreliable protocols: Many devices, especially those which are small and power-limited, use unreliable transport mechanisms similar to UDP: they send data out and hope that it will be received. Sometimes an acknowledgement might be expected and if none arrives, the message is repeated a few times. This not only allows DoS attacks, but also delaying or replay attacks.
- Intranet and Internet reachability: Because a smart-home system today must be reachable from the internet to allow e.g. monitoring/issuing commands from mobile devices, the central server needs to be connected to the internet and reachable from there, in effect acting as a public server. At least generally the server can therefore be attacked from the Internet and all remote applications have to employ a secure channel and authenticate the counterpart of a communication. Typically here a web-interface (or web-services, e.g. REST) is employed, which might use TLS (certificate to prove to the client that the server is the correct one) and a password (to make sure the correct user is accessing the system) for encryption respectively authentication (or even better a client certificate, but this may create usability difficulties). But this also means that all common web attacks need to be taken into account.
- System architecture incompatibilities: This approach of a central server is not necessarily perfectly compatible with existing systems. E.g. KNX is built on a distributed system with no central server. Some special devices to aggregate or translate commands may exist, but these are distributed too. KNX is configured through specific software, which works according to this model and e.g. connects sensors (light switch) directly to actors (relay for turning on the light). Integrating a central server to such a system is cumbersome, as e.g. all messages must be passed on to the central system too, and commands from there must not only match "internal" ones exactly, but also potentially pass some rudimentary security

measures (line couplers), which will not work without the integration of the server into the configuration software.

- Translation: If devices from a new system shall be integrated, only the central server needs to be updated and requires a matching physical interface. Therefore also only a single interface needs to be verified for security problems and interoperability issues.

3. A model for securing smart-home systems

While a smart-home system is at the moment commonly installed either by enthusiasts who familiarize themselves with all details, or professionals with intimate knowledge of all technical aspects, this might not be true in the future any more. And even if designed and implemented by a professional, extensions will definitely also be performed by someone else or again non-specialists. Therefore a prime focus needs to be on easy integration and automatic configuration. While this may be true for the functionality, it is even more important for security features: adding a new device and nothing works because of security restrictions is a sure incentive to switch security off (at least temporarily and as a minimum for the new device and its counterpart – in most cases however a permanent and "global" security shutdown is done). Also, when everything works as intended, performing some additional work to secure the changed system is unlikely, especially in the private area, which is often very cost-sensitive and where end-users will avoid paying for work not producing any immediately visible "output". And as security does not bring any useful results and merely prevents potential undesirable results sometime in the future, in case an attack occurs.

Security self-configuration is therefore a necessity. For this some assumptions must be made:

- During the learning or self-configuration phase the system must be secure: If attacking devices, persons etc are already performing an attack then, they might be recognized as legitimate elements. This assumption is not unreasonable for new installations, but can be much less relied on during extensions potentially years after the first installation. So some "absolute" elements not obtained through learning (e.g. attack signatures) should be present too.
- The learning phase may take some time, e.g. at least a full day. If "rare" events are also part of the system (e.g. retracting shades in case of a storm) it might take very long and become problematic then. It must therefore be distinguished between devices known to exist with commands/activities/… not yet observed but at least possible or likely, and completely unknown devices and commands not possible for such devices or extremely unlikely. This may require at least coarsely classified devices (e.g. "switch" or "light switch" → may only issue dimming/ switching commands respectively colour settings in addition; see also below).
- Multiple levels of response: Long learning phases and uncertain results require that several degrees of "alert" exist. From this follows that several levels of response are necessary, which could range from increased observation over stopping this device (an obvious usability problem!) to issuing an alarm to a human (audible, visually, E-Mail etc).
- The security element needs to know details about all devices in the system, including the physical things connected to them. E.g. for lamps any state is acceptable (it might be dark if a problem occurs, but this is typically not dangerous), but extensible shades do have a secure (retracted) and insecure state, similar as door locks (locked for entries and unlocked for emergency exists) or heating (all radiators turned on fully and all heating devices turned

off). As the door lock example shows, at least for some devices an individual configuration is absolutely necessary (consider e.g. power loss attacks). Integration with planning, configuration, or visualization tools is therefore desirable, as these often already do contain such information (e.g. default state in case of power returning after a loss) or users might be willing to add it there. Complete self-configuration through learning alone is therefore not possible.

- Holistic view of the system: From the previous element follows, that every security element needs a view of the whole system, or at least all parts which could ever even potentially connect with the elements it should protect. This renders them a desirable target to attack for information gathering, so their physical security is necessary (see above). Additionally, as alarms must be coordinated/passed on, attacking them through another communication medium (typically the Internet) is at least a possibility so precautions are necessary there too.

Because of this, when designing a smart-home system many security precautions are required. While not all can be described here, at least their classes are discussed.

3.1. Physical protection

Any attack can either be performed through physical access to either the devices or their communication links or from afar through external interfaces. In many cases the local communication is comparatively unsecured or practically not secured at all. In this case special considerations are required during physical cabling (for wireless communication this is not really applicable; preventing physical access through shielding electromagnetic radiation is simply not feasible in this setting). Taken from the area of computer networks, either a collapsed backbone can be used where the whole "electronic" communication takes place within a single cabinet and all devices are connected only by power/signal lines. A drawback of this approach is extensive cabling, but from a security point of view the digital management does not introduce any security problems above those already present through access to the device itself. Another option is a distributed system, where the digital communication is extended to individual installation cabinets, rooms, or even devices. In that case access to a cabinet/device simultaneously results in access to the communication medium. Such communication lines must then only be routed on the inside (within the physically secured area) and no devices may be accessible from the outside. Especially the latter may be very difficult to achieve, as it at least partially prevents the advantages of a smart-home. In that case all communication elements potentially exposed to attackers must be put into an "insecure" domain and partitioned from the rest of the network. Ideally tamper-proof/-resistant hardware is used for communication, so that access to the device does not compromise and information like encryption/authentication keys, which are a necessity in this configuration.

3.2. Cryptography: Encryption and key management

If a wireless network is used or if the digital communication lines are accessible from an insecure area, all communication must take place encrypted. If attackers can see the communication, they might be able to use replay attacks or deduce a lot of information from the communication content. Communication analysis is unavoidable here, and using a central server is only of little help, as correlation over time (message from A to SERVER leads to message from SERVER to B) will yield the same information. As in this scenario some devices might be compromised or rogue devices introduced, it is a necessity to use individual keys for each communication link or device (requiring a central server to avoid a large number of pairwise keys; this problem is however reduced as in most smart-home systems e.g. the light switch will never communicate with the

laundry machine; unless this is a mesh network and the laundry acts as a forwarder), to avoid breaking the whole system through a single problem. As all cryptographic keys should only have a limited lifetime, key updates are necessary as well. A common approach could be using an asymmetric master key, and regularly agreeing on a symmetric key for communicating. While this is useful (especially regarding the computation load of devices), it only reduces the problem, but does not remove it, as the asymmetric master keys also need updates, e.g. when the cryptographic system has been broken or is no longer secure enough (such an installation might easily exist for 20 years!). Additionally, the typical solution for initial configuration would be to print the public key on the device itself – which is not really very usable for long asymmetric keys (but see e.g. QR-codes) and is a security issue if the devices might be accessible to attackers. Therefore only an initial manual configuration and regular updates based on the current key are suitable. Forward secrecy is of less importance in this context, as decrypting stored old messages results in little additional information as compared to decrypting current messages. The reason is that most messages are "repetitive" (switching on the light happens every day identically). However, if detailed knowledge about personal preferences is obtained in addition, past "global" data (who was present when, what activities were performed) can yield some new information.

3.3. Authentication

If the central server (or any device) receives a notification or command, it should be able to ensure that it was really sent by the counterpart claiming to be the sender and not anyone else, e.g. introduced to the system by an attacker [Al-Muhtadi et al 2000]. In bus or wireless systems it is always possible to introduce additional devices (see above). Most of the time they can also disable/jam communication by the original device. This becomes especially apparent when considering mobile devices like tablets, phones etc. Encryption (see before) may be a solution if the keys are secret. If they are for instance printed on the device this cannot be assumed any longer. Additionally devices for human use may suffer from other security problems or for instance weak passwords, potentially allowing access to the encryption key. If cloud services [Ye/Huang 2011] are used (e.g. for relaying messages or more complex calculations like energy optimization) even third parties may have access to the system or its keys. Similarly, basing the authentication on an external third party like the utility provider or ISP and using the smart meter as an anchor [Ayday/Rajagopal 2011] may seem tempting, but basing it on third parties and hardware which is neither owned nor controlled by the home owner is probably not acceptable to many users. Authentication of devices is especially problematic, as biometrics is not really an option (although even electronic circuits may potentially be individualized through tiny manufacturing differences) and knowledge as well as possession cannot be separated from the device itself. The only solution is tamperproof hardware – which is quite expensive to add. Small chipcards (like those used in mobile phones, credit cards etc) could be a solution as they are cheap and can, for added security, be randomly assigned to devices by the person installing them and not only its manufacturer. But they are easy to remove, so an attacker could unplug and insert them into his own device. Therefore they have to either securely identify the device they are mounted in (very difficult, probably impossible without tamperproof hardware in it, but which would render the approach obsolete), or perform all relevant computation within itself (which should not be a problem e.g. for switches or small displays, but does not work for complex devices like heating systems or big screens – but these are less likely to be physically insecure). Recovering from technical problems is also an issue here, as e.g. a device whose battery ran out one month ago must be reintroduced into the network, although it might have skipped multiple changes of communication keys because of this, while simultaneously preventing attacks.

3.4. Network segmentation

Some devices in the system might need more protection than others (e.g. switching on/off solar power/mains power; heating systems), while other might be more endangered (like physically located on the outside). Also, some devices are stationary ("home" devices), while other are mobile (e.g. those worn on a person, like smart watches) [Wang/Yang/Yurcik 2005]. These different security categories need to be matched in segmenting the smart-home communication network. This is typically the case for wired networks, but even for wireless networks this might be useful. The latter could result e.g. in different WLANs inside a large facility and on the outside or different communication frequencies/keysets, significantly increasing problems for an attacker. Network segmentation typically has two main aims: Reducing communication load (e.g. limiting broadcasts) and creating artificial choke points for introducing security barriers like firewalls. Self-configuration could be possible here, as devices might provide at least a coarse classification of their security risks (light bulb vs door opener). In most cases however manual assignment will be a necessity. Another approach could be based on automatically detecting the physical layout (bus interconnections etc). In connection with authentication (see above) this could also limit attacks: if physical access is achieved to one segment, all devices on this segment might be ("physically") compromised. This could be detected e.g. through increased authentication failures or new devices appearing, so cutting it (the offending device or even the whole subsection) off from the rest of the network would contain an attack. Through this additional levels of response become feasible and "core functions" might still be working even in a partially compromised system. Obviously the location of the central server is an important aspect here, as its segment cannot really be disconnected without severely impacting the whole, or if all communication goes through it, shutting down everything. Segmentation has also some drawbacks, e.g. the need for additional devices (price, power…), but especially that they might be prime targets. Their controlling functionality allows them access to at least two segments and their complex tasks increase the chance for vulnerabilities. However, as they do not have to provide any service themselves, merely passing on a subset of all received messages, they can be secured very well. Some segmentation will always be present in systems consisting of multiple communication protocols, with the adapters/intermediaries acting as a boundary. A simple example is a security intermediary integrated into the central server sitting "in front of" every physical communication medium.

3.5. Intrusion detection

On segments (mostly on boundaries) as well as the central server intrusion detection is a necessity, as only detecting an attack or a compromise can result in any activities to counteract them. This may range from quite simple (checking source and destination addresses of all messages against the known position of all devices) to complex (correlating messages like changing the target room temperature or heating amount too fast is useless, comparison to known usage as well as attack patterns etc). This may also be useful to spot configuration problems. Typical preconditions are detailed knowledge about the whole system (itself a problem if the detection device should be compromised), information on the individual devices and their capabilities, as well as their typical usage patterns. An example could be e.g. correlating commands/sensor readings with input from a smart-meter [Namboodiri/Aravinthan/Mohapatra 2011]: larger devices like refrigerators, air conditioners, or cooking utensils can be identified by their power consumption even from an aggregate reading. Additionally they may check not only for the presence of abnormal events, but also the absence of normal ones. In contrast to network segmentation devices they will require regular updates – new attack samples, changed preferences etc. One big limitation is that in computer networks such systems have been proven to be potentially very problematic. They either detect only known attacks, bringing little advantage as compared to firewalls/gateways, or contain

heuristics but then suffer from many false positives. Such false alarms would very quickly lead to those systems being switched off, both in private houses (“useless”, “unnecessary psychological pressure”…) as well as companies (responding to them, paying for official alerts etc). The big advantage in smart-homes over LANs is that the usage patterns are very regular – nothing is downloaded from the internet, no new work needs to be performed and so on – and messages are simple (no huge documents with macros or encrypted archives). Additionally they can ameliorate a common problem in such installations, the lack of documentation. Often more devices are added, some are reprogrammed etc, but the “official” documentation is not updated accordingly. Here any change, especially unauthorized ones from internal persons too, would lead to an alarm. Either the documentation can be extracted from these systems (also quite advantageous) or it must be adapted for them to continue working. Here a practical problem can be that programming a “new” configuration would mean losing all accumulated experience, so explicitly adding the change alone would make those systems more complex (integration into existing knowledge: what has to be deleted and what learned anew?), but also more reliable. This is especially important in the context of rogue devices (see above), which cannot be ruled out completely. Against them only internal countermeasures are possible.

3.6. Automated security scanning

While intrusion detection is working passively, automatic and active checks are possible too. So checking whether devices are still behaving as they should (e.g. not sending out spam) and still working (especially important for security devices, like motion detectors) could be an option. However, in my opinion this is not that useful. E.g. switching on the light to check whether it is still working through a light sensor is in practice not very desirable (and not everything is as easy to verify). And any device on its own can, if compromised, easily produce a matching response. This is therefore useful if a genuine device has been replaced with a fraudulent one, which lacks some of its original’s knowledge. But in combination with encryption/authentication this is going to become apparent very soon through passive monitoring as well. Scanning the security devices themselves is also not that useful: Updating them (see below) is more useful than merely updating the attack signatures. Integrity checks of devices are useful and similar, but do not normally contribute anything to the security of the system.

3.7. Update handling: Server, device firmware

Updates are a necessity, especially for all complex systems like those providing security services. This entails acquiring updates (checking whether new ones exist and downloading them) and distributing them. Additionally each device must ensure that only authorized updates are performed – and not those introduced by an attacker. This can be ensured either through the device itself, e.g. a public key embedded in the hardware where the counterpart private key is used by the manufacturer to sign updates (complicated for such simple and cheap devices), or through the central server. The latter would download all updates and then distribute them to the individual devices securely, based on authenticated and encrypted communication. Especially important in this context is backwards compatibility of updates to not break any existing rules, handling methods, displays etc. Automatisation is very important as users (who often do not even update their PCs) are unlikely to manually update their smart home systems regularly (especially if devices of multiple manufacturers might be used; in extreme cases every week another device needs an update!). Service contracts might be an option in a business environment, but at least for private homes they would be very hard to sell. Here the system would depend on the manufacturer: good quality assurance and explicit tagging of updates introducing changes. Additionally, notification of a user on all other updates not handled automatically should be implemented. These could for instance be

installed during a yearly "servicing" of the system – which is again unlikely in private homes. A big problem here is the lifetime, which may vary widely. While users might accept buying a new mobile phone, PC, or TV every few years, reinstalling large parts of a house (lighting, heating, and alarm systems) is out of the question. Updates therefore need to be available for extremely long times, or such devices must be moved into separate "quarantine" partitions with extended security precautions. This also favours "centralised" approaches, where the individual devices are very simple and therefore do not need any updates or only very rarely. Keeping the single central system – which is connected to the Internet anyway - up to date is much simpler and therefore more likely.

4. Conclusions

In summary, several aspects need to be introduced to existing smart-home systems or taken care of when designing new ones: First, secure communication between all elements is a necessity, which requires tamper-resistant hardware in all devices to be fully secure. Today this should even be economically feasible, at least for simpler devices where small chipcards would be sufficient. Problematic in this regard is compatibility with existing systems. Secondly, even in private houses, adding "non-functional" devices or function blocks (e.g. software modules) solely responsible for security is a necessity. Some incentive for this could be that e.g. when such a smart-home system is hacked and a burglary occurs because of this, the insurance could see this as gross negligence (compare e.g. the door key under the mat to an easily reachable light switch allowing unlocking the door by sending a simple command).

Similar considerations hold true for cloud services from providers of such systems. If these are not adequately secured and some incident occurs through hacking, passing the responsibility off to consumers – as opposed to the operating companies - is going to be extremely hard. Such clauses are very likely either illegal or at least ineffective. But the international nature of cloud systems renders enforcement of legal claims for private persons extremely difficult. If such systems are installed by professionals, the company designing this work might also be liable. This all will lead to at least a modicum of security.

The biggest danger are therefore such systems when designed and implemented by private individuals. They will likely primarily focus on costs and "getting things working" and neglect security. As components might stem from various vendors, interoperability is important not only on the functional level but also regarding security features, requiring standardization.

Many current smart-home systems do not follow any of the security principles identified above and most cover only very few selected aspects. But for systems with such a long lifespan and directly causing physical changes, security is an absolute necessity. Imagine e.g. that the smart-home of a person suffering from epilepsy is hacked. Switching the lights on and off rapidly (LED lighting!) could induce fatal seizures, being caused from any distance and leaving no traces. While this is a more theoretical example, the more devices (e.g. fridges, cooking plates, and washing machines) are connected to the smart-home, the larger the danger becomes, e.g. similar to ransomware: preventing access to your house or using the devices within.

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TOWARDS THE TRUSTWORTHINESS OF DATA, INFORMATION, KNOWLEDGE AND KNOWLEDGE PROCESSING SYSTEMS IN SMART HOMES

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Keywords

Trust, Data, IT, Information, Knowledge, Knowledge Management, Knowledge Processing Systems, Smart-Home, Security

Abstract

In this paper, we want to give a first insight to the question "how can you trust data, information or knowledge" - especially in the context of measuring trustworthiness. We think that the topic of smart home security is a very good research environment for this question. Building on this research environment, we made some investigations concerning the measurement of trust.

1. Introduction

We want to give an insight into the topic of giving trust into data, information and knowledge, and how you can measure the trustworthiness of them. This is closely related to the usage of smart-home systems, because the communication of security related devices in these systems must happen in a trusted manner. Every area of application of technology in nowadays life is confronted with questions like "Are you secure?" and "Can I give you my personal details without being worried about my privacy?"

All the more important, the question of security and trustability comes into account when we want to secure our personal homes. Smart-home systems can assist when managing our homes and they can provide a high level of comfort (managing e.g. heating or lighting from your workplace, etc.), also when improving the security on your home (locking specific areas, establishing alarm systems, video surveillance, etc.).

Most of these systems (whether the comfortable assistance or the managing of security), provide their services via mobile applications or via web pages and they try to make the availability of accessing their systems in a very easy way - most of the time in expense of the security. The services and systems are often accessible without any complicated permissions, biometric or authentication procedures. Here the self-complacency of the users of "everything works intentionally" can cause high security impacts, due to the fact, that most of the users do not know anything about IT security.

Beneath this fact, we want to discuss some trustworthiness concerning the internal behaviour of smart-home systems - can you be sure, that the information (e.g. the signal from a video surveillance camera installed in front of your door), provides the current view at the door and isn't compromised by anyone (e.g. an intruder who wants to commit burglary, for example with an old video signal, where nobody is shown on the screen)? Well, you can try to assure the information by putting some additional information on the video signal (like a clock or a display with the date, so you always see the current date and time), but a professional security system should not require such steps - it should provide trusted information - every time in every state of work!

After some important preliminaries (description of important terms and keywords) in Section 2, we focus on the importance of secure smart homes in Section 3. In Section 4, we investigate some projects in a related work field, which also take care of smart-homes' security and in Section 5 we show a first classification of what trusted data/information/knowledge could be. Finally we give a conclusion and some suggestions for further research steps.

2. Preliminaries

Before we go into detail by explaining our models and suggestions, we need to describe a few terms, to provide an easier way of understanding concerning our research. What is data, information and knowledge and what are smart homes and how do they work?

2.1. Definition of Data, Information, Knowledge, Knowledge-Management and -Processing

There is no general and common understanding of knowledge and knowledge management. It always depends on the specific working domain in which your conception of knowledge is understood. Within the context of organizations and IT there are typically three central keywords to distinguish: data, information and knowledge. So, before studying knowledge management or knowledge processing systems in more detail, we will go for this already classical distinction, where neither the definitions of each term, nor the distinction between are common ground.

Data: Data is most of the time a discrete set of objects or facts. It is the raw material for the creation of information. Data today is typically stored in IT systems, distinguished by quantitative and/or qualitative measures. In general more Data is not always the better option. For example, "24122015" is data.

Information: Compared to data, information itself consists of data elements, but information adds a meaning to this data. Information is usually stored as data. For example, "24-12-2015 is a date", this is information.

Knowledge: Knowledge is one step further than information. It is obtained from knowers (people who put together or link information) which link information and data to something higher - it is experience and transactions. For example, "24-12-2015 is more than a date, it is Christmas", this is knowledge. Another example for some extended/linked knowledge: "On Christmas I should buy some presents for my family" (without discussing about anticipated behaviours or manners).

Knowledge Management: This term refers to the usage of knowledge and getting higher levels of knowledge and benefits through combining the intellectual assets. You can distinguish between explicit and tacit knowledge, where explicit knowledge is written and tacit knowledge is the personal know-how. The effort of managing knowledge usually can bring improvements in almost all fields of usage.

Knowledge Processing: Managing knowledge needs some additional activities to get the different knowledge bases together: you need to process data, information and knowledge. You can process knowledge by connecting human knowledge and networking (this is a chaotic form of knowledge processing) and you can store knowledge in databases (which have a much higher usable capacity than the human brain) and use technical networking (this is systematic information and knowledge processing) (Skyrme, 1998).

2.2. Description of Smart-Homes

With the development of embedded systems, electronic appliances have built-in functions insides that help them automatically execute their tasks according to their pre-defined programs and user preferences. For instance, a washing machine does a series of actions to wash laundry in the mode of color type and at the temperature about 30 degrees Celsius or an advanced air-conditioner with the build-in thermostat manages itself to switch on or off according to the temperature of the room. These machines give automation to humans' daily housework and form a concept of home automation. Nevertheless, a smart home is a further step from home automation and Internet of Things. It does not only hold various electric and electronic devices but also have a control system be in charge of them. In other words, this term describes a house where appliances are connected and communicate to one another in order to properly react to humans' activities or their related living environments.

For instance, lights will be automatically turned on at a suitable bright level when they detect whether there is a human movement. Or when one leaves home, lights will be automatically turned off, doors and windows are closed, and the intruder system is activated. Besides, Aldrich defines a smart home as "a residence equipped with computing and information technology which anticipates and responds to the needs of the occupants, working to promote their comfort, convenience, security and entertainment through the management of technology within the home and connections to the world beyond." (Aldrich, 2003). Other than self-connections and a centralized control system, these devices in smart homes can also be remotely controlled by end-users with suitable applications not only installed in private devices like smart-phones, laptops, or a personal digital assistant but also accessed through web-based services.

As a consequence, the emergence of smart homes brings not only comfort and convenience but also a meaningful goal to human beings, especially for the elderly, convalescents, disabled people and those who have special needs or have difficulties in household tasks as well. Within the context of smart homes, their living would be different towards a better quality of life. For example, one's health conditions can be monitored by surveillance sensors and cameras so that an alarm will be triggered to call for help when there are any emergencies. Or in case of energy saving, smart homes adjust the amount of electrical power to devices when they are active or cut the power when they are not used. To briefly sum up, smart-homes, together with modern technologies, are playing a significant role supporting our daily lives, and they deserve our attention as well as our promotion to be further developed.

3. The Meaning of Trust

The question of "How can we trust anything/anybody?" is discussed since the beginning of mankind, but what does this topic mean in context to today's technology age and especially for the information technology?

Usually, we have a high trust in man-made technology - from cars to airplanes, from computers and buildings to space shuttles. As long as they work properly, we most of the time don't even think about (not) trusting them. Only in case they stop working in their usual behaviours, the question of trust comes up. The trust in IT systems is becoming even more important, as today people rely on IT more than ever before. Beside the usage of IT in every part of our lives, special treatment has to be done with the Internet in this domain. Everybody is online, (most of the time) every time, and the trust into content from the Internet has to be handled crucial. When we talk about this, there isn't meant the information you retrieve or read on websites, much more the download of files must be taken into account: everybody trusts into a "Download Button" by clicking it, but nobody knows what is really behind this mechanism, when you download a file on your computer. You make yourself highly vulnerable, when downloading content from the Internet to your computer, because you never know, what is really inside a file (just one example: malware).

The three main types of applicable trust after (Rosseau et al., 1998) are (1) trusting beliefs, (2) trusting intentions, and (3) trusting behaviours, where these three types are connected to each other: "*1. Trusting beliefs means a secure conviction that the other party has favorable attributes (such as benevolence, integrity, and competence), strong enough to create trusting intentions. 2. Trusting intentions means a secure, committed willingness to depend upon, or to become vulnerable to, the other party in specific ways, strong enough to create trusting behaviors. 3. Trusting behaviors means assured actions that demonstrate that one does in fact depend or rely upon the other party instead of on oneself or on controls. Trusting behavior is the action manifestation of willingness to depend.*

Each of these generic trust types can be applied to trust in IT. Trusting behavior-IT means that one securely depends or relies on the technology instead of trying to control the technology." (McKnight, 2005)

Another point of view is the similarity of trusting people and trusting technology, especially information technology, where the main difference lies in the application of trust in the specific area: *"The major difference between trust in people and trust in IT lies in the applicability of specific trusting beliefs. People and technologies have both similar and different attributes, and those similarities and differences define which trusting beliefs apply.*

[...]

With trust in people, one trusts a morally capable and volitional human; with trust in IT, one trusts a human-created artifact with a limited range of behaviors that lacks both will and moral agency. [...] Because technology lacks moral agency, trust in technology necessarily reflects beliefs about a technology's capability rather than its will or its motives.

[...]

Trust in information technology has several interesting implications. First, trust in IT should influence use or adoption of a technology. Unless one trusts a software product to reliably fill one's needs, why would one adopt it? Second, trust in IT is a general assessment of the technology that probably affects other IT perceptions, such as relative advantage or usefulness of the technology. Thus, it may influence beliefs and attitudes that affect intentions to use a technology.

Trust in technology is built the same way as trust in people." We highly recommend to read the paper "Trust in Information Technology" from D. Harrison McKnight (McKnight, 2005).

Another very interesting publication about the trust in information sources is given by (Hertzum et al., 2002). They compare the notion of trust between people and virtual agents, based on two empirical studies. The testimonials were software engineers and users of e-commerce systems.

4. The Importance of Secure Smart-Home Systems

Although smart-home systems have been developing time by time thanks to the development of modern technologies, smart-home security has not still received much awareness in both industry as well as academia. Among a few of them, Balasubramanian and Cellatoglu present some guidelines for home security concerns in their work (Balasubramanian and Cellatoglu, 2010). The authors consider, however, some problems in home security known as fire and intruder alerts, regulating visitor entry, and threats from the Internet. Besides, commercial products and services for smart-home security are also available in the market: (Arlo, 2015), (Cocoon, 2015), (Loxone, 2015), (SmartHome, 2015), (SmartThings, 2015). Nevertheless, these products or services mostly provide surveillance devices like cameras, sensors, and related applications to monitor a house rather than a whole security solution in smart-home systems. There are still more security issues that would form key points in building such systems, and the goal of a secure smart-home systems is not only to protect one's home but also keep other properties inside the home secure (ADT Authorized Home Security Company, 2014). Firstly, the security demands for smart-home systems originate from practical needs. Let us say that instant warnings and alerts are switched on when unwanted accidents happen. Secondly, security is an essential factor that paves the way for the development of smart-home systems. For instance, automatic processes activated by smart-home systems should not be either misused or interfered by attackers. One would be uncomfortable to enjoy what smart-home systems can offer once he or she has to take those risks. Hence, assuring smart-home security promotes him or her to live in such a smart and dynamic environment.

Engaging in the important role of smart-home security, we present two main aspects of a secure smart-home system in this paper as follows: (1) *Emergency reactions* indicate that a secure smart-home system should be able to effectively deal with emergency cases such as there is something on fire; intruders invade the house; or its residents are in urgent needs, to name a few. Then, it will take a series of appropriate actions to meet users' need and the cases; and (2) *Self-protection* implies that a secure smart-home system should be able to protect itself as well as its sub-components such as electronic and electrical devices, applications, related software and firmware from possible attacks. For instance, it would be impossible to let intruders disable the alarm systems or violate user privacy. Consequently, a secure smart-home system should achieve two essential properties known as confidentiality and integrity. In addition, we address two levels of taking actions a secure smart-home system may perform when it is insecure contexts as follows: (1) *Passive mode* mostly takes the responsibility of notifying owners, end-users, or contacts in emergency. When an intruder invades the house, let us say, the secure smart-home system triggers the alert and then immediately sends emails about the case to its residents and/or calls the local police; and (2) *Active mode* shows the way a secure smart-home system reacts to the emergency other than in passive mode. As an illustration, it will activate the fire extinguishing systems and turn off electricity in case of fire. Or it will capture videos and images when an intruder enters the flat and show real-time interactions from remote monitoring and control devices to end-users in case they are absent.

In short, vulnerabilities in a smart-home system come not only from intruders who want to illegally invade a house but also from devices constituting the system themselves. To give a practical example for the latter, Jin and his team at the Black Hat tech session demonstrate their ability to remotely control a Nest Thermostat within 15 seconds (Jin et al., 2014). This raises a big warning that security in smart-home systems is not seriously considered.

5. Related Work

Smart Homes that use algorithms from the area of data mining or artificial intelligence can only work well if they have enough data about the user. This can be data provided either by the user, or data generated by analyzing the environment (sensors, like light sensor, movement sensor, etc.). Having such data circulating in a network opposes several security and trust issues.

(Kaspersky, 2015) discusses a recent study on the security of access to Smart Home systems. The result of the study was that most systems lack of security and can easily be hacked. The consecution of a hack can be physical damage on the one hand, but on the other hand also access to private data in the network.

Robles et al. identified current security issues in a smart home system in (Robles, 2010). Besides the description of the general architecture of a smart home, it also reveals various smart home components that produce data. Special attention is payed to the security of the data transport (when data is sent e.g. over a network). Also access control is discussed and the usage of artificial intelligence technologies for detecting unknown persons.

An architecture for a middlware system for managing profiles in a smart home environment is presented by Schaefer et al. (Schaefer, 2006). It is based on OSGi and contains components for managing security, profiles, devices. It distinguishes between various authenticators (e.g. username and password, face recognition, etc.). Also the usage of data mining and artificial intelligence in order to recognize the user is discussed.

Mantas et al. (Mantas, 2010) present the current concept of a smart home and also details about the networking technology of the single components. After a short description on existing threats for Smart Homes, a discussion is made about specific methods to handle these threats, like authentication, authorization, intrusion prevention and intrusion detection.

The survey done by Komninos et al. (Komninos, 2014) concentrates on electric smart grids and homes, but also has the same concerns in security of classical smart homes: confidentiality, integrity, availability, authenticity, authorization, non repudiation. An overview about various risks and attack possibilities is given and a list of countermeasures is presented, which also contain techniques like encryption and data obfuscation.

A special data analytics framework for smart home systems is introduced by Chakravorty et al. (Chakravorty, 2013). The framework tries to maintain security & privacy in smart homes without compromising the ability to analyze this data.

6. Suggestions and further Work

If we take the nature of risk into account, trustworthiness has some important influencing factors like reliability, competence, discretion, integrity, empathy, and so on (Sheppard and Sherman, 1998). These factors have to be considered, when talking or researching in the field of trust. Concluding we can say, that the handling of trust and trustworthiness in the information technology sector is a field, which covers the whole range of technology and only the distinct investigation of a specific area for detailed research is possible in a meaningful way.

We will continue our research in this field focused on the sector of information and knowledge processing systems, especially on the questions, how can you trust a knowledge processing system, how can you trust information in general, how can you compute or calculate trust for information,

how to develop a representing scale for calculated values, and how can you implement trust(worthiness) in a knowledge processing system?

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SESSION J: hDATA PROCESSING: SOCIO-TECHNICAL ASPECTS OF HEALTH

HEALTH DATA PROCESSING – SYSTEM THEORY BASED MEANING AND POTENTIAL FOR FUTURE HEALTH

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Keywords

hDATA, system theory, health data, data processing

Abstract

This paper is about the conceptuality of health related data and the definition of a health system by theoretical models from system theory for social systems and techno-social constructions. In a discussion of the elements and the core relation between physician and patient, the empowerment process of patients is major motivator and driving factor for the development in health systems. This goes along with an increased need for information and a request to be an active part in the therapy process. This is a change from classical top-down therapy models of patient compliance to a responsible patient model of adherence with an even level of expertise between physicians and patients. The use of technology to gather and process data is a key feature for this development.

1. A perspective on health related data

Within the last few years, and especially in 2013-2015, more and more data is collected about individuals and their health status. Not only medical institutions keep a record of people but also the people themselves start to collect health related data. Already during the first years of this century, pharma industry started broad actions to implement diaries for blood pressure and blood sugar. The idea was to give the medical doctor a binding to the company, as all his patients would use the same diary and for the physician it would be easy to check them at a first glance (e.g. Blopress Blood Pressure Diary between 2001 and 2006 by Takeda Pharma Ind. In Austria).

But also the patients started to be more aware of what is going on with their body and physical functions. They started to build thesis about the impact of situations to their health and what could have caused a bad result in measurements – not at least with the new opportunity of using the internet: people do take their time to research about their symptoms, therapies, medication and related issues. Patients became experts for themselves!

During the last few years, this phenomena became more visible in the fitness sector. With the upcoming of wearable fitness tracker, a market was kicked into place that also has the potential to revolutionize classical health care in Europe. This revolution has an impact or is a trigger in the change of the self-awareness of patients and the increasing availability of affordable devices for self-measuring vital signs. Another trigger and impact is the use of the internet as a form of communicating about health and related topics. They become self-assured experts and can act in a

new way with their physician. The roles are transformed from a top-down compliance system to an even level of competences of adherence.

Not all patients are in favor of such a model and not all physicians are very positive about it either. But the potential of a new adherent medicine is becoming obvious. The idea of a personalized medicine is not just about individualized medication but also about personalized therapy plans and adherent treatment settings.

This paper is about the construction of a system based approach for health care under the premise of adherence. Theoretical considerations as well as evidence from market and projects will define the image of a system approach for processing health-related data, which is called hDATA.

2. Construction of the systems

2.1. From relation to system

A relation is at least between two communicating subjects who are related to each other in a certain way. This relation defines the interpretation process when data is exchanged. This interpretation provides information about the data and its contextuality. This is explained by Blumer with the symbolic interactionism. Blumer (1973) is posting three principles for interaction: 1.) People act to objects on the base of the meaning the object has to them. 2.) This meaning is created by the social interaction with other people concerning the object and 3.) this meaning is within the framework of constant discussion of the objects in an interpretation process and constantly used and adapted. This constant use and constant adaptation is a process of development. It is a way of construction. Basic elements of meaning are related to objects and are developed further by use and in interaction with other people. This makes the construction of meanings and the perspective to objects, increasingly complex. If a set of objects is defined which builds a closed cluster, this can be understood as a system with a self-referential behavior. Systems like this are described under the term of Autopoiesis by Maturana and Varela (1982): "*Autopoietic Systems are living organisms, which reproduce themselves. This happens as they build the components and elements, they are consisting of, from their own operations within their organization structure in an ongoing process. This can be imagined as components in a circular process with interacting iterations. By this the components are permanently produced to keep the system going.*"[5] This was specialized for social systems by Niklas Luhmann (1984). Essential to these systems is that they are increasing their complexity against the environment to secure their existence, reproduce their content and build on their existing structures. A practical example for this thesis is the idea of self-fulfilling prophecies by Paul Watzlawick (2000). By developing structures existing on objectives and their related meanings to an individual, the person can reflect on situations and has the potential to start interpretation cycles before an action is stated. This iteration cycles correlate to the actions but instead of being a result of actions, the predominantly influence actions. By this, a meaning can influence already the outcome of an interaction. The relations between individuals become a definition for the system and its interaction patterns within the system. By this, simple rules can be defined for the system internal communication similar to the pragmatic axioms of Watzlawick (2000): 1.) One cannot not communicate. E.g. if a physician does not respond to the patients request, this is going to be interpreted as intended communication by the patient. 2.) Every communication has a content and a relationship aspect such that the latter classifies the former and is therefore a meta-communication. E.g. a blood pressure of 160/120 is very high. But if the patient

[5] translated from German to English by the author

has otherwise a pressure of 210/160, there is also an improvement. 3.) The nature of relationship is dependent on the punctuation of the partner's communication procedures. 4.) health-related communication includes digital and analog modalities. The digital content is the pure information as the analog content is the relational aspect of communication. 5.) The inter-human communication procedure is supposed to tend from a complementary form to a symmetric form. As there are three forms of communication, the tendency is from a one-down approach as in classical compliance to a one-across form as an expression of adherence

2.2. (Re)Construction of elements

Systems tend to build their elements during interaction processes and by this evolve from simple systems to highly complex systems. By this, certain parts are constructed, deconstructed and reconstructed. The core of the system is the relation between patient and physician. The major topic of this relation is disease management or - in a more positive way - health. The relation starts with an issue of the patient who consults a physician. By this, it is a natural disbalance in the system, as the patient is in need of support and the physician - in classic relation - the wise entity with the knowledge of cure for the suffering. There is a certain familiarity with feudalistic structures. By a special right, the status of a physician is granted. In feudalistic structures, it is the right by birth - which is not to be changed - in health care it is the university degree of a medical doctor, which is changeable. So there is a legislation that gives power and responsibility. The bargain for the patient is that he has no power about the medication and therapy but also has "outsourced" the responsibility for his health and cure to the physician. This accepted disbalance is the foundation for a good compliance. The functionality of such a system is already described very precisely by GWF Hegel (1807) in the dialectic approach of The Phenomenology of the Mind about dependency and independency (Hegel, 1986). Just in interaction and acceptance of the role of the other, the own role can be accepted and lived up to. In this relational system it is compliant to do what is asked by the physician without thinking about getting more information from somewhere else. This historic approach of feudalistic structures, which also inspired Karl Marx (1844) for his idea of communism to break the disbalance and move it to an even level ground for all people. For health care this would represent adherence. In a cooperative way, both roles, patient and physician, become partner for a goal, both want to achieve: health. The physician helps to find therapeutic approaches that are acceptable by the patient and his/her lifestyle. The responsibility of the patient is to become an expert for the efficiency of the therapy under his physical conditions and to give adequate feedback to the physician. The physician has the responsibility to act on the best behalf for the patient and to give advice, prescriptions and sympathy for the patient - not to lead but to guide the patient to a better health. This asks for an iterative, cybernetic model - an autopoietic system with a biological aim, which brings us back to the principle idea of Maturana and Valera (1982) and the biological foundation of autopoiesis as a holistic approach not just of mechanics but also of relations, elements and functionalities.

So it is possible and normal that roles can change and shift. And also that a dialectic system can change its constants to allow an even function. This reconstruction of basic elements within a systems allows them to react to triggers of the environment without collapsing or destroying the system. This potential of reconstruction and re-form complexity is a dynamic form of resilience in social systems. And for hDATA System.

The dynamic element for this change is the information, and with this the expertise.

When the disbalance in information between the physician on top and the patient down is brought to balance, a full change in the system is done. All elements of the system are affected by this

change. But this change is also a process and takes time. And it has begun already with the change of the patient's role.

2.3. Change and evolution of the patient's role

To start with a perspective on the patient's principal motivation, it has to be understood that this paper is oriented on the Salutogenesis of Antonovsky (1997) and the idea of a continuum in life with two poles of life/healthiness and death/disease (Antonovsky, 1997, p.22). At certain time, a person is at a certain place in the continuum between the poles. According to the person's lifestyle and actions, there is a tendency towards one of the poles. The basic question in Salutogenesis is: what are the factors to tend toward the pole of healthiness? One answer is the sense of coherence (SOC). The SOC is split in three branches: comprehensibility, manageability and meaningfulness.

Comprehensibility is similar to the idea of causality. It is a belief that situations are a result of former actions and with awareness it is predictable what will come in future.

Manageability is the belief of control. With the given resources and your own skills and abilities, it is possible to manage the situation at hand.

Meaningfulness is the idea of purpose. Life can be interesting and a source of satisfaction and joy. There is a meaning and gain to take care of things.

Antonovsky (1997) state that all three elements together provide the Sense of Coherence. But the meaningfulness is the most powerful element because if there is a lack in meaningfulness, there is now motivation to manage situations or to comprehend situations any further.

So there got to be purpose on taking care for oneself. With this basic idea, the change in the system is taking its start. Directly followed by the idea, that if there is a meaning, I want to take a chance on it and try to comprehend and manage my health. Meaningfulness makes the patient self-aware. Comprehensibility makes the patient full of self-esteem. Manageability is the key to patient empowerment.

2.4. A need for information and responsibility

To undermine the stated theoretical approach, there is evidence that is pointing the same direction. Rieder and Giesing (2011) show that patients wish to have a therapy that is according to their personal values and lifestyle (p.21). The patients want to be more informed and more integrated in the decision making process for the therapy. Within the clinical sector 30% of patient want to be more actively integrated (Schirmer et al., 2009) and at the physician side, there is an increasing demand for cooperative therapy finding since 1997 proven by Schmid and Wang (2003). But there is a strong discrepancy between wish and reality. 85% of patients at the physician want to be integrated in decision making but just 49% say to be able to make this wish a reality (Wang, 2007).

But are patients already experts for their health? Beside an ethical Principe of full sovereignty of the own body and soul, the question has to be asked, if patients are able to understand effects and impacts on their health by certain therapies? An overall answer cannot be given because of the variety of intelligence and knowledge in the broad mass but there is evidence that expertise and wisdom is increasing in by support of modern communication infrastructure. Patients are online and start networking! Already 44% of people are trying to get information about health by the internet (Andreasson et al. 2007). Also patients started to form networks of people with similar diseases. These self-help groups even establish national wide networks with experts, medical doctors and their own magazines. Prominent example is the tpiweb.com (information platform for people with transplantation, completely organized by volunteers on a very high level).

Rieder and Giesing (2011) announce this type of patients as "working patients" ("arbeitende Patienten"). Special indicators for this class of active patients are:

1. The patient is not just a user of health system but is an active part of the outsourcing agenda of the health system and takes over professional parts especially in contact to other patients. The working patient as a productive role in health systems and is not just a private, anonymous person.
2. The working patient is a source of value for health organizations. The patient is an active part of the value chain.
3. Finally the patient becomes a co-worker for health organizations. The private consumption of health services gets and institutionalized connection and control.

This is a hard change of role for the classical patient-physician interaction pattern. Patient empowerment is the key. So a closer look at this would be needed to get an understanding of the potential of activity for the new, personalized health system.

2.5. Patient empowerment

The major aim of empowerment is to provide information and services for patients to improve their knowledge and understanding of their illness or disease. The autonomy of the patient has to be improved and the capability to make decisions needs to be increased (Feste, Anderson, 1995). This is essential in long term care in case of chronic diseases like diabetes. The patient has to take care of his disease and to use his own resources and the supportive resources of his environment to react on the challenges of the disease. In the Ottawa Charta of the WHO (1986), a basic line for empowerment is drawn. Health is built on care for oneself and others and to be able to make decisions and have control of one's life situation as well as on the communities' capability to build a supportive framework so that all members of the community have the chance to participate.

The most important feature of this empowerment model is the control. This is also according to the Sense of Coherence. Actions have to have effects and there has to be a cognitive model available for the patient to identify the potential of setting actions to achieve aims for health. By this, there are three ways how control can be experienced (Averil, 1973):

1.) Behavioral control

2.) Decisional control

3.) Cognitive control

The behavior has an effect on the situation, the decision has an effect on the outcome and the cognitive control is the understanding of the situation. All three control mechanism allow a patient to be have the power to take care of oneself.

To come from a perspective of the patient to a system perspective again, the other system elements have to be named and brought in relation to the core, the patient-physician relation. Another component of the system is that this relation patient-physician is not just an isolated relation but is in competition with the social environment of the patient. The relation to relatives, friends and colleagues are also part of the system. There is a strong influence in the interpretation of exchanged information in the core relation by persuasive information in the near social field of the patient. 80% of care is done within the family (Moser-Siegmeth, Aumayr, 2011, p.41). There is also the wider range of internet related information gathering and the information by TV and radio, which is still a major mass media.

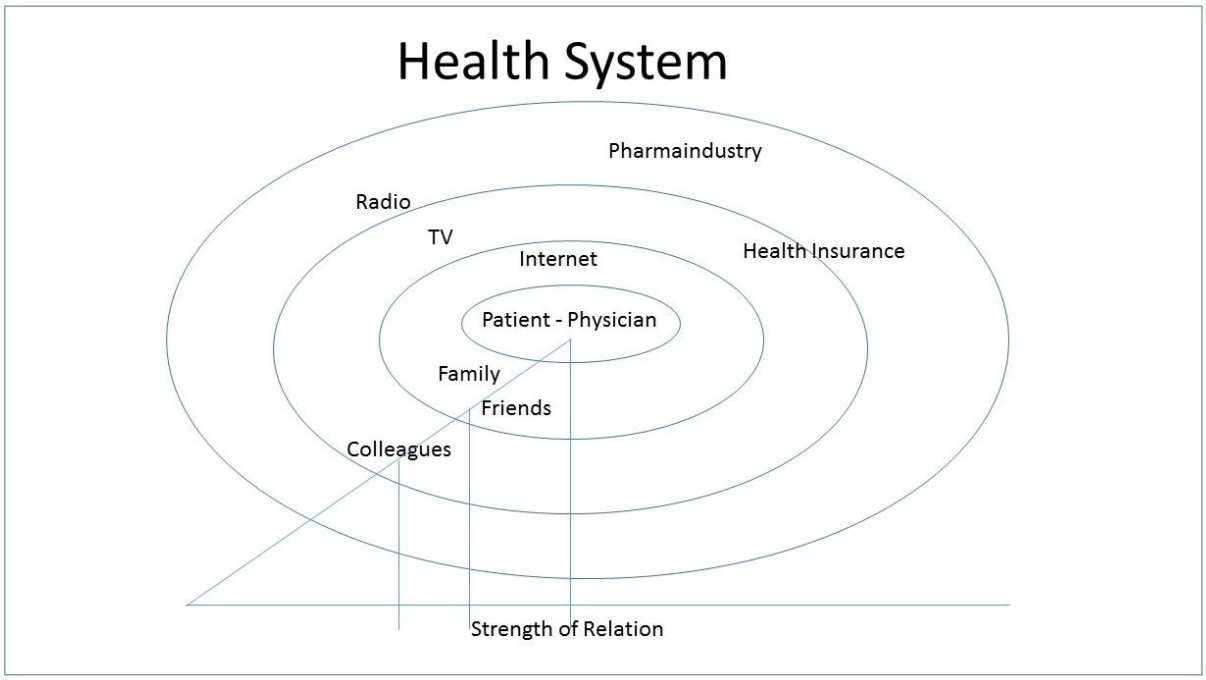

Figure 1 Health System Overview

All these elements are in a different strength of relation to the core relation. In Figure1 it is shown as a distance-effect correlation. The bigger the distance, the lower the impact on the core relation. Between the elements are relations as well that define the push and pull strength of information. So if the Pharma industry is releasing a new medication, the push to the physician is the strongest. But there is also a push to health insurance and the other elements. Also different information speed is a critical factor for the dissemination of new information.

These relations and connections build the structures of the system.

3. System approach for use of technology in health

The use of technology within a system or the introduction of technology to a system can be complicated. If the technology is complementing existing tasks - like measuring blood pressure - the acceptance within the system is achieved in a reasonable time. But if there is something completely new, that has no reference in the structures of the system, it probably will be evaded. So technology has to be compliant to the existing structures and elements of the system. In that case, technology can be used by the elements and provide support. Technology is the combination of hardware and way of use. This is summarized by Weyer (2008) in a wider and focused term of technology. The focused term is the object of technology, the device. The wider term of technology is the usage and implementation. This allows to form subsystems for technology within the health system and brings back hDATA in the discussion by the relation of technology and elements of the health system.

In health care, documentation is not just an administrative issue but also a way to follow the therapy outcome. Health is not a punctual phenomenon but the movement in the continuum between the poles of healthiness and sickness. So gathering data is immanent for the system to get a direction and tendency. But not just the gathering and documentation is of need. Also the processing and interpretation, the systems autopoiesis, brings the real value of data collection. Data is collected and

brought in relations to the elements. Data collection is an augmented experience of the patient's vital status and it's tendencies towards one of the poles. hDATA is the processing and understanding of collected data for the use of steering the movement on the continuum to the intended direction. Different classes of data can be defined by their state of processing:

Basic data: heart rate, SpO2, blood sugar, breathing frequency, etc.

Processed data: heartrate variability, HbA1C, stress level etc.

Interpreted data: diagnosis of disease

Class of understanding data: therapy design

Combining these data types to an idealized therapy cycle for hDATA based therapy design, an iterative process is triggered and supported by a constant monitoring. Figure2 illustrates the idea of getting hDATA for a supportive health system.

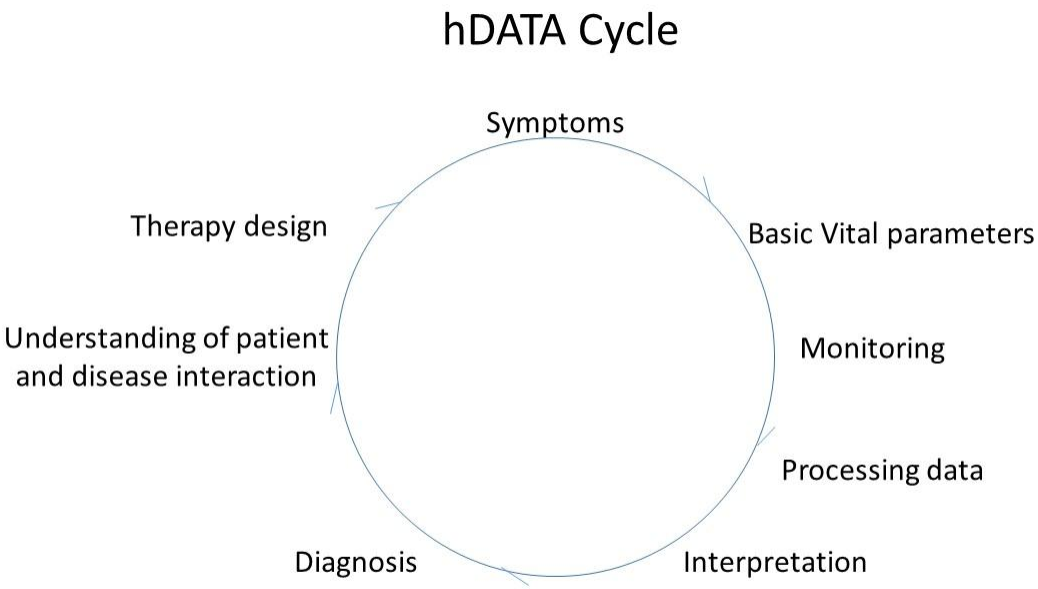

Figure 2 hDATA cycle

4. Conclusion

A major support for this model can be found in the forthcoming of health tracker and smartwatches as well as new types of sensors for vital parameter. The technology readiness level had a gap between the potential of technology and the need of patients. But this gap is closing rapidly with commercialization and fitness trends. Within the next years the patients will request more and more authority in the health system. The existing structures of insurance models will not be sufficient to cover the needs of informed, educated patients who are taking responsibility for themselves and their community. Health will become a democratic good. This could be the revolution of health in the 21st century.

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PSYCHOLOGICAL ASPECTS AND BARRIERS OF EHEALTH IMPLEMENTATION

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Keywords

Adoption rate, eHealth, health information systems, healthcare, implementation, psychological aspects

Abstract

Currently, eHealth is ready to provide improvements in quality of patient care, elimination of risks, labour and financial savings. Unfortunately, wider implementation of eHealth has not been successful in many countries yet. Thus, the aim of this article is to identify and analyse psychological aspects and barriers of eHealth implementation. The identification and analysis was based on qualitative research, namely a case study and a qualitative content analysis. The study lists psychological aspects and individual attitudes that should be considered when planning eHealth projects.

1. Introduction

Implementation of information systems and information and communication technologies (IS/ICT), processes and services, known as eHealth, to all levels of patient care includes not only medical facilities but also the government and patients themselves (MZČR, 2008). Use of eHealth supports work and processes within individual healthcare facilities and remote collaboration among more facilities (telemedicine is used for this purpose). The results of the research (Kunstová & Potančok, 2013), (OECD, 2010) and (Ilminen, 2003) confirm that a significant improvement in quality of patient care, labour savings to medical personnel, financial savings and elimination of risks in the course of preventive, diagnostic and therapeutic processes might be achieved by proper implementation of eHealth. While the benefits of eHealth elements have been proved, wider implementation of an eHealth ecosystem and its elements as such has not yet been successful in

many countries of the European Union (EU) (e.g. Czech Republic, Slovakia, and Poland). Figure 1 shows eHealth profiles (an eHealth implementation rate) of the EU 27+3 (n=1753), the Czech Republic (n=20) and Sweden (n=26). The Czech Republic is the environment of the case study that has been carried out; Sweden, as a leading country in eHealth implementation, has been selected to demonstrate the diversity of eHealth implementation within the EU.

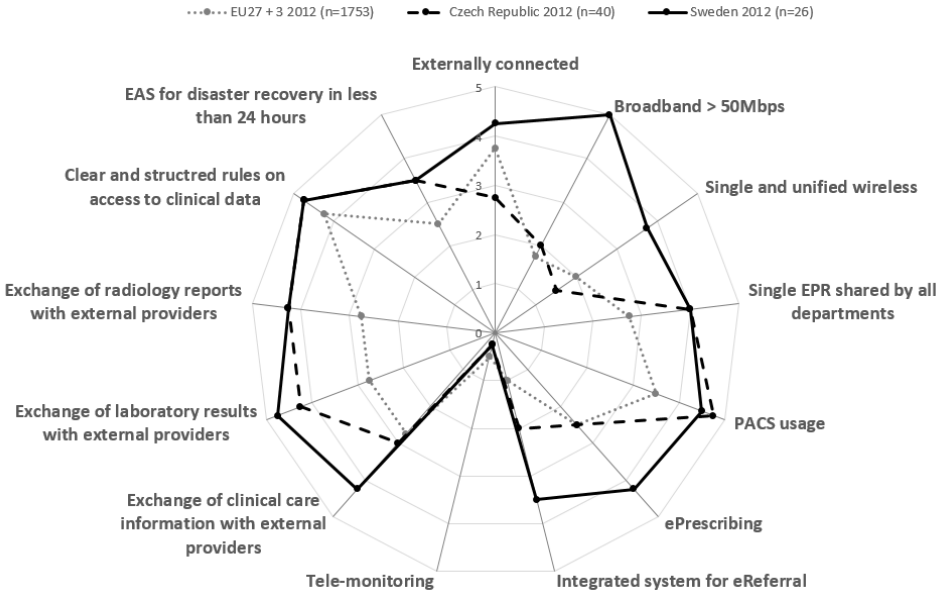

Figure 1. eHealth profiles, data source (Sabes-Figuera, 2013)

The aim of this paper is to identify and analyse psychological aspects and barriers of eHealth implementation and to lay the foundations for a methodology of eHealth implementation. The following research questions have been posed.

1. Are psychological aspects the main constraint in implementing eHealth and are they taken into consideration when trying to implement eHealth?
2. Why have the eHealth pilot projects failed and are not supported as broadly as expected?
3. How to prevent future projects from failing due to psychological barriers?

The following research methods have been used: firstly, general eHealth implementation barriers and challenges were identified and analysed on the basis of a literature, action plans and strategies review at the level of the EU; secondly psychological aspects and barriers were identified by a pilot case study and a qualitative content analysis in Czech healthcare facilities. The structure of this paper corresponds to the above.

2. eHealth barriers

Implementation of eHealth faces a number of challenges posed by the general nature of IS/ICT projects. These may include insufficient input control, technical and social complexity, or poor risk management (Dwivedi et al., 2014), (Nelson, 2007). Many projects fail within the adoption and implementation phases. In healthcare, the general issues are exacerbated by the specifics of the healthcare environment. According to M. Potančok (Potančok & Voříšek, 2015) these include: human life, highly sensitive data, strong regulation, huge amounts of data, flat rate payments and costs versus revenues in individual cases and prejudice.

Prejudice characterizes the attitudes of both professionals and patients: *"a number of physicians, other healthcare professionals and patients still have a very negative attitude towards and prejudice against using new technologies (IS/ICT) in the healthcare sector" (Potančok, 2014).* Individual attitudes of physicians, healthcare professionals and patients are one of the key healthcare environment specifics; and it is, therefore, essential to address the following question: Are psychological aspects the main constraint in implementing eHealth and are they taken into consideration when trying to implement eHealth?

Prior to analysing psychological aspects in healthcare facilities, we analysed strategies and action plans to discover the position and role of the primary and secondary users (doctors and patients) at the strategic level of eHealth. Since 2004, the European Union has introduced two action plans to support wider eHealth implementation within its member states. The first European eHealth action plan 2004–2011 listed the following main challenges/barriers for wider eHealth implementation (Communities Commission of the European, 2004).

- Commitment and leadership of health authorities
- Interoperability of eHealth systems
- User friendliness of eHealth systems and services
- Lack of regulation and fragmentation of the eHealth market in Europe
- Confidentiality and security issues
- Establishment of European networks of reference
- Needs and interests of users
- Access for all to eHealth
- Common understanding and concerted efforts by primary and secondary users

Overall, the challenges mainly related to system functionality, regulatory framework, security and cross-country data and functionality operation. While the issue of commitment and leadership may seem to cover the psychological aspect, financial and organisational issues were mentioned in the detailed overview in this respect. The confidentiality issues were perceived more from the patients' point of view than from the doctors' one. As for the common understanding, the detailed overview said that any user had the power to veto eHealth implementation if it was not found beneficial, but no tools that could be used to persuade the users of eHealth benefits were mentioned.

The new eHealth action plan 2012–2020, Innovative healthcare for the 21st century, mentions new challenges/barriers, which are more specific. While the issues of legal regulation and system functionality remain, there are many new or radically modified issues. A brief list of challenges/barriers is provided below (European Commission, 2012).

- Lack of awareness of and confidence in eHealth solutions among patients, citizens and healthcare professionals
- Lack of interoperability between eHealth solutions
- Limited large-scale evidence of cost-effectiveness of eHealth tools and services
- Lack of legal clarity for health and wellbeing mobile applications and lack of transparency regarding utilisation of the data collected by such applications

- Inadequate or fragmented legal frameworks lacking reimbursement schemes for eHealth services
- High start-up costs of setting up eHealth systems
- Regional differences in accessing ICT services, limited access in deprived areas

The shift from the 2004 issue of commitment and leadership of health authorities to the lack of awareness of and confidence in eHealth solutions among patients, citizens and healthcare professionals, which is mentioned in the first place, turns the attention to growing resistance of some of the users to implementation of eHealth. While in 2004–2011 the main problem lay in the financial and organisational issues, the new action plan transfers the attention to the issue of awareness and confidence among patients, citizens and healthcare professionals. Due to the significant change in the perception of the users, it is necessary to look into the recommendations suggested to raise patients', citizens' and healthcare professionals' awareness and acceptance of eHealth. This problem is addressed in great detail in the report on the public consultation on the eHealth action plan 2012–2020. This report provides the following set of recommendations (European Commission, 2011).

- Promoting inclusion of eHealth in the medical curricula and trainings at the workplace
- Organising information campaigns and supporting dissemination of good practices and results at professional conferences at national and international level
- Providing evidence-based input and research and encouraging promotion of eHealth benefits
- Involving health professionals in the design and implementation of eHealth solutions
- Providing reimbursement for using eHealth
- Improving interoperability
- Clarifying the legal framework of eHealth, in particular security/privacy rules applicable to health professionals, which would increase users' acceptance; eHealth should become a part of the standard of care; and professional associations should play an active role in promoting eHealth

Even though there have been discussions about eHealth implementation, a more practical approach would be beneficial. Strategies do provide a vision, but specific actions are usually the constraint to overcome. Engaging the users in eHealth development or making eHealth applications a part of the medical curricula are just some of the possible recommendations. Also solid, evidence-based research could support overall eHealth acceptance. A systematic review by the World Health Organization (WHO) (Mair et al., 2012) has mentioned the fact that professional resistance to new technologies is cited as a major barrier to progress, even though evidence for such assertions is weak, as reviews do not give sufficient coverage to factors that promote or inhibit user engagement and participation, although engagement and participation are vital for success of new technologies. The aim of this paper is, however, to analyse barriers in the practice of healthcare facilities and to discover attitudes of the individual users to communication and other barriers.

The Czech Republic started preparing a national eHealth strategy late in 2014 (MZČR, 2015). None of the previous strategies and action plans (previously designed by the ICT Union and the Czech national civic association Forum for eHealth) did reflect any of the above mentioned EU recommendations or findings (eHealth Forum & ICT Unie, 2012). eHealth is being promoted by increasing awareness through marketing activities, such as creating a logo, doing PR,

and employing social networks, or by increasing technological skills of the elderly. One of the risks to successful implementation is also seen in low motivation; but no steps or a communication strategy preventing it has been introduced yet in the Czech Republic despite the growing importance of this topic in the EU.

3. Pilot project of eHealth in the Czech Republic

The Czech Republic, which was the environment for the following case study, has many projects that focus on eHealth issues. The biggest eHealth project that was widely supported (especially in terms of money and other resources) by the Czech government was IZIP, an EHR project. We have chosen this project because we aim to analyse failures of eHealth projects from the users' perspective and are interested in the following research question: Why have the eHealth pilot projects failed and are not supported as broadly as expected?

IZIP was founded in 2002 as a small company aiming to implement electronic patient records; shortly after, a 51% share in the company was bought by VZP (the biggest health insurance company in the Czech Republic). In 2011 a pilot implementation project was carried out in the Karlovy Vary and the Vysočina regions. The IZIP system provided a nation-wide web-based EHR containing information on lab results, radiology reports, emergency care and other data; information for more than 20 % of the population were recorded and available to the connected healthcare providers if the patients agreed. (Emmanouilidou & Burke, 2013) The Ministry of Health decided, however, to end the project. According to the Ministry, neither doctors, especially those based outside of hospitals, nor patients were using it sufficiently (Ezdrav.cz, 2015). The eHealth Impact Organization (eHealth Impact Organization, 2006)concluded that the main lesson learned is how important voluntary but well organised involvement of the users, close attention to citizens' needs and also step by step advancement is. In an interview for Týden.cz, J. Kotková, one of the board members of IZIP, said: *"Doctors are widely known for having a traditional approach to documentation and computers." (Hympl, 2012)*

4. Psychological aspects of eHealth implementation

Identification of psychological aspects and individual attitudes has been based on a case study research and a qualitative content analysis (Mayring, 2000). The need to investigate eHealth within the context of actual healthcare facilities was the most significant reason for having selected this research approach. During the case study, four interviews with randomly selected doctors (healthcare professionals) from Vlašim, a small town in Central Bohemia, were conducted. All the doctors included in the representative sample have their own practice (both general practitioners and specialist). This type of healthcare facility was chosen due to its specifics – the doctors are always the owners. All interviews were conducted separately. The length of the interviews ranged from 45 min to 1.5 h. The beginning of each interview was structured with the questions drawing on eHealth and individual attitudes. The set of questions started with general questions (What do you imagine under IS/ICT? How do you use IS/ICT in your practice?); and gradually proceeded to more specific ones (What would motivate you to further IS/ICT implementation? What would help you to acquire and implement new technologies?). Other sources of information for the case study included several eHealth national strategies, annual reports and project descriptions.

The application described above is fully consistent with the definition of a case study (Myers, 2013), (Yin, 2009) as a qualitative research method using evidence from real organizations within the exploratory phase.As mentioned above, at the beginning of each interview we addressed general

and more theoretical questions. On the one hand, the interviews revealed that it is not very clear to the healthcare professionals what **IS/ICT represents**. Most often it is seen as hardware (a computer case for example) and other infrastructure (e.g. cables). But on the other hand, the physicians perceived the importance of IS/ICT, which is illustrated by the following quotation: *"IS/ICT is necessary for my work."* At first sight, the doctors were not familiar with the terms **eHealth** and **digital health**; only one paediatrician immediately described the use of technologies for diagnosis and treatment. However, upon closer examination and an indication of eHealth elements, we found out that doctors do know it: suddenly some of them began explaining in a great detail how patient tele-monitoring (remote monitoring) works. Doctors often do know sub-elements of eHealth, but the concept as such and a broader understanding of the eHealth or digital health concept eludes them.

The main reasons for initial acquisition of IS/ICT (the IS/ICT currently used) mentioned by the doctors included financial and time savings, necessity (e.g. required reporting to health insurance companies) and expected simplification (being more efficient than a typewriter, offering predefined findings). None of the interviewees was a high-tech lover who would acquire new technologies just out of interest. Objective reasons clearly prevailed.

After covering the initial acquisition, we began to examine what was the **hardest part of practically implementing new technologies**. One of the doctors described the learning phase as follows: *"I was not scared that I would not be able to treat severely injured patients, but I was terrified of computers and programs."* Actions that seem to be trivial to IS/ICT specialists (for example updating support applications, such as Adobe Reader, Java etc.) can be a nightmare for doctors. One of the reasons may be lack of IS/ICT education of medical students.

Three out of four doctors agreed that they usually spend 50–60 % of their working time **directly interacting with IS/ICT**. This can be due to administration, extensive bureaucracy and an increase in the collected data. The following quote may seem rude, but it describes accurately the situation in healthcare facilities: *"I am a doctor not a clerk, unfortunately I often feel exactly the opposite."* The growing volume of data connected with new technologies often increases the fear.

At the end of our interviews, we examined **motivation factors** for implementation of new (future) technologies related to eHealth. Within the case study, we have already mentioned the reasons for the initial acquisition. The interviews showed that the strongest motivating factors for doctors to implement new technologies would be diagnosis simplification and clarification, improving patient care quality, financial and time saving and interconnection of insurance companies' portals.

The findings of the case study and the qualitative content analysis are summarized in the following list of psychological aspects and individual attitudes that should be considered when planning eHealth projects to prevent future failures caused by psychological aspects and barriers.

- Fear and concern
- Distrust
- Motivation
- Expectations
- Core work vs new one
- Misunderstanding

New IS/ICT still raise many questions among medical staff. The results of our case study confirm the need to consider the above mentioned psychological aspects and individual attitudes within eHealth design. They also confirm the partial results presented by M. Potančok (Potančok, 2014)

that many patients, citizens and healthcare professionals still feel prejudice towards the use of new technologies (IS/ICT). However, when they learn to use them, they are able to manage standard operations at a very good level, even if they say they do not.

5. Conclusion

The aim of this paper was to analyse psychological aspects and barriers of eHealth implementation and answer research questions focusing on constraints in eHealth implementation and project failures.

The results of the first part of our analysis have shown that in the EU eHealth strategies and action plans there is a noticeable shift in the perception of the issue of awareness and confidence in eHealth solutions among patients, healthcare professionals and citizens. According to the eHealth Impact Organization (eHealth Impact Organization, 2006) the main lesson learned is how important voluntary but well organised involvement of the users, close attention to citizen needs and also step by step advancement is. This fact was also demonstrated by the biggest eHealth project in the Czech Republic (IZIP), which failed. Motivation aspects and individual attitudes of the users were not taken into consideration, which caused lack of motivation and lack of information among the users; no preventing steps were considered either.

The final list of psychological aspects and individual attitudes contains fear and concern, distrust, motivation, expectations, core work vs new one, and misunderstanding; it should be used within eHealth projects and considered when creating a methodology for eHealth design and implementation.

Applicability of the results is twofold. Firstly, project designers and promoters will be able to work with the psychological aspects and target projects directly to healthcare professionals. Additionally, the results can be used by IS/ICT professionals to design an eHealth implementation methodology. Secondly, the results can be used in further research. It is necessary to expand the case study by providing a detailed view of patients and citizens.

6. Acknowledgement

This paper has been supported by the IGA grant “Methodology of eHealth implementation to healthcare facilities” VSE IGS F4/61/2015. This paper has been produced thanks to long-term institutional support of research activities by the Faculty of Informatics and Statistics, the University of Economics, Prague.

The support of the doctors at all participating healthcare facilities is gratefully acknowledged.

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USER PREFERENCES FOR SPEECH-BASED INTERACTION WITH MOBILE HEALTH MANAGEMENT APPLICATIONS

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Keywords

hDATA, elderly, mobile apps, heart rate monitoring, medication reminder, usability studies.

Abstract

This work reports the main results from two lab studies involving elderly users on relevant usability aspects during the interaction with assistive systems and simulated speech interaction components, starting from the main interactions for socio-technical health related systems. The first study reports on usability aspects and usage scenarios during the interaction with a smartphone-based prototype for real time vital sign detection and visualization. The second study provides insights on user preferences toward different speech-based output variants for an activity reporting feature. Design recommendations are given toward the enhancement of perceived control of the service as well as of means and quality of health related data documentation.

1. Introduction

Taking the growing popularity of smartphones (Cook et al., 2013) into account, today's users can choose from over 800,000 medical apps that are available for the dominant mobile platforms (Android, Apple). 86 iOS applications are solely focussed on reminders while 408 applications support users to keep track of their health data (Seabrook et al., 2014). Accordingly personal medical data are collected via context-sensitive sensors and further processed in a social frameset

with increasing complexity when involving several persons beside the user such as formal or informal caregivers and medical professionals. As part of a European Project named AHEAD a tool for heart rate data recording and visualization is developed and improved toward providing a good usability of health data collection and management as well as positive user experience of speech-based interaction components, especially for people with hearing impairment and their formal caregivers. In a usability study an early functional was evaluated with elderly people in the city of Vienna. The goal was to ensure that issues regarding usability and quality of experience are detected at early stage and to unveil problems a future user would probably encounter with vital data detection, retrieval and visualization. A second lab study was conducted in the city of Munich focusing on concrete user preferences regarding the speech-based presentation and interpretation of the measured health data as well as of medication reminders.

Overall the two studies aimed at uncovering principal user needs and preferences toward mobile applications for health data collection and management as well as setting out the design space regarding speech-based interaction elements. Generally speaking the use of such data generated by e.g. wearables like a smartwatch or blood pressure measurement devices, blood sugar devices etc. brings the data and the use of it with a certain aim, the aim of increasing the health status of the person who the data is about, makes it health related data. Going one step further and defining the interaction system for the use makes the health related data to hDATA, referring to health-related contextual data processing to information. By this statement, there is a clear system theoretical approach visible. This asks for a definition of the core system and the framework of it as well.

1.1. Core System for hDATA

The central element is the patient. This role is directly linked to all other elements (physicians, informal caregivers and formal caregivers). These four roles have an interaction pattern that includes all elements and can – by following strictly just the aim of improving health – act as a closed system with self-referring interaction patterns. This is an autopoietic system (Maturana, Varela, 1982) as it is a living system that is reproducing its own elements by the roles and partly cybernetic circuits. Time passing by, the system becomes more and more complex. The interaction models between the elements of the system are increasing in complexity because of the social aspects that add up to the pure data. In comparison to its environment, the social system is an island of low complexity (Insel von geringer Komplexität) (Luhmann, 1970 in Kneer, Nassehi, 2000). But by building up its own structures and working autopoietic, it is re-fracturing its structure and increases its stability against external stimuli.

To access this social system and to implement modi operandi for a more efficient way of building its internal structures for achieving the major aim of the system, technology could be one way. Technology is the combination of hardware, software and way of use (Weyer, 2008). So it is possible to use technology for a better – more efficient – interaction between the roles within the social system. More determined: there are three interactions for a socio-technical system for hDATA: control, documentation and support. Technology provides solutions for control and documentation by using monitoring tools like wearables and includes assistance systems for an increasing effect in adherence by its specific support – like an app with medication reminders or activity tracking. The AHEAD project is one potential way for realising these interactions.

1.2. The AHEAD Project

Hearing, eye-sight, memory, and coordination capacities decrease with age. To improve quality of life of elderly people, sensory impairments could be technologically compensated. However, still many elderly remain rather skeptical toward the emphasis of daily use of technology-supported

services for personal health management. The project AHEAD (Augmented Hearing Experience and Assistance for Daily life) aims at increasing the quality of life of elderly (55+) by assisting them for keeping an active and independent lifestyle. The focus is set on devices that elderly people have already adopted: eyeglasses and hearing aid. Within the early phase of the project the user needs and requirements analysis (interviews, focus groups) elderly users and formal care givers revealed two relevant service scenarios to be deployed: vital signs monitoring and medication intake reminders (Barrolon et al., 2015). Following a scenario-based design approach accordant interface and interaction prototypes are developed and evaluated in an iterative way by adopting a user-centered design process (Vredenburg et al., 2001), an approach demanding for the continuous involvement of the addressed target group (i.e. by asking or observing users for their needs, by presenting design ideas frequently to users for their feedback and updating the design iteratively). In the current stage usage preferences of the features vital sign monitoring and medication reminder were addressed in the two lab studies which are presented in the following.

2. Study 1: Vital Signs Detection

With the emergence of the "quantified self" trend these days very popular fitness trackers (fitbit, Withings, Jawbone, etc.) are available for multiple platforms. Apps specialised in training for different kinds of (outdoor) endurance sports like Runtastic, Runkeeper or Endomondo also aim at counting ones activity, recording routes, acting as fitness coaches and building up communities around personal training via hDATA processing. Also more and more telemedicine systems constituting of different variations of smart and wearable systems have penetrated the mobile technologies´ markets (Chan et al., 2012). However still many solutions provide a dedicated collection database and interfaces failing important requirements. In this study elderly users´ needs and preferences were investigated through the evaluation of a heart rate detection prototype.

2.1. Study design

The study procedure was structured along three phases: introduction and pre-interview, main task phase, and post-interview and questionnaires. In the pre-interview participants indicated their previous experience with mobile phones and smartphones, and whether they had impaired hearing. In the task phase participants were asked to conduct certain tasks with the mobile app and to provide verbal feedback. A user scenario being defined earlier in the design phase was introduced by the facilitator before the participants took over with the three tasks i.e. i) attaching the sensor to the ear independently, ii) generating real time vital sign data and ii) setting heart rate threshold for alarm. Hearing impaired participants removed their hearing aid to accomplish this task. Participants were instructed to comment on everything that comes into their mind (Thinking aloud) and to provide criticism. The post-interview targeted at participants´ general opinion about the tested functions covering participants´ answers regarding their general impression (positive and problematic aspects) and perceived satisfaction with the tested components.

In the actual prototype version the vital signs detection module can measure various vital signs using photoplethysmography (light-emitting technique used to determine skin blood flow) and contact thermometer. As the module needs access to the ear canal, a wireless silicon cap, a so called dome, with the sensing elements was inserted (see Figure 1, left). The prototype provides real time heart rate data collection and visualization on the display of the smartphone (see Figure 1, center), as well as options for setting alarms in case a certain heart rate or temperature value has been reached (see Figure 1, right).

Participants

In total eighteen elderly people, 14 male and 4 female participated in the first lab study. Participants were between 57 and 80 (Mean = 66.2, SD = 8.1) years old. Among

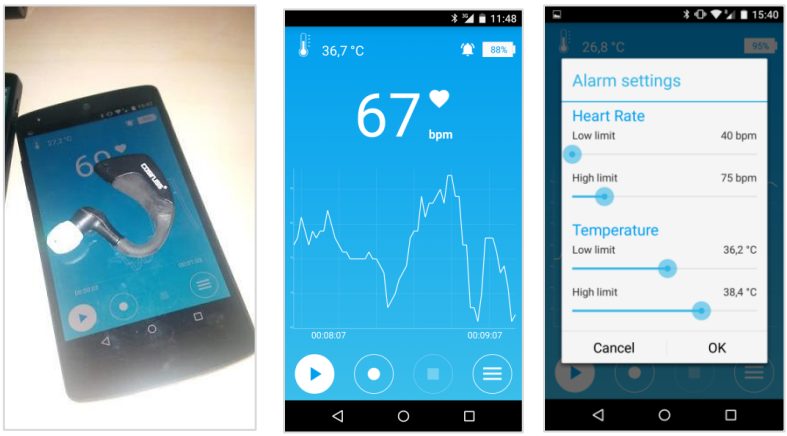

Figure 1: heart-rate and temperature sensor (left), data visualization screen (center), settings screen (right)

the involved sample 9 out of 18 participants (50%) had a hearing impairment in some way. From these 9 persons 7 had a diagnosed hearing impairment. Overall 13 participants (72.2% of the final sample) own a mobile phone. All of these 13 participants were able to initiate a phone call via contact list or calling list, while the majority (11 out of 13) was able to write a short text message (7 persons with word recognition and 6 persons without word recognition). Overall 10 participants owned a smartphone. Among them all were able to initiate a phone call via contact list or calling list, write a text message, take pictures and to set an alarm.

2.2. Results

Overall 9 out of 14 participants managed to attach sensor without help, while 5 needed help to insert the sensor successfully to produce real time heart rate data (due to technical problems i.e. device activation and BT connectivity the task could be accomplished by 14 participants only). Problems with mounting the sensor occurred due to anatomical characteristics such as size differences of the auditory meatus, as the sensor was loose and fell out. After having examined the data visualization, participants were asked to exemplarily set the alarm for maximum heart threshold level. Then they should provoke a raise of the heart rate level to activate an alarm by performing physical activity (see Figure 1, center). The majority of participants managed successfully to find the setting (11 participants), use the slider to set the alarm for the maximum heart rate level (see Figure 1, right).

All participants correctly anticipated the main UI elements on the main screen i.e. real time heart rate detection curve, temperature and battery level of the Bluetooth sensor. Although the three tasks (attaching the sensor, generating data, setting the heart rate threshold for the alarm) were perceived as being easy to solve, some usability issues were observed related to

- Data visualization: participants had difficulties understanding the purpose of the visualization. Changing scales and axe labels were confusing, while the potential benefit of such visualization was not always perceived.
- Feedback: While participants performed physical activity to raise heart rate level, the smartphone was put on a table nearby. Perceptibility of the alarm triggered by the detected heart rate was low, as most of the time the vibratory signal was not recognized.

The mounting of the ear sensor was well accepted by especially participants without hearing loss who provided useful usability recommendations for the improvement of the future service:

- Flexibility: enable the user to remove the ear piece easily when vital signs are not measured. The application should allow the quick and easy mounting of the sensor and the instant use of the corresponding module on the smartphone according to when and in what situations a measurement needs to be done. This action should be easily undertaken by the elderly user e.g. comfortely activate and connect the device via single button press in the app.
- Understandability: the meaning and purpose of the real time curve should be more clear if depicted, by e.g. providing additional information such as e.g. depicting selected thresholds or activity history. Moreover real time feedback should be provided in form of a stable and consistent information output such as diagrams with fix scales for better orientation.
- Awareness: Alarms and notifications should be given more prominently e.g. via audio signal, a message and corresponding visual feedback information on the display. Moreover, several alarm output modes should be configurable, such as e.g. auditory beep tone when threshold has been reached, or voice-based notification containing a short message (e.g. “maximum heart rate level reached”, “please lower your heart rate“, “call your doctor” depending on the data).

Overall, participants enjoyed using the application and freely anticipated various use cases for its application, such as monitoring the heart rate level e.g. during long term driving against drowsiness behind the wheel, during physical activity on the home trainer, or in case of heartbeat irregularities.

3. Study 2: Health data presentation and medication reminders

As forgetting medication intakes can lead to increased morbidity and mortality especially for elderly people (Yu et al., 2015), there are various possibilities of medication reminders on the market. Reminders written on paper sheets and phone calls by family members are being increasingly replaced by digital systems. With the endless possibilities, there are some important questions to be answered, most notably which context, type of feedback and device fits best for which user. According to Hartin et al. (2014) there are time-specific reminders on one hand and different emerging context-aware solutions on the other hand. While time-specific reminders tend to be delivered during inconvenient situations, context-aware reminders aim to avoid these situations by connecting location data, activity level or more complex contexts to the reminders. A pilot study of Reidel et al. (2008) showed that especially the technical implementation of the voice interface is key to the success and the acceptability of the whole system. Therefore the second lab study attempted to give answers on issues like the technical implementation and user preferences concerning the structure and content of health related audio messages.

3.1. Study design

The second study aimed at extending the vital signs detection paradigm with corresponding monitoring and reporting features, such as activity reports based on daily heart rate and temperature data. The study followed the same procedure as study 1 (see 2.1). More specifically user preferences regarding different variants of speech-based output were investigated in a simulated lab setting. For the testing of speech interaction, participants were equipped with a wireless bone conducting Bluetooth headset with a built-in microphone (simulating the final AHEAD system providing bone conduction based hearing aid via the hearing glasses). In order to become familiar with the activity monitoring feature, every participant performed six easy voice interaction tasks.

To simulate physical activity, the scenario of a hiking tour was introduced and participants were asked to walk a distance of 10 meters twice while wearing the headset. After the first 10 meters, a pre-recorded voice was played back saying 'Nice that you're active!', while another pre-recorded voice at the finish line said 'Please take a break!'. After that, the participants were asked to give their opinion on the positive reinforcement and the warning.

Addressing the users' preference of an activity history or a summary report, three different pre-recorded reports were presented (identical message, different level of detail):

- Basic: The report (7 seconds) contained basic information that everything was alright, but the user should move a bit more the next day.
- Recommendation: The report (14 seconds) gave an additional recommendation how to be more active.
- Recommendation and feedback: The report (36 seconds) included several recommendations as well as precise heart rate data ('your daily low heart rate was 52 and your highest heart rate was 150').

In addition to preferences on the reports, participants were asked at which moment they would prefer to receive this summary. While giving their feedback, a medication reminder was played back to see if the elderly (and partly hearing impaired) participants were able to keep track of the conversation as well as remember the medication they should take. The reaction of the participants to the medication reminder was carefully monitored by a second facilitator while the main facilitator kept up the conversation in case the participant stopped talking. After giving their comments on the surprising medication reminder and how the system could make these situations easier to handle, each participant gave his overall impression of the evaluated features and further fields of application.

Participants

The second study featured ten participants between 56 and 79 years old (Mean = 69.2, SD = 8.4). Seven of them were wearing hearing aids to compensate their diagnosed hearing impairment. Unfortunately one participant had serious problems with his hearing aid and wasn't able to understand the pre-recorded voice samples even on the highest volume level. Because of that, only nine participants completed the whole test.

Six of the ten participants owned a smartphone, four owned a mobile phone. Interestingly two of the four mobile phone owners stated, that they would only use their device in case of emergency or not at all. While every participant was used to calling somebody off the contact list, only 70% had ever written a SMS with their device. Half of the participants were able to send e-mails, install applications, set alarms and navigate to a given destination with their smartphones. Every smartphone owner stated that he had taken and sent pictures as well as video files. 60% had made experiences with voice user interfaces before, two in their car for navigation purposes, two with dialogue systems on the phone (tele-banking) and two of ten participants had already tried the voice assistant on their smartphone. On a scale from 1 (extremely bad) to 10 (ideal), these participants rated their experience with voice user interfaces as 'poor' (Mean = 2.8).

3.2. Results

After the participants had experienced both a positive reinforcement ('Nice that you're active!') and a warning ('Please take a break!') they shared their thoughts. 80% of the participants appreciated the warning and freely anticipated numerous situations where audio warnings could be beneficiary (e.g. on hot sunny days and if users are overly ambitious). The audio message should be clear, short

and unmistakable. Only one participant (10%) said that he needed further information like the reason of the warning. Conversely the positive reinforcement was rated poor as the majority of the participants (60%) did not see any benefit, questioning if the system could properly assess when praise was justified.

Almost every participant (90%) liked the idea of a regular health and activity summary. Recommendations can be summarized as follows:

- According to 80% of the elderly participants this summary shouldn't be too extensive (longer than 14 seconds) but nonetheless contain concrete information such as heart rate values (70%). It was mentioned three times that a short basic report with the possibility to ask for further information would be the ideal solution.
- Suggestions for physical activities were also rated well, but needed to be customized to the activity level and the preferred activities of the user. Asked for their favourite time to hear the summary, participants had substantially different opinions. Three preferred a particular time, two liked the idea of a time span of two hours and three wanted the summary to be played back when sitting in front of the television or after lunch. One participant stated that the summary shouldn't be played back on a regular basis and only come up on his command.

The medication reminders were rated as a very useful feature in general as some participants immediately remembered the last time they had forgotten their medication. But as the reminder was played back in the course of a conversation only 30% could correctly reproduce which medication they had to take. Most participants (60%) noticed that the system said something but as they wanted to follow the ongoing conversation they just suppressed the reminder. In total three participants (1 of 7 hearing impaired participants) were able to keep up the conversation and understand what medication they had to take. To address this common problem the participants could basically think of two solutions:

- A mute button attached to the audio system so the user can mute the message in inconvenient situations. In this case the message should be repeated after a certain period of time, e.g. after half an hour.
- A short but unique announcing sound that is played a short time before the message starts. This way the user would be more aware and could probably listen to the message and the conversation.

4. Conclusion and Outlook

Real time measurement of the heart rate impressed study participants in the first study who envisioned potential use cases for future *support* by such functionality. The wearable sensor was well accepted and easy to handle. Referring to the claim for adequate *documentation* mechanisms in hDATA processing systems, the visualization should be enhanced with additional information on set thresholds, e.g. for specific activities and contexts. Vital signs summary reports should not be too extensive but nonetheless contain concrete health data such as heart rate values toward complete and comprehensive information and useful behavioral implications for *control* and increased adherence. In study 2 questions on information amount and timing for speech-based medication intake reminders were tackled as a key aspect for perceived *control* in interaction with hDATA. For the users to be able to understand every medication reminder, audio messages should start with a unique sound enabling the users to shift their attention to the reminder. To handle audio

messages in inconvenient or social situations participants suggested a button attached to the audio system which mutes and postpones the message.

Taken together, the conducted studies provided valuable insights for the advancement of the tested modules (vital signs monitoring, medication reminders). Feedback from user´s attitudes toward gathering hDATA by (health) monitoring and management approaches and elaborated implications for the design of speech-interaction elements will flow into the further development of the AHEAD system. Hence AHEAD demonstrates how to use generated health related data set in a context in the sense of *documentation*, *control* and *support* with the aim to improve health: if an individual set of threshold is reached by monitored data, the system interacts with the primary user and in some use cases also with health professionals and informal carers (e.g. personal alert system) and gives instructions without annoying the user. The user receives supporting information within the actual situation and is enabled to react in time. AHEAD shows a new dimension of socio-technological systems, a full system, building on its own references and structures, is constructed and can interact with its environment on the base of reports. AHEAD provides an autopoietic system that keeps its core – the patient – alive by using alarms to make the environment react to its needs. This makes it a new kind of socio-technological system. AHEAD is an augmented, bio-supportive socio-technological system.

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SESSION K: OPEN INNOVATION AND NEW E-BUSINESS MODELS

OPEN INNOVATION, OPEN DATA AND NEW BUSINESS MODELS

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Keywords

Open government data, open data, business model innovation, business model

Abstract

Open government data are the result of as well as the preconditions for open government. Data made publically accessible are an important basis for creating added value for society as a whole. Open data business models support entrepreneurs in reusing and combining available open data sources to provide value-added services. Three cases show how open data business models can be realized.

1. Introduction

Societies, as well as the business world, are undergoing a digital transformation. Means of information and communication technologies (ICT) are triggering significant and fundamental changes. ICT have had have multiple, diverse effects since their emergence and continue to do so. From an economic and business perspective, several industries have undergone major transformations over the past four decades; the banking and finance or travel industries are key examples. Many industries are struggling and are searching for new strategies and business models to cope with the effects of digitalization.

Nowadays, eBusiness (i.e., doing business electronically) can be considered standard practice in the business environment. Business models define the overall concept of how an organization or a network of (business) organizations will generate value. The term "business model" was introduced in the late 1980s along with the emerging digital economy to systematically enable adjusting business activities to emerging new ICT. In general, a business model is the logic of an organization (or a business network) to create value. One of the first authors who discussed the term was Paul Timmers (1998). The Business Model Canvas, developed and introduced by Osterwalder and Pigneuer, is a strategic management and entrepreneurial tool. It enables the description, design, challenging, invention, innovation and pivoting of a business model. It consists of nine building blocks arranged into four segments (Osterwalder & Pigneur, 2010): **infrastructure**, defining *key activities*, *key resources* and *partner networks;* **offering**, defining

value proposition; **customers**, defining *customer segments*, *channels*, and *customer relationship; and* **finances**, defining *cost structure* and *revenue streams*.

However, ICT has affected not only the commerce sector, but also other sectors, e.g., the health or the public sector. Today, many activities and changes are taking place not only in the fields of eMarkets, eBusiness, or eCommerce, but also in areas such as eGoverment or eHealth. While the economic and business perspectives of these developments have been intensely examined in recent decades, the more societal and public areas have been addressed less frequently.

"Open innovation" mainly refers to the opening of the innovation process to knowledge from the outside of the innovating organization. "Open innovation is a paradigm that assumes that firms can and should use external ideas as well as internal ideas" (Chesbrough, 2003). The boundaries between a company and its ecosystem will become increasingly invisible, and innovations will be able to be easily transferred inward and outward. Thus, open innovation may lead to innovative business models. Business models can be understood as a broader concept and may also refer to the entire logic in which value is created and captured from technological and social or societal innovations.

Thus far, open innovation has mainly focused on the business world. However, this perspective can be considered as being too narrow: it does not go far enough. In modern and open societies, not only businesses but society as a whole have to be considered.

"Open societal innovation" (OSI) is the adaptation and subsequent sustainable use of appropriate open innovation approaches from business, adapted and utilized by the state and society to solve societal challenges (von Lucke et al., 2012). Innovation stimuli can be generated by civil society through applying open innovation methods and instruments to cope with various societal challenges. Such stimuli may lead to the development of new eBusiness models.

Furthermore, the provision of open government data (OGD) through public administrations and governmental bodies may also lead to new and innovative eBusiness models through applying open innovation instruments, e.g., hackdays. McKinsey, for example, estimates that open data can help unlock $3 trillion to $5 trillion in economic value annually across seven sectors (Manyika et al., 2013). Furthermore, the European Union estimates the total direct and indirect economic gains from open data re-use would be in the order of €140 billion annually (European Commission, 2011). OGD are a result of the openness movement in the public sector and are simultaneously the underlying prerequisites for further Open Government activities. These activities are not inherently profit oriented.

As already mentioned above, businesses are attempting to develop new business models based on digital transformation with profit oriented focus.

Although these two perspectives might seem contradictory at first glance, they are not. Furthermore, both perspectives complement each other in the current digital world.

Openly available government data may serve as a starting point for creating added value. Entrepreneurs develop business models based on open government sources by leveraging its value through a combination of different sources. There are already some examples on the market, e.g., the US-based company climate.com providing added value services to farmers or the Swiss mobile app Wemlin, which provides real-time public transport data.

We discuss open government and open government data in Chapter 2. In Chapter 3, we discuss open data business models in greater detail from the perspective of business model archetypes and categories. In addition, we present some general fields of application for open data business

models. In Chapter 4, we present three cases to illustrate applications of open data business models. We conclude with summary and discussion.

2. Open Government and Open Government Data (OGD)

Open Government can be considered an umbrella term covering different ideas and concepts. “The narrow definition of Open Government consists of transparency, participation and collaboration of the state towards third actors like the economy or the citizenship” (Geiger & von Lucke 2012, 266). Therefore, it follows the New Public Management philosophy, which was introduced at the beginning of the 1990s. The Open Government movement is correlated with terms such as “freedom of information”, “open standards and interfaces”, “open society”, “open (societal) innovation” or “open (government) data (OGD)”. The means of ICT are an important enabler of open government concepts.

In the context of open government, the concept of open government data can be considered to be one of the fundamental preconditions. Only if government data are openly available can concepts such as transparency or participation be achieved and realized.

OGD can be understood as non-personal data generated and produced by government or government-controlled entities. “Open” refers to free use and free reuse as well as free redistribution by anyone. Furthermore, OGD have to be machine-readable. For a detailed discussion of OGD, see Geiger & von Lucke (2012).

OGD are being provided through OGD portals, which can be offered by national, regional or local governments. Examples include the national OGD portals of the USA (www.data.gov), Slovenia (http://nio.gov.si) and Switzerland (www.opendata.admin.ch), the OGD portal of the federal state of Baden-Württemberg in Germany (opendata.service-bw.de) or the OGD city portals of Zurich (www.stadt-zuerich.ch/opendata) and Vienna (open.wien.gv.at/site/open-data).

It has to be emphasized that OGD are just data in a raw format. To create added value, these data have to be processed, combined and/or visualized accordingly. Either governments themselves or third parties provide these kinds of value-adding services.

3. Open Data Business Models

3.1. Eight Archetypes

As there are enormous economic potentials based on open (government) data, and as there already are success stories available, several authors have described and analyzed potential business models based on open data and developed frameworks. Ferro and Osella (2013) developed eight business model archetypes for open data re-use. The authors differentiate the business models using two axes: The positioning of the company in the value chain (“on the front line” vs. “behind the scenes”) and the strategic vision (“bread and butter” vs. “attraction tool”).

Zeleti at al. provide a systematic review of the existing open data business models analyses and frameworks. Based on their analysis and conceptualization, they have developed five categories of open data business models: Razor-Blade, Indirect Benefit, Cost Saving, Premium, and Freemium (Zeleti, Ojo, & Curry, 2014).

Saxena (2014) has identified five goals of an innovative business model that can be achieved by re-using open data: delivering a personal touch, solving problems, creating benchmarking solutions, expanding offerings, and informing new product ideas.

3.2. Open data as a source for innovative business models

The "Open Data 500 U.S." project (www.opendata500.com) at the GovLab at New York University studies the extent to which US companies are re-using open data in order to give a broad, inclusive view of the field. The comprehensive list covers 500 US companies that use open government data as a key business resource. An interactive graphic shows which company categories re-use data from which kind of federal agencies. For example, companies from the category Lifestyle & Consumer re-use data from the Departments of Agriculture, Commerce, Energy, and Justice, among others (see Figure 1).

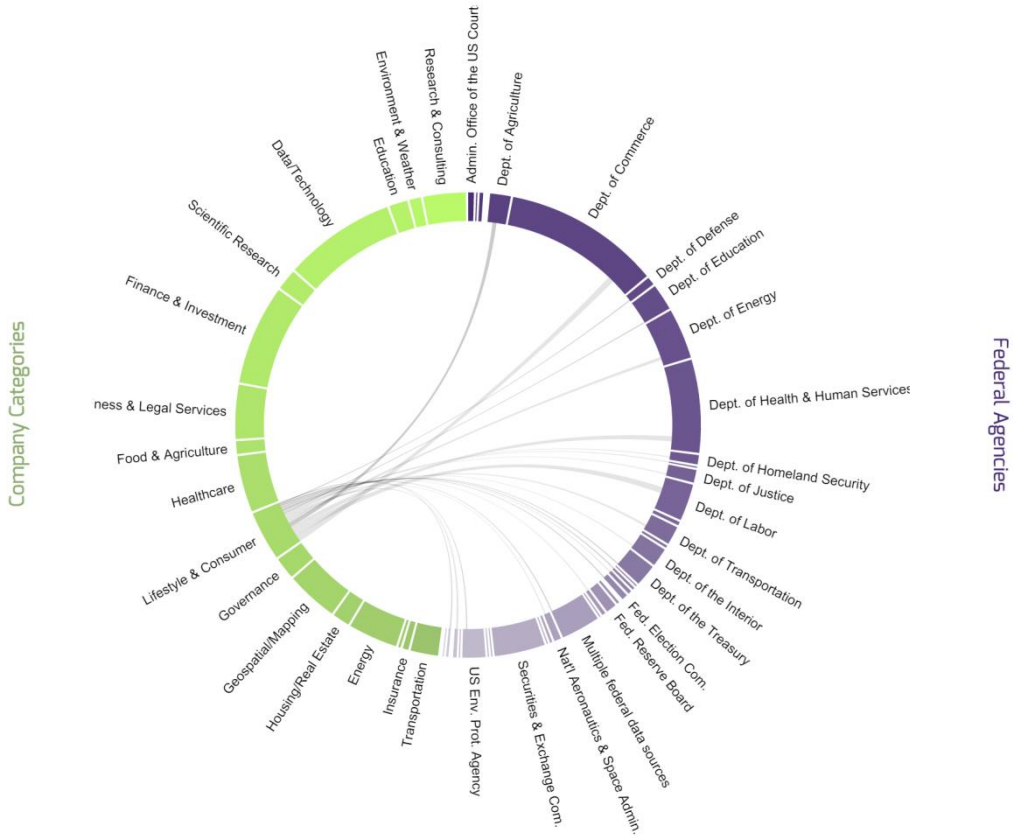

Figure 1: Open Data Compass: What types of companies use which agencies' data?

Example of Lifestyle & Consumer companies (www.opendata500.com)

In their extensive report, the McKinsey Global Institute provides an extremely detailed analysis of creating added value based on the re-use of open data in different sectors, which we will summarize in the following. For details, refer to Manyika et al. (2013).

In **education**, the report identified five factors that can enable potential value from using open data in education: improved instruction, better matching of students to programs, matching students to employment, transparent education financing, and more efficient system administration.

There are three major elements for unlocking value with open data in **transportation**: improved infrastructure planning and management; optimized fleet investment and management; and better-informed customer decision making.

In the area of **consumer products**, the authors identified five elements that can deliver value throughout the consumer products domain through the use of open data: improved product design and manufacturing, efficient store operations, more targeted marketing and sales, better-informed consumption, and improved post-sales interactions.

For the **electricity value chain**, five elements for using open data have been identified: improved generation investment, efficient generation operations, optimized investment in transmission and distribution, efficient transmission and distribution operations, and optimized retail and consumption.

In the **oil and gas value chain**, five elements have been recognized: optimized upstream investment, efficient upstream operations, optimized midstream and downstream investment.

In **health care**, the authors have identified the following elements for capturing value: right living, right care, right provider, and right value.

Finally, the report looked at how open data could be applied in three different areas of **consumer finance**: retail banking, insurance (property and casualty, and life), and residential real estate.

For all seven areas, the data sources are either different governmental bodies or public organizations, private households, individuals, e.g., as consumers or patients, and any commercial organization.

Figure 2 presents economic value of open data re-use.

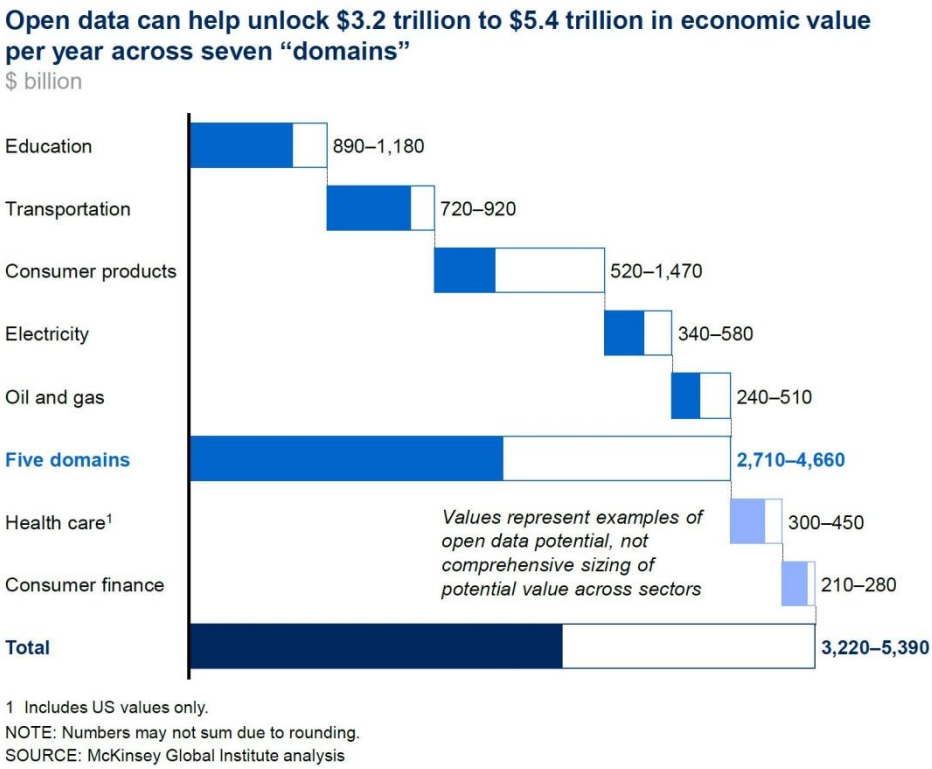

Figure 2: Economic value of open data re-use (Manyika et al., 2013, 9)

4. Cases for Open Data Business Models

In the following, three cases showing how open (government) data can be re-used to create innovative business models will briefly be presented.

4.1. The Climate Corporation

The Climate Corporation (climate.com) is a company based in San Francisco and founded in 2006. One of the company's activities is underwriting weather insurance for farmers; it examines weather data to provide insurance to farmers who can lock in profits even in the case of drought, heavy rains or other adverse weather conditions. Beyond weather data, the company re-uses geographical as well as public satellite data. Furthermore, the company's proprietary Climate Technology Platform™ combines hyper-local weather monitoring, agronomic modeling, and high-resolution weather simulations to deliver its Climate Basic™ and Climate Pro™ products as well as mobile Software as a Service (SaaS) solutions that help farmers improve profitability by making better informed operating and financing decisions (climate.com). The products provide decision support tools, such as *Nitrogen Advisor* or *Field Health Advisor*. The nitrogen tools can help farmers track the level of nitrogen in their soil throughout the entire corn-growing season. The field health tools combine remote sensing imagery with field-by-field data on rainfall, temperature, growing degree days, crop stage, soil type and field topography. Figure 3 shows an example for field-level weather information.

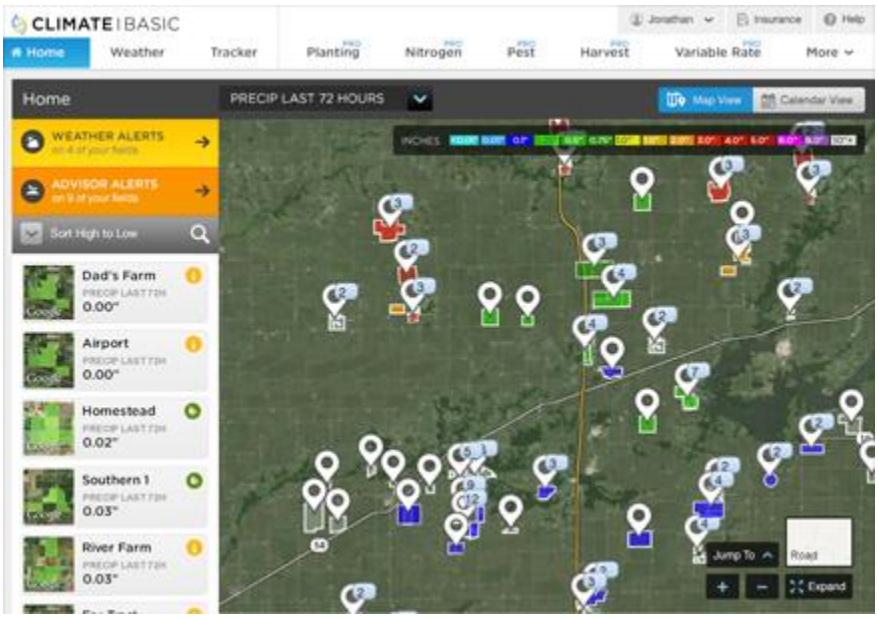

Figure 3: Climate Basic - Field-Level Weather:

View historical, real-time and forecasted weather at the field level (hourly + daily)

(climate.com/products/climate-basic)

Based on the well-known concept of the Business Model Canvas developed by Alexander Osterwalder (www.businessmodelgeneration.com/canvas/bmc), Hannes Gassert, an entrepreneur and open data activist from Switzerland, mapped the "Crop Intelligence" business model of The Climate Corporation (Figure 4).

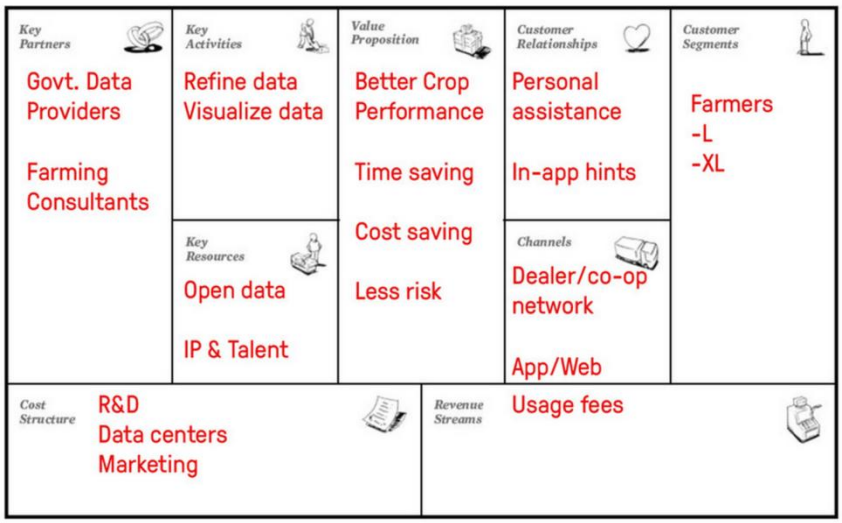

Figure 4: Business Model Canvas for the "Crop Intelligence" business model of the Climate Corporation (Gassert, 2015)

4.2. Wemlin

Netcetera (www.netcetera.com) is a Swiss software company founded in 1996, specializing in tailor-made software. Today, Netcetera has approximately 350 employees in four countries. The company assumes its social responsibilities and supports socially valuable projects in the areas of culture, education, society and leisure time activities. Furthermore, Netcetera is a member of OpenData.ch, an association supporting the development of open data in Switzerland. In addition to supporting government agencies in their open data initiatives, Netcetera also provides data and other services to support the goals of the Open Knowledge Foundation. Additionally, Netcetera provides converted data for software developers' further use. With this free offering, Netcetera aims to support and promote the Open Data developer community in Switzerland.

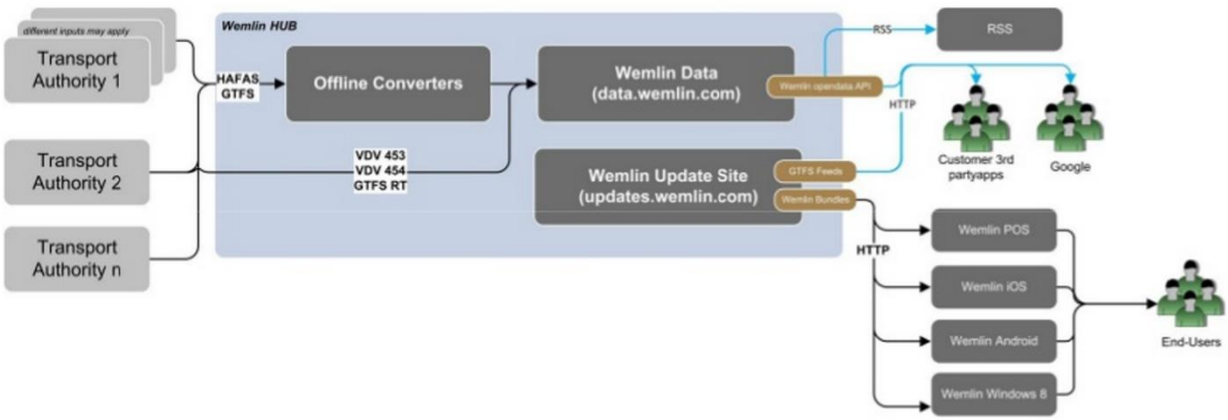

Figure 5: The Wemlin Hub architecture (Rageth, 2013)

One of the company's products is Wemlin, which is an app based on open data from public transport. It was created in 2008 as a marketing case. Today, the company offers Wemlin for free to end users. The app provides timetable information over the entire transport network and precise, up-to-date departure times at a particular stop close to the passenger's location based on location information provided through a smartphone. The app covers the public transport systems in

German-speaking Switzerland, including the Zurich public transport system. Wemlin uses open data, such as timetables and real-time public transport information. The architecture of the Wemlin Hub is presented in Figure 5. Similar apps are available in Slovenia as well, e.g., for the city of Ljubljana.

Netcetera also uses the Busines Model Canvas to illustrate the Wemlin Open Data Business Model, which is briefly presented in Figure 6.

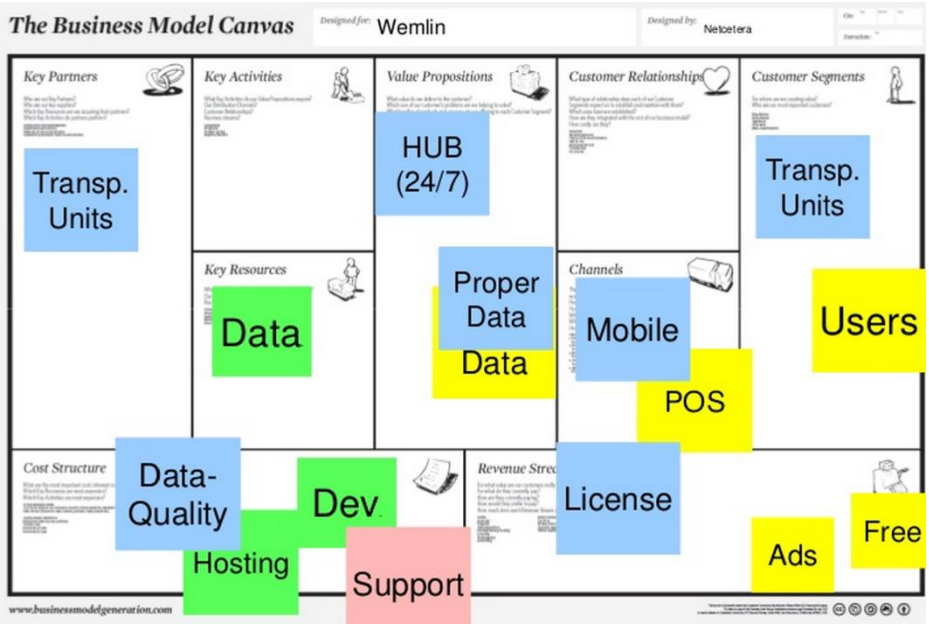

Figure 6: Business Model Canvas for Wemlin by Netcetera (Rageth, 2013, 31)

4.3. Openwords

Openwords considers itself to be a social enterprise. Their credo is: "We believe education should be free *and* open source. We'll always remain open and committed to learner privacy" (www.openwords.com). Openwords offers an open-source language learning app that can be used by all languages. In particular, Openwords supports lesser-spoken languages that are not covered in the current language learning app market. The app is open source and free for users. It utilizes crowd-sourced open data that already exists, e.g., from Wiktionary or Apertium (an open machine translator). Openwords has mined content for more than 1000 different languages. The data are accessible Online at Openwords.org with an http API.

The business model of Openwords is still under development. The company's goal is to assign revenue models to the Openwords app that supports the open data and social good purposes. Therefore, developing teacher modules as well as services to connect learners with job opportunities is planned. For the business model development, Openwords is applying the Open Business Model Canvas (OBMC) offered by the Creative Commons open business models initiative (Stacey, 2015). The OBMC adds elements such as "Social Good" and "CC License" to the original Canvas by Osterwalder & Pigneur (2010) Figure 7 shows a draft as of March 2015. The initial phases of Openwords have been funded via crowdfunding using Kickstarter.

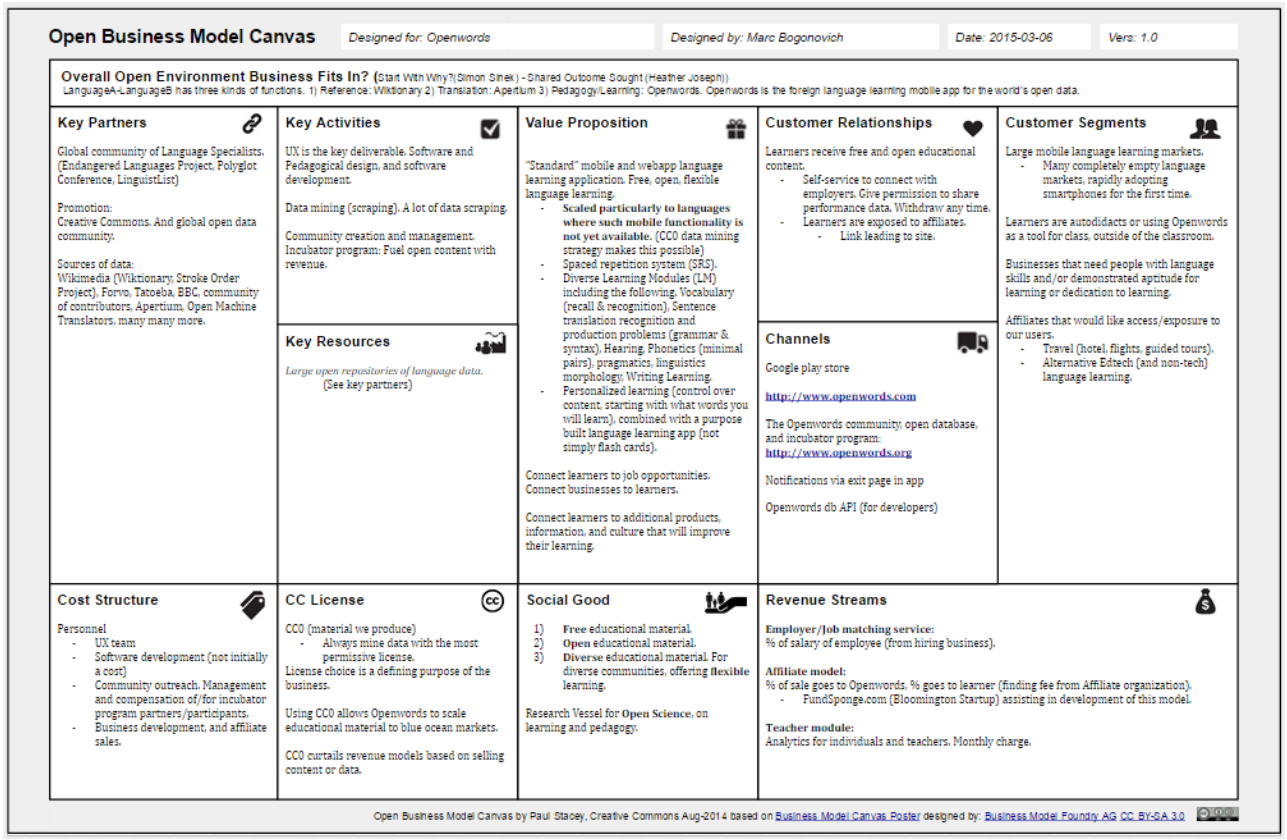

Figure 7: Open Business Model canvas for Openword (Bogonovich, 2015)

5. Summary and Conclusions

In this paper, we have addressed the linkage of open government data with innovative business models, based on re-using data and developed by entrepreneurs. We have shown that publically provided open data (i.e., by public bodies) are not in conflict with for-profit oriented businesses, but, in fact, they complement each other. Using open data, entrepreneurs and other businesses create added value for the benefit of consumers, other businesses, or public bodies as well and thus for society as a whole. Whereas Ferro & Osella (2013) have developed eight archetypes, while Zeleti et al. (2014) have 15 different open data business models in five categories. Applying the eight archetypes of open data business models by Ferro and Osella (2013) the open data business model of the Climate Corporation could be categorized as a *Premium Service*. The Wemlin app by Netcetera fits the category of the *Free as Branded Advertising* open data business model, and Openwords fits the two categories *Freemium Service* and *Open Source Like*.

Several studies and global initiatives have identified an enormous potential for value creation based on open data. For example. the McKinsey Global Institute study (Manyika et al., 2013) estimates that open data have the potential to enable more than $3 trillion in added value annually across seven domains of the global economy: education, transportation, consumer products, electricity, oil and gas, health care, and consumer finance. However, it is expected that new business models will have to be designed in cooperation with different stakeholders to foster value creation and boost the innovation potential for the benefits of the whole of society.

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OPEN INNOVATION AS A EFFECTIVE WAY OF TRANSFER TECHNOLOGY BETWEEN UNIVERSITIES AND THE SECTOR OF COMMERCE

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Keywords

Open innovation phenomenon, innovation vouchers, regional innovation strategy, high-tech industries

Abstract

The open innovation phenomenon has developed from a small club of innovation practitioners, mostly active in high-tech industries, to a widely discussed and implemented innovation practice. Opening up the innovation process requires a set of instruments. Those tools, for example, enable customers to create or configure their own product with tools kits or enable companies to integrate external problem solvers or idea creators. Currently a broad awareness of open innovation and its relevance to corporate R&D. The implications and trends that underpin open innovation are actively discussed in terms of strategic, organizational, behavioral, knowledge, legal and business perspectives. Aim of paper is research and measure the results after five years since Open innovation has been supported by region government in South Moravian region in Czech republic and was implemented in innovation strategy of this region. Working together innovation strategy has managed to create hundreds of skilled jobs in dozens of new high - tech companies. One of the target is to reach successful cooperation between industry and universities. One of the very important tool, which was implemented is model of Open innovation session as a tool of transfer technology.

1. Open innovation as a effective way of transfer technology between universities and the sector of commerce

The transfer of technologies between universities and the sector of commerce belongs to domains that do not function properly despite significant improvements in recent years at present though at the same time they are of great importance both for the sector of commerce and universities. The stimulation of entrepreneurship should bring about a greater number of established companies together with a change of their relationship towards entrepreneurship. It concerns especially the change of the well-established practice in case when the university graduate let himself get employed rather than he would try to start up his own business. Workshops, promotion events and a

cycle of lectures on innovative enterprise are suggested to be appropriate tools for this. One of main goals is also to disseminate knowledge of existence of incubators as well as of possibilities that incubators offer for entrepreneurs-beginners.

Monitoring of university projects will bring a view of ongoing projects and possibilities of commercialization of such projects. The fact of existence of the project itself, respectively an intention to realize the idea, represents an important element of the technology transfer from universities. Further step that follows is establishing a contact with a team of organizers and a continuous transfer of information relevant for a successful commercialization of the monitored project. On the basis of such collaboration the project will be assessed from the standpoint of a possibility of its further development. A methodology for the evaluation of an idea will give us a tool to identify a project quality regarding its possible commercialization, to evaluate the project from the standpoint of its technical feasibility and to assess its market potential and qualities of a management team standing behind the project.

The point of securing the initial intellectual property protection at the universities is to provide the intellectual property protection wherever it is necessary. The most appropriate form of the protection will be chosen and recommended for these projects and the assistance in securing the protection will be provided as well. This sub measure is closely connected to the third measure that secures financial aspects. The conception dealing with finding of partners for the commercialization will help to find them (natural persons, investors, distributors etc.) The choice of reliable and right partners is a key moment for a fruitfulness of the project.

Setting up a standard procedure for a commercialization of the project aims at changing the situation when scientists, who are mostly holders of projects do not have experience of the company development. They encounter difficulties they have neither time nor desire to solve themselves. On that account many projects are either not opened at all or they are not completed and thus the region loses a number of promising opportunities. Counselling of key business enterprise spheres will help to change the described situation. The aim of the research and development cooperation in the international level is sharing results and an exchange of information. Personal contacts among researchers coming from various countries and an engagement of universities in networks of excellence represent possible tools of the cooperation. EU framework programmes are oriented to create a connection between the research and the development in the international level. The training of experts for transfer of know-how from universities will result in a sufficient number of experts in this field and will raise the awareness of possibilities regarding this issue at universities in the region. The aim is to raise the awareness of technology transfer both at universities and in the business sector.

Open innovation is considered as a effective way of transfer technology between universities and the sector of commerce. For the successful implementation of open innovation is required to have the appropriate tools, one of these tools are innovation vouchers.

2. Innovation voucher as effective tool of Open innovation

Main goals of innovation voucher are increase demand within research institutes for greater functionality of internal procedures and rules regarding collaboration of researchers and companies. And we can see after five years of implementation of innovation voucher great successful of transfer technology between universities and research Centre and companies. The main reason for this we can say that is very easy administration of proposal of project. Also the innovation vouchers and agenda around this tool is very transparent. The South Moravian Innovation Centre (innovation centre located in South Moravia – region of Czech Republic) first introduced innovation vouchers

in 2009. Since then over 270 companies have used the vouchers. The cooperation in innovation between companies and scientists was quick to inspire other Regions of the Czech Republic. Especially the low degree of interconnection of the corporate and academic sectors, which prevents the full use of the knowledge base of the region to create the foundations of the long-term prosperity of the local economy.

The mission of the programme is to initiate the creation of new relationships between companies (from anywhere) and researchers from the South Moravian Region, while it is expected that some of them will gradually develop into long-term collaboration.

Tasks	**Description**
Overall objective of the voucher system	Support: Link between the SMEs and the Universities Competitiveness of the SMEs More effective setting of the internal mechanisms of the commercialization of the Un Stronger position of the Offices of Technology Transfer at the Universities
Supportable activities in the voucher system	Knowledge transfer projects such as: Product, process or service development Testing and measurements Feasibility study Access to research facilities Prototyping Product design Innovative product business plan development Economic impact assessment Market analysis or marketing strategy Business plan for an innovative product Innovation/technology audit

Table 1. Description of the voucher system in South Moravia, Czech Republic (Brno)

Tasks	Description
Ineligible activities	Standard training courses Software purchases Aid that would promote/ subsidies the cost of exports Internships for students Design and production of advertising materials Sales activities Legal services Grant consultancies Standard services (auditing, accounting etc.) Material purchases.
Description of the financing procedure of the projects.	Online application form. Voucher recipients chosen by a lot. Once the voucher recipients (SMEs) are chosen, they must sign a contract with the knowledge provider and pay for the project delivery to this knowledge provider. After these conditions are fulfilled, the Intermediary organization pays a subsidy up to 150000 CZK to the voucher recipient. The company, who gets the service, has to pre-pay it. Therefore, it is rather a guarantee of subsidy than a voucher in a literal sens
Support intensity	75% Each voucher = subsidy up to 150 000,- CZK. (appr. 6 000,- EUR) Total amount allocated: 5 700 000,- CZK. (appr. 220 000,- EUR) De minimis support. Cca. 10 month accounted from the positive decision
Further information	SMEs are limited to be located only in the South Moravian region. Research instititution can come from the whole Czech Republic and also abro Activities made before the submission of the application form are not eligible. The Intermediary organization is the South Moravian Innovation Centre

Table 2. Description of the financing procedure of the projects.

Innovation voucher is a grant of up one hundred thousand crowns, by means of which, innovative companies from South Moravia can try out collaboration with researchers from around the world.

The financial guarantor of the project is the Statutory City of Brno – the main city of the Czech region South Moravia. See scheme of implementation, fig 1.

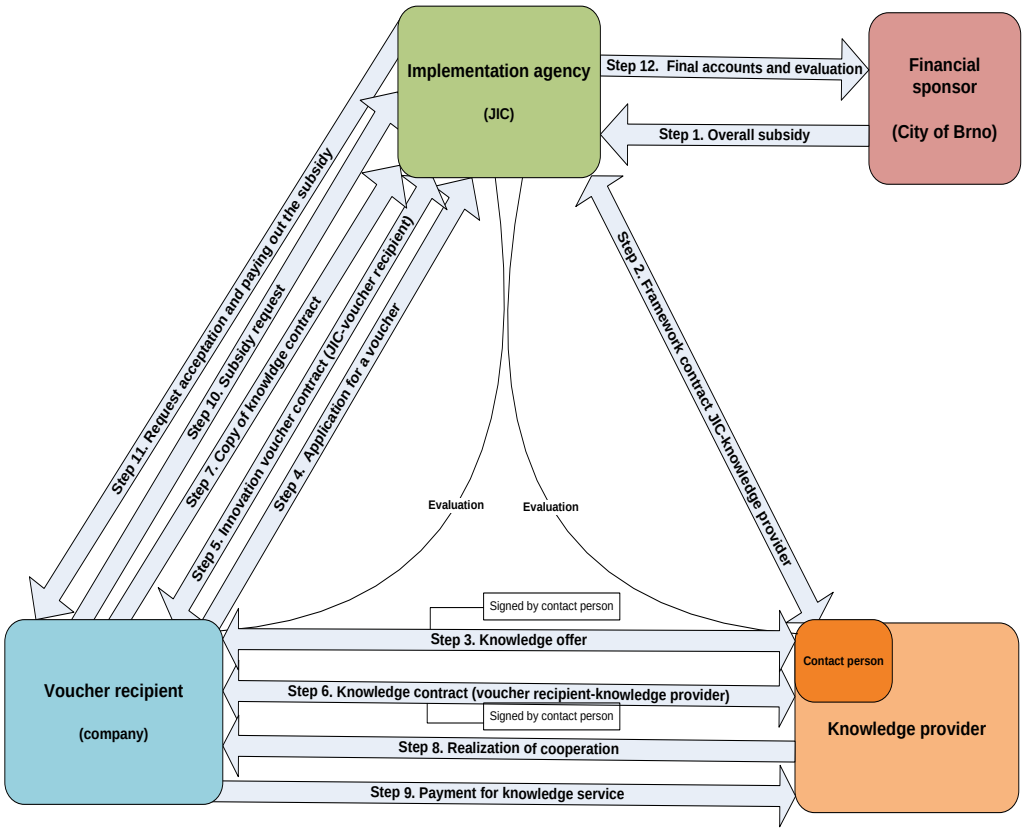

Figure 1. Scheme of implementation

Problem	Presumed deliverable
Knowledge paradox	New and sustainable links between companies and university research
At SMEs: Insufficient RD capac	Higher competitiveness of SMEs
Universities: slow and untranspa	More effective commercialization of academic research

Table. 3. Scheme of project goals

In the group of companies whose projects fit the definition of new collaboration, 36.7% of the companies are continuing in the collaboration.

If we compare this to the group of all companies, then for every 100 supported projects there are 17 newly initiated collaborations that continue after the end of the project. Continuing collaboration projects are financially bigger. The average is CZK 341 thousand / year. One quarter of the cases represent projects that are on the order of CZK 1 million and more a year. This corresponds to the findings from the field survey of companies that mutual trust plays a crucial role and determines the nature and thus the financial extent of collaboration. Innovation vouchers can be perceived as an "icebreaker" that starts the process of strengthening mutual trust, which subsequently increases the motivation of companies to invest their own funds into research collaboration.

The tool perspective: Opening up the innovation process requires a set of instruments. Those tools, for example, enable customers to create or configure their own product with tools kits or enable companies to integrate external problem solvers or idea creators via websites

And also one of important tools could be innovation vouchers

Two-thirds of supported companies had their partner from the research sector solve a specific technical problem for them. More than two-thirds of companies found a researcher who was able and willing to help them. However, the obtained information says nothing about the nature of the resolved problem and its significance for the company

Do you think that participation in the programme led to the fact that: (Y/N – number of Yes responses)	Supported Companies	Unsupported Companies	Researchers
… you are more aware of the opportunities arising from collaboration?	47 (75.8)	27 (57.5)	31 (54.4)
… it is easier for you to orient yourself in how the academic/business world works?	29 (46.8)	15 (31.2)	18 (31.6)
… you now better understand the personal goals and motivation of researchers/entrepreneurs?	28 (45.6)	13 (27.7)	26 (45.6)
… you can communicate easier with people from the academic/business environment?	28 (45.2)	11 (23.4)	26 (45.6)
… you now better understand existing barriers to collaboration?	26 (41.9)	18 (38.3)	28 (49.1)
… you can now better organize collaboration?	45 (72.6)	18 (38.3)	31 (54.4)
… your ability to find a suitable partner for collaboration has increased?	32 (51.6)	17 (36.2)	27 (47.4)
Total companies	62 (100.0 %)	47 (100.0 %)	57 (100.0 %)

Table. 4. Innovation vouchers break down barriers between the academic and business sectors

2.1. Conclusion

Identify new collaboration opportunities; knowledge of regional, as well as Czech national ecosystem will allow companies to tap into the pool of expertise and talent of start-ups, SMEs, as well as academic institutions in South Moravia, or across the Czech Republic. Regional strategy is partnership of South Moravian companies, local scientists, public authorities and other parties connected to development in the region. Working together innovation strategy has managed to create hundreds of skilled jobs in dozens of new high - tech companies. One of the target is to reach successful cooperation between industry and universities. One of the very important tool, which was implemented is model of Open innovation session as a tool of transfer technology. The main benefits of Open innovation session model are: Simplify work and save time for the company only explain its challenge once, and facilitators take over the tedious job of pre-selection and routine

communication with potential partners and multiply your offer to the relevant partners across the region / country. Interactive format may generate more ideas - the design of the Open innovation session model allows several participants to interact during the session which increases the chances of coming up with unexpected solutions to the identified challenges.

The tool perspective: Opening up the innovation process requires a set of instruments. Those tools, for example, enable customers to create or configure their own product with tools kits or enable companies to integrate external problem solvers or idea creators via websites. Especially the low degree of interconnection of the corporate and academic sectors, which prevents the full use of the knowledge base of the region to create the foundations of the long-term prosperity of the local economy. The mission of the programme is to initiate the creation of new relationships between companies and researchers from the South Moravian Region, while it is expected that some of them will gradually develop into long-term collaboration. The primary objective is the initiation of new collaboration, defined as collaboration that continues even after the end of the project, while there was no collaboration between the two parties before entry into the programme. Initiate the creation of new collaboration reducing transaction costs associated with the commencement of collaboration. Contribute to entrepreneurs' and researchers' understanding of each other, especially in the very different contexts of the objectives and conditions of collaboration. Increase demand within research institutes for greater functionality of internal procedures and rules regarding collaboration of researchers and companies. Build trust in local public administration. Improve the image among companies and researchers.

Reinforce the perception of City Brno and the south Moravian region as leader in the knowledge economy promotion in Europe. Bring symbolic value to foreign investors. Demonstrate the interest of the local government to create conditions for the development of knowledge-intensive operations of transnational corporations (Honeywell, Microsoft, ON Semiconductors, etc.). Besides the "technical" objectives of the model, it is also necessary to emphasize its marketing objectives, though some of them came into existence only during the programme.

The objective of the programme was also to contribute to the greater understanding of each other between entrepreneurs and researchers, especially in the very different context of objectives and conditions with which the parties approach collaboration.

The data in the table show that participation in the programme led to a shift in the perception of the objectives, needs and conditions of the business / academic world. Participants in the programme are now more aware of the potential hidden in collaboration and at the same time are better prepared to organize this collaboration.

The model can be applied towards improving the very low trust in public administration. It also contributes to the development of the image of Brno as a centre where the knowledge economy is smartly supported.

Two-thirds of supported companies had their partner from the research sector solve a specific technical problem for them. More than two-thirds of companies found a researcher who was able and willing to help them.

Therefore, this is a purely subjective perception of the benefit by the respondents. The objective of the Open innovation session model was also to contribute to the greater understanding of each other between entrepreneurs and researchers, especially in the very different context of objectives and conditions with which the parties approach collaboration. In 68% of cases the main reason of cooperation by companies side were knowledge of specific researcher´s team.

The data show that participation in the programme Open innovation session led to a shift in the perception of the objectives, needs and conditions of the business / academic world. Participants in

the programme are now more aware of the potential hidden in collaboration and at the same time are better prepared to organize this collaboration. After the end of the project, companies continuing in collaboration with new partners from the local research sector. Open innovation is an effective way of transfer technology between universities and the sector of commerce and innovation vouchers are suitable tools to achieve a satisfactory result.

3. Acknowledgements

This work was supported by internal research of University of Hradec Kralove: Economic and managerial aspects of Biomedicine and Excellence 2015.

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BUSINESS MODEL DESIGN FOR A PLATFORM FOR THE COLLABORATIVE INNOVATION OF TOURISM SERVICES

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Keywords

Business model, tourism services, collaborative innovation

Abstract

Innovative solutions that are developed in the framework of different projects, co-financed from public funds, typically have a short lifespan. The problem lies in weak business models, which could enable innovative solutions to be implemented in a real business environment after the end of the project. In this paper, we present a case of the development of a business model for a platform for collaborative innovation of tourism services that has been developed in CentraLab project. The proposed business model is based on the CANVAS business model methodology.

1. Introduction

Slovenia lies in the heart of Europe, where the Alps meet the Mediterranean, and the Pannonian Plain meets the Karst. Slovenia is a small, green country, offering diverse natural capital from mountains to seaside, forests, lakes, rivers, caves and much more; all which is on only 20,273 km². Slovenia is divided into 12 regions. One of the most attractive regions for tourists is the Gorenjska region, which is located in the northern part of Slovenia. Tourists can visit Lake Bled and Lake Bohinj, go hiking in the Julian Alps and the Kamnik-Savinja Alps, visit Triglav National Park, engage in a wide range of outdoor activities in resorts, such as Kranjska Gora (mostly recognized as a skiing resort, also organizing the men's FIS Alpine Skiing World Cup race every year) and explore the history of old towns such as Kranj and Škofja Loka (The Official Travel Guide by Slovenian Tourist Board, 2015).

This diversity of natural resources offers enormous economic potential and represents one of the key industries in Slovenia. As defined in Slovenia's 2014–2020 development strategy (Republic of Slovenia, Ministry of Economic Development and Technology, 2013), the tourism industry is a key priority, which is expected to develop even more strongly in the future.

Despite its many natural potentials, a strong orientation to the sustainable development of green and eco-tourism services, and even formal recognition of its importance on the national level, the tourism industry in Slovenia continues to face many challenges in attracting more tourists and convincing them to stay longer in the country.

The initial idea to address current challenges in the tourism industry in the Gorenjska region came from the CentraLab project, which used the living lab approach and co-design process with stakeholders and end users with the aim of innovatively fostering regional development. Having this in mind, we have established a living lab for addressing the abovementioned challenges in tourism as a priority industry in our region.

The goal of the tourism living lab was to foster collaboration between tourism service providers in the region and beyond; a parallel goal was to explore the opportunities of tourists' engagement in the process of the co-creation of new, innovative tourism services. Having in mind the potential benefits of Internet and Web 2.0 technologies, a web-based platform has been developed. The platform enables collaboration between tourist service providers, sharing their current offers, and tourists sharing information about their trips and experiences (Pucihar et al., 2013).

After successful pilot usage of the platform and the interest of stakeholders to continue the cooperation after the end of the project, a proper business model had to be designed to enable sustainable operation of the platform.

Further in this paper, we present the case of business model development for a platform, which enables collaborative innovation of tourism services. First, we define basic definitions of living labs and collaborative innovation, and introduce various business models ontologies. Further on, we present the case of business model development for the abovementioned platform based on the CANVAS business model methodology. We conclude with a discussion and suggest potential future development.

2. Literature review

2.1. Living lab and collaborative innovation

In a broader sense, a living lab is a technologically socio-economic approach, which is used as a strategy for the adaptation, innovation and development of new products and services (Liedtke et al., 2012; Schaffers et al., 2009). Følstad (2008) and Gričar (2009) define a living lab as an environment in which researchers, developers and users are working together to develop innovative products, services or solutions, in accordance with users' needs, in the shortest time possible, and test it in a real environment.

A living lab approach engages end users in development and innovation processes as co-creators of new products, services or solutions (CoreLabs, 2007). Such an open ecosystem for research and innovation uses the tools, processes and methodologies that enable end-users to participate, co-create products, services or solutions, and to test the results (Chen, 2011; van der Walt et al., 2009). This is a so-called customer-focused approach, whose goal is to develop innovative products or services that are consistent with the needs of end-users. It can also be used as a user-oriented research methodology aimed at refining existing solutions (Bergvall-Kåreborn et al., 2009, Eriksson et al., 2005; Gričar, 2009).

Living labs often support and result in open innovation. Open innovation is defined as a paradigm that assumes that companies can and should use external ideas in addition to internal ideas, e.g. involving in innovation processes external partners and customers to explore advances in the newest technologies (Chesbrough, 2003a; Chesbrough 2003b).

Through the living lab, collaborative innovation networks are often formed as self-organizing groups of highly motivated individuals working together towards a common goal. Collaborative innovation results from collaborative knowledge networks, defined as distributed communities

taking advantage of the broad connectivity and the support of novel communication technologies. Collaboration goes beyond organizational borders, as groups of various self-motivated individuals evolve and share the idea of something new and exciting. They share a common goal and aim to improve existing business practices, design new products or services for which they recognize a real need. The strength of collaborative individuals is related to their ability to activate creative collaboration, knowledge sharing and social networking mechanisms, affecting positively individual capabilities and organization's performance (De Maggio et al., 2009).

Collaborative networks nowadays are heavily supported by social media, which have dramatically changed the ways people communicate with each other and have the potential to change the ways companies do business (McAfee, 2006). Social media enables employees, suppliers, partners, customers and other stakeholders' new ways of effectively communicating, collaborating, sharing knowledge and innovating (McNamee et al., 2010).

These principles have been taken into account while developing a platform for collaborative innovation of tourism services, which will be further presented in Chapter 3.

2.2. Business models methodologies

The term "business model" came into increased usage at the end of the 1990s (Osterwalder et al., 2005, p. 6). Several definitions of the phrase can be found in the literature. In general, a business model can be defined as the logic of an organization that reflects its business strategy (Johansson et al., 2012, p. 85). In addition, business models can be defined as the way an organization or network of organizations creates and captures value. Bowman et al. (2008) introduced a broad definition of business models. They define business model as:

> […] a blueprint for a service or product to be delivered, the service or product definition and the intended value for a target group of consumers, the sources of revenue, and an enterprise architecture for service or product delivery, including processes, resources (capabilities and assets) required and the financial arrangements between the involved business actors, including a description of their roles and the division of costs and revenues […] (Bowman et al., 2008).

Over time, many different business model methodologies have been introduced in literature and practice. Among the widely recognized and used ones are CSOFT, STOF, VISOR, and CANVAS. CSOFT (Heikkila et al., 2010) focusses on product-customer segments. Quantifiable objectives are derived from the strategies of a business, while innovativeness is essentially subject to strategic goals. In contrast, STOF (Bowman et al., 2008) is more focused on technological architectures and platforms, which deliver specific services or products in combination with value networks and ecosystems. VISOR (El Sawy & Pereira, 2012) is a rather new methodology, and it focusses on changes in digital businesses, also addressing platforms and interfaces (Heikilla et al., 2015).

The CANVAS business model (Osterwalder and Pigneour, 2002; Osterwalder & Pigneur, 2010) is one of the most popular and widely used methodologies for business model design. The business model canvas is a strategic management and entrepreneurial tool. It enables description, design, challenging, invention, innovation and pivoting of the business model. It consists of nine building blocks arranged into four segments (Osterwalder and Pigneour, 2010):

- **infrastructure**: *key activities* for executing a company's value proposition, *key resources* that are necessary to create value for the customer, and *partner network* – buyer-supplier or ecosystem partnership,

- **offering**: *value proposition* – the collection of products and services a business offers to meet the customers' needs. Value proposition is defined as what distinguishes the company from its competitors. It can be defined as quantitative (price and efficiency) or qualitative (overall customer experience and outcome),
- **customers**: *customer segments* – the company must identify which customers it tries to reach and segment them based on different criteria; *channels* through which value propositions could be delivered to different customer segments, the type of *customer relationship* that the company would like to build with its customers,
- **finances**: *cost structure* that will occur as a result from operating under different business models and *revenue streams* as a way the company makes income from each customer segment have to be defined.

The CANVAS business model will be used as a tool for business model design for a platform for collaborative innovation of tourism services. The business model will be presented in Chapter 4.

3. Platform for collaborative innovation of tourism services

The living lab consisted of seven important stakeholders in the region (one in the position of regional policymaker), and two research and development organizations. After several workshops and brainstorming sessions, the main idea and goal was to exploit the potential of Internet and Web 2.0 technologies to foster collaboration among tourist service providers and tourists through a web-based platform. The main challenges were to define the innovation characteristic of the platform, as many of different websites and portals for tourism already exist on the market and operate with different functionalities and business models (Pucihar et al., 2014).

The main idea was to engage users in the co-creation process of new, innovative tourism services. The intention of the platform was to enable tourist service providers to present their existing tourism offers as well as to enable tourists to share their "real-life" experiences of the attractions and routes that they have discovered on their own.

The platform enables the sharing of multimedia content and incorporating Web 2.0 functionalities for commenting, rating and adding the additional content of various users. The innovation part differentiating the platform from others available on the market is reflected in the possibilities to re-use existing content (in our case, attractions) for the creation of new routes (two or more attractions connected in routes) as shown in Figure 1.

With the use of the platform, tourist service providers can obtain insights to what kind of services tourists actually want and have an opportunity to improve and develop new services targeted to different customer segments. It is expected that the wider utilization of the platform on the market and user (tourist) involvement in a co-creation process can lead to the design of new innovative value-added tourism services (Pucihar et al., 2014).

The possibility of content re-use and existing content update from various users (tourist providers and tourists) directly implements the open innovation philosophy and generates collaborative innovation. The platform itself serves as a collaborative innovation network.

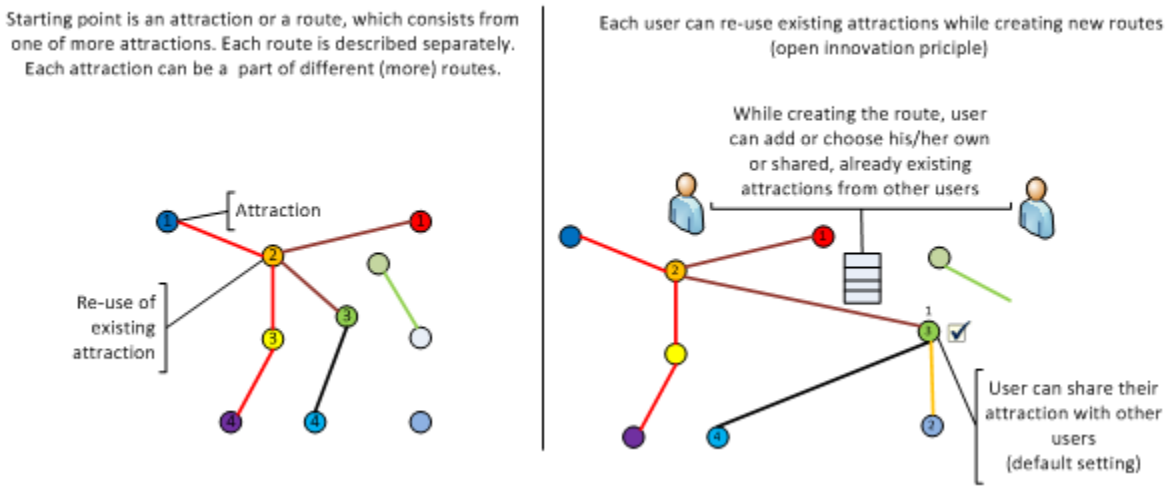

Figure 1: Collaborative innovation dimension of the platform

4. The CANVAS business model for the platform for the collaborative innovation of tourism services

Figure 2 presents the CANVAS business model for the platform for the collaborative innovation of tourism services. The business model is presented on the CANVAS template, which supports the process of business model design. This template consists of nine building blocks, providing supporting questions, which have to be answered in detail to define a business model.

In the template, we define all nine building blocks in detail (Osterwalder and Pigneour, 2010). To define each of the building blocks, several questions have to be answered. In the case of key partners, questions regarding our key partners, suppliers, and key resources acquired from partners and activities have to be answered. It has to be defined which key activities are required for value proposition, distribution channels, customer relationships and revenue streams. Furthermore, the key resources our value propositions require have to be defined, bearing in mind distribution channels, customer relationships, and revenue streams. In addition, what value we deliver to the customer, which problems we aim to solve, products and services offered to various customer segments, and so on all have to be defined. Concerning customer relationships, what relationships are expected to be established and maintained for each of customer segments, how we integrate them with the rest of our business model, and how costly they are must be defined. Channels help us to define how customer segments will be reached, how the channels are integrated, which ones work best, which ones are the most cost efficient, etc. Customer segments define for whom we are creating value and who our most important customers are. In cost structure, we define the most important costs in our business model, as well as which key resources and key activities are most expensive. Under the revenue streams, we have to define what value our customers are really willing to pay, what and how they currently pay, what their preferences are and how much each revenue stream contributes to the overall revenues.

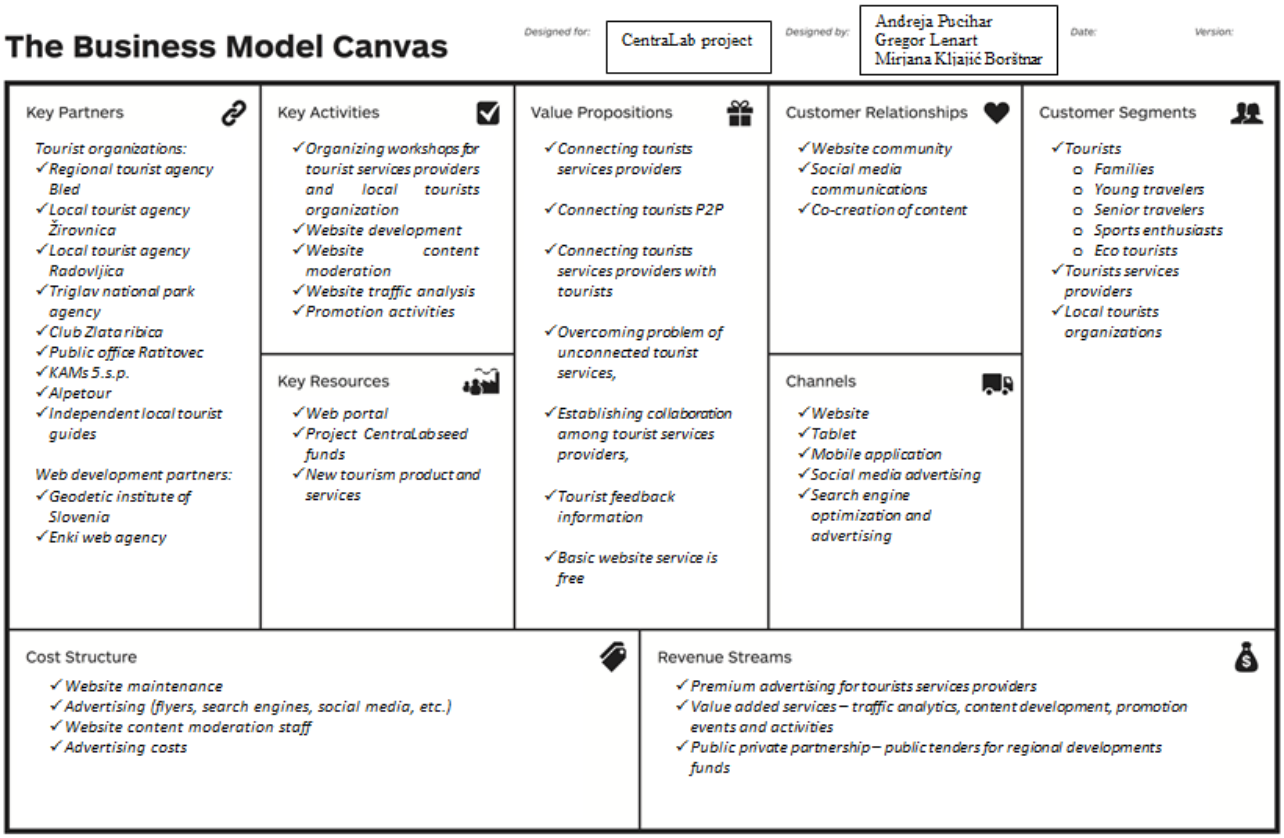

Figure 2: Business model CANVAS for collaborative innovation dimension of the platform

5. Discussion

This paper presents a case of business model design for a platform, which enables the collaborative innovation of tourism services. The platform has been developed as a result of the collaboration of seven stakeholders and two research and development organizations in a tourism living lab in the CentraLab project. After successful pilot usage of the platform, stakeholders have shown an interest in exploiting the innovation potential of the platform and deploying the platform on a market. However, as the project has limited time and financing, the critical step was to prepare a business model that would enable successful implementation of the platform in the real business environment.

After reviewing different business model methodologies, the CANVAS business model was chosen as a tool for brainstorming, communicating and designing the business model. The main advantage of the CANVAS business model is its simplicity, which enables an easy-to-understand framework for business model design.

Based on our experiences, the simplicity of the tool is one of the key success factors for working with companies, especially with SMEs. In our case, the CANVAS business model has been used in several workshops with key stakeholders. It enabled a collaborative business model design with the dynamic engagement of all stakeholders.

The business model itself is not a guarantee for successful implementation. Stakeholders need to commit to executing it. The critical part is to allocate seed and start-up capital. Therefore, in

addition to the definition of all nine building blocks of the CANVAS business model, the definition of network of partners, in our case stakeholders, was of crucial importance.

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SESSION L: AUTONOMOUS SYSTEMS AND VEHICLES – SOCIETAL, ECONOMIC AND TECHNICAL ISSUES

CONNECTED AUTONOMOUS VEHICLES AND SYSTEMS – CAN COMBINING SAFETY & SECURITY STANDARDS HELP TO AVOID ECONOMIC LOSS, SECURITY BREACHES AND CATASTROPHES?

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Keywords

Autonomous Systems, Highly Automated Systems, Autonomous Vehicles, Cyber-physical Systems, Safety, Security, Systems-of-Systems

Abstract

A key long-term trend is towards highly automated vehicles and autonomous driving which will have huge impact on road transport in the future. Besides comfort and enabling efficient road transport particular in cities even for people not being allowed or able to drive, another fascinating aspect to achieve a sustainable urban transport system is the chance to reduce considerably the number of vehicles required because they could be called on demand and after a drive do not occupy parking space for a long time because they will continue with their next order. This requires not only a considerable amount of functionality, sensors, actuators and control devices, situation awareness etc. but also integration into a new type of critical infrastructure based on communication between vehicles and vehicles and infrastructure, and regional traffic control centers to optimize traffic as a whole and not just locally in the environ of the vehicle. A similar, but not so drastic effect is to be expected in other domains of application of highly automated or autonomous systems (industrial, rescue, health).

The functional safety standards of the first generation did not tackle the challenges of highly connected "systems-of-systems". Particularly the arising security issues were not considered at this time in context of safety. Therefore, e.g. security in an open vehicle system has become a new factor to be considered in system engineering and safety analysis, as well as in other domains. The keynote will address by providing an overview of upcoming standardization activities towards such a holistic system view covering both safety and security in different domains. It will be demonstrating by a few examples how standardization could (have) supported engineers and the public to avoid economic loss and sever harm to people.

1. Introduction – Cyber-physical Systems Everywhere

Cyber-physical systems (CPS) are everywhere – may they be visible or invisibly integrated into every day devices. Comfort, health, services of all kinds (including emergency services, rescue work and surveillance/monitoring etc.), safety and security of people depend increasingly on them. In the industrial context, particularly in transportation, robotics, smart electric or power grids and

smart cities, highly automated or autonomous systems are becoming the main driver for innovations and efficient production and services. The interconnection of different levels of such systems on a regional or global scale leads to so-called "systems-of-systems" (including very often legacy systems). The impact on society and economy as a whole is tremendous and will change our way of living and economy considerably - thus dependability (safety, reliability, availability, security, maintainability etc.), resilience, robustness and sustainability in a holistic manner (Laprie, 2005) become an important issue, despite potentially unwanted emergent behaviors and interdependencies. We have to take into account trade-offs and prioritize in case of conflict. Co-operative, distributed networked cyber-physical systems and adaptive systems interoperation at "systems-of-systems" level add a hardly to manage dimension of complexity.

It should be noted, that systems-of-systems are created and evolving because of wanted emergent behaviors although in the public mind set "emergent behavior" is primarily associated with negative aspects. A new trend beyond CPS is evolving with the "Internet of Things" (IoT), and all massively distributed, deployed and interconnected devices and systems are now associated with "IoT".

Demanding challenges have to be met by research, engineering and education. Smart (embedded) systems are regarded as the most important business driver for industry. They are a targeted research area for European Research Programmes in Horizon 2020, particularly in the industry-driven ECSEL Joint Undertaking Initiative (ECSEL JU, 2014), and in several dedicated Programmes (PPPs – Public-Private Partnerships like the "Green Cars Initiative", euRobotics and the Electric Vehicles Initiatives). The European Commission has created the concept of the JTI (Joint Technology Initiative) ECSEL (Electronic Components and Systems for European Leadership) which in fact is integrating the three ETPs (European Technology Platforms) ARTEMIS (ARTEMIS 2011), EPoSS (EPoSS, 2011) and ENIAC (ENIAC, 2010) and JTIs.

Some difficulties arising will be demonstrated in a set of real-world examples, primarily (but not only) from the context of "safety vs. security", and currently arising standardization efforts in different standardization contexts and domains will be discussed.

2. Cyber-physical Systems (CPS) and Dependability/Resilience Challenges

We have to tackle particular aspects of the three levels of software-intensive networked, highly integrated embedded systems. These levels are known as

- Embedded systems (software-intensive systems, integrated in a hidden or visible manner in everyday devices, mobile or fixed, inside or outside us)
- Cyberphysical systems (combined complex embedded systems with sensors, actuators, integrating physics, mechatronics, intelligence, decision-making and perception)
- Systems – of – systems (aggregation of systems, composed of interconnected autonomous systems originally independently developed to fulfil dedicated tasks.

The design, operation, and protection, but also risk assessment, validation, verification and certification, maintenance and modification throughout the life cycle of these systems have to take into account the interplay between humans, environment and systems. Systems must be robust to cope with these problems in an adaptive manner ("resilient systems"), which is an ever increasing challenge (Schoitsch, 2013).

This paper will focus on aspects of "safety" and "security" – as separated and interrelated system properties, and the impact if the interaction is neglected as has been done for a long time.

3. Safety and Security – some overview on application areas

Massively deployed systems applications of high potential for safety, security and privacy risks are arising in context of

- The grid control approaching private homes: smart grids for efficient power distribution, but our civilisation is very sensitive on loss of power because of almost all services and protective measures depend on appropriate power availability – on the other hand a lot of data on individual behaviour, habits, information on presence and absence etc. become available, endangering privacy, in:
- Building automation and control (heat, cooling, elevators, fire alarm and fire fighting, doors/entrance and rescue), at least with remote maintenance access,
- AAL (Ambient Assisted Living) and health-care (from remote monitoring to automatic or triggered intervention),
- Large machinery and construction vehicles operating (semi-) autonomous, service robots in human populated environment and robotic farms.
- Highly automated process industry plants, power plants and manufacturing plants, even with remote "control via internet", and particularly autonomous but interconnected systems cooperating with each other and humans,
- Transport, particularly road vehicles utilizing car2car and car2infrastructure communication for (semi-) autonomous driving, platooning and road safety in general; security and particularly privacy are endangered.

4. Safe and secure production - Industrial Control Systems (ICS/SCADA)

For a long time, there was little awareness that industrial plants or process industry may be attacked by cyber-attacks because for a long time they were mostly isolated systems. In the meantime not only the attack on the Iranian nuclear site (which required in-depth knowledge and considerable effort) became known but several other incidents which led to considerable damage or loss.

Already in August 2005, 13 US auto plants were shut down by a simple Internet worm. Despite professionally installed firewalls separating the internet, the company network and the control network, the Zotob worm made its way into the control systems (probably via a laptop). Once in the control system, it was able to travel from plant to plant in seconds. Approximately 50.000 assembly line workers ceased work during the outage. The cause of the incident was introduction of malicious code via a secondary pathway into the control network.

Failures of industrial control systems due to malware are much more frequent than anticipated. In the US, the Industrial Control Systems Cyber Emergency Response Team (ICS-CERT) investigated between Oct. 2011 – Sept. 2012 198 cyber-attacks. Several have been successful and led to several weeks of stop of production. The reasons have been in most cases maintenance activities (USB sticks), or remote "industrial control via internet". A distribution over application domains is shown in Figure 1 ("Dams 1" means: one dam control system was affected).

One can imagine, that e.g. chemical plants, nuclear plants and sewage plants can be really critical endangering humans and environment severely (and not only cause financial loss).

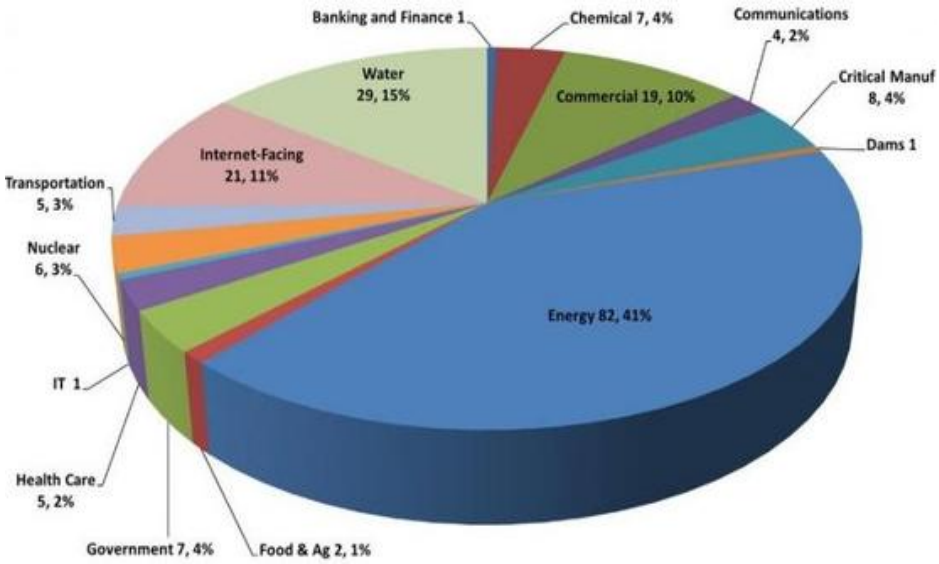

Figure 1: Failures of industrial control systems due to Malware (ICS-CERT, USA, 2013 April-June)

5. The Connected Car: What risks next?

The most fascinating aspect of connected cars and highly autonomous driving is the chance to achieve a sustainable urban transport system by reducing considerably the number of vehicles required because they could be called on demand and after a drive do not occupy parking space for a long time because they will continue with their next order. This requires not only a considerable amount of functionality, sensors, actuators and control devices, situation awareness etc. but also integration into a new type of critical infrastructure based on communication between vehicles and vehicles and infrastructure, and regional traffic control centers to optimize traffic as a whole and not just locally in the environ of the vehicle.

5.1. Modern Cars: Increased attack surface of an "open system"

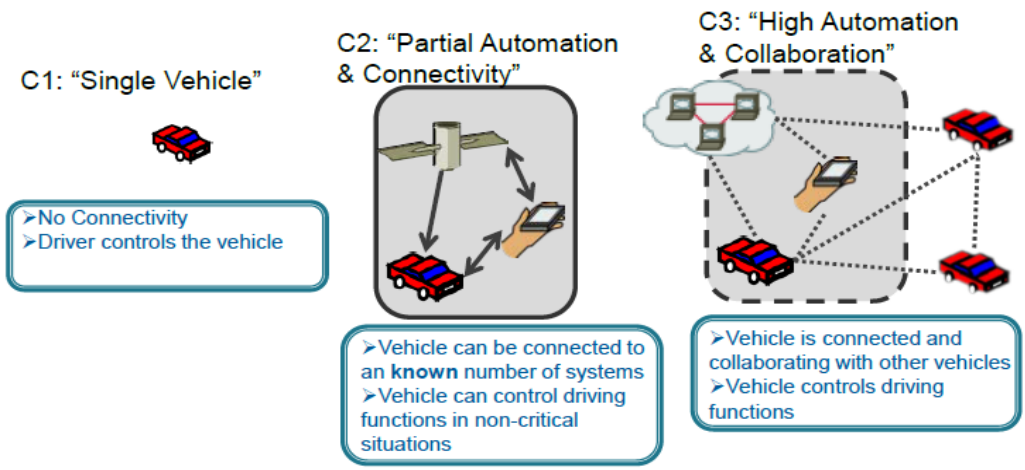

Figure 2: „Open System" car – single vehicle and connected vehicles - increased attack surface, privacy

Any modern car, even if not "connected" or "highly automated", has many access points for control from outside with safety and security impact (**Chyba! Nenalezen zdroj odkazů.**). We have to

onsider three different levels of automation with increasing order of complexity and risk of cyber-attacks.

5.2. Car to Car (or V2V – Vehicle-to-Vehicle) and Car2X Communication

Integration into a critical infrastructure: V2V and V2I (often generalized by V2X or C2X) are expected to make future road traffic much more efficient and safe, and many (research) projects, prototypes and evolving communication standards are engaged in this direction, with the final goal of truly autonomous driving; the first step would be platooning of "car trains" on high ways, i.e. a bunch of vehicles following a lead vehicle autonomously, controlled by information via V2V communication, and supported by a number of sensors controlling near distance behavior and safety.

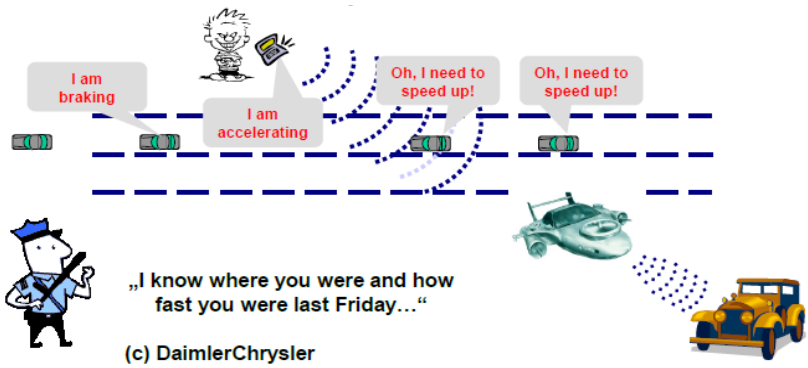

Figure 3: Platooning road traffic: safety, security and privacy issues

This concept implies a number of safety, security and privacy issue (see **Chyba! Nenalezen zdroj dkazů.**) – and the liability issue is far from being resolved legally (who is responsible in case of an accident? The first driver? How strong is the individual driver in control of his vehicle, how can alertness (which is basis for "controllability" of a situation caused by a failure of the electronic system, an important factor in defining the risk and required ASIL (Automotive Safety Integrity Level) of a device or system) be guaranteed?). An additional problem is the long-term guarantee of security, keys can be broken, electronics can wear out partially, there must be alternatives in case a car is used ten years or longer, with the same devices inside or not, etc.).

5.3. Safety and security risks through Maintenance

Imagine that manufacturers of cars see advantages in doing of remote maintenance (update) of in-car software (updates, error corrections) in the field via wireless communications to avoid expensive call-back. It works (sometimes) with space vehicles and satellites – why not for cars? (see Figure 4).

Here again, the hazards and risks need very thorough analysis – it has to be guaranteed that only in a safe situation and in a secure manner downloads of proven updates for the actual configuration of software in the individual car are possible, taking into account many complex scenarios – just to download when the car is not moving is for sure not sufficient, since many scenarios can be imagined where cars stop, but have to restart immediately if required by the traffic situation (Schmittner, 2015).

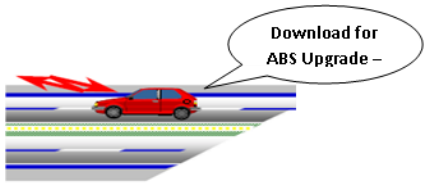

Figure 4: Software download in the field?

At the moment, this is only possible in a standardized way via diagnostic interfaces in a qualified maintenance station. But several automotive OEMs already supply critical updates via over the air update systems. As an example, the security vulnerability in the BMW ConnectedDrive was resolved by sending a security patch via the BMW ConnectedDrive system (BMW, 2015).

6. Functional Safety and Industrial Security Standards

There are basically two approaches how standards are trying to achieve conformance with required high level safety (and security) goals:

- Means-prescriptive: recommends means to achieve a certain safety/assurance level (easy to use if application conditions are well known, more difficult to handle if new technologies, methods or tools emerge) (example: IEC 61508 (ref. 8) and the whole IEC 61508 family).
- Objectives-prescriptive: describes objectives (safety goals) to be achieved, means have to be argued by the applicants of the standards (more open to interpretation, but more flexible to new methods and technologies) (example: DO-178); planned to be added in IEC 61508-3 (software part) Ed. 3.0 to allow goal-oriented requirements besides the prescriptive ones.

A safety case is required in EN 50129 (railways) and ISO 26262 (automotive), but only implicitly in other standards.

Security standards like ISO 15408 (Common Criteria - CC) defines EALs (Evaluation Assurance Level EAL 1 - 7, quite different from the ISO/IEC 61508 group probabilistic risk levels (SIL 1-4), which are not applicable to security). This standard helps evaluate, validate, and certify the security assurance of a technology product against a number of factors, such as the security functional requirements specified in the standard. Hardware and software can be evaluated against CC requirements in accredited testing laboratories to certify the exact EAL (Evaluation Assurance Level), i.e. its product oriented. Requirements for evaluation become stricter from EAL1 - Functionally tested, EAL2 - Structurally tested, EAL3 - Methodically tested and checked, EAL4 - Methodically designed, tested and reviewed, EAL5 - Semi-formally designed and tested, EAL6 - Semi-formally verified, designed and tested, to EAL7 - Formally verified, designed and tested.

ISO 27002 (formerly ISO/IEC 177799) establishes guidelines and general principles for initiating, implementing, maintaining, and improving information security management in an organization. It contains best practices of control objectives and controls in information security management and looks at security from a systems perspective, not only IT devices.

IEC SC65C Standards: Industrial networks (covering industrial communications security)

This subcommittee handles an enormous number of standards and subparts of standards on (industrial) buses (field bus standards, real-time Ethernet, etc.). Very important for the safety and security aspect is the series IEC 61784 (Industrial communication networks – Profiles), particularly (1) Profiles for real-time networks (IEC 61784-2), (2) functional safety fieldbuses (IEC 61784-3-xx) and (3) IEC 61784-4 - Profiles for secure communications in industrial networks

IEC TC 65 WG 10 – IEC 62443 and ISA 99 standards: a major activity is centred around the series of IEC 62443 - Industrial communication networks - Network and system security, consisting of several parts, including e.g. System security requirements and security assurance level, Patch management, and Certification of IACS supplier security policies and practices, focused on system level security (not fieldbuses). This work is now done in close co-operation with ISA (Instrument Society of America, ISA 99 committee). IEC 62443 defines 4 SLs (Security Levels) which are of qualitative nature based on the level of efforts and skills required to successfully attack a system:

- SL1: casual or coincidental violation
- SL 2: simple means: low resources, generic skills and low motivation
- SL 3: sophisticated means: moderate resources, IACS-specific skills and moderate motivation
- SL 4: sophisticated means: extended resources, IACS-specific skills and high motivation

7. Recent Developments towards "Security-aware" Safety

Functional Safety Standards for several domains based on the generic basic safety standard ISO/IEC 61508 have evolved since 2000 after IEC 61508 Ed. 1 was completed. The automotive functional safety standard ISO 26262 Ed. 1.0 was published 2011 (parts 1-9) and 2012 (part 10).

The functional safety standards of the first generation did not tackle the challenges of highly connected "systems-of-systems". Security in an open vehicle system will now become a new factor to be considered in system engineering and safety analysis.

IEC 61508 Ed. 2.0, finished 2010, took as first functional safety standard into account that security may impact safety of a system. Therefore it requires consideration of security threats ("*malevolent and unauthorized actions")* in risk and hazard analysis, with accompanying measures to be undertaken throughout all lifecycle phases. A security threat and vulnerability analysis should be conducted if a security threat is identified as a potential cause for a hazard in order to specify security requirements (IEC 61508, Part 1, 7.5.2.2). Security has then to be reflected in the safety manual as well (Part 3, Annex D 2.4). In notes are definitely addressed IEC 62443 and ISO/IEC TR 19791 (Part 1, 1.2, k) for guidance on details.

In the preparation phase of IEC 61508-3 Ed. 3.0 (Software part), which started Nov. 20-21, 2014, it was decided to look at the ongoing activities in ISO and IEC with respect to "security-aware safety" and to provide more mandatory and informative guidance on a coordinated approach to security in context of functional safety.

In IEC TC65 (Industrial-process measurement, control and automation) considerable concerns arose with respect to the safety impact of security issues in industrial automation systems, since many complex systems of that kind are becoming connected "systems of systems", particularly by interaction based on wireless connectivity from sensors/actuators to complete plants, grids etc., and in maintenance and operations. An Ad-hoc Group (AHG1- "Framework towards coordination of safety and security") was founded to look into the issue and provide recommendations how to handle the co-ordination of security issues in functional safety standards. The kick-off took place Oct. 28/29 2014 at VDE in Frankfurt. In the first meeting overviews were provided by several participants from Europe, Japan, China, US and Australia on ongoing activities and some research projects. E. Schoitsch from AIT provided an overview on several domains and the ARTEMIS projects ARROWHEAD, EMC² and SESAMO which had in-depth work provided in the field of security-aware (security-informed) safety. The domains were not restricted to IEC standards areas

but included also conceptual ideas from railways (EN 50126/28/29 and EN 50159), Airworthiness standards, Nuclear, Off-shore Platforms and Automotive. A short overview on standards' approaches discussed is provided here:

- Railways (DIN/VDE just updating EN 50129: Pre-standard DIN V 0831-104) – integrative approach (with IEC 62443, SL 1)
- Airworthiness Standards: 3 security standards (DO 326A (E 202A) Airworthiness Security Process Specification; DO 355 (ED 204) Information Security Guidance for Continuing Airworthiness; evolving DO YY3 Airworthiness Security Methods and Considerations) – far reaching separation
- IEC 62859: Nuclear power plants – fundamental principles defined how to include cybersecurity without impacting safety
- IEC 61511/ISA TR 840009 (draft) proposes the Cyber Security Life Cycle to be integrated with Process Safety Management
- TC44, Safety of Machinery, electro-technical aspects: separation of safety and security already at requirements level, OEM (integrator) should be the only responsible, not the machinery manufacturer – strict separation not appreciated by ISA or most of the experts.
- Example from off-shore facility: different safety and security levels at different parts of the facility assessed jointly, to be considered in allocation phase.
- IEC 62443 (security levels SL 1-4) vs. Common Criteria (ISO 15408, Evaluation Assurance Levels EAL 1-7): IEC 62443 the preferred standard for industrial automation.
- The proposal from Austria (AIT) to ISO TC22 SC32 WG 08 presented at the ISO 26262 meeting at VDA in Berlin, Jan. 29/30, 2015, taking up ideas from AHG1 members.

The Austria proposal for ISO 26262 was prepared particularly under the aspect that many other standardization groups in different domains and the top-level group of TC65 have taken up the challenges arising from increasingly connected rather open systems. It was argued that automotive is even more affected than e.g. rather closed systems with smaller attack surface and of less opportunity or motivation to attack like railways. "Connected Car", V2V and V2I (vehicle to infrastructure) communication, highly automated and autonomous driving, are no longer unrealistic.

David Strickland, Chief Administrator for the National Highway Traffic Safety Administration (NHTSA), stated: *"…electronics systems are critical to the functioning of modern cars, and are becoming increasingly interconnected, leading to different safety and cyber security risks. (…) With electronic systems assuming safety critical roles in nearly all vehicle controls, we are facing the need to develop general requirements for electronic control systems to ensure their reliability and security".*

The known use of Common Criteria in automotive domain is its application to the assessment of security of in-car digital devices, but rather not safety allocated parts. In the industrial automation domain and in functional safety standards like IEC 61508 (and related ones), IEC 62443 is preferred since it addresses the system and not only devices. IEEE 1609.2 specifies methods to secure messages in IEEE 802.11p wireless communication, an amendment to IEEE 802.11 standards for wireless vehicular communications.

The proposal left open, of course, the details which approach should be taken, although a more integrated approach was preferred by the proposer (AIT, Austria):

- Cyber-security threats should be included as a risk factor during hazard and risk analysis
- If necessary appropriate security measures should be implemented, e.g. include recommendations for fitting security standards into ISO 26262 Ed. 2.0
- Include a requirement consolidation phase to resolve potential conflicts and coordinate safety and security requirements
- Validation of safety concept should <include>/consider security concept
- Security has to be considered throughout the whole (safety) life cycle – recommendations to be included where appropriate

Several countries (e.g. Japan, Germany, France, Austria) reacted positive and some pointed already out which approach they would prefer. There were several objections as well, particularly since some time ago it was decided not to take up the issue in the safety community because of missing knowledge and experience in security. A small subgroup was defined which should look into the issue again and proceeded towards some mandatory requirements in Part 2 and Part 4 and an informative part on a possible "safety – cybersecurity interface" between both teams and processes.

Here I want to cite an article from the (UK) Safety-critical Systems Club Newsletter, Sept. 2014, Robert Oates and David Banham (Rolls Royce) on "Safety & Security": *"High-integrity systems engineers will need to expand their skills!"*

8. Conclusions

Cyber-physical highly automated systems can already be found in aerospace, automotive, process industry, civil infrastructures, energy, health care, manufacturing, robotics, but also in private spaces serving at home, in entertainment and for ambient assisting living (AAL) purposes. The EC in its H2020 Research Programmes and the US National Science Foundation have both identified CPS and systems-of-systems as key research areas. Developments towards autonomous systems and vehicles are becoming increasingly important, in the first steps mostly called "highly automated". Advances are expected with respect to intervention (collision avoidance), precision (nanotechnology, manufacturing, robotic surgery), operation in dangerous or inaccessible environments (rescue, emergency, catastrophe services, deep sea, mountains, mines) and co-ordination (traffic management and control in air, sea and ground), buildings and energy, health-care covering different aspects (ECSEL MASRIA 2014 and 2015). We should learn from the examples that we have to understand that

- In a networked world („cyber-physical systems") we need a holistic view: safety & security are interacting, we have to understand the impact of security on safety and vice versa,
- Safety & security co-engineering is of utmost importance
- Safety and security standards have to take the interdependent properties and dependencies into account
- Safety Cases are a well-known method to provide arguments and assurance that a system is reasonably safe, but have to be extended „assurance cases" or "security aware" safety cases.

Just recently, effort is undertaken to consider security in context of safety-critical systems and functional safety standards, particularly in IEC 61508, Ed. 3.0, ISO 26262 (automotive) Ed. 2.0, EN 50129 and EN 50159 (railways) and on a general basis in the IEC TC 65 Ad-Hoc Group 1 "Framework towards cooperation of safety and security (in industrial automation)".

9. Acknowledgement

Part of the work has received funding from the EU ARTEMIS/ECSEL Joint Undertaking under grant agreements n° 332987 (ARROWHEAD) and n° 621429 (EMC²) and from the partners' national programmes/funding authorities (in Austria FFG (Austrian Research Promotion Agency) on behalf of BMVIT, The Federal Ministry of Transport, Innovation and Technology).

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THE OPTIONS FOR ACTIVELY INCREASING ROAD SAFETY

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Keywords

Communication, early warning, Radio-Help, forced broadcasting, data mining, models, crashes, warning, information,

Abstract

This article is about the possibilities of actively contributing to increasing the safety of ground transportation. Firstly it describes the most common and most well known parts of active and passive safety measures which modern cars are equipped with. Next, the focus is directed towards active and passive systems which would help increase the safety on roadways, such as the eCall and RDS-TMC. The main aim of these articles is to design a concept of an active system which would use more sources of information to warn the driver of a dangerous location on the road ahead of time and which could predict the risk of an accident using data mining methods.

1. Introduction

Traffic accidents are sadly inseparable part of traffic, and despite the police trying to find ways to increase the safety in the traffic, the amount of accidents, material losses and injuries aren't decreasing as much as would be expected. The development of the amount of light and heavy injuries in the last 5 years is displayed in Figure 1. It is apparent that in lowering the amount of light and heavy injuries, the active and passive elements inside of the vehicles or various electronic systems increasing the stability of the vehicle in dangerous situation help tremendously. It is therefore necessary to find new possibilities of preventing traffic accidents using modern information and communication technologies. This article describes only selected and most well known and most important elements of passive and active safety.

The aim of this article is to create a concept for a design of and application warning the driver before dangerous situations on the roadway. The concept assumes the usage of multiple channels to receive warning messages, to achieve maximum reliability of the delivery of the message and maximum relevance of the provided information. Another function of the application is to predict the accident in real time and space. Theoretical concepts are described in this article, which will only later be composed into case studies due to the lack of space in this article.

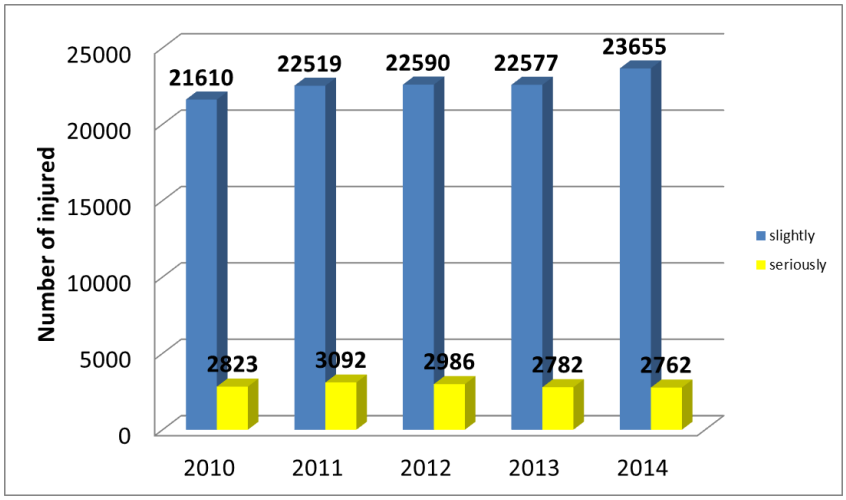

Figure 1: The number of injured people in CZ traffic, source: (Sdružení automobilového průmyslu, 2015)

2. Active and passive elements of safety in vehicles

This chapter is dedicated to common active and passive elements which modern cars are equipped with and which prevent traffic accidents. Described here will also be the vehicle specifications and devices and systems which don't use any external sources of information and are integrated in the vehicles. Those devices either don't need any sensors to function or they only use information provided by sensors inside the vehicle. The aim of this projecting is not an exhausting description of all possible active and passive elements of protecting passengers - to create a general overview, only a selected few important elements of passive passenger protection are described.

2.1. Options for passive safety for vehicles

Elements of passive safety can be defined as devices which are only activated in moments of increased danger or traffic accidents. The purpose of these devices is to minimize the consequences of traffic accidents. Therefore they solve the situation after it already happened. The most common elements of passive safety in modern automobiles are mainly binding systems (seatbelts, children's car seats), head rests, safely designed bodyworks and airbags.

2.1.1. Binding systems and head rests

A binding system is used to lessen the risk of injuring a passenger in the case of a sudden decrease of the speed of the vehicle by limiting the forward movement of the passenger. Binding systems eliminate the unwanted movement of all passengers of the vehicle during a collision. They can be constructed in numerous ways while the most well known are 3-point and 2-point safety belts and children's car seats. One of the basic elements of passive safety is the seatbelt, the purpose of which is to lower the speed of impact of the head and sternum.

The head reset is an important element of passive protection for automobile passengers. The correct adjustment of the head rest lessens the risk of injuring the cervical spine and lessens the permanent consequences of the accident. Collisions from behind the passengers can cause a "whiplash injury". Barnsley (1994) defines the whiplash injury as an injury to one or more elements of the cervical spine that arises from inertial forces being applied to the head in the course of a motor vehicle accident that results in the perception of neck pain. The correct adjustment of the head rest is also

necessary even during frontal collisions, when the body of the passenger caught by the airbag and seatbelt begins to return into its original position. Certain modern automobiles have an active system for adjusting the head rest which can minimize the consequences of such collisions.

2.1.2. Airbag

Just like the seatbelts, the airbags are also designed to protect the passenger form colliding with the vehicle interior equipment, while airbags usually protect a certain body part. To maximize the effect of airbags, seatbelts have to be used. The main component of the airbag system is a strong fabric bag folded and stored in a module on the steering column for the driver, and in the dashboard for the passenger. When onboard sensors detect a frontal crash of severity exceeding a set threshold, equivalent to a delta-v of about 10 mph, detonators deploy the airbag. High pressure chemically-produced gasses force the bag out of the module and inflate it sufficiently rapidly that it is in place in front of the occupant before the occupant has had time to move forward appreciably in response to the crash forces (Evans, 2004).

2.2. Possibilities of active safety in vehicles

Active safety elements in vehicles try to prevent the accident from happening altogether unlike the passive elements. They are mostly types of devices, systems and vehicle properties using the information from sensors inside of the vehicles. Basic elements of active protection are for example quality brakes and accurate steering. In modern automobiles are however several sophisticated systems of active safety, for example the anti-lock braking sytems (ABS), antriebs-schlupf-regelung (ASR) and electronic stability program (ESP), and many others.

2.2.1. Anti-lock braking systems

In situations in which the driver has to suddenly brake the wheels could lock into one position. Critical situations like this one happen mostly on slippery surfaces (wet or frozen surfaces). These situations can be prevented using the Anti-lock braking systems (ABS). ABS is based on the principle of measuring the RPM of the wheels using sensors. The sensor signals are transmitted into the control unit which processes them and in case it detects that the wheels are in danger of locking, it activates electropneumatic control pistons of the wheel and this decreases the negative effect (Vlk, 2006).

2.2.2. Traction control systems

Mainly in situations where the wheels on one side of the vehicle have different levels of adhesion to the surface than the wheels on the other side, the Traction control system (TCS) is used. There are many different types of this system and different car manufacturers use different names for these devices (TCS, ASR). The principle behind those systems is controlling the slip of the driving wheels using sensors which are also used in ABS and optimizing the transfer of the torque. If the adhesion and axle load are large enough, the wheels will after stepping on the pedal start to transfer the torque onto the surface and the vehicle will start to accelerate. In the case of the torque being larger than what the wheel can transfer onto the surface, the wheel starts to slip. If the RPM of one wheel suddenly increases, ASR informs the control unit and the control unit will use the electromagnetic piston and the electropneumatic control piston to slow down the wheel or lower the output of the engine. This makes it possible for the wheel to transfer the torque to the road (Vlk, 2006).

2.2.3. Electronic stabilisation program

There are several variants of the electronic stabilization system (ESP, ESC - Electronic stability control, dynamic stability control - DSC). All ESP variants are however designed with the same principle. The ESP is an extension of ABS and ASR, it uses sensors of the steering wheel rotation, RPM sensors on all wheels, sensors of acceleration in all directions and others. Unlike ABS and ASR is the ESP able to regulate the slip of the wheel in the lateral directions. The ESP is useful mainly in borderline situations and it can eliminate both under and over steering of the vehicle, and it also aids in evasive maneuvers, where the driver suddenly steers in one direction to avoid an obstacles. In the moment where the control unit detects a dangerous situation, it can automatically regulate the effect of brakes of individual wheels and the prime mover of the engine. For example, understeering and oversteering is eliminated by braking individual wheels and lowering the torque according to the situation (Vlk, 2006). Every new homologated vehicle has to be equipped with ESP since 2011, and on top of that all newly sold vehicles since 2014 have to be equipped with ESP even if they were homologated before 2011.

3. Telematic systems for passive and active passenger protection

3.1. eCall

eCall mainly solves the consequences of traffic accidents which makes it a passive safety system. eCall is a service designed to provide quick emergency response in the case of a road accident anywhere in the EU. Its aim is to improve the protection and safety of European roadways and to reduce the fatalities caused by road accidents, as well as all related injuries and property losses. This project co-financed by the EU assumes that after its full deployment, it will be able to save 2500 lives every year (European Commission, 2013).

eCall can decrease the reaction time during emergency situations up to 40% in urban areas and 50% in rural areas. Pilot testing and implementing the eCall system in Europe is done by the HeERO consortium. The Czech Republic is also a part of the HeERO (Harmonised eCall European Pilot) project. It is predicted that accidents cost around 160 billion euros, in the event of implementing the eCall system, 20 billion euros could be saved every year (Harmonised eCall European Pilot, 2013).

Every car equipped with an eCall device can create an emergency connection with the 112 hotline either automatically during an accident or manually using a button in the car. According to latest information, the EU comission approved that the eCall system will only activate when the car's sensors have detected an accident. In that moment will not only a voice connection with the workers at the emergency centre (PSAP) be created, the device will also send a minimum set of data (MSD) standardized by the European Committee for Standardization (CEN). The list of MSD attributes with descriptions can be found in Table 1.

According to the original plans all new cars should have been equipped with the eCall system starting in the year 2015. However, the EU commission was resolving complaints from the system opponents, which listed the possibility of the system being hijacked to involuntary, localize the vehicle as their main complaint. In May 2015 the eCall system was finally approved by the EU parliament as mandatory equipment for all new cars starting 1. April 2018 (European Emergency Number Association, 2015).

Attributes	Description
Message identifier	MSD format version (later versions to be backwards compatible with existing versions)
Activation	Whether the eCall has been manually or automatically generated
Call type	Whether the eCall is real emergency or test call
Vehicle type	Passenger Vehicle, buses and coaches, light commercial vehicles, heavy duty vehicles, motorcycles
VIN	Vehicle identification number
Vehicle propulsion storage type	This is important particularly relating to fire risk and electrical power source issues (e.g. Gasoline tank, Diesel tank, Compressed natural gas (CNG), etc.)
Time stamp	Timestamp of incident event
Vehicle location	Determined by the on-board system at the time of message generation. It is the last known vehicle's position
Confidence in position	This bit is to be set to "Low confidence in position" if the position is not within the limits of +/-150m with 95% confidence
Direction	Helpful to determine the carriageway vehicle was using at the moment of the incident
Optional attributes	
Recent vehicle location	Vehicle's position in (n-1) and (n-2)
Number of passengers	Number of fastened seatbelts
Optional additional data	In some cases, optional data may be available in the MSD (at the vehicle manufacturer discretion).

Table 1 MSD attributes description, data source: (European Emergency Number Association, 2014)

3.2. Advanced possibilities for navigation devices - RDS TMC

Radio Data System - Traffic Message Channel provides the transfer of prepared information about the traffic into the vehicle where they are processed and displayed to the driver. RDS-TMC is a part of the traffic information system and it is deeply connected with a selected broadcast station, due to this the data sent by each station can differ. GPS navigators and cell phones equipped with a TMC decoder can use the RDS-TMC. Localization tables are used to mark the positions of objects in the real word - every row in the table is connected to a selected geographic entity, such as crossroads, roads or objects of interest. The main disadvantage of RDS-TMC is the quality of the tables which can cause an event to be displayed on a location differing from reality, on top of that it often happens so that information's appear with a delay. The service can also have trouble receiving messages in locations with weak FM signal.

3.3. System for Automated Forewarning of Vehicle Crashes

To further the advance of trying to distribute critical information about dangerous events more efficiently, the System for Automated Forewarning of Vehicle Crashes was invented (Kubát, 2012).

Implementing the eCall system, it is based on full automation of transmitting and generating information data about accidents happening near the vehicle equipped with it. When a vehicle equipped with it crashes, the device creates data about the time and location of the accident and broadcasts it to the central office of the System, which then processes the data, creates visual and voice information about the event and its location and transmits all this data into nearby vehicles using radio waves (Brunclík, 2010).

Positional codes are used by the Radio-Help to identify areas to which the broadcast needs to be directed - receivers maintain a standby mode which enables them to capture transmissions with a fixed rate and compares the position using the GPS coordinates with the positions listed in the broadcast and in the event of the coordinates matching it activates a forced broadcast reception mode. After the transmission is over the standby mode is re engaged (Kubát, 2012).

4. The concept of a multi-source prediction mobile application

The eCall and RDS systems mainly solve problems which have already happened, unlike prediction applications, which use multiple source of information to try to prevent the accidents from happening altogether and should be a way to actively protect all passengers by warning the driver early. The aim of the multi-source prediction application is to predict the risk of a traffic accident in real time, and for that it uses multiple sources of data, technologies and data mining methods to create it's prediction models.

4.1. The principle behind the application

The concept is based on using multiple sources of information to reach maximum accuracy, reliability and to provide most recent information for the driver. Data sources and systems of information distribution for the application concept should be the eCall and RADIO-HELP systems, the National traffic information center (NDIC), RDS-TMC, and information about traffic accidents collected by the Czech police department.

In case of danger the driver is warned by a visual representation on their cell phone display and by audio sequences - a synthetic voice message for example, which enable the driver to focus on driving as much as possible.

The application should be able to warn the driver not only before a dangerous situation on the roadway, but before the increased risk of an accident in a specific location and time - in principle there can be two types of warnings - before an existing situation and before a potential situation using prediction. Gathering and distributing information about accidents along with distribution of prediction models into the device is shown on Figure 2.

4.1.1. Warning the driver before an existing problem

The main prerequisite for this situation is that e.g. an accident has happened on the road and the driver needs to be warned. The data about the situation on the road is streamed into the application by 3 independent channels - the first one being the data transferred from the national information center through the internet. In this case gathering the data from server’s distributing this information from NDIC (e.g. doprava.idnes.cz) could also be used. The second channel is RDS-TMC, which also uses the data from NDIC. Messages transmitted via RDS-TMC tend to be shorter in nature, however in the case of lack of mobile signal it still allows to transmit at least a basic warning. The fastest method of transmitting information about a situation on the road should be used automated system for emergency broadcasts using the RADIO-HELP concept. Using this

technology should ensure higher reliability of message reception and higher accuracy in GPS location, because along with the information, GPS coordinates would be transmitted, which are a part of the MSD system eCall.

The probability of successful reception of the warning is high due to using three separate information channels, but a necessary algorithm to ensure that neither duplicates nor contradicting information is received needs to be developed.

4.1.2. Warning the driver before a dangerous situation occurs by using prediction models

This type of warning should notify the driver of locations with increased accident risks on roadways with relation to other attributes of the current situation. To predict a dangerous location in real time and space, models created using data mining methods and based on historical data about accidents from the traffic accident database are used. The application in the vehicle compares the result of the prediction with the actual situation and in the moment where the similarity crosses a set threshold, the driver is warned - the concept of warning is of the same audio- and visual design as in the last chapter.

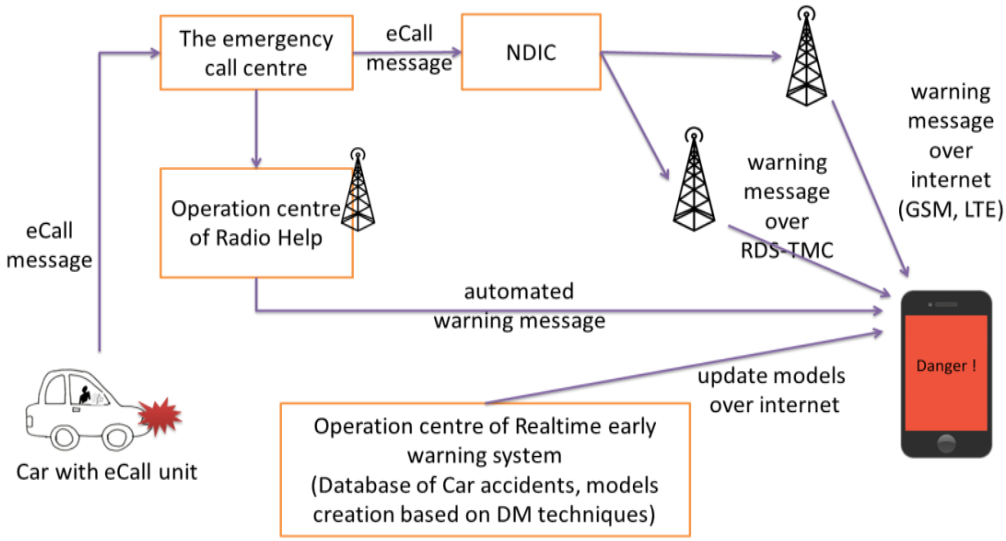

Figure 2: Transmission and acquisition of data about accidents, distribution of predictive models into a car

4.2. The creation and distribution of actual prediction models into the cell phone

Using prediction models in the application properly requires a control part where the accident database would be periodically updated. The control part imports and processes heterogenic data, maintains and supervises the database and prepares a modeling matrix for the needs of data mining. Using data mining methods and algorithms (e.g. cluster analysis) models are created, and their most recent versions are transmitted into mobile devices in the vehicle. Updates for the models in the application are transferred using the internet connection to update servers.

A prerequisite for using the traffic accident database is the existence of a unified traffic map maintained by the ministry of traffic. Currently, there are more than 600 000 entries about traffic accidents in the traffic map project, while the entries spend from 2007 till now. Every entry about an accident contains GPS coordinates and 48 attributes describing the state of the selected situation which led to the accident, e.g. the wind speed, date, time and the state of the driver.

5. Conclusion

Application predicting the risk of an accident and warning the driver in case of a problem on the roadway is one of the first conceptual designs of a new large project - this project will be based not only on early and relevant distribution of information for the driver, but also on the design of a complex system which would enable the real-time prediction of the risk of a traffic accident in a location and in case of an emergency situation would directly influence the control of the vehicle. Thanks to the usage of multiple sources of information the system guarantees higher reliability, relevance, and recentness of the information presented to the driver. The main advantage of this method is that it tries to prevent the accidents both actively and passively.

6. Acknowledgments

The current work is supported by the SGS project with the Number 21079, from Technical University of Liberec.

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SAFETY BY DESIGN USING THE OPEN MOTION PLANNING LIBRARY

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Keywords

system design, autonomous systems, hybrid systems, reachability analysis, motion planning, OMPL

Abstract

The design of software systems is a complex task which is especially true for dynamical systems like robots, autonomous vehicles or assistance systems. The internal dynamics as well as the environment have to be modeled properly to guarantee that the system operates in a predictable and therefore safe way. The goal of the modeling process of such a system should be safety by design which means, that critical or uncertain system configurations can be identified and avoided in advance. A method that can be used for this task is called reachability analysis. This concept tries to evaluate the dynamical boundaries of a system in order to identify inherently safe configurations and transitions. This information can be used to improve basic system designs and generate a better understanding of the underlying dynamics. This work presents a form of reachability analysis which uses the concepts and algorithms provided by the Open Motion Planning Library (OMPL). Two practical examples show how this software framework can be used to handle a variety of problems related to dynamical systems and reachability analysis.

1. Introduction

Software systems in the field of robotics, autonomous vehicles, navigation, guidance, and control are primarily designed in order to represent and control some kind of underlying physical system. An accurate representation is a key aspect of a proper design that inherently supports the safety of the system. Therefore, safety by design can be achieved by an advanced understanding of the physics underneath as well as the variety of operational modes covered by a system. Hence, the predictability of a systems behavior as well as the understanding of different modes as well as the transitions between these modes is a relevant part of an advanced system design process. Since the safe conditions of a dynamic system might change when observed over time, an advanced model should also cover temporal transformations in order to produce a more accurate representation. Real-time evaluation and propagation of the current state might not always be possible due to computational complexity or limited resources. Therefore, a priori identification of time-dependent system boundaries might be beneficial in many fields of applications. This may range from robotic applications and autonomous systems over optimization problems to high-level control theory.

1.1. Reachability Analysis

Reachability analysis has proven to be a powerful tool for verification and control of dynamic systems which can already be applied during system design. Its ability to model complex processes makes it applicable in many challenging fields of applications like robotics, avionics, autonomous systems, and optimal control theory. Especially the analysis of hybrid systems, which combine both discrete state dynamics and concrete state dynamics, is a challenging research field that often can significantly benefit from reachability analysis.

1.2. Sampling-based Motion Planning

In the field of motion planning and control the majority of state-of-the-art algorithms relies on sampling-based methods like described in LaValle (2006). This class of algorithms which is generally referred to as sampling-based motion planning has found its use in a variety of applications like robotics, autonomous systems, path planning, and collision avoidance. Their general concept is the continuous generation and integration of randomly chosen states within the configuration and planning space. These configurations are tried to be connected to a graph that represents valid state transitions within the planning space. While constantly checking the validity of generated states and transitions between them, these algorithms try to explore the configuration space until a valid solution is found that reaches the planning goal. Many algorithms have been developed during the last decades that implement this basic concept in different ways. One of the two main categories are roadmap-based methods like e.g. Probabilistic Roadmap Method (PRM) which were introduced by Kavraki (1996) and improved by Karaman (2011) (PRM*) and Sparse Roadmap Spanner technique (SPARS) introduced by Dobson (2013). The other group are tree-based methods like e.g. Rapidly-exploring Random Trees (RRT) introduced in LaValle (1998) and improved by Kavraki (2011) (RRT*), Expansive Space Trees (EST) introduced in Hsu (1997), and Fast Marching Trees (FMT*) introduced by Janson (2013).

1.3. Problem Description

The application of reachability analysis often requires the use of advanced mathematical methods to describe the system dynamics as well as the transformations of the system state boundaries. One state-of-the-art approach to create invariance-preserving system representations is the computation of time dependent Hamilton-Jacobi partial differential equations by using level-set methods. As introduced by Osher (1988) the basic concept of level-set methods is the representation of the systems state boundaries in an n-dimensional configuration space via a function in n+1 dimensions. The identification of these equations is often challenging and the computation of the resulting reachable sets can be very costly in terms of computational resources. Many applications that might benefit from the concept of reachability analysis are related to dynamical systems like robots or autonomous vehicles. These applications require an adequate representation and interpretation of the system dynamics and its operational boundaries. Especially the computation of time-dependent effects can be very challenging and computationally expensive which makes it often unpractical in real-time. Therefore, a priori identification of safe system envelopes can be a great advance.

The implementation of autonomous systems is often based on programming frameworks and libraries that cover specific tasks like sensor processing, mapping, localization, path planning, collision avoidance, and motion control. One widely used programming framework within this domain is the Open Motion Planning Library (OMPL) introduced by Sucan (2013). This library covers path planning and collision avoidance in a very flexible, modular, and scalable way and is therefore applicable for a very wide range of planning problems.

2. OMPL-based Reachability Analysis

The idea of sampling-based reachability analysis has been a research topic in previous publications like e.g. Althoff (2010, 2012) and Bhatia (2004). Mainly tree-based algorithms like RRT were used for space exploration and safety validation. Nonetheless, this work introduces an advanced concept that incorporates the idea of reachability analysis and the motion planning capabilities of OMPL. Therefore, some of the main components of the OMPL framework are used in order to generate reachable sets of system configurations within the state space rather than concrete solution paths. Initially, the configuration space X is defined which covers all possible system configurations. Since reachability analysis might be especially interesting for time-dependent systems the temporal dimension can also be covered by X. In the case of a dynamical system with controls it is also necessary to define the control space U that covers all possible system inputs.

OMPL provides a variety of sampling-based motion planning algorithms which can be used to find a solution for a given problem definition by exploring X. Typically, such a solution is found when the planning algorithm finds a feasible path from a state $a \in X_{Start}$ to a state $b \in X_{Goal}$. The presented reachability analysis approach neglects such kind of problem definition in order to keep up space exploration for a certain amount of time. This leads to the effect, that the planning algorithm utilized to explore X produces extensive planner data in the form of a graph $G = (V, E)$. This graph contains a set of vertices V that covers all valid sampled states as well as the set of edges E representing all valid state transitions.

Unfortunately, the range of planning algorithms that are capable of dealing with control inputs is rather limited. This is mainly due to the fact that most optimized sampling-based path planning algorithms use "rewiring" concepts in order to improve G. The determination and validation of optimal control inputs for an optimized state transition can be very complex and computationally intensive which often makes it unfeasible for motion planning with control inputs.

2.1. Yellow Light Interval Dilemma

As mentioned above, the introduced concept for reachability analysis can be used to investigate hybrid systems. A hybrid system H combines the continuous configuration space X with a set of discrete modes Q and a transition function $R: Q \times \sum \times X \to Q \times X$ where $\sum$ is a set of discrete inputs or events. The dynamics of each mode $q \in Q$ are defined by $f_q(x, u): Q \times X \times U \to X$ where U is the control or input space. Furthermore, each mode has an initial set $W_0(q) \subset X$. This basically represents a system consisting of multiple modes represented by different system dynamics. A mode switch is represented by a discrete control input $\sigma \in \sum$ and can either be initiated automatically, through system disturbances, or via an external input like e.g. by a user.

The first example presented in this work investigates a rather simple hybrid system which was presented by Oishi (2008). The so-called *yellow light interval dilemma* describes the situation of a vehicle approaching a traffic light that turns yellow. It's assumed that a driver or an autonomous system controlling the vehicle faces two options to either stop the vehicle in front of the intersection by braking or to accelerate and pass the intersection before the light turns red. Since braking may not stop the vehicle early enough this option might result in an unsafe state in form of a red light violation. Another unsafe state is reached when the vehicle accelerates and the intersection is not fully passed when the light turns red. In order to determine the invariant state sets that ultimately lead to safe configurations, reachability analyses are performed on the hybrid subsystems H_i that are separated by a mode transition σ_u initiated by the instance controlling the system. Although, this problem could easily be solved by a numerical approach it gives a good example of what hybrid

systems are and what kind of applications reachability analysis can be used for. Like presented by Oishi (2008) the two hybrid subsystems H_{brake} and $H_{accelerate}$ represent the two options given to the driver by either braking or accelerating when the traffic light turns yellow. Since the initially safe sets $W_0(q)$ are known for the moment the traffic light turns red $t_{red} = 0$ s and the reachability analysis shall identify the safe configuration space previous to that moment the state propagation has to be performed backwards in time. In this example the yellow light interval is 4 seconds (t_{yellow} = - 4 s), the length of the intersection area d_{int} = 10 m and the maximum speed of the vehicle v_{max} = 86 km/h.

Using the OMPL framework a sampling-based planning algorithm is applied on two distinct configurations. Both are initialized with a set of multiple start states uniformly distributed at the boundary between the state space and the initially safe sets for the hybrid subsystems $W_0(brake)$ and $W_0(accelerate)$, respectively. $W_0(brake)$ is the space where $v = 0$ and $d <= 0$ representing a stop ahead of the intersection. $W_0(accelerate)$ covers the space where $d > d_{int}$ and $v >= 0$ representing the vehicle that has passed the intersection. Since time is a relevant dimension in this scenario the state space is defined as $X \subset \mathbb{R}^3$ covering distance D = [-120 m, 10 m], velocity V = [0 km/h, 86 km/h] and time $t = [t_{yellow}, t_{red}]$. The control space U for this example represents the acceleration of the vehicle $a \in [-4\ m/s^2, 2\ m/s^2]$. For W_{brake} only negative acceleration inputs are used while $W_{accelerate}$ requires positive ones. Similar to Oishi (2008) it's assumed that the drivers reaction time t_{react} = 1.5 s which implies that the velocity is constant for this time span after t_{yellow}. This can be achieved by implementing a directed control sampling strategy within the OMPL framework which sets $a = 0$ if $t < (t_{yellow} + t_{react})$. The state propagation is performed backwards in time by setting a negative propagation time step for the Euler integrator. The reachable sets shown in Figure 1 were produced by running the RRT algorithm for one second. W_{brake} is densely covered by a graph that contains approximately 28.300 vertices/states from where a braking maneuver can successfully be completed before the traffic light turns red. The other option where the vehicle is accelerated in order to pass the intersection before $t = 0$ is covered by a graph with 26.600 states filling $W_{accelerate}$.

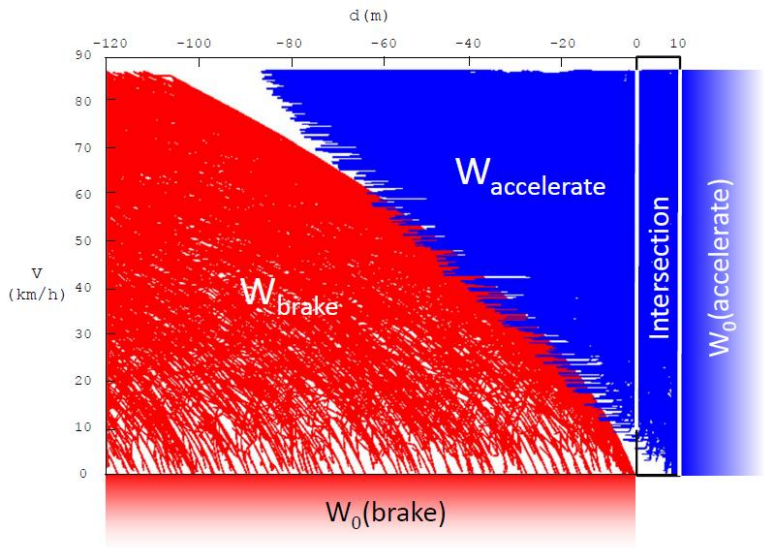

Figure 1: Reachability analysis results for W_{brake} and $W_{accelerate}$ in 2D (velocity and distance).

The region where the two graphs interdigitate represents the subset of the configuration space where both options would lead to safe final configurations. In contrary, regions of X that are covered by neither Wbrake nor Waccelerate represent configurations where a red light violation is inevitable. As shown in Figure 1 this is the case for relatively high velocities and far distances as well as for very low velocities at distances within the intersection area or just ahead of it.

2.2. Aircraft Landing

The second example presented in this work has been introduced by Oishi (2003) and was further investigated in Oishi (2008) where the landing maneuver of a large civil jet aircraft is modeled as a hybrid system. In this scenario it's assumed that a regular landing approach maneuver might have to be aborted and the pilot has to initiate a so-called "TO/GA" (Take-Off/Go-Around) maneuver which steers the aircraft to recover a safe altitude. While Oishi (2008) investigates a variety of hybrid subsystems in this scenario this work focuses on the initial mode switching operation that brings the aircraft from the final "Flare" landing mode to the TO/GA maneuver. These modes are represented by the hybrid subsystems H_{flare} and H_{toga} which are connected via the user initiated state transition σ_{toga}. The landing approach is modeled as nonlinear longitudinal dynamics by $\dot{x} = f(x, u)$ where state $x = [V, \gamma, h] \in \mathbb{R}^3$ containing the aircrafts speed V, the flightpath angle γ, and altitude h. The control input $u = [T, \alpha]$ contains aircraft thrust T and angle of attack α.

The first part of this example shall determine whether the aircraft is in a configuration that allows safe landing. Therefore, safety boundaries are defined for the moment of landing, limiting the aircrafts pitch angle and the maximum rate of descent in order to prevent damage to the aircraft. In this example these boundaries are $\theta = \gamma + \alpha \in [0°, 12.9°]$ and $\dot{h} > -1.829$ m/s. The investigated configuration space X_{flare} is defined as $V \in [55.57$ m/s, 87.46 m/s$]$, $\gamma \in [-6.0°, 0.0°]$, and $h \in [0$ m, 20 m$]$. The control space U_{flare} contains $\alpha \in [-9.0°, 15.0°]$ and $T = 0$. Similar to the previous example the reachability analysis is performed by an RRT-based planner which utilizes Euler integration for state propagation. Since in this scenario the initially safe set W_0(flare) is the part of the configuration space where a safe touchdown is achieved the start states are distributed over V and γ, while touchdown altitude $h = 0$. Figure 2 shows the exploration of X_{flare} from $h = 0$ m up to $h = 20$ m.

G_{flare} contains states that ultimately lead to a save landing within the configuration space under the given input boundaries. As shown in Figure 2 safe landing cannot be achieved from any altitude h if the velocity V is too low. Furthermore, the angle of descent must not be too low at low altitudes in order to prevent the aircraft from exceeding $\dot{h} > -1.829$ m/s at touchdown. The illustrated graph contains 166.000 vertices that were calculated in 50 seconds.

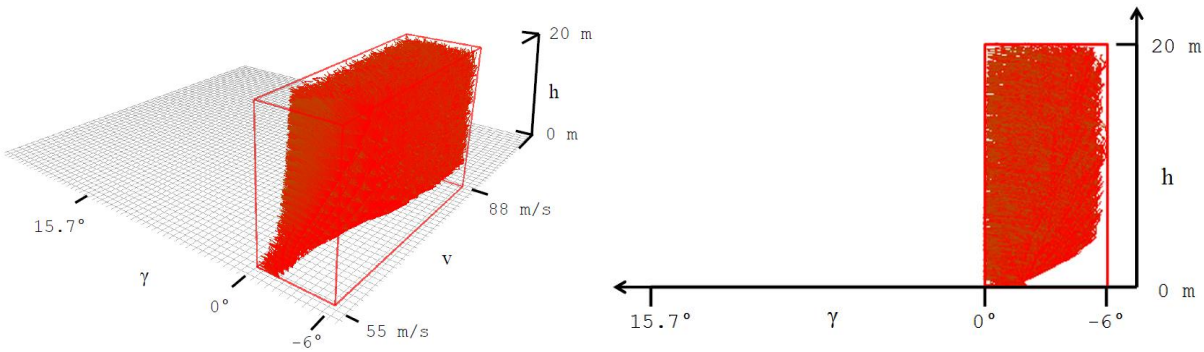

Figure 2: Reachability analysis results for W_{flare} within the configuration space (wireframe).

The hybrid subsystem H_{toga} represents the operational mode and dynamics of the TO/GA maneuver in case of a missed approach. The state space X_{toga} is defined as $V \in [55.57$ m/s, 87.46 m/s$]$, $\gamma \in [-6.0°, 15.7°]$, and $h \in [0$ m, 20 m$]$ covering both X_{flare} as well as the configuration space that represents the intended climb of the aircraft. The control space U_{toga} is defined as $\alpha \in [-9.0°, 15.0°]$ and $T = [0, T_{\text{max}}]$ where $T_{\text{max}} = 686.700$ N. In Oishi (2008) H_{toga} is separate into two modes which cover the part of the TO/GA maneuver where the aircraft is still in decline and $T = T_{\text{max}}$ and the part

where the climbing rate $\dot{h} > 0$ and the aircraft is gaining altitude and therefore $T = [0, T_{max}]$. In this work this automatic mode transition is implemented by a variable control sampling component returning $T = T_{max}$ for negative climbing rates. The safe initial set $W_0(toga)$ for this subsystem is defined as the part of the configuration space where the aircraft reaches the altitude h_{alt} = 20 m. Therefore, the OMPL planner is initialized with a set of start states uniformly covering V and γ at $h = h_{alt}$. The resulting graph G_{toga} covers the invariant subset of the configuration space that leads the aircraft to a safe altitude once the TO/GA maneuver is initiated. As shown in Figure 3 G_{toga} (174.000 vertices) fills the majority of the configuration space X_{toga} showing some empty/unsafe regions for low velocities in combination with a negative flight path angle.

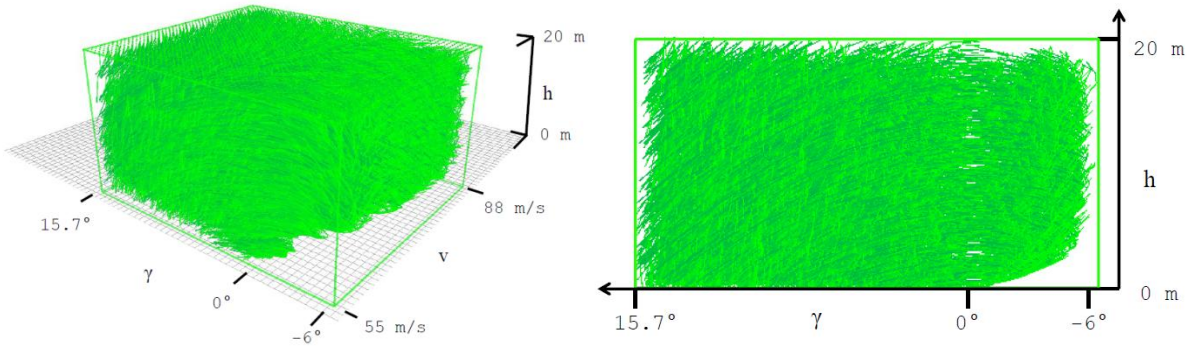

Figure 3: Reachability analysis results for W_{toga}.

The resulting reachable sets for the two investigated hybrid subsystems H_{flare} and H_{toga} can now be combined in order to verify if the eventually user initiated mode transition σ_{toga} is safe or not regarding the current system state. In Figure 4 the two graphs are illustrated together showing that there is a significant overlap of the two time invariant safe sets W_{flare} and W_{toga}. States within this overlap region allow both options landing and initialization of the TO/GA maneuver without possibly reaching an unsafe configuration.

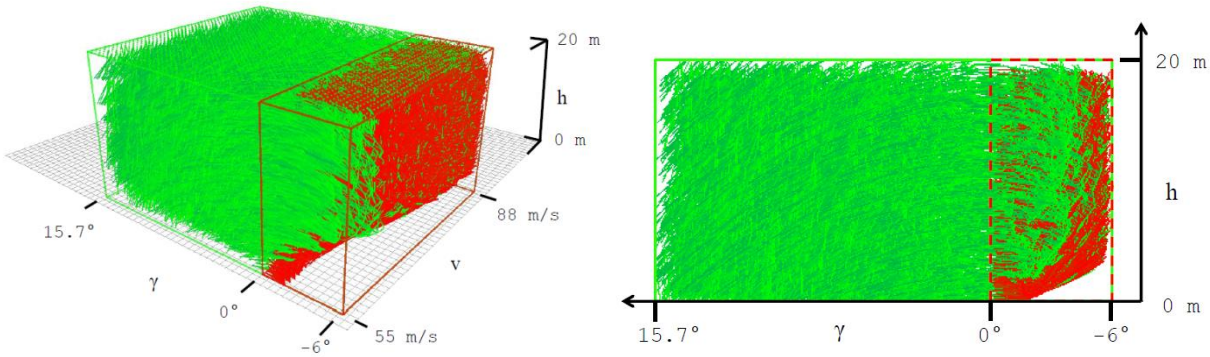

Figure 4: Combined illustration of W_{flare} and W_{toga}.

2.3. Reachable Set Inclusion

The reachable sets identified by the presented graph-based method cannot be represented as a continuous boundary where a defined *inside* and *outside* exist. Therefore, the determination whether an arbitrary configuration might belong to a certain reachable set $W(q)$ has to be done by checking if a valid connection to its space exploration graph G can be found within a certain distance threshold. Since the primary purpose of the OMPL is the identification of feasible paths from one or more start states to a goal state this can be performed using conventional motion

planning strategies. The states that are included in G are used as initial data of the planning algorithm and connectivity to state x is checked by using it as the goal of the motion planning problem description. This method might identify a feasible connections to a certain state x, hence, meaning that this configuration can be considered to lead to an initially safe state in $W_0(q)$. However, it has to be kept in mind that the whole reachability analysis process as well as state connectivity checking is subject to multiple uncertainties that might differentiate its results from reality. Depending on the quality of the physical model and the intended purpose of the reachability analysis it may be necessary to manipulate the connectivity thresholds in order to realize a more or less conservative abstraction. For identification of safe mode transitions between multiple hybrid subsystems connectivity inclusion has to be checked for the multiple states within the resulting graphs. Such connectivity checking strategies can range from a very basic brute-force approach to more sophisticated cost-based methods. Furthermore, OMPL provides algorithms like e.g. RRT-Connect introduced in Kuffner (2000) that try to connect multiple graphs in order to identify feasible transitions between configurations.

3. Conclusion and Future Work

The two examples presented in this work have shown that a sampling-based reachability analysis concept can be used as a design method for arbitrary dynamic systems and applications. Systems with diverse complexity can be represented by using standard OMPL components and algorithms. This approach allows a wide audience of software developers and system designers to handle challenging problems by using a modular, flexible, and scalable state-of-the-art framework. This can give rise to a certain level of safety by design in a vast field of applications related to dynamical systems like e.g. autonomous systems, robotics, navigation, guidance, and control. Although the level of detail in the resulting data can vary due to specific configurations the effort to produce initial results is relatively low and further improvement of quality can be achieved through ongoing refinement and extension of processing time. The capabilities of the OMPL cover both forward and backwards propagation. Furthermore, a variety of state-of-the-art motion planning algorithms can be utilized. Time-dependent dynamical systems can also be handled by extending the configuration space by a temporal dimension. Processing time and scalability are the main benefits of the sampling-based reachability analysis strategy presented in this work. Nonetheless, this concept comes with the drawback that a factor of uncertainty is added to the result of the state space exploration due to the propagation strategy and the definition of the initially safe start set.

Practical applications for the system design method presented in this work can be found in a variety of research fields. For example collisions detection and avoidance can be supported by using this concept in order to identify regions within the configuration space that might be reached within a certain time and should therefore be considered for collision checking while others are neglected. Another major field of application is the identification of feasible mode transitions within complex systems. Since, autonomous systems are becoming increasingly popular software often has to compensate some amount of missing human intuition. Conventional system design processes are often not capable of considering all possible outcomes of a certain transition which might eventually lead to an indetermined and therefore unsafe state.Future research effort related to this work will focus on the validation of the presented results as well as the extension of the method by investigating further dynamical systems. Especially more complex settings and systems will be modeled in order to emphasize the strengths and weaknesses of the presented concept. In a related research project the OMPL-based reachability analysis is currently used to determine the safe operating range of a construction vehicle. Although, this does not investigate a hybrid system the general approach is similar to the one presented in this paper.

4. Acknowledgement

This research has been supported by the Austrian Research Promotion Agency (FFG).

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INVITED PAPER

WE AND ICT:
INTERACTION AND INTERDEPENDENCE

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Abstract

ICT has been all-pervasive, fertilizing and empowering nearly all areas of our life creating interaction and interdependence. We will examine some of the developments, starting with the state of the industry economically and technologically, the transition from mM to MtM and its impacts on us as individual and society. Additionally we will render tribute to the two anniversaries meriting special attention: 50 Years of "Moore's Law"and 25 Years of Public Internet.

1. ICT some business aspects

How did they fare in 2014?

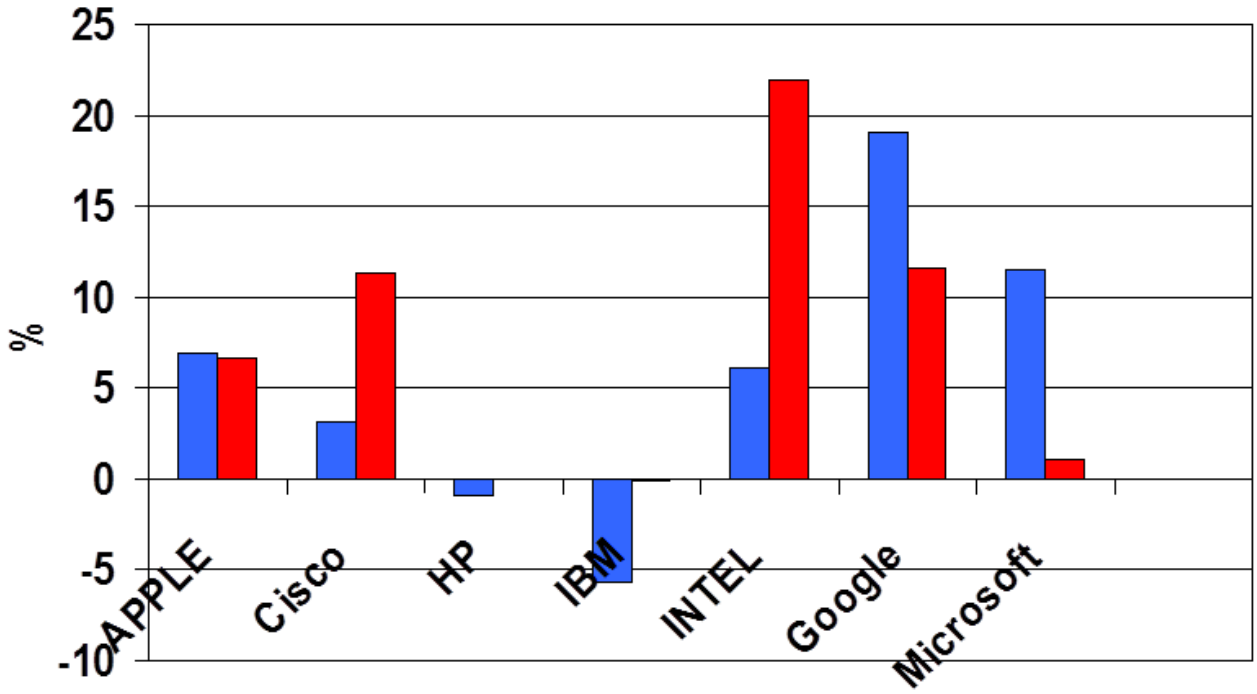

Figure 1: Selected companies: Revenue and Net Income 2013 to 2014

The major common denominators are change and restructure, characterize also by developments as tablets reaching 50% market share making it one of most disruptive devices ever, the cycles for wearables now averaging two years, and for smart TV's six years only. Or other emerging phenomena are Android surpassing iOS, US adults spending more time on smartphones than on

PCs (34 vs. 27h/month) and the growth of health and fitness Apps by 62% last year (female use is three times higher than male).

The shift of the centre of economic gravity from the "saturated" West to East as the market of future is making China for 2016 the largest smart phone market of the world.

For the user it does not matter who is on top but that there is a variety to choose and competition.

2. IC Technology

2.1. 50 Years of "Moore's Law"

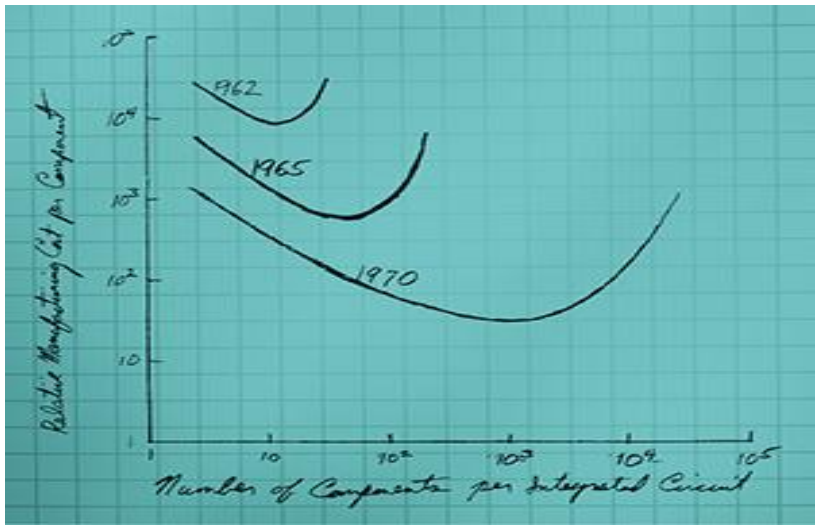

Figure 2 Intel (Moore's original picture)

Economics was at the core of Moore's 1965 paper. He argued that, there is a cost curve of manufacturing technology. The cost of making a component declines the more you pack onto an integrated circuit, but past a certain point, yields decline and costs rise. The sweet spot, where the cost per component is at a minimum, moves to more and more complex integrated circuits over time. Ten years later, Moore revised his prediction. In an analysis for the 1975 IEEE Meeting, he argued that three factors contributed to the trend:

- decreasing component size,
- increasing chip area, and
- "device cleverness," which referred to how much engineers could reduce the unused area between transistors.

Of the three technology drivers Moore identified, one turned out to be special: decreasing the dimensions of the transistor. For decennia, shrinking transistors offered something that rare in the world of engineering: no trade-offs. The scaling rule named for IBM engineer Robert Dennard, says every successive transistor generation is better than the last, faster and less power hungry. This single factor has been responsible for much of the staying power of Moore's Law, and it lasted several decennia.

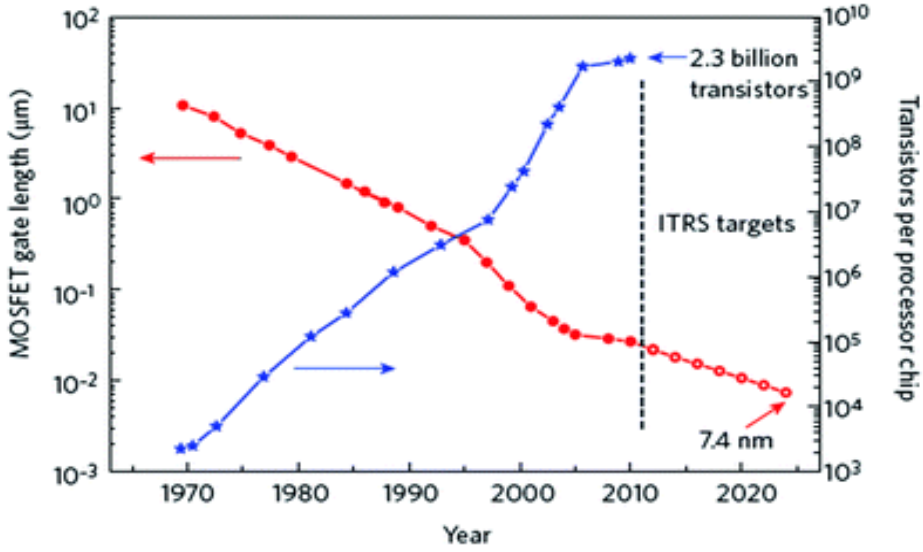

Figure 3 Moore's law illustration

In the early 2000s, transistor sizes began to creep down below 100 nanometres, and Dennard's scaling rule hit its limit. Transistors became so small that it was quite easy for electrons to sneak through them even when the devices were supposed to be off, leaking energy, and lowering device reliability.

For the last decade, Moore's Law has been more about cost than performance, making transistors smaller to make them cheaper. There have been design improvements, but much of the gains have come from the integration of multiple cores enabled by cheaper transistors. Today's smartphones has three times the computing power of yesterdays Cray's supercomputer and without the progress we would not enjoy mobile computing, GPS in the car or HD video.

The steady work also improved yield, starting in the 1970s at around 20% and now at 80 to 90 %. The tools employed in lithography cost 100 times as much today as they did 35 years ago. However, these tools pattern wafers 100 times as fast, making up the cost increase while delivering far better resolution. This trend may be ending largely because lithography has gotten expensive.

Over the last decade, the manufacturing cost per unit area of finished silicon raised about 10% p.a. Since the area per transistor shrank by about 25% p.a. over the same period, the cost of each transistor kept going down. If lithography costs rise fast, Moore's Law as we know it will come to a quick halt. Innovations in semiconductors will continue. Instead, new forms of integration will define progress, gathering disparate capabilities on a single chip to lower the system cost. We are talking about uniting the non-logic functions that have historically stayed separate from our silicon chips.

An example of this is the modern cell-phone camera, which incorporates an image sensor directly onto a digital signal processor using large vertical lines of copper wiring. Chip designers are integrating micro-electromechanical systems, as accelerometers, gyroscopes, relay logic, or micro-fluidic sensors.

However, this new phase of Moore's Law also called "more than Moore" (MtM) may not make always economic sense. Instead of a regular, predictable road map for continued success, the path forward will be much murkier and Moore's Law as we know it ending. However, new options emerge:

2.2. Overall characteristics of the Roadmap

- DRAM
  - Half pitch 2013 28nm, 4-years cycle i.e. 0,5 every 8 years formerly before 3years cycle
- MPU
  - For faster MPU/ASIC the 3-years cycle will continue until 2026.
- FLASH
  - Four years cycle until 2018 (0,5 per 8 years)
- Increasing role of non-traditional scaling

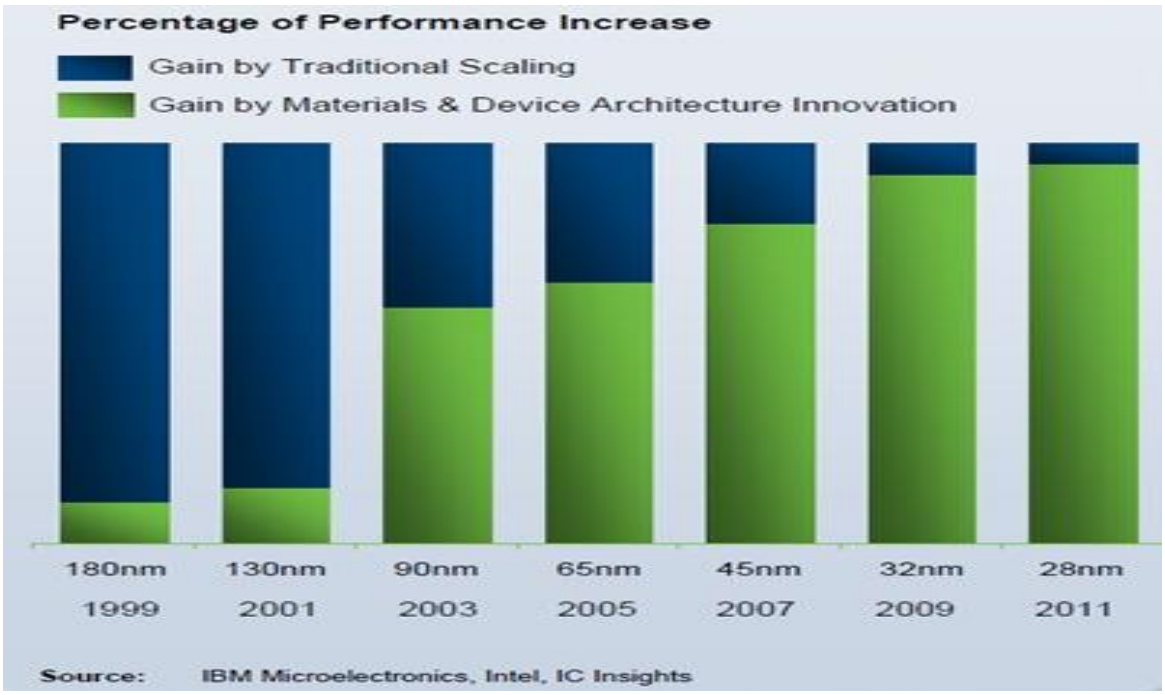

Figure 4 Performance increase

2.3. Devices

The era until the beginning of last decade classical geometric scaling has been followed by the era of equivalent scaling, strained silicon, high k/metal gate, and multi-gate transistors integration of Ge and compound transistors.

The new era of scaling is characterized by features as 3D, reducing interconnect resistance by increasing the vertical conductor cross section and reducing the length of each interconnect, new materials to improve performance by III-V materials and Ge (higher e-mobility than Si)

2.4. MtM and mM

MtM encompasses the incorporation of functionalities that do not scale with Moore's law but provide additional value to migrate from system board level to SiP and SoC, provide functional diversification, interaction with outside world and the subsystem for powering the product included.

This implies analogue and digital signal processing, the incorporation of passive components, high voltage components micromechanical devices, sensors, actuators, micro-fluid devices enabling biological functionalities, as well as an increased role of software.

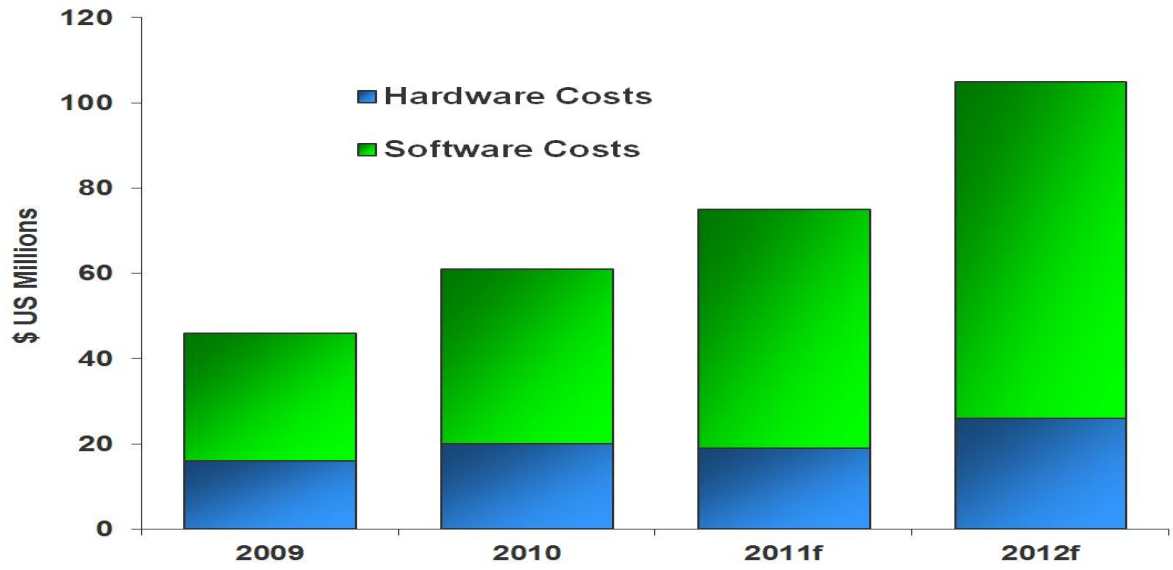

Figure 5 Costs

2.5. SCM (Storage Class Memory)

The specialists describe the situation with a term called "Pentalemma" - which represents a conflict in five different requirements such as write current, stability of the bits, readability, read/write speed and the process integration with CMOS.

Approximately ten new technologies, called Storage Class Memory (SCM), are currently under development and promise to be fast, inexpensive, and power efficient, showing potential of a 100- to 1,000-fold improvement for SCM in terms of the space and power required examples are:

- MRAM (stored by magnetic storage)
- SRAM (Static random-access memory)
- Universal memory (ferroelectric gate over Ge channel material)
- FeFET (faster semiconductors for channels either Ge or GaAs)
- STT (spin transfer torque) spin-aligned "polarized" electrons)
- ReRAM (resistance)
- TAS-MRAM (Thermal Assisted Switching)

2.6. Transistors Emerging Alternatives

- Graphene
- Ge (Germanium)
- InAs/Si Nanotube Tunnel Transistors
- Spin-based computing schemes

2.7. The 450 mm Wafer Transition

The transition of leading-edge semiconductor manufacturing to 450mm wafers is a complex and challenging issue. Improved silicon productivity is the primary argument for wafer size transitions leading to a theoretical reduction in die cost of approximately 30% (all other costs constant). Even after two years of analysis, the 450 mm wafer scale-up still represents a low-return, high-risk investment opportunity. Advocates claim larger wafers are necessary to keep pace with Moore's Law cost targets and that there are no technical showstoppers. Opponents claim it will negatively affect profitability, and drain precious R&D funding away from essential innovations in scaling, cycle time improvements, and manufacturing.

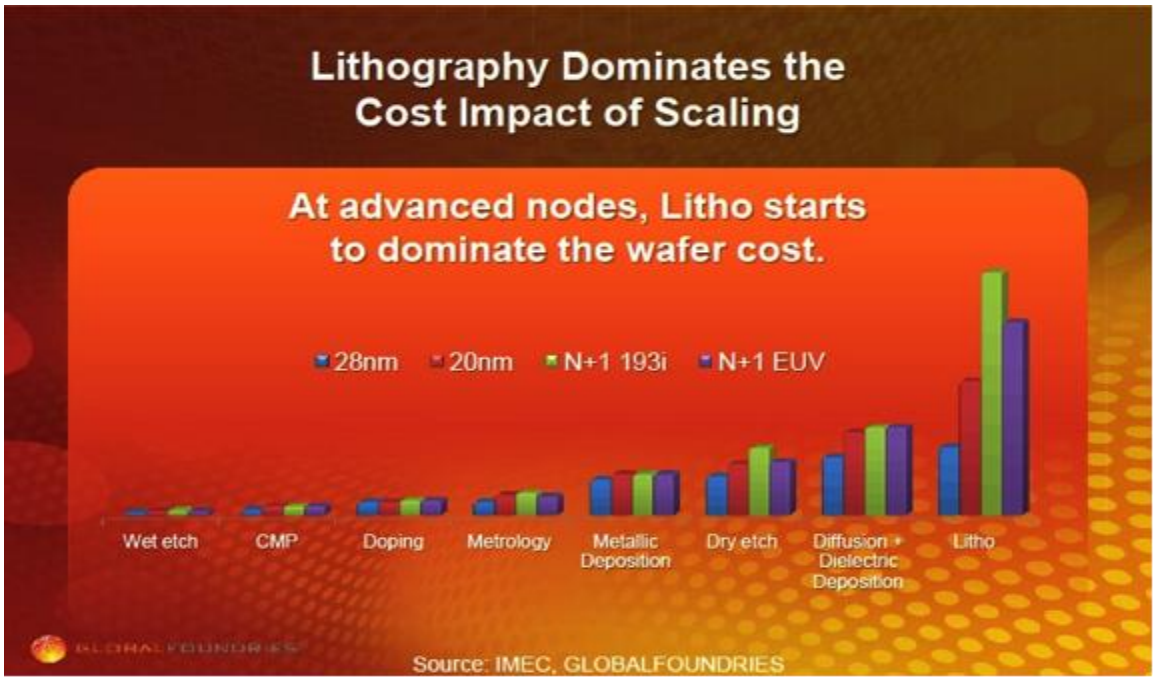

Figure 6 Wafer transition

2.8. Quantum Computation

The idea sounds promising, but there are tremendous obstacles to overcome as:

- De-coherence: During the computation phase of a quantum calculation, the slightest disturbance in a quantum system (a stray photon or wave of EM radiation) causes the quantum computation to collapse.
- Error correction: Because isolating a quantum system has proven so difficult, error correction systems for quantum computations have been developed. Qubits cannot use conventional error correction. Error correction is critical - a single error can cause the validity of the entire computation to collapse.
- Output observance: Closely related to the above, retrieving output data after a quantum calculation is risks corrupting the data.

Even though there are many problems to overcome, the advances in the last years, have made some form of practical quantum computing not unfeasible, but there is much debate as to whether this is a decade away or a hundred years into the future; remains an open question.

2.9. Neuromorphic Chips

The idea of neuromorphic chips dates back decades. Carver Mead, the Caltech professor emeritus coined the term in a 1990 paper. One neuromorphic processor, a noise suppression chip developed by Audience sold in the hundreds of millions. The chip, which based on the human cochlea, has been used in phones from Apple, Samsung, and others.

Neuromorphic chips	Detect and predict patterns in complex data, using relatively little electricity	Applications that are rich in visual or auditory data and that require a machine to adjust its behavior as it interacts with the world

These "neuromorphic" chips will be designed to process sensory data such as images and sound and to respond to changes in that data in ways not specifically programmed. They promise to accelerate progress in artificial intelligence and lead to machines that are able to understand and interact with the world in humanlike ways. Neurons also change how they connect with each other in response to changing images, sounds, and the like. A process we call learning; chips do the same. Especially of interest is the possibility that neuromorphic chips could transform smartphones and other mobile devices into cognitive companions.

2.10. ICT, Robots and their Impact

The driving force is costs (salaries) increasing faster than productivity in industrial countries, thus promoting the development in the areas of robotics and software to replace expensive human work by cheaper machines. Four companies, i.e. Fanuc, Yaskava, ABB and Kuka are sharing 2/3 of the world industry automation market of 122 billion US$ p.a.

According to several studies, the impact can be dramatically, potentially replacing (in the German labor market only) 18 million jobs. Especially administrative and accounting jobs are highly exposed (up to 86%), as well as delivery, sales, and secretarial jobs. The less qualified the more exposed. Nevertheless, there are areas less impacted as healthcare, chemists, or physicists.

The experience of preceding technological developments shows that it is not realistic to assume that people loosing jobs by these changes will be easily absorbed in other fields.

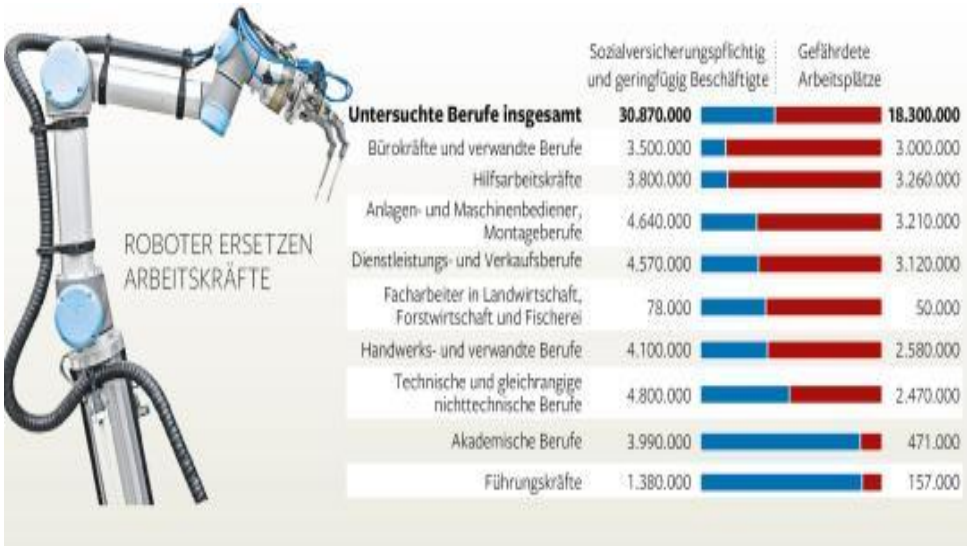

Figure 7 Die Welt, 59% of all jobs endangered by robots

Two of the most disruptive technological innovations of the recent decennia came from Mobility and Communication

3. 25 Years of Internet

A fundamental development in communication, if not the most important and disruptive was and is Internet. Its idea and potential fascinated brilliant people around the world, who contributed an abundance of enthusiasm and personal dedication to its success.

The enthusiasm and joy of the early years faded, as today it has become an integral part of our life. However, this was not an easily achieved breakthrough. The worldwide enthusiastic appreciation in and success is beyond discussion and nobody wants to be remembered as having been on the other side of the fence. Adversaries were ranging from national telecommunication administrations to the department manager of Tim Berners-Lee at CERN were not very helpful. In Austria, the famous 64k-backbone connection from Vienna to CERN had to be financed by a department of a private company for a year because the responsible Ministry claimed to have no money for this. So only based on our contribution of 1,000.000 ATS and the efforts of the Supercomputer Centre of the Univ. of Vienna this endeavour could take off.

In many countries, predominantly the enthusiasm and ingenuity of individuals enabled this key project of the 20th century to lift off, while most of these people remained unrewarded, many latecomers are striving today for the glory.

4. We and ICT

Some of the well-known positive effects of ICT on Social Media, Society, and us as Individuals are

- Facilitating to meet, communicate and organiz.;
- Making researching information easier.
- Communicating 24/7 to and from anywhere.
- Bringing many benefits to organizations, such as cost and productivity improvements as VoIP, email, messaging, video conferencing, e-commerce, access to worldwide markets and to process financial and other transactions 24/7.
- Social networking allowing people to participate in a wider, even worldwide, society.
- Increasing opportunities for education.
- Real-Time Information Sharing and Increased News Cycle Speed.
- Free promulgation of ideas and advertising.

4.1. Personal Impact of ICT

There is a plethora of phenomena arising in the context of personal use of ICT and the rise of social networks and there is another side of these developments.

As Marcus Aurelius wrote: The brain takes in the long run the color of the thoughts, we should not only enjoy the benefits but also monitor the negative effects as effects of social networking , neuro-physical effects or loss of privacy .

Social networks allow an individual to have thousands of “friends.” However, these supposed “friends” are no more than strangers. Many of those people will “know what fifteen of their friends had for breakfast, but don’t know of their struggle with major life issues” Social networks became the market place (“Bassena”) of the 20th century and watching the mobile phone is a substitute for searching rewards. Research has proven deteriorating influence on the:

- storage capabilities in the working memory
- reaction to false alarms
- capability of multitasking
- judgement for order of magnitude (Columbia disaster, financial products, mm/inch)
- differentiation between important and unimportant information

This is not just speculation; it can be measured and related to the volume of the amygdala (and the size of the prefrontal cortex relates to the size of social group).

Is there a Digital Dementia on the horizon?

There exist correlations between:

- Poor and low IQ parents correlate with higher use of screen
- TV use as child is inverse proportional to education level in future
- Videogames alter programming of brain by using and activating different regions as reading

Network (NW) structure is not accidental; it follows “power laws”. Search machines are rank high if a page is read/consumed by many people and creates much traffic (comparable to the idea that a species is important if it eats many different things and is eaten by many different species). The number of links not content gives importance, not quality but number (Paris Hilton, Boris Becker). Also the selection of content, is shifting from established journalists, newspapers, and TV- and radio stations to uncontrolled secret search algorithms and private companies.

Men as “Informavoris rex” as carnivores successor, with Digital Darwinism is based on the belief that the best informed survives and NW brings advantages. Being afraid to miss something, compulsion to consume and swallow every information leads to neglecting independent thinking and loosing the distinction between import and unimportant information.

With ICT, many new legal issues arise ranging from copyright to personal privacy. All major technological evolutions triggered an adequate legal framework:

The Industrial Revolution led to labor law, Motorization to traffic law and the Digital Revolution...?

4.2. Privacy

Technology should be used to create social mobility and improve the lives of citizens.

However, it added also new dimensions of surveillance.

The company Cataphora offers tools to identify people in companies who contribute more than others in new ideas etc. thus estimating the value of employees (and may in future include their medical/genetic data) to the company.

In the wake of the Snowden revelations, the question was asked repeatedly: Why would the US continue to wiretap its entire population, given that the only “terrorism” they caught with it was a single attempt to send a small amount of money to Al Shabab?

One of the obvious answers may be: it is very cheap. Spying is cheap and becomes cheaper every day. Many people have compared today's mass spying to the surveillance programme of East Germany's notorious Stasi.

An important difference is dimension. Stasi employed one snitch for every 50 or 60 people it watched. Today a million-ish person workforce keeps six or seven billion people under surveillance, a ratio approaching 1:10,000. Thus, ICT has been responsible for the two to three order of magnitude"productivity gains" in surveillance efficiency. Stasi used an army to survey a nation; today secret services use a battalion only to survey a planet.

Technology also brings productivity gains to social programmes. Basic sanitation, green revolution crops, cheap material production, and access to vaccines and mobile internet devices allow states to lift the desperately poor into a more sustainable existence for less than ever, affording stability to wealth gaps that might have invoked the guillotine in previous centuries. The mobile phone is important example, since it is both a means of raising quality of life, through access to information and markets, and keeping its users under close, cheap surveillance ironically paid by the user.

5. Summary

We have discussed how the famous Moore's Law is approaching its end, but we can look forward to a decade of further device improvements. We have perused the challenges ranging from lithography costs, interconnect resistance and capacitance slowing performance, to connectivity problems and seen that the historical cost trends that we have been enjoying are fading out. We have shown that Dennard type scaling has already reached diminishing returns and looks like going to 'hit the wall'. Since atoms do not scale, and it is hard to imagine good devices smaller than ten lattices across - reached in 2020.

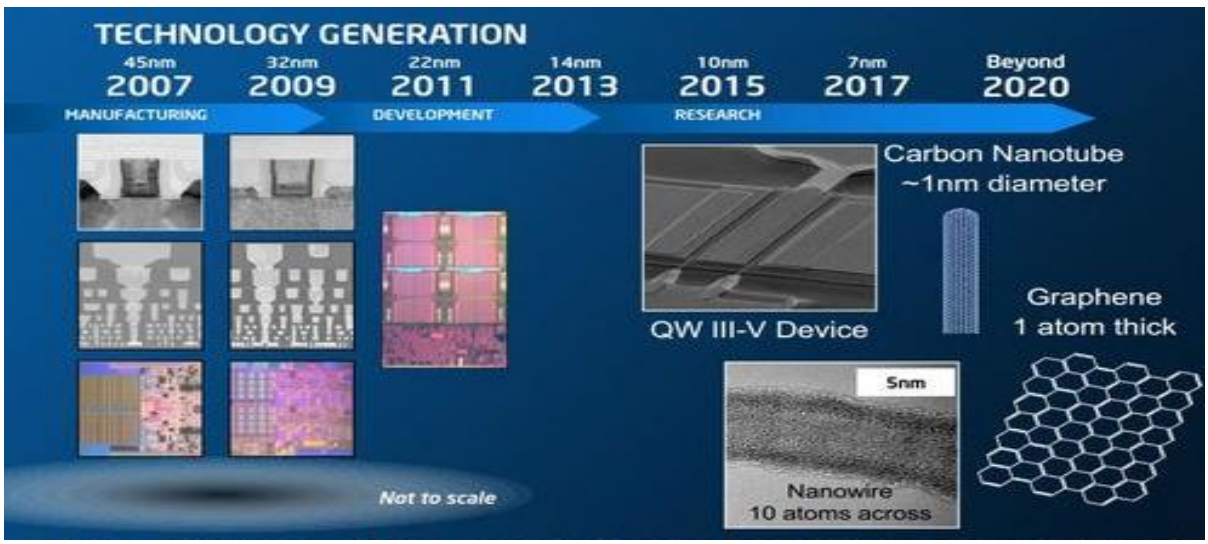

Figure 8 Technology generation - Intel

The question remains: Do you have you an urgent need and are you prepared to use efficiently the still coming 100-fold improvements?

For SCM the result of an extrapolation is even more impressive showing a 100- to 1,000-fold improvement potential.

Extrapolations of the next ten years may be technically viable but the question remains, will carbon nano-tubes, graphene, nanowires, InGaAs, spintronics, etc. save Moore's law in time? Not likely, and most probably not by 2020.

We are witnessing the fascinating developments facilitated by ICT, especially the effects of Moore's law, Communication and Internet and many phenomena which we did not foresee, some very inspiring and innovative, some less so. Having to concede that it saddens that the proliferation of the Internet for many years involuntarily also contributed to the implementation of a dangerous global surveillance and repression tool.

ICT is not only an unprecedented technological advancement and cultural asset for all humanity; it is also a turnkey infrastructure on the verge of being abused.

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