BLED eCONFERENCE 2016

UNI BIZ TECH GOV

29th Bled eConference

June 19-22, 2016
Bled, Slovenia

Digital Economy

Conference Proceedings

Editors:
Johan Versendaal, Christian Kittl,
Andreja Pucihar, Mirjana Kljajic Borštnar

bledconference.org

CIP - Kataložni zapis o publikaciji
Narodna in univerzitetna knjižnica, Ljubljana

659.23:004(082)(086.034.4)

BLED eConference (29 ; 2016)
Digital economy [Elektronski vir] : conference proceedings / 29th Bled eConference, June 19-22, 2016, Bled, Slovenia ; editors Johan Versendaal ... [et al.]. - El. knjiga. - Kranj : Moderna organizacija, 2016

Način dostopa (URL): http://domino.fov.uni-mb.si/proceedings

ISBN 978-961-232-288-5 (pdf)
1. Gl. stv. nasl. 2. Versendaal, Johan
285014784

The Proceedings Research Volume includes original research papers which have been selected from the submission after a formal double-blind reviewing process and have been revised based on the recomendations of the referees.

University of Maribor
Faculty of Organizational Sciences
Kidričeva cesta 55a, 4000 Kranj

phone: +386 4 23 74 218
e-mail: andreja.pucihar@fov.uni-mb.si

Research Volume

General Research Track

Social Media and Big Data

eHealth

Digital Wellness

Business Volume

Doctoral Consortium

29th Bled eConference

Digital Economy

June 19 - 22, 2016; Bled, Slovenia

Determining the Target System for Mobile Systems as Part of an Integrative Approach for the Economic Impact of ICS: Validation at an SME

Tamara Högler

CyberForum e.V., Germany

hoegler@cyberforum.de

Johan Versendaal

HU University of Applied Sciences Utrecht; Open University of the Netherlands

johan.versendaal@{hu, ou}.nl

Abstract

Mobile technologies are reshaping the global economic landscape, enhancing speed and comfort of communication and information exchange. Existing studies on the economic impact of mobile technologies taking a socio-technical system perspective are scarce. Our study shortly describes an integrative approach for such systems, which is in detail described in Högler et al. (2015), and specifically constructs the first activity in the integrative approach, i.e. defining the target objectives of the mobile system; it provides a case study at an SME to show this step's applicability and validity. In defining the target system the Analytical Hierarchy Processing technique is extended. It encompasses a) the identification of objectives, and b) the determination of the hierarchy of objectives, c) the determination of the dependencies between objectives, d) the identification of strengths of the dependencies, and e) their likeliness of appearance, a f) prioritisation and g) a consolidation of all previous sub-steps. The case study confirms the validity and applicability and provides reasons for generalisation.

Keywords: Mobile Systems, Target Systems, Integrative Approach, Analytical Hierarchy Processing, Economic evaluation

1 Introduction

We are living in a digital world that is directed increasingly by mobile technologies. These have "emerged as a primary engine of economic growth […]" (Bezerra et al. 2015), becoming "the fastest adopted technology of all time" (ibidem). According to e.g. West (2014), mobile technologies have enabled new forms of communication, interaction and work; by doing so they have revolutionized business practices in all ranks. Nevertheless, when it comes to investigating the economic impact of mobile technologies in companies, particularly SMEs, little research work is done yet. In an in-depth analysis of existing economic analysis approaches (see Högler 2012) the author concludes that still methodologies are prevalent that only focus on monetary effects and thus neglect many aspects of mobile technologies – i.e. qualitative effects like impacts on employees or structural and organizational changes. These effects as well as the strategic alignment of mobile technologies and thus their overall organizational success need to be considered more explicitly (cf. Vuolle 2011). An approach is required that allows new ways of assessing and evaluating economic impacts of mobile technologies which have to be considered as parts of socio-technical systems.

A socio-technical system includes hardware, software, people, and business or community structures and processes (Alter 1999, 2001; Whitworth 2006). In the context of mobile technologies, the authors define a mobile system as a set of mobile technologies and human (system) elements, which are inherently related by structures and processes (see also Goos & Zimmermann (2005)). They aim at integrating people, processes and mobile devices into internal, mostly stationary corporate and enterprise-wide process chains. Hence, they may overcome spatial separation and information losses (Schiller 2000; Isaac & Leclercq 2006). Mobile systems exist in different forms and have a multiplicity of characteristics, which make them specific compared to stationary Information and Communication Systems (ICS). This specific setting implies certain singularities to be considered for their implementation and evaluation.

These considerations have encouraged the development of an integrative approach, which is shortly described in section 2. In this paper we specify the integrative framework of Anonymous (2015) by constructing the details of its first activity: the definition of the target system. The definition of the target system is of high importance as it is not only the basis for all further activities of the integrative approach, but also for any requirements definition. In contrast to objectives that are defined as a "specific result that a person or system aims to achieve within a time frame and with available resources" (Business Dictionary 2016), requirements are "(1) a condition or capability needed by a user to solve a problem or achieve an objective […]" (CMMI 2006, p. 553) and are derived from objectives. An improper requirement definition (Davis et al. 2006) is according to many researchers and consulting companies, the most-cited reason for implementation failures and represents "the lack of clear understanding of what the company wants to achieve" (IMG 2015).

The goal of this work is to present and validate the proposed definition of the target system by a case study at an SME. The case study research design was chosen as it is a useful tool for testing theoretical models by applying them in real world situations (Yin 2013). In our case we apply the first activity of the integrative framework in a practical case in the building industry.

In the next section we will first re-address (Högler et al. 2015) the integrative framework and define its first activity in detail. In section 3 the case study is described and analysed. We end this paper with conclusions, impact and discussion.

2 The Integrative Framework – A Socio-Technical Approach for the Evaluation of Mobile Systems

The analysis of existing approaches shows that an integrative approach for the evaluation of information and communication systems (ICS) needs to consider, besides monetary and qualitative effects, also interdependencies between the systems´ elements as well as singularities and related critical success factors of ICS to predict the potential system performance (Högler et al. 2015). Following these specifications, it becomes clear, that research on ICS evaluation taking an integrative view is scarce. Mobile systems, a form of ICS, have been chosen as object of investigation as they are more complex than stationary ICS and have specific singularities that need special attention. The assumption is that if the integrative framework works well for mobile systems, then it can be used for any kind of ICS.

The integrative framework for mobile systems as proposed by Högler et al. (2015) builds on following principles (figure 1):

- For an integrative evaluation a detailed internal (intra-company) analysis and design has to take place, including business process reengineering.
- A detailed economic analysis is necessary which considers all life-cycle costs as well as quantitative, qualitative and integrative benefits of mobile systems.
- A sensitivity analysis has to be proceeded that surveys in which way success factors and risks affect the potential target achievement when implementing mobile systems.

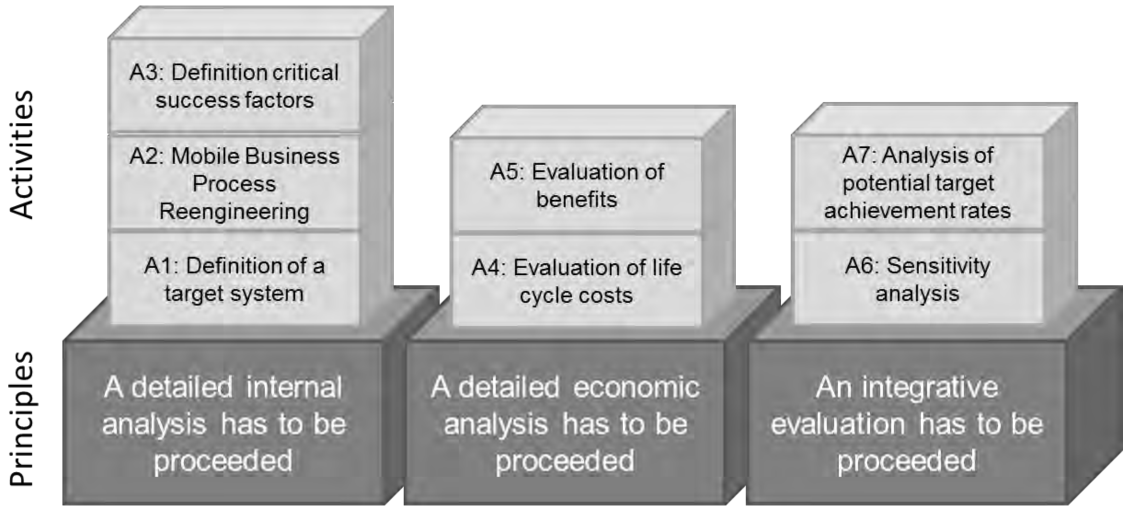


Figure 1. The integrative framework

These principles are covered by the seven activities of the framework (see figure 1):

1. Activity 1: Definition of the target system by following the multi-attribute decision making (Hwang & Yoon 1981). This activity outlines a new procedure for defining the target system leveraging the Analytical Hierarchy Process (AHP) (Saaty 1996). The main contribution of this paper is that the AHP is extended and applied in the context of an integrative approach for evaluating the economic efficiency of mobile systems in order to determine objectives for such a system. The uniqueness of the extended AHP is that the determination of priorities is not based on subjective assessment, but on the following steps (see figure 2), differing from previous approaches:
    - Interdependence analysis between individual objectives (Kirchmer 1999; Drews & Hillebrand 2010; Rückle & Behn 2007);
    - Consideration of the effective strength of the objectives and the probability of occurrence of interdependencies (Klabon 2007; Charette 1991) and thus their respective value; and
    - Preference-neutral weighting of objectives in the context of these latter two aspects.

    By following such a preference-neutral weighting and prioritization of objectives, a consistency test becomes unnecessary and is thus omitted in the proposed procedure.

    The validity of this activity is the main focus and contribution of this research paper and will be described in section 2.1 in detail. Agile methodologies like SCRUM are considered not appropriate for the definition of the target system as they focus on defining and managing *requirements*, which are derived from *objectives*. As such methodologies are process models that focus on project and product management, they are used in a later stage of implementing a system than the definition of the target system.

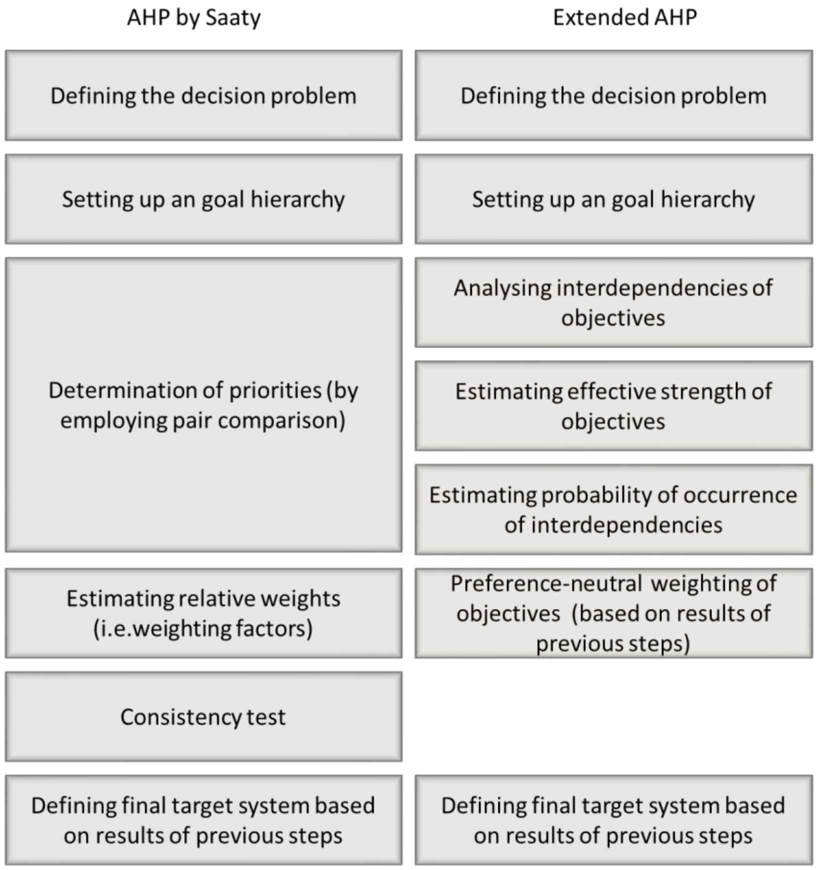


Figure 2: Comparison of original and our extended AHP

2. Activity 2: Mobile Business Process Reengineering as proposed by the authors builds upon Mobile Process Landscaping (Gruhn & Wellen 2001; Köhler & Gruhn 2004).

3. Activity 3: Definition of critical success factors, their interdependencies, correlation analysis and weighting (Iqbal et al. 2015; Nysveen et al. 2015; Hway-Boon & Yu 2006).

4. Activity 4: Evaluation of life cycle costs (Wild & Herges 2000; Berghout et al. 2011), performed by identifying costs during the whole lifecycle of mobile systems including the preliminary phase, utilization phase and disposal phase.

5. Activity 5: The evaluation of benefits, based on the total benefit of ownership model (Gadatsch & Mayer 2004), involves the capture of cost savings and non-monetary benefits or qualitative and strategic variables which are not considered in the traditional approaches of economic evaluation.

6. Activity 6: Sensitivity analysis: As an uncertainty of the results achieved in the previous steps remains, a sensitivity analysis is conducted to check the stability of results. Particularly the variables *success factors* (Corsten 2000; Rockart 1979), *risks* (Kronsteiner & Thurnher 2009) and the accompanying volatility effects (Kulk & Verhoef 2008; Singh & Vyas 2012) are analysed.

7. Activity 7: Analysis of potential target achievement rates: Based on the results of the sensitivity analysis, the potential achievement rates can be determined. To do so, results of activity 1 (target system), activity 2 (current and target processes incl. key (performance) indicators) and activity 6 (volatility effects) are merged.

2.1 Definition of the Target System

The definition of the target system is the first activity of the integrative framework. Figure 3 depicts the single steps:

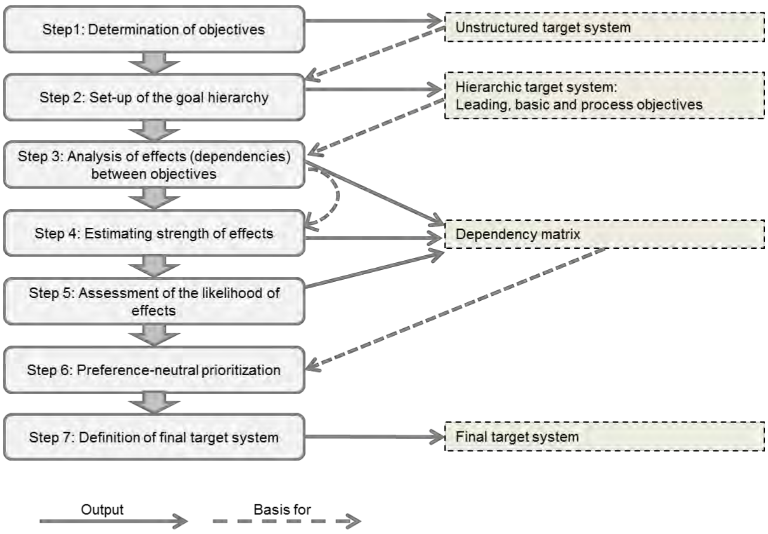


Figure 3: Steps in the definition of the target system

First, objectives are determined e.g. by task observation, in a workshop or from interviews with the help of a questionnaire. An unstructured target system contains all gathered objectives. In step 2, the identified objectives are brought in a hierarchical relationship (goal hierarchy; what we define in levels 'key objectives', 'basic objectives' and 'process objectives'). A goal hierarchy is only complete if "each element of a hierarchy level has a direct relationship to the next higher element [...]" (Ahlert 2003, p. 37) (figure 4).

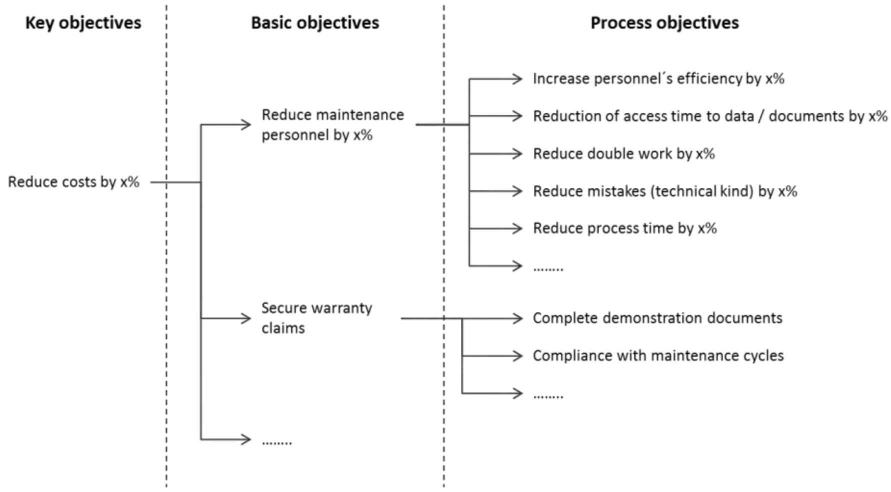


Figure 4: Example for a goal hierarchy

In the 3rd step, the identified process objectives are evaluated in a paired comparison concerning their mutual, direct interdependencies. The aim of this comparison is to identify particularly competing objectives, as setting priorities among them reduces inconsistencies in the target system.

The strength of interdependencies is estimated in step 4, which is largely subjective and based on experience of the involved interviewees. The scale for the estimation can be chosen freely, but it should not be too fine-grained, since this would cause pseudo-accuracies (Meixner & Haas 2012, p. 202). Thus, the authors propose a three-level scale (low (value 1), medium (value 2), strong effects (value 3)).

Next the estimation of their likelihood (probability) is needed (step 5). It is methodologically based on risk management (e.g. NIST 2012, p. 23) and in practice on the experience of the involved individuals. Again a three-level scale is proposed to estimate the likelihood of effects: effect is possible, but improbable (value 1); effect is probable (value 2); effect will occur with the utmost probability (value 3).

It is necessary that the interviewees agree internally on the nature of the effects – but not necessarily on their effective strength and likelihood, since without such an agreement, the target-relation-matrix cannot be installed. The individual effects between objectives should not be regarded as absolute and as in all circumstances occurring, but rather they indicate general trends which may be reinforced, mitigated or neutralized under certain circumstances, or by the use of respective (appropriate or inappropriate) systems.

To ensure that mainly high priority objectives are pursued, which have the greatest benefit, competing relations between objectives must be detected. This is done in the 6th step, where the objective priorities are determined. Based on the prospect theory by Kahneman & Tversky (1979), a preference-neutral weighting assumes that the weight of an objective can be determined by its active and passive value. To receive these values, for each objective its strength of effects is multiplied with the likelihood of its occurrence. The resulting (mathematical) products are subsequently summed up for each objective in both the horizontal (so-called "active value”) as well as in the vertical ("passive value") axis of the table. This procedure is legitimate insofar as the value of an effect can be defined as the product of strength of effects and their likelihood of occurrence (see also Kahneman & Tversky, 1979). A threshold should be defined by a decision maker which allows the classification of objectives in different priorities. As there is no standardized procedure for defining a threshold, the authors propose to choose a threshold that divides the objectives 'on sight'.

In the last step (7) the final target system is defined by consolidating the earlier steps and assigning final priorities to objectives.

3 Definition of the Target System in an SME of the Building Industry

We validate the first activity of the integrative framework in practice. We do so by operationalizing it at an SME in the building industry, where the definition of the target system was applied in the field of resource planning processes for workers who spend most of their working time outside of the company´s industrial premises (e.g. truck drivers, operators). An earlier version of the integrative framework, including the activity for defining the target system, has been applied to a large company (Högler et al. 2015). From this experience we were able to fine-tune the first step, and prepare optimally for our SME.

In contrast to most of the available research literature, which focuses on large companies, the authors have chosen an SME as they have typically fewer financial resources and lower IT expertise (Andersson & Tell 2009; Forsman 2007; Haug et al. 2011; Huin 2004) in comparison to larger companies. At the same time, SMEs are the economic backbone of many countries in Germany, representing 99.8% of companies, whereas 89.3% are companies with less than 10 employees (IfM 2013). Particularly for these micro companies a proper definition of the target system is of key importance in this context as they need to increase their digitalization level to increase their efficiency and to develop new products and services (cf. BMWi 2016).

According to the Annual Report on SMEs of the European Commission (Muller et al. 2014), the building industry is one of the five most important SME sectors in the EU28, but is facing since the economic crisis still many challenges. One of the challenges is the fact that the building industry lags significantly behind other sectors in terms of ICT adaption (Hosseini et al. 2013). As different kinds of vehicles are used for the transport of construction material, their reliability and disposability is of high importance; resource planning and maintenance management systems help to keep track of (maintenance) schedules and thus to increase availability and service life of vehicles and machines. Bearing these facts in mind, we think that our case study organisation, which is providing mainly mobile services for the building and construction industry in Germany, is appropriate. Moreover, as many German construction logistics companies, the case study SME faces competition from eastern European countries and has to optimise processes to increase efficiency of staff and to become more competitive.

The particular SME was also selected due to already existing contacts of the authors with the organisation, allowing easy access to management and operational employees.

3.1 Description of the Case Study

The case study company is located in Rhineland-Palatinate, Germany, and has six employees; two in management (CEOs) and four operational workers (truck drivers). Main activities of the company are excavation and earthwork, supplying of building material, pavement and demolition works and garden design within a range of 100 km around their offices. The fleet of cars encompasses 15 vehicles, among excavators, wheel loaders, caterpillars and trucks that have to be maintained regularly and that form the backbone of the daily business. As all processes rely on the availability and reliability of the cars, their maintenance is of key importance.

The application of the first activity of the integrative framework to a real case study followed the recommendation of Yin (2013, pp. 84) and Maimbo & Pervan (2005), resembles the approach of Miles et al. (2013), and had four stages:

- Designing the case study protocol (section 3.2),
- conducting the case study (section 3.3),
- analysing the case study evidence (section 3.4) and
- developing the conclusions, recommendations and implications based on the evidence (section 4).

The single stages – used to validate the theoretical construct of the framework – are described in detail in the following sections. We end our paper with a discussion on the validity of our integrative framework based on its partly operationalization.

3.2 Designing the Case Study Protocol

The research methodology integrates a structured case study protocol that guides in conducting the case study (Yin 2013) and supports to address issues of both rigor and validity in the data collection process. The protocol was upfront designed following the procedure proposed by Maimbo & Pervan (2005) (see annex I). While the case study was conducted, the proposed protocol was followed. The following subsections describe the case study's process and results in detail. The procedure follows the seven sub-steps (see section 2.1) of activity 1 of our Integrative Framework.

3.3 Conducting the Case Study

To get a first impression on the daily work, a task observation and analysis (Kosiol 1976) was proceeded; for this, one of the authors was accompanying a truck driver for 4 days. The a-priori categories of objectives contained in this questionnaire were the result of:

a) main literature on business process (re-)engineering and management (e.g. Hammer & Champy 1993; Gruhn & Wellen 2001; Turowski & Poustchi 2004; Aichele 1997;

Darnton & Darnton 1997; Harrington et al. 1997; Staud 2006) and mobile business (e.g. Köhler & Gruhn 2004; Lehner 2002; Schiller 2000) and

b) former analyses proceeded in the timeframe 2006-2009 at several German companies, mainly of the chemical industry and the public sector, when one of the authors was working as a product manager at "Rösberg Engieering Ingenieurgesellschaft mbH für Automation" for mobile maintenance management systems at several German companies in the chemical industry.

These objectives were completed with objectives that were identified during the task observation and its analysis. For the final questionnaire, their hierarchy was constructed (also based on literature review, see a)), leaving room for additional objectives in the semi-structured interviews (see excerpt in Table 1 for the constructed questionnaire; full questionnaire in annex 2):

Key objective 1	**Profit maximization**
Basic objective 1.1	**Cost reduction**
Process objectives:	
	Savings on machines by
	Savings on personnell costs by
	Savings on (maintenance)processes by
	Savings on repairs by
	Savings on material consumption by
	Increasing availability of own machines by
	Securing warranty claims
	Other process objectives
Basic objective 1.2:	**Increasing plant availability by x%**
Process objectives:	
	Reduction of troubles by %
	Reduction of system failures by
	Other process objectives

Table 1: Excerpt of the questionnaire

Two workshops were subsequently held, executing steps 1-6 with the participants, using the constructed questionnaire. During the workshops no additional objectives were mentioned by the participants, indicating that the literature, working experience and task observation and analysis proved to be appropriate preparation for building the questionnaire. The scheduling of workshops was in all cases spontaneous with a lead time of one or two days as a longer lead time led to postponements due to unscheduled workload. The workshops were conducted in separate groups – one with the management (2 CEOs) and one with a worker (truck driver). The visits took place early 2016, the workshops had an average duration of 2 hours.

For step 7 a third workshop with the company's management and an external financial advisor was performed. By this, the separate results from the two different groups were consolidated and eventually agreed upon. During this workshop one of the authors presented the determination of objectives in every single step. Objectives with high priority were discussed in detail with the CEOs and the financial advisor. Objectives with low priority were omitted as the CEOs and the financial advisor wanted to focus on objectives with the highest positive impact. The advisor, although not involved in the process, confirmed the transparency of the procedure as well as the achieved results, which accord with his findings to a great extent.

3.4 Results and Analysis

The outcomes of the semi-structured interviews with CEOs and worker can be summarized and processed as follows.

3.4.1 Step 1-2: Determination and structuring of objectives

Table 2 shows the results of the two workshops for the determination of objectives. The worker identified more process objectives than the CEOs. This implies that he sees more need for optimisation than the CEOs. Here, the worker sees much more need for action than the CEOs. The reason for this could be a constant information loss between the CEOs and the workers, which is either not recognised by the CEOs or not always reported / confirmed by the workers. In contrast, the CEOs identified the key objective “enhancing (the company) image” which was not chosen by the worker.

Also the percentages for the quantitative objectives differed in some cases, but only to a limited extent. Summarising the findings, the worker saw less potential in cost savings regarding repairs than the CEOs. At the same time, he has identified additional cost saving potential by enhancing the availability of machines, at maintenance processes and for the material consumption. In contrast, the worker saw less potential to reduce the workload (20% in comparison to 40% desired by the CEOs). In terms of the key objective “enhancing process quality”, the worker generally saw a higher need for optimization than the CEOs, although there are only slight differences for most process objectives. Note the difference in the process objectives “efficiency of machines” (worker: 50%, CEOs: 30%) and “improving the planning ability (calculability) of tasks”, where the worker sees a higher need for improvement (100% in comparison to 70% mentioned by the CEOs). Also this difference indicates the different view on current processes and related deficiencies. It seems that the worker sees himself strongly affected by the unpredictable nature of task allocation.

		CEOs		Worker		
		%			%	
Key objective 1	**Profit maximization**		x	x		
Basic objective 1.1	**Cost reduction**		x	x		
Process objectives:						**Legend:**
	Savings on machines by	30	x	x	25	X: Objective identified by participant as
	Savings on personnell costs by					relevant
	Savings on (maintenance)processes by			x	10	
	Savings on repairs by	50	x	x	30	
	Savings on material consumption by			x	20	%: numeric description of the quantitative
	Increasing availability of own machines by			x	50	objective (best-case scenario)
	Securing warranty claims		x	x		
Key objective 2	**Increased process quality**		x	x		
Basic objective 2.1	General support of processes			x		
Process objectives:						
	Enhanced task overview		x	x		
	Reduction of information losses by	90	x	x	100	
	Prevention of entry errors (validation documentation)			x		
	Secure available knowledge		x	x		
	Overview on "who, what, when"			x		
	Predictive Maintenance		x	x		
	Optimization of maintenance intervals		x	x		
Basic objective 2.2	**Enhanced Controlling /Monitoring**		x	x		
Process objectives:						
	Problems / troubles with machines		x	x		
	Problems / troubles within processes		x	x		
	Condition of machines			x		
	Repairs of machines		x	x		
	Tracking of tasks / processes		x	x		
	Efficiency of employees		x	x		
	Efficiency of machines		x	x		
	Material consumption		x	x		
	Inventory / stock			x		
	Costs of machines		x	x		
	Costs of employees			x		
	Costs of processes		x	x		
	Costs of material		x	x		
Basic objective 2.3	**Enhanced working conditions**			x		
Process objectives:						
	Reduction workload of personnel by	40	x	x	20	
	Compliance with regulations		x	x		
	Increased work safety		x	x		
Basic objective 2.4	Enhanced data availability			x		
Process objectives:						
	Ubiquitous data availability			x		
	Seamless collection of data / information			x		
Basic objective 2.5	**Support of decision processes**		x	x		
Process objectives:						
	Enabling data analysis			x		
	Fast access to (all) necessary documents			x		
	Complete verification documentation		x	x		
Basic objective 2.6	**Minimization of environmental effects**		x	x		
Process objectives:						
	Compliance with environmental protection requirements		x	x		
Key objective 3	**Reaching production targets**		x	x		
Basic objective 3.1	**Optimisation of processes**		x	x		
Process objectives:						
	Increased utilization of machines by	30	x	x	50	
	Reduction of downtime of personnel by			x	100	
	Reduction of downtime of machines by			x	100	
	Reduction of process interruptions by	80	x	x	100	
	Reduction of unnecessary work by	90	x	x	100	
	Reduction of follow-up work by	90	x	x	100	
	Reduction of duplication of work by	90	x	x	100	
	Reduction of false tasks by	90	x	x	100	
	Unambiguousness of tasks		x	x		
	Increased predictability of tasks by	70	x	x	100	
	Enhanced task planning		x	x		
	Enhanced resources planning		x	x		
	Enhanced coordination of personnel	50	x	x	40	
	Increased productivity of employees by			x		
	General improvement of operational procedures		x	x		
	Reduction of paperbased documentation by			x		
Key objective 4	**Improved Image**		x			
Basic objective 4.1	Increased quality of processed tasks			x		
Process objectives						
	Increased process quality		x	x		
	Enhanced working conditions			x		
	Minimised environmental impacts		x	x		

Table 2: Management (CEOs) objectives and worker (truck driver) objectives shown together

3.4.2 Steps 3-5: Analysing effects between objectives

In the next step, the effects or dependencies between process objectives were analysed as described in section 2.1. As key and basic objectives are used only for structuring process objectives, they have been omitted during the analysis. For each objective its strength of effects is multiplied with the likelihood of its occurrence. The resulting (mathematical) products are subsequently summed up for each objective in both the horizontal (so-called "active value”) as well as in the vertical ("passive value") axis of the table.

The results of the steps 3-5 were two tables: one contains estimations of the CEOs and the other estimations of the worker. As the interviews were proceeded separately and the different participant groups (2 CEOs, 1 worker) had no possibility to discuss their assumptions and estimations, the authors propose to keep the different target systems until step 7, where the resulting target systems are merged. The resulting target-relation-matrices document the effects between individual objectives (step 3).

			Savings on machines by	Savings on repairs by	Securing warranty claims	Enhanced task overview	Reduction of information losses by	Secure available knowledge	Predictive Maintenance	Optimization of maintenance intervals	Problems / troubles with machines	Problems / troubles within processes	Repairs of machines	Tracking of tasks / processes	Efficiency of employees	Efficiency of machines	Material consumption	Costs of machines	Costs of processes	Costs of material	Reduction workload of personnel by	Compliance with regulations	Increased work safety	Complete verification documentation	Compliance with environmental protection r	Increased utilization of machines by	Reduction of process interruptions by	Reduction of unnecessary work by	Reduction of follow-up work by	Reduction of duplication of work by	Reduction of false tasks by	Unambiguousness of tasks	Increased predictability of tasks by	Enhanced task planning	Enhanced resources planning	Enhanced coordination of personnel	General improvement of operational procedures	Increased process quality	Minimised environmental impacts	Active values
			Profit maximization			Increased process quality																				Reaching production targets												Improved Image		
			Cost reduction			General support of processes					Enhanced Controlling /Monitoring										Enhanced working conditions			Sup port of deci	Mini miz atio n of	Optimisation of processes												Increased quality of processed tasks		
Profit maxi	Cost reducti	Savings on machines by			-2																					-1							-1	-1	-1		-1	-1		-8
		Savings on repairs by	6													-1																								5
		Securing warranty claims	9	9																																				18
Increased process quality	General support of processes	Enhanced task overview											1	4	9	9	1	1	1	1							6	6		3			9	9	9	9	2			80
		Reduction of information losses by	1					6	1	1	6	6	1	4	2	2	2	4	4	4	2						3	9	6	9	9	3	1	9	2		9	6		112
		Secure available knowledge		1					4													2	2		2			2			2						9	9		33
		Predictive Maintenance	4	4						9								1		1						3	6	3			1		2	4	4		2	4		48
		Optimization of maintenance intervals	6	4	1																	1				6							2	1	1		2	1		25
	Enhanced Controlling /Monitoring	Problems / troubles with machines	6	2	1		1		6			2	1			9		9	9		1					3	6	2		1	2		4	6	4	4	4			83
		Problems / troubles within processes	1	1			1								6	6		1	9				1			1	9	2					9	9	6	6	6			74
		Repairs of machines	4	2	6		1		9		3	2				3		3	3	1							1	1	1	3	1		1	1	1		1			48
		Tracking of tasks / processes	1	2	9		3		1		6	6	1		6	6		2	2	2				9		1		9	2	6	1		3	6	3	2	6			95
		Efficiency of employees					1					6							6		4												9	9	9	4	2			50
		Efficiency of machines	9	1			1				3	3						3	2							3							3	6	6	4	2			46
		Material consumption	1	1			1				1	1							4	9													1							19
		Costs of machines	6	4			2				3	3							3																					21
		Costs of processes	2	1			2				6	6																												17
		Costs of material	2	2			2						3				9		4																					22
	Enhanced working conditions	Reduction workload of personnel by																				1	4																	5
		Compliance with regulations			9																		3		2													9	9	32
		Increased work safety																				9																9		18
	Su pp ort of	Complete verification documentation			9	1	9	2	1	1	6	6	3	9	3	3	3	6	6	6		3	1				2	6	4	9	3	6	2	2	1	3		6		122
	Mi ni mi zat	Compliance w. environ. protection require.																				6																	9	15
Reaching production targets	Optimisation of processes	Increased utilization of machines by	1	-9																																	2			-6
		Reduction of process interruptions by																								4							6	1	1	1	9			22
		Reduction of unnecessary work by	4																		9																3	9		25
		Reduction of follow-up work by	2																		9																3	6		20
		Reduction of duplication of work by	4																		6																3	9		22
		Reduction of false tasks by	4																		6																3	6		19
		Unambiguousness of tasks		2			6														9						3	9	9	9	9		2	2			9	9		78
		Increased predictability of tasks by	2								1	1	1		2	2	1	1	1	1	4					6	9	1		1				6	9	9	2	9		69
		Enhanced task planning																			2					6	9	3	1	3	1		3		6	3	9	9		55
		Enhanced resources planning	2								2		1	1		2		1	1	1						9	6						6	9			2	9		52
		Enhanced coordination of personnel												1							2		1			1	6		1	1	2		6	9	6		6	6		48
		General improvement of operat. procedures																			9					4	3	1	2	1	1					1		9		31
Improv ed Image	Increa sed quality of	Increased process quality	2				4				1	1	1	1	1	1	1	1	1	1	6		2			2	1	3	4	6	2					3				45
		Minimised environmental impacts																					2		9															11
		Passive Values	*79*	*27*	*33*	*1*	*34*	*8*	*22*	*11*	*38*	*43*	*13*	*20*	*29*	*42*	*17*	*33*	*56*	*27*	*69*	*22*	*16*	*9*	*13*	*48*	*70*	*57*	*30*	*52*	*34*	*9*	*68*	*88*	*67*	*49*	*95*	*124*	*18*	

Legend: Yellow marked fields: Objectives that were identified as relevant by management, but not by the worker
Green marked fields: Positive effects
Red marked fields: Negative effects

Table 3: Results of steps 3-5, CEOs´ view

	Savings on machines	Savings on (maintenance)processes	Savings on repairs	Savings on material consumption	Increasing availability of own machines	Securing warranty claims	Enhanced task overview	Reduction of information losses	Prevention of entry errors	Secure available knowledge	Overview on "who, what, when"	Predictive Maintenance	Optimization of maintenance intervals	Problems / troubles with machines	Problems / troubles within processes	Condition of machines	Repairs of machines	Tracking of tasks / processes	Efficiency of employees	Efficiency of machines	Material consumption	Inventory / stock	Costs of machines	Costs of employees	Costs of processes	Costs of material	Reduction workload of personnel	Compliance with regulations	Increased work safety	Ubiquitous data availability	Seamless collection of data / information	Enabling data analysis	Fast access to (all) necessary documents	Complete verification documentation	Compliance w. environm. protection requirem	Increased utilization of machines	Reduction of downtime of personnel	Reduction of downtime of machines	Reduction of process interruptions	Reduction of unnecessary work	Reduction of follow-up work	Reduction of duplication of work	Reduction of false tasks	Unambiguousness of tasks	Increased predictability of tasks	Enhanced task planning	Enhanced resources planning	Enhanced coordination of personnel	Increased productivity of employees	General improvement of operational procedures	Reduction of administrative tasks	Increased process quality	Enhanced working conditions	Minimised environmental impacts	Active Value
Savings on machines		1	1		-9																																	1	-9	1															-14
Savings on (maintenance)processes	2		-9	2	-9	-9																							-9									-9	-9																-50
Savings on repairs	2				-9	-6																						-6	-9										-9														-9		-46
Savings on material consumption																																																							0
Increasing availability of own machines	2		1																																		9	9												6					27
Securing warranty claims	9	3	9													1	1																																						23
Enhanced task overview	1			1					1		9							9		9	9				3	3							3				9	6	9	6	3	6	6	3	9		9	9	6	9			3		141
Reduction of information losses	3		1	1							6		9				6	3			6		3	3	3	3												4	3		6	4	4	3	9					9					89
documentation)	1	1	1	1	1								1	6			2	2																			1				3	3	3	1	1	1					9	9			47
Secure available knowledge								9						2	2	6	3																				1	2	1	3	2	2	6	1						6					46
Overview on "who, what, when"	1																			9			3	3	3	3	1	1	2							9	9	9	6	6	1	6	1	1		9	9	9	9	9		9			128
Predictive Maintenance					9	9										6																				9	6	9	9	9										9		9			84
Optimization of maintenance intervals	9	9	9		9	2										1	1										2	6	6								6	6	3	1															70
Problems / troubles with machines	9		4			3		9				9			6		2			9			3		3											9			6	6		2	6		9	9	9	9		6					128
Problems / troubles within processes	1		2					9											6	9			3		3				3							9			9	6					9	9	3	3		6					90
Condition of machines			9		9							9	9	9	9		9						3						9						6	9	6	9	6							9			6		3	9		138
Repairs of machines	2		9			3		3				9		9	9					9			3		1	1										9			1	2	1	6	2		1	1	1			1					83
Tracking of tasks / processes	1		2			9		9				3		9	9		9		9	3			3		3	2								3		3				9	3	9	3		6	2	2	6		6					123
Efficiency of employees							9				9				2			2						9	9		1										6									9	9	3	6	6		6	-6		80
Efficiency of machines	3							3							3		3						3		3											9									9	9	9	9		4					67
Material consumption	1		1					6							1		3								3	3																			6										24
Inventory / stock																																							9																9
Costs of machines	2		1					2						9	9										3																														26
Costs of employees																									9																														9
Costs of processes	2		1					2						6	9																																								20
Costs of material	1		1					2									3				9				2																														18
Reduction workload of personnel																												4	9																										13
Compliance with regulations						6																							9						9																	9			33
Increased work safety																												9																								9			18
Ubiquitous data availability							3	9			9	1	1					1		3												3	9	1									1	9	6	9	9	9	9					92
Seamless collection of data / information							3	9																		9			9		9		3																		9			51
Enabling data analysis		1	1		-9																																1	-9	1															-14
Fast access to (all) necessary documents							2	3			9															9				1								9	4	2	4	6	9	3	1	1	3	9	9		9			93
Complete verification documentation						9	2	3				9	9	9	9		9	9	6	6	6		9		9	9		9	2									2	6	2	9	3	3	1	1	1	1				9			162
Compliance w. environ. Protect. Require.																											9																											9
Increased utilization of machines	9		-9																	1																													1					2
Reduction of downtime of personnel																										-9	-4	-4							6		9	1																-1
Reduction of downtime of machines			-9		9																														9			6																15
Reduction of process interruptions																																			9								6	1	4	2		9		9			40
Reduction of unnecessary work	6		3											1	1	1	1									9													3				1	1	1			9		9			46
Reduction of follow-up work	6						1																			9																		1			9		9			35
Reduction of duplication of work	6																									9												9	1				1					9		9			44
Reduction of false tasks by	6																									9											2	9	9	6								9		9			59
Unambiguousness of tasks	3		9				1	9												1						9		2									9	9	6	1	9		6	2				9		9			94
Increased predictability of tasks	2						1	1	1	1									6	1						2									6			9	1		1				9	9	9		9		9			77
Enhanced task planning	3		2	1	3	1	3	2	1	1							1	1	2	1						4		2	1	1	1	1	1	1	9			9	9	9	2	2		9		9	9		9		9			119
Enhanced resources planning	6													1			1	1		1															9			9					9	9				9		9			64
Enhanced coordination of personnel	2						1						1						9	1						4		2							2			9		2	4	1		9	9	9			9		9			83
Increased productivity of employees																																																						0
Gen. improvement of oper. procedures	9					3		3						2	2		2	3	6	3	3				1	1	6	6	6						3	9			9	9	9	9	6				9	9				9			137
Reduction of administrative tasks																											9							9																	1			19
Increased process quality	9					3		3						2	2		2	3	6	3	3				1	1	6	6	6						3	9			9	9	9	9	6				9	9						6	134
Enhanced working conditions	-3																									9	6	9																						4			25
Minimised environmental impacts																											9							9																	6			24
Passive Value	116	15	40	6	4	33	26	96	3	2	42	40	30	65	73	15	58	34	50	69	36	0	33	15	59	26	89	64	45	10	2	13	13	8	40	143	44	56	124	115	71	83	64	22	113	88	122	99	39	192	9	191	-3	6	

Legend: Yellow marked fields: Objectives that were identified as relevant by worker but not by the management
Green marked fields: Positive effects
Red marked fields: Negative effects

Table 4: Results of steps 3-5, worker´s view.

3.4.3 Step 6: Preference-neutral prioritization

For the preference-neutral prioritization, the active and passive values have been calculated as described in section 2.1 for each interview group. The CEOs and the worker were asked to insert a vertical and a horizontal line that divides the identified objectives into four priorities (A-D). To do so, they were asked to compare two objectives that are near to the centre of the figure and to decide which of these objectives is more important than the other and then to decide which priority the more important objective should get. Within three iterations (management) and two iterations respectively (worker) the thresholds were defined.

The resulting dependency matrix of each interview group is shown in figures 5 and 6:

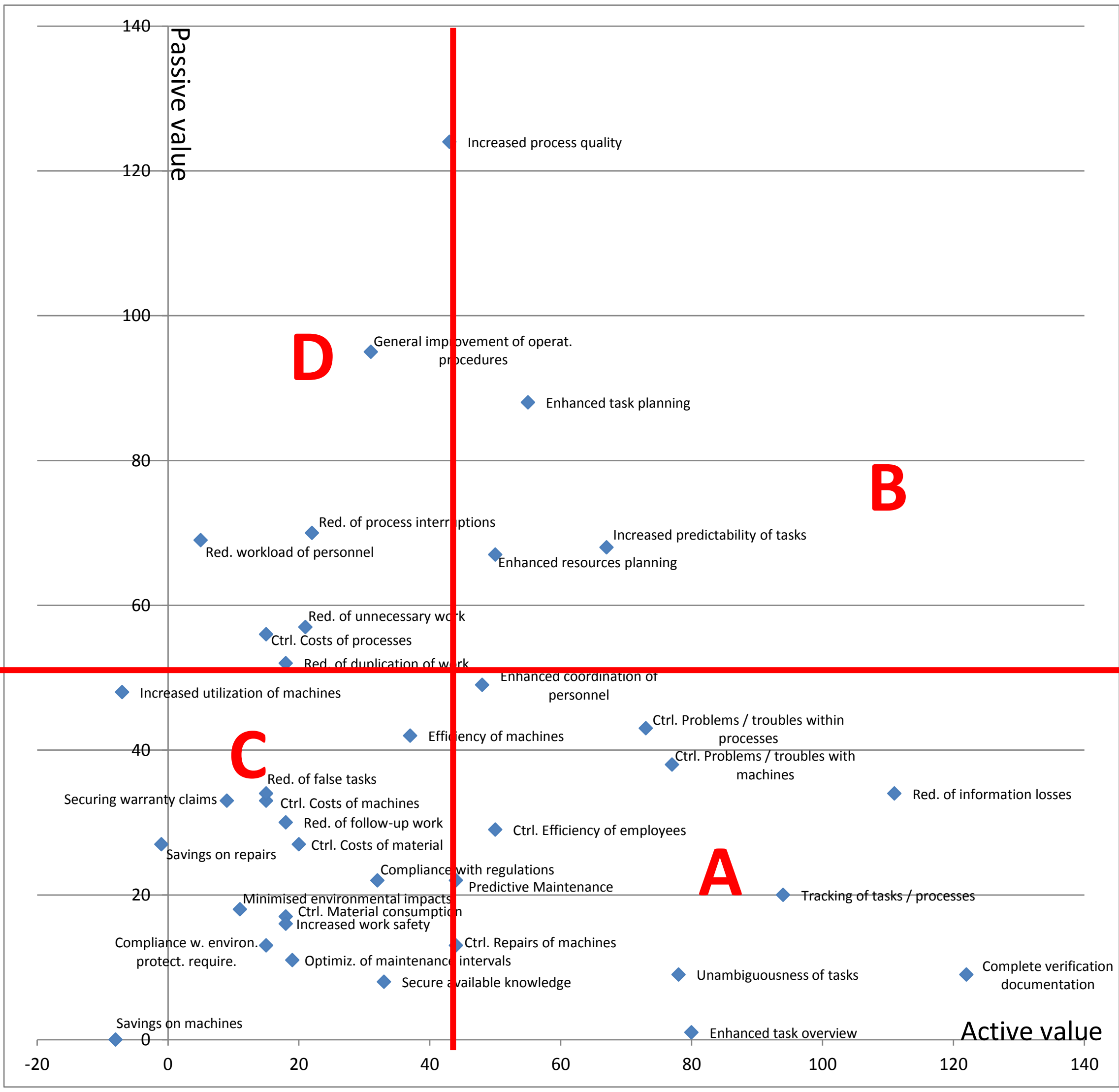


Figure 5: Objectives and their preference-neutral priorities (CEOs)

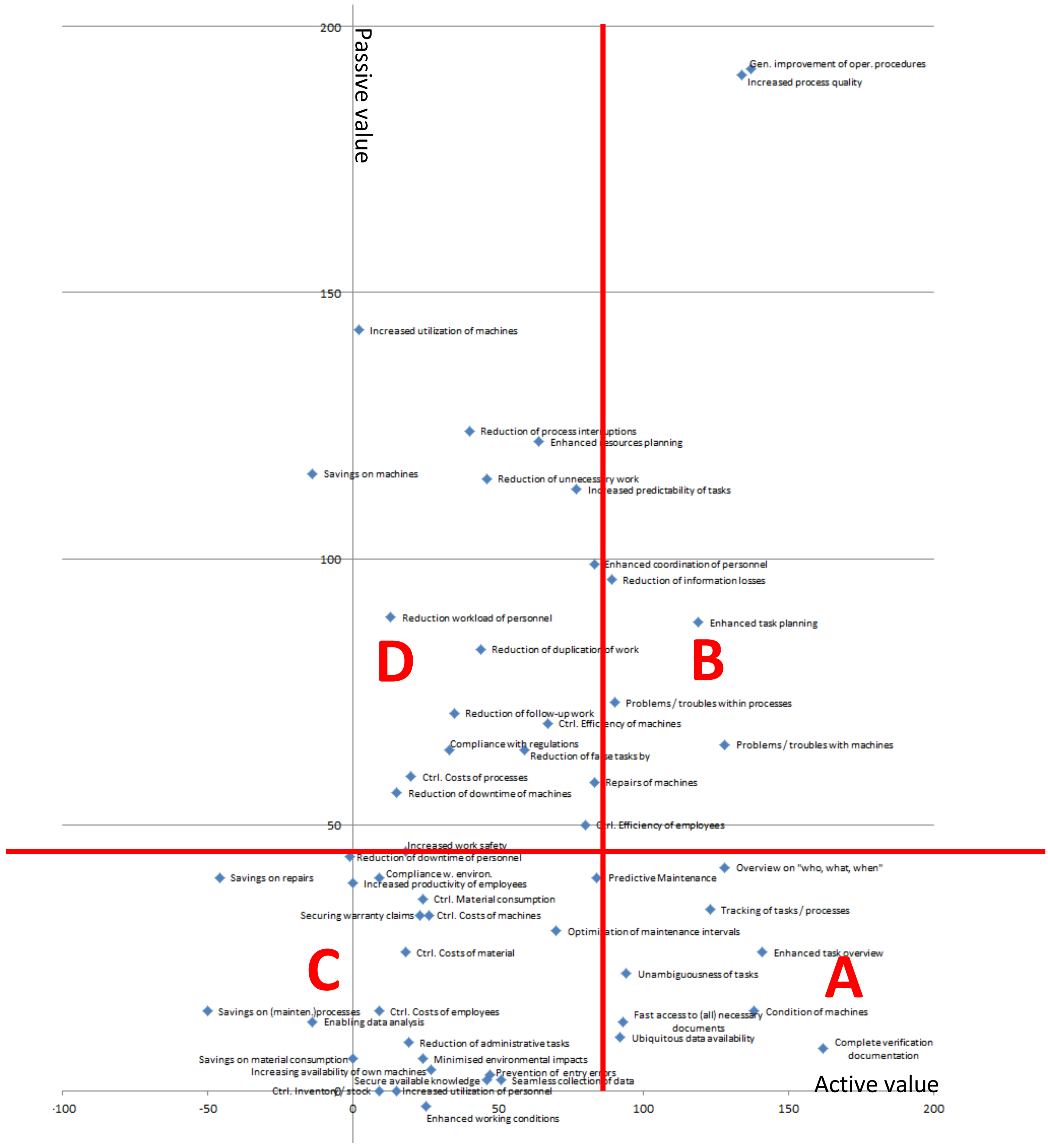


Figure 6: Objectives and their preference-neutral priorities (worker)

3.4.4 Step 7: Definition of the final target system

In the last step the final target system is defined by merging the existing target system of CEOs and the interviewed worker and assigning final weightings to objectives. Table 5 gives an overview on the objectives and their preference-neutral prioritisation (result of step 6). The main focus of the discussion was put on figures 4 and 5 as well as on table 5, which was the basis for merging and consolidating the two target systems.

A comparison of objectives shows that prioritisation of CEOs and the worker correspond to a great extent. It is obvious, that a complete documentation is a very important objective as the preference-neutral prioritisation (table 5). The objectives “tracking of tasks & processes”, “enhanced task overview” and “unambiguousness of tasks” have also been identified for both groups as of high relevance and received very similar weightings.

Analysing the other objectives it becomes clear, that the worker has a higher information need as his priority-A objectives focus mainly on a better data and document availability as well as on a better overview on the assignment of tasks and the state of machines. From this we can derive that the worker faces information losses and a lack of necessary information during his daily work.

The CEOs focus on very similar objectives, but from another perspective. E.g. the “reduction of information losses” has received the second highest weighting for objectives of priority A, which supports the findings described in the previous paragraph (worker´s view). Five objectives focus on enhancing monitoring and controlling, mainly of processes (“tracking of tasks”, “troubles within processes”, “efficiency of employees”), but also of machine malfunctions and repairs. The latter ones are both important factors for allowing a predictive maintenance, which was also identified as a very important objective for the CEOs. The objectives “unambiguousness of tasks” and “enhanced coordination of personnel” are connected to the objective “better task overview” as the latter one is the prerequisite for a better coordination.

	CEOs					Worker	
	Objectives	Active Value	Weighting	Weighting	Active Value	Objectives	
Priority A	Complete verification documentation	122	15%	17%	162	Complete verification documentation	Priority A
	Reduction information losses	112	13%	15%	141	Enhanced task overview	
	Tracking tasks / processes	95	11%	14%	138	Ctrl. condition of machines	
	Ctrl. problems / troubles machines	83	10%	13%	128	Overview on "who, what, when"	
	Enhanced task overview	80	10%	13%	123	Tracking tasks / processes	
	Unambiguousness of tasks	78	9%	10%	94	Unambiguousness of tasks	
	Ctrl. problems / troubles within process	74	9%	10%	93	Fast access to documents	
	Ctrl. efficiency of employees	50	6%	9%	92	Ubiquitous data availability	
	Predictive Maintenance	48	6%	20%	137	General impr. of operat. procedures	Priority B
	Ctrl. repairs machines	48	6%	19%	134	Increased process quality	
	Enhanced coordination of personnel	48	6%	18%	128	Ctrl. problems / troubles machines	
Priority B	Increased predictability of tasks	69	39%	17%	119	Enhanced task planning	
	Enhanced task planning	55	31%	13%	90	Ctrl. problems / troubles within processe	
	Enhanced resources planning	52	30%	13%	89	Reduction information losses	
Priority C	Ctrl. efficiency of machines	46	15%	20%	84	Predictive Maintenance	Priority C
	Secure available knowledge	33	11%	17%	70	Optimization of maintenance intervals	
	Compliance with regulations	32	11%	12%	51	Seamless collection of data	
	Optimization of maintenance intervals	25	8%	11%	47	Prevention of entry errors	
	Ctrl. costs of material	22	7%	11%	46	Secure available knowledge	
	Ctrl. costs of machines	21	7%	7%	27	Increasing availability of own machines	
	Reduction of follow-up work	20	7%	6%	26	Ctrl. costs of machines	
	Ctrl. material consumption	19	6%	6%	25	Enhanced working conditions	
	Reduction of false tasks	19	6%	6%	24	Ctrl. material consumption	
	Securing warranty claims	18	6%	6%	24	Minimised environmental impacts	
	Increased work safety	18	6%	6%	23	Securing warranty claims	
	Compliance w. environ. protection requirem.	15	5%	5%	19	Reduction of administrative Tasks	
	Minimised environmental impacts	11	4%	4%	18	Ctrl. costs of material	
	Savings on repairs	5	2%	4%	15	Increased utilization of personnel	
	Increasing availability of own machines	-6	-2%	2%	9	Ctrl. Inventory / stock	
Priority D	Increased process quality	45	28%	2%	9	Ctrl. cost of employees	
	General impr. of operat. procedures	31	19%	2%	9	Compliance w. environ. prot. requirem.	
	Red. of unnecessary work	25	16%	0%	0	Savings on material consumption	
	Red. of process interruptions	22	14%	0%	0	Increased productivity of employees	
	Red. of duplication of work	22	14%	0%	-1	Reduction of downtime of personnel	
	Ctrl. costs processes	17	11%	-3%	-14	Enabling data analysis	
	Reduction workload	5	3%	-11%	-46	Savings on repairs	
	Savings on machines	-8	-5%	-12%	-50	Savings on (maintenance)processes	
				11%	83	Ctrl. repairs of machines	Priority D
				11%	83	Enhanced coordination of personnel	
	Legend:			10%	80	Ctrl. efficiency of employees	
	Yellow marked cell:			10%	77	Increased predictability of tasks	
	- objectives that were identified as relevant			9%	67	Ctrl. efficiency of machines	
	by management, but not by worker (CEOs'			8%	64	Enhanced resources planning	
	column)			8%	59	Reduction of false tasks	
	- objectives that were identified as relevant			6%	46	Reduction of unnecessary work	
	by worker, but not by management (Worker's			6%	44	Reduction of duplication of work	
	column)			5%	40	Reduction of process interruptions	
				5%	35	Reduction of follow-up work	
	Priority A: Very important objective			4%	33	Compliance with regulations	
	Priority B: Important objective			3%	20	Ctrl. costs of processes	
	Priority C: Less important objective			2%	18	Increased work safety	
	Priority D: Least important objective			2%	15	Reduction of downtime of machines	
				2%	13	Reduction workload of personnel	
				0%	2	Increased utilization of machines	
				-2%	-14	Savings on machines	

Table 5: Comparison of results (preference-neutral prioritization)

	Both	CEOs	Worker
Priority A	Complete verification documentation	Ctrl. efficiency of employees	Ctrl. condition of machines
	Tracking tasks / processes	Predictive Maintenance	Overview on "who, what, when"
	Enhanced task overview	Ctrl. repairs machines	Fast access to documents
	Unambiguousness of tasks	Enhanced coordination peronnel	Ubiquitous data availability
Priority B	Enhanced task planning	Increased predictability of tasks	General impr. of operat. procedures
	Enhanced resources planning		Increased process quality
Mixed priorit	Reduction info. losses		
	Ctrl. problems / troubles machines		
	Ctrl. problems / troubles within process		
	Legend:		
	Yellow marked cell: - objectives that were identified as relevant by management, but not by worker (CEOs' column) - objectives that were identified as relevant by worker, but not by management (Worker's column)	Mixed priority: Objective received different priority	

Table 6: Merged priority A and B objectives of CEOs and worker

During the feedback loop workshop the CEOs and financial advisor discussed the results. They have been asked by one of the authors to merge objectives for “A” and “B” prioritization. As they recognized the importance of their own but also of the worker´s high priority objectives, they agreed on the following consolidation of priorities of objectives with A or B priority:

- Priority A for objectives, that are relevant for the CEOs AND the worker (column “Both” in table 6)
- Priority A for objectives, that have priority A for the CEOs OR the worker
- Priority B for all other objectives.

The resulting final target system is shown in table 7. It will be used by the CEOs as starting point for the definition of requirements of an ideal resources planning system (with focus on mobile processes) and in a later stage for the support of the decision making process on which system to implement.

Priority A	Priority B
Complete verification documentation	Enhanced task planning
Tracking tasks / processes	Enhanced resources planning
Enhanced task overview	Increased predictability of tasks
Unambiguousness of tasks	General impr. of operat. procedures
Ctrl. efficiency of employees	Increased process quality
Predictive Maintenance	
Ctrl. repairs machines	
Enhanced coordination peronnel	
Ctrl. condition of machines	
Overview on "who, what, when"	
Fast access to documents	
Ubiquitous data availability	
Reduction information losses	
Ctrl. problems / troubles machines	
Ctrl. problems / troubles within process	

Table 7: Final target system

4 Conclusions, Recommendations and Implications

In this paper the authors applied the definition of the target system as part of an integrative framework for determining the economic impact of ICS using the example of mobile technologies, which was described in detail in section 2.1. This validation was carried out through the practical case in a German SME (building industry) described in this paper which was in its first stages of deciding whether to implement a mobile resource planning system. The main results of the applied procedure for defining a target system were presented in section 3.4. Defining the prioritised target objectives in the context of the German SME proved to be usable: we were conveniently able to a) defining a priori objectives and a resulting questionnaire through among others literature and task observation and analysis, b) holding workshops in identifying and prioritising objectives, and c) validating and consolidating results in a separate workshop with CEOs and an external financial advisor.

In order to improve validity of the integrative framework, further implementations in practice are necessary in other branches and for different kinds of applications. Further case studies are planned within some research projects, specifically the German projects BigDieMo1 and Mittelstand 4.0 Stuttgart and the EU-funded project PERMIDES, which are currently in the preparation phase. In addition, the proposed methodology for defining a target system can be applied to different kinds of target systems, not only in the field of mobile IT as presented in this paper as it is a generic approach based on the Analytical Hierarchy Process which is used for decision-making processes in general. The authors are aware that for validating the complete integrated framework from the very beginning of a project until the first monitoring stage (e.g. after 2 years after implementation), more case studies and longitudinal data collection is needed.

1 For more information see: https://www.ksri.kit.edu/news_1765.php

References

Ahlert, M. (2003). Einsatz des Analytic Hierarchy Process (AHP) zur Analyse von Wirkungsbeziehungen im Relationship Marketing. Wiesbaden: Gabler.

Aichele, C. (1996). Kennzahlenbasierte Geschäftsprozessanalyse. Wiesbaden: Gabler.

Alter, S. (1999). A general, yet useful theory of information systems. Communications of the AIS. 1 (13), pp. 13-60.

Alter, S. (2001). Which life cycle: Work system, information system, or software? Communications of the AIS. 7 (17), pp. 1-52.

Andersson, S. and Tell, J. (2009). The relationship between the manager and growth in small firms. Journal of Small Business and Enterprise Development. 16 (4), pp. 586-598. http://dx.doi.org/10.1108/14626000911000938.

Berghout, E., Nijland, M. and Powell, P. (2011). Management of lifecycle costs and benefits: Lessons from information systems practice. Computers in Industry. 62 (7), pp. 755-764.

Bezerra, J., Bock, W., Candelon, F., Chai, S., Choi, E., Corwin, J., DiGrande, S., Gulshan, R., Michael, D.C. and Varas, A. (2015). The Mobile Revolution: How Mobile Technologies Drive a Trillion-Dollar Impact. BCG Perspectives. Retrieved on 16.08.2015 from https://www.bcgperspectives.com/content/articles/telecommunications_technology_business_transformation_mobile_revolution.

BMWi Bundesministerium für Wirtschaft und Energie. (2016). Retrieved on 27.04.2016 from http://www.bmwi.de/DE/Themen/Digitale-Welt/Mittelstand-Digital/mittelstand-4-0.html

Business Dictionary (2016). Retrieved on 25.04.2016 from http://www.businessdictionary.com/definition/objective.html

Charette, R. N. (1991). The Risks with Risk Analysis. Communications of the ACM. 34(6), p. 106.

CMMI (2006). CMMI for Development, Version 1.2. Software Engineering Institute. Retrieved on 25.04.2016 from http://resources.sei.cmu.edu/asset_files/TechnicalReport/2006_005_001_14771.pdf

Corsten, H. (2000). Lexikon der Betriebswirtschaftslehre. München: Oldenbourg.

Darnton, G. & Darnton, M. (1997). Business Process Analysis. Albany: International Thomson Business Press.

Davis, A. et al. (2006). Effectiveness of requirements elicitation techniques: Empirical results derived from a systematic review. In Requirements Engineering, 14th IEEE International Conference, 11.-15.09.2006 (pp. 179-188).

Drews, G. and Hillebrand, N. (2010). Lexikon der Projektmanagement-Methoden. Freiburg: Haufe.

Forsman, H. (2008). Business development success in SMEs: a case study approach. Journal of Small Business and Enterprise Development. 15 (3), pp. 606-622. http://dx.doi.org/10.1108/14626000810892382.

Gadatsch, A. and Mayer, E. (2004). Grundkurs IT-Controlling: Grundlagen - Strategischer Stellenwert - Kosten- und Leistungsrechnung in der Praxis. Wiesbaden: Vieweg.

Goos, G. and Zimmermann, W. (2005). Vorlesungen über Informatik, Band 1: Grundlagen und funktionales Programmieren. Springer, Berlin.

Gruhn, V. and Wellen, U. (2001). Process Landscaping: Modelling Distributed Processes and Proving Properties of Distributed Process Models. In: Unifying Petri Nets: Advances in Petri Nets. Ed. by Ehrig et al. Lecture Notes in Computer Science 2128. Berlin: Springer.

Hammer, M. & Champy, J. (1993). Reengineering the Corporation: A Manifesto for Business Revolution. New York: Harper Business Essentials.

Harrington, H. J; Esseling, K. C.; Nimwegen, V. (1997). Business Process Improvement Workbook. New York: McGraw-Hill.

Haug, A.; Pedersen, S.G.; and Arlbjørn, J.S. (2011). IT readiness in small and medium-sized enterprises. Industrial Management & Data Systems. 111 (4), pp.490 – 508. http://dx.doi.org/10.1108/02635571111133515.

Högler, T. (2012). Framework for a Holistic Evaluation of ICT. In 25th Bled eConference 19.-22.06.2012. https://domino.fov.uni-mb.si/proceedings.nsf/0/a0f9c70c2698908fc1257b6e003b0e2b/$FILE/03_hoegler.pdf

Högler, T., Versendaal, J. and Batenburg, R.S. (2015). Evaluation of Mobile Systems – An Integrative Framework. In American Conference on Information Systems, 13.-15.08.2015. http://aisel.aisnet.org/amcis2015/EntSys/GeneralPresentations/7

Huin, S.F. (2004). Managing deployment of ERP systems in SMEs using multi-agents. International Journal of Project Management. 22 (6), pp. 511-517. 10.1016/j.ijproman.2003.12.005.

Hwang, C. and Yoon, K. (1981). Multi Attribute Decision Making: Methods and Applications – A State of the Art Survey. Berlin: Springer.

Hway-Boon, O. and Yu, C.M. (2003). Success factors in e-channels: the Malaysian banking scenario. International Journal of Bank Marketing. 21 (6/7), pp. 369-377.

IfM Institut für Mittelstandsforschung Bonn. (2013). Retrieved on 27.04.2016 from http://www.ifm-bonn.org/statistiken/unternehmensbestand/#accordion=0&tab=1

IMG International Management Group. (20.10.2015). Succeed with IT projects. 07.02.2016, from http://imgcorp.co.uk/outside/archives/12194.

Iqbal, N., Nadeem, W. and Zahee, A. (2015). Impact of BPR critical success factors on inter-organizational functions: an empirical study. The Business & Management Review. 6 (1), pp. 152-165.

Isaac, H. and Leclercq, A. (2006). Give me a mobile phone, and I will work harder! Assessing the value of mobile technologies in organizations: an exploratory research. In Proceedings of the International Conference on Mobile Business ICMB.

Kahneman, D. and Tversky A. (1979). Prospect theory: An analysis of decision under risk. Econometrica. 47 (2), pp. 263-291.

Kirchmer, M. (1999). Market- and Product-Oriented Design of Business Processes. In: Business Process Engineering – Advancing the State of the Art. Ed. by Elzinga, D.J., Gulledge, T. R. and C.-Y. Lee. New York: Springer, pp. 131-144.

Klabon, M.L. (2007). An Investigation of the Quantification of the Probability of Occurrence of Software Engineering Project Risks with Bayesian Probability. http://calhoun.nps.edu/bitstream/handle/10945/3121/07Dec_Klabon.pdf?sequence=1&isAllowed=y (visited 11/22/2015).

Köhler, A. and Gruhn, V. (2004). Mobile Process Landscaping am Beispiel von Vertriebsprozessen in der Assekuranz. In: Mobile Economy: Transaktionen, Prozesse, Anwendungen und Dienste. Proceedings of the 4. Workshop Mobile Commerce. Ed. by Pousttchi, K., Turowski, K. Bonn: Köllen, pp. 12-24.

Kosiol, E. (1976). Organisation der Unternehmung. Wiesbaden: Gabler.

Kronsteiner, R. and Thurnher, B. (2009). Opportunities and Risks for Mobile Decision Support. In: Handbook of Research on Mobile Multimedia. Ed-. by I. K. Ibrahim Hershey: IGI Global, pp. 93-104.

Kulk, G.P. and Verhoef, C. (2008). Quantifying requirements volatility effects. Science of Computer Programming. 72 (3), pp. 136-175.

Lehner, F. (2002): Grundlagen und Entwicklung - Einführung und Motivation. In: Teichmann, René; Lehner, Franz (ed.): Mobile Commerce - Strategien, Geschäftsmodelle, Fallstudien. Heidelberg: Springer 2002, pp. 3-28.

Maimbo, H. & Pervan, G. (2005): Designing a case study protocol for application in IS research. In Chau, P. (ed.): Proceedings of the Ninth Pacic Asia Conference on Information Systems, Hong Kong, pp. 1281- 1292

Meixner, O. and Haas R. (2012). Wissensmanagement und Entscheidungstheorie: Theorien, Methoden, Anwendungen und Fallbeispiele. Wien: Facultas.

Miles, M. B.; Huberman, A.M. and Saldana, J. (2013). Qualitative Data Analysis: An Expanded Source Book. California: Sage Publications.

Muller, P.; Gagliardi, D.; Caliandro, C.; Bohn, N. U. and Klitou, D. (2014). A partial and fragile recovery: Annual report on European SMEs 2013/2014. European Commission.

NIST. (2012). Guide for Conducting Risk Assessments. National Institute of Standards and Technology (NIST). Special Publication 800-30. http://csrc.nist.gov/publications/nistpubs/800-30-rev1/sp800_30_r1.pdf (visited 01.03.2016).

Nysveen, H., Pedersen, P.E. and Skard, S.E.R. (2015). A review of mobile services research: Research gaps and suggestions for future research on mobile apps. SNF Working Paper No 01/15. http://brage.bibsys.no/xmlui/bitstream/handle/11250/279041/A01_15.pdf?sequence=1&isAllowed=y (visited 22.11.2015).

Rockart, J.F. (1979). Chief Executives Define Their Own Data Needs. Harvard Business Review. 57 (2), pp. 81-93

Rückle, H. and Behn, M. (2007). Unternehmenserfolg mit Zielen. Renningen: Expert.

Hosseini, M.R.; Chileshe, N.; Zuo, J.; Baroudi, B. (2013). Approaches of Implementing ICT Technologies within the Construction Industry. Australian Journal of Construction Economics and Building – Conference Series. 1 (2), pp. 1-12. http://dx.doi.org/10.5130/ajceb-cs.v1i2.3161.

Saaty, T. L. (1996). Multicriteria Decision Making: The Analytic Hierarchy Process. RWS Publications, Pittsburgh.

Schiller, J. (2000). Mobilkommunikation. Techniken für das allgegenwärtige Internet. Munich: Addison-Wesley.

Sing, M.P. and Vyas, R. (2012). Requirements Volatility in Software Development Process. International Journal of Soft Computing and Engineering. 2 (4), pp. 259-264.

Staudt, E. (2996). Reporting und strategische Steuerung im Profifußball. In: Karagiannis, Dimitris; Rieger, Bodo (Hrsg.): Herausforderungen in der Wirtschaftsinformatik. Heidelberg: Springer, pp. 127-142.

Turowski, K. & Pousttchi, K. (2004). Mobile Commerce - Grundlagen und Techniken. Heidelberg: Springer.

Vuolle, M. (2011). Measuring Performance Impacts of Mobile Business Services from the Customer Perspective. PhD thesis, Tampere University.

West, D.M. (2014). The State of the Mobile Economy, 2014: Its Impact and Future. Center for Technology Innovation at Brookings. Retrieded on 15.06.2015 from http://www.brookings.edu/~/media/research/files/papers/2014/09/10-state-of-mobile-economy-west/state-of-mobile-economy_v13.pdf.

Whitworth, B. (2006). Social-technical Systems. In: Encyclopedia of Human Computer Interaction. Ed. by C. Ghaoui. Idea Group Reference. Hershey, pp. 533-541.

Wild, M, and Herges, S. (2000). Total Cost of Ownership (TCO) – Ein Überblick. In: Arbeitspapiere WI, Nr. 1/2000. http://geb.uni-giessen.de/geb/volltexte/2004/1577/pdf/Apap_WI_2000_01.pdf (visited 11/22/2015).

Yin, R.K. (2013). Case Study Research: Design and Methods (Applied Social Research Methods). Thousand Oaks: Sage Publications.

Annex 1: Upfront case study protocol

Preamble	Confidentiality and data storage	Anonymous, full data
	Publication	For research purposes only
	Documentation	Via Laptop and Excel file
	Layout of protocol	Excel file (Annex 2)
General	Overview of research project	It is generally accepted that ICT & ICS are an integral part of most businesses. Also accepted is that many of these systems are ineffective and under-utilised, but in most cases it is less a shortcoming of the implemented technologies but the lack of business/IT alignment and appropriate evaluation methodologies. To close this gap, it is proposed that a new way of evaluation and alignment between IT and business is necessary – a so-called socio-technical approach. The proposed Integrative Approach starts from the very beginning in a user-centric way and allows to identify critical success factors (both human and technical ones) that lead to a better business/IT alignment. The research aims to address the application of the first activity of the Integrative Approach – definition of a target system – in practice at a German SME in the building sector.
	The case research method	A triangular and qualitative-quantitative research approach is followed, including a literature study, previous workshops and a questionnaire that will be used during interviews. Operational task observations: in order to learn the SME's operations several days the tasks of one or more employees are to be observed. The subsequent interviews will follow the procedure proposed by Miles and Huberman (2013): Collect data (interviews with 3 separate groups: blue collar(s), management and external financial advisor). Structure data (following steps 2-6 of the proposed procedure for defining the target system); this should also done in association with the interviewees. Reduce data (step 7).
Procedures	Initial approach to organisation	Selection of cases: As most research is done within large enterprises, SMEs are chosen as research field. Maintenance processes are chosen as the author worked for years as product manager in the field of Mobile Maintenance Management. The selected company was chosen as good contacts already existed and the company is aiming at enhancing its processes. Number of cases: 1
	Establishing contact	The contact to the company management is established via private relationship to the company.
	Scheduling of field visits	4 days of task observation, 2 visits of the management (1 visit for interviews, 1 for discussion of results (together with financial advisor) and definition of further steps to be taken) 1 interview of financial advisor 1 interview with truck driver / employee / worker
	Session length	4 separate days for task observation, per subsequent interview 1 hour in average
	Equipment	Laptop, Excel file
Research Instru-ment	Semi-structured interviews	A questionnaire will be used during interviews, allowing also to add additional objectives that are not given by the questionnaire
Data analysis guidelines	Overview on data analysis process	Steps 2-6 of the 1st activity of the Integrative Framework (in association with the interviewees): - set up of goal hierarchy - analysis of effects (dependencies) between objectives - estimating strength of effects - assessment of the likelihood of effects - preference-neutral prioritization Step 7: - reduce objectives to final target system
	Convergence of data	Definition of an a-priori list of objectives (see annex 2): - Objectives related to "cost reductions" - Objectives related to "process quality" - Objectives related to "monitoring & control" - Objectives related to "working conditions" - Objectives related to "decision processes" - Objectives related to "environmental impact" - Objectives related to "processes" - Objectives related to "quality of work" Triangulation of data as follows: - 4 days observation of tasks of employees (truck driver) - 1 workshop with management (2 CEOs) - 1 workshop with employee (truck driver) - 1 workshop with management and external financial advisor - Suggested merging of outcomes Only one source of data (data gained during interviews) will be used as no further documentation or similar exists. Triangulation will be achieved by including all identified objectives into 1 table and taking average values of (steps 3-5)

Annex 2: Questionnaire

Key objective 1	**Profit maximization**
Basic objective 1.1	**Cost reduction**
Process objectives:	
	Savings on machines by
	Savings on personnell costs by
	Savings on (maintenance)processes by
	Savings on repairs by
	Savings on material consumption by
	Increasing availability of own machines by
	Securing warranty claims
	Other process objectives
Basic objective 1.2:	Increasing plant availability by x%
Process objectives:	
	Reduction of troubles by %
	Reduction of system failures by
	Other process objectives
Key objective 2	**Increased process quality**
Basic objective 2.1	General support of processes
Process objectives:	
	Enhanced task overview
	Reduction of information losses by
	Prevention of entry errors (validation documentation)
	Secure available knowledge
	Overview on "who, what, when"
	Predictive Maintenance
	Optimization of maintenance intervals
	Other process objectives
Basic objective 2.2	**Enhanced Controlling /Monitoring**
Process objectives:	
	Problems / troubles with machines
	Problems / troubles within processes
	Condition of machines
	Repairs of machines
	Tracking of tasks / processes
	Efficiency of employees
	Efficiency of machines
	Material consumption
	Inventory / stock
	Costs of machines
	Costs of employees
	Costs of processes
	Costs of material
	Other process objectives
Basic objective 2.3	**Enhanced working conditions**
Process objectives:	
	Reduction workload of personnel by
	Compliance with regulations
	Increased work safety
	Other process objectives
Basic objective 2.4	Enhanced data availability
Process objectives:	
	Ubiquitous data availability
	Data availability 24/7
	Realtime data collection / availability
	Seamless collection of data / information
	Other process objectives
Basic objective 2.5	**Support of decision processes**
Process objectives:	
	Enabling data analysis
	Fast access to (all) necessary documents
	Complete verification documentation
	Other process objectives
Basic objective 2.6	**Minimization of environmental effects**
Process objectives:	
	Compliance with environmental protection requirements
	Other process objectives
Key objective 3	**Reaching production targets**
Basic objective 3.1	**Optimisation of processes**
Process objectives:	
	Increasing utilization personnel by
	Increased utilization of machines by
	Reduction of downtime of personnel by
	Reduction of downtime of machines by
	Reduction of process interruptions by
	Reduction of unnecessary work by
	Reduction of follow-up work by
	Reduction of duplication of work by
	Reduction of false tasks by
	Unambiguousness of tasks
	Increased predictability of tasks by
	Enhanced task planning
	Enhanced resources planning
	Enhanced coordination of personnel
	Increased productivity of employees by
	General improvement of operational procedures
	Reduction of paperbased documentation by
	Reduction of administrative tasks by
	Other process objectives
Key objective 4	**Improved Image**
Basic objective 4.1	Increased quality of processed tasks
Process objectives	
	Increased process quality
	Enhanced working conditions
	Minimised environmental impacts
	Other process objectives

29th Bled eConference

Digital Economy

June 19 - 22, 2016; Bled, Slovenia

Privacy Awareness in Mobile Business:
How Mobile OS and Apps Support Transparency in the Use of Personal Data

Mattis Hartwig

Leipzig University, Germany
hartwig@wifa.uni-leipzig.de

Olaf Reinhold

Leipzig University, Germany
reinhold@wifa.uni-leipzig.de

Rainer Alt

Leipzig University, Germany
rainer.alt@uni-leipzig.de

Abstract

Personal data of consumers has become a highly valuable resource in e-business. Technologies like smartphones, social networks or search engines help to access, collect and monitor an almost infinite amount of data about consumers. In this environment the traditional notice and consent principle seems insufficient for effective privacy protection. Awareness and control are constituting parts of an effective privacy management. This paper investigates how privacy awareness is supported in mobile business. Due to the critical privacy situation in this field, several third-party privacy enhancing mobile apps emerged beside the OS functionalities. The paper explores what information objects these awareness enhancing apps provide. Based on a detailed analysis of 19 apps, a set of 11 information objects is identified that contributes to 4 dimensions of privacy awareness. The findings show that the OS mainly focus on transparency regarding permission systems, that users can obtain more information about the use of their data by using specialized apps and that some dimensions of privacy awareness are almost not supported and open for research as well as the development of new solutions.

Keywords: Mobile Apps, Privacy Awareness, Mobile Business, Privacy Apps

1 Motivation

The amount of data collected and captured increased rapidly in the last few years and will keep rising even faster in the future (Buhl & Müller, 2010). The success of companies like Google Inc. and Facebook Inc. that collect, store and use a massive amount of data illustrates the increasing importance of data as a valuable business asset (Buhl, 2013). In conflict with this growing amount of data used in business processes are the privacy concerns of consumers (Alt, Militzer-Horstmann & Zimmermann, 2015), who start to worry about who has access to their data (Spiekermann, 2012).

In parallel, the technical development of smartphones and the amount of people who own and use a smartphone on a daily basis is also fast increasing (Jin, Yoon & Ji, 2013). Due to its broad applicability, high processing capacity and almost permanent usage, smartphones and their applications (mobile apps) are a suitable tool for gathering personal information about their user (Sutanto et al., 2013). However, the collection and capturing of data is often not transparent, because the existing infrastructure (e.g. IOS, Android) with its monopolized app repositories (Mylonas, Kastania & Gritzalis, 2013) and limited permission systems provide only a minimum of information and influence for the users.

In mobile business, this low trust and rising concerns should be a warning signal as laid out in a study by IPSOS (2012a) where only 55 percent of British Internet users trusted companies with their personal information online and 78 percent of the respondents reported to avoid using specific smartphone apps. The missing transparency of the data use is an important factor as illustrated by a study of the Pew Internet Project on Mobile Privacy and Data Management. The results showed that 30 % of the users had uninstalled an already installed app, due to its collecting of personal information that they did not want to share (Computer & Internet Lawyer, 2012). Another survey has analyzed the 50 most used mobile apps from the iTunes Store and Google Play Store and found that many of these apps transmit data like the phone ID or the current location to the app developer and even to third parties (The Wall Street Journal, 2010). With the increasing presence of multimodal sensors in mobile phones, environmental and user-centric sensor data of unprecedented quantity and quality can be captured from and reported by a possible user base of billions of mobile phone subscribers worldwide (Christin et al., 2011). At the same time, smartphones and tablets are still often poorly secured (Network Security, 2014). A global survey by Accenture shows that 54 percent of the surveyed 1,000 participants worry that using smartphones will erode their privacy (Accenture, 2010).

The current situation calls for a higher privacy awareness, which gives users sufficient information to actively control their privacy level based on their preferences and desired privacy level. This need for more privacy awareness and corresponding knowledge was identified by several app developers who provide privacy enhancing apps that help the consumer to get more privacy relevant information about their mobile phones and the used apps.

The aim of this paper is to provide an overview of the current mobile privacy situation, to analyze what kind of additional information a user can obtain through the usage of privacy enhancing mobile apps and to derive certain fields where the OS provider or other parts in the ecosystem need to adapt in order to enhance the transparency for the user. The research questions of this paper are (R1) What kind of information are available for the user through the usage of privacy applications that are not provided by the OS; (R2) How does this information fit into the dimensions of privacy awareness?

The remainder of this paper is structured as following. In section 2, privacy awareness in the mobile context and the related literature is discussed. Section 3 resumes the work from Au et al. (2011) and compares the three most relevant mobile OS Windows, Android and iOS regarding their privacy handling. Section 4 contains the analysis of privacy enhancing mobile apps first from a broad perspective and then in more detail for the Android OS. Section 5 presents the identified information object that a user can obtain through the usage of privacy enhancing mobile apps and discusses implications for OS and app providers. Section 6 summarizes the key findings and limitations of this paper and suggests directions for future research.

2 Privacy and Mobile Business

In a first step, a literature review about the constituting elements of privacy awareness and the role of mobile Apps and OS was conducted. Following the approach of von Brocke (2009), based on the relevant basic concepts of "Privacy", "Privacy Awareness" and "Mobile Apps" combinations of the key words "privacy", "awareness", "app(s)", "mobile", "permission", "OS" were used for a structured search within the databases Ebsco, IEEE and Google Scholar. In general, only a limited number of papers with relevance for the R1 and R2 was identified and research about mobile apps that support privacy awareness seems scarce. Following Cooper (1988), this literature research helped to identify central issues in existing research outcomes for the presented analysis in this paper.

Clarke (2006) defines privacy as follows: *„Privacy is the interest that individuals have in sustaining a 'personal space', free from interference by other people and organisations*". Furthermore, privacy can be divided into four interpretations: *Privacy of the Person*, *Privacy of Personal Behavior*, *Privacy of Personal Communications* and *Privacy of Personal Data* (Clarke, 2006). Whereas the last two are maybe heavily harmed by mobile applications.

The general need for more privacy is answered by different approaches, such as Digital Forgetting (Karla, 2010), Privacy by Design (Shapiro, 2010) or Data Property Rights (Lessig, 2006). Current solutions in mobile business often apply so-called privilege or permission systems, but a major issue is the definition of the right amount of permissions. Several researchers work on methods to measure (Geneiatakis et al., 2015) and handle (Han et al., 2014) such privileges. Besides permissions, identity management systems are also discussed as solutions for better privacy protection. Some researchers, such as Enck et al. (2014), also developed technical solutions for analyzing the access and distribution of data to third parties. A study by Mylonas et al. (2013) shows that users often trust official app repositories and that security controls are not enabled or users disregard security during selection and use. The adoption of security and privacy enhancing apps not only increases with negative experiences by users (Okazaki, Li & Hirose, 2009), but also with higher awareness and trust (Han, Wu & Windsor, 2014). In 2011, Passerini (2011) discusses the difficulties of striking a balance between privacy issues and opportunities by mobile tools and apps.

Stach and Mitschang (2013) reviewed android based privacy approaches and conceptualized an own Privacy Management platform. This research was a good basis for this paper but the reviewed approaches where mostly scientific prototypes that focused on hardware and needed a rooted system. Next to those innovative and but rather conceptual approaches there are several app developers who implemented apps that enhance the privacy of the user. The privacy apps from independent providers are more flexible and put the user demand in the center. They also often go further than just fixing the permission problems and introduce new privacy related features such as a risk indicator, virus protection or code analysis for showing what happens with the user data in a broader context. These privacy awareness apps advertise with slogans like "Be a know-it-all to your device's safety with privacy alerts" and "[…] take back control of your privacy!" However, there is still no research analyzing the existing privacy awareness applications, the mobile OS features and the corresponding privacy-related information a user gets and which influences the privacy awareness. Winkler and Rinner (2012) defined four levels of privacy awareness where the privacy level is higher when the user knows more about the system that is a danger to his or her privacy, based on the example of video surveillance. Following this conceptualization of privacy awareness, the user needs to know as much as possible about potential privacy threats. A high level of privacy awareness also requires some sort of warning for the user if new privacy threats come up. Mentioned by Konings et al. (2013) the main approach in privacy management is often only the control of certain privacy threats but ***privacy awareness*** is a precondition for privacy decision making and therefore for effective privacy management by users or service providers.

The performed literature review provided no concepts or measuring methods for evaluating privacy awareness. However, based on existing research four dimensions for measuring privacy awareness in R2 can be identified (see Figure 1). One dimension is the Permission dimension which is often discussed in the context with smartphones and their permissions to access data (Geneiatakis et al., 2015; Hoffman, 2013). Awareness in this context means, that the user knows what kind of information can theoretically be accessed by certain applications, tools or people. The second dimension is the actual ***Requested Data***. Enck et al (2014) discussed and analyzed this dimension with their TaintDroid app, which analyzes what kind of information is communicated to the outside. The third dimension is ***Consumption***, which deals with the purpose of the data collection. Awareness means that the user knows why the data is collected and how it is used (Cavoukian, 2012). This requirement is also included in the European Privacy Directive. The fourth dimension is ***Self-profiling***. Awareness means that the user knows his own behavior and how it is connected to the other dimensions. The mismatch of the stated interests and the actual behavior is often called privacy paradox and discussed by Norberg et al. (2007).

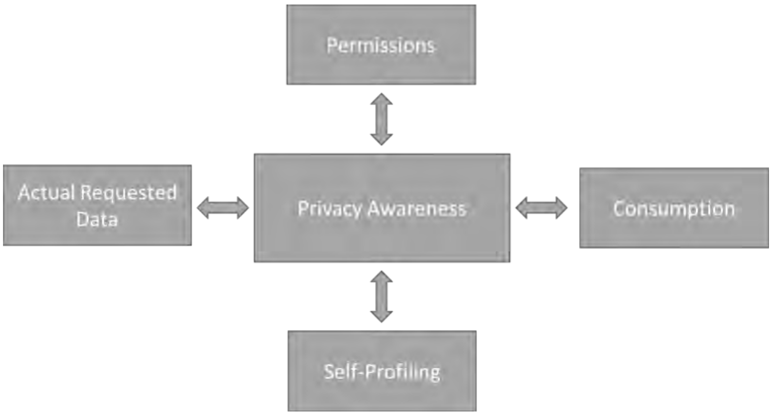


Figure 1: Dimensions of privacy awareness

Winkler and Rinner (2012) included three of these dimensions (without self-profiling) into an examination of awareness levels in the context of video surveillance. The collected data and permission dimension is mentioned in level 0 and 1 where the user gets information about the possibility of video surveillance and the locations where the data is collected. The consumption is addressed in level 2 where the user knows about the purpose of the camera.

The importance of privacy awareness is also recognized by the mobile OS providers. The OS providers constantly update their privacy protection features to meet with market and user requirements, resulting in increases as well decreases of transparency and control. Au et al. (2011) analyzed smartphone permission models of the different operating systems in 2011 and pointed out basic functionalities. More recently Google introduced the new Android 6.0 version where they remodeled their permission system and now offer the user more control. This was also a reaction to the displeasure of many Android users which also resulted in many Privacy Apps violating the marketplace rules that needed a “rooted” android system to give users the control they asked for (Hoffman, 2013). Providers of privacy apps and mobile OS providers are working in parallel to anticipate the privacy demand of users and develop solutions to address that need. OS providers have the better options for enforcing privacy protection by features or standards, but are also limited by the need to attract app creators that finance the platform and often build their business model around the obtained user data.

3 Privacy handling of different OS

As a first step for answering R1 the functionalities of mobile OS related to privacy awareness are examined. Since Au et al (2011) have already compared different OS with regard to their permission system, their research was used as a basis and enhanced for the purpose of this paper. The analysis of this paper was performed on the three OS: Android, iOS and Windows who together cover a market share of 99,3% (see Table 1). Since Android 6 introduced a brand new permission system, the old and new system are included to highlight the advancement.

Feature / OS		Android		iOS	Windows 10 mobile
		Android < 6.0	**Android 6**		
Detail of Permissions /Complexity		High	High	Medium	Medium
Point in time for granting permissions		Installation	Runtime when needed	Runtime when needed	Not specified
Revoking Permissions		Uninstallation of the whole app	For each app and each application possible	Single and global possible	Single and global possible
Awareness features of the OS	Permissions	Detailed permission system and information when installing	Detailed permission system with insight at any time	Medium detailed permission system with some insight at any time	Medium detailed permission system with some insight at any time
	Requested data	None	None	None	None
	Consumption	None	App Developer can explain why he is requesting data in runtime but it is not binding.	Request at runtime and user can only guess about the reason by the situation	Request at runtime and user can only guess about the reason by the situation
	Self-Profiling	None	None	None	None
Available *Awareness Apps* in the respective AppStore		19 Apps that focus on giving information about the privacy status.	16 Apps that focus on giving information about the privacy status	3 Apps that are also available for android (Leo Privacy Guard, My Permissions and Privacy Fix)	None
Available *Control Apps* in the respective AppStore		Apps that hide data, manage passwords, secure VPN-Connections, block advertisements or revoke permissions with rooted system	Apps that hide data, manage password, secure VPN-Connections or block advertisements	Apps that hide data, manage password, secure VPN-Connections or block advertisements	Apps that hide data, manage password, secure VPN-Connections or block advertisements

Table 1: Overview of privacy features in mobile OS

All three OS implement some kind of sandboxing which isolates the apps from each other and the rest of the system (Au et al., 2011). To access certain resources, the app needs a permission, which is handled differently by the OS.

For third-party apps, Android distinguishes between normal permissions like setting the time zone that are automatically granted by the system and dangerous permissions, for example the ability to read the contacts that the user has to grant the app explicitly (Android Developers, 2016). Prior to Android 6, the user had to grant all needed permissions when installing the app. It was a take it or leave it concept where the user could not get anything in between. Being the biggest point of critique of Android's permission system this concept was changed. Android 6 introduced the runtime permission system, which means that users will grant certain permissions when needed. And when they decide not to grant the permission the app is still usable just without the functions that need the permission. The user is also enabled to revoke granted permissions later on which was not possible before and resulted in many rooted systems where workarounds were implemented. Dangerous permissions are packed into groups and if a permission is granted, always the entire group of permissions will be granted.

Apple introduced certain permissions into their iOS that are called during the runtime. Before Android 6 this was a clear advantage for Apple. Some of these permissions can be revoked later on. The biggest problem for iOS is that it still lacks a complete permission system as Android has. First, there is no complete list of permissions the iOS uses and second, the permissions that exist are not as fine-granular as the android permissions and therefore do not give as much information as its competitor.

Microsoft's Windows 10 mobile has the smallest market share of the three OS. The permission system is not as extensive as Android's but the user can grant permissions at runtime and can revoke them later in the privacy settings. Confusingly, some permissions are asked for when installing the app, making this approach a hybrid one.

The improvement of the permission systems from 2011 shows that the critique from Au et al. (2011) and many others (e.g. blog author's, app developer) was fruitful and lead to a change within all three market leaders. Especially the turnaround of the Android OS from being the one with much critique for the permission system to the one with deep transparency methods is a remarkable step. The many third-party apps that offered exactly this level of transparency and control over the permissions in the app store may also have supported that decision. In the context of privacy management, the functionalities from this OS and the functionalities from third-party apps also often complement each other.

Next to the permission system the OS have other characteristics that influence the privacy of the user. Apple and Microsoft have a verification process for the submitted apps which ensures a minimum level of security and correct development whereas Android misses such a process. The high amount of apps in the Android-Store is also influenced by the easy and free publishing process for the app developer. The general technologies and functionalities that are provided by the three OS are very similar which results in similar privacy risks for the user. Examples are the usage of the internet, location-based services communication tools and the like.

The support of the awareness dimensions is quite similar between the OS. Remarkable is that they offer no functionalities for the ***Self-Profiling*** and ***Requested Data*** dimensions. Android below 6.0 offered only little in terms of the ***Permission*** dimension whereas the Android 6.0 offered very detailed information. In the ***Consumption*** dimension, again Android below 6.0 offered no possibility to enhance the awareness, whereas Android 6.0 enables the developer to give optional information about the purpose. In Windows and iOS, the user can only guess and derive a purpose from the point in time at which he or she is asked for granting a permission.

4 Analysis of mobile privacy applications

4.1 Methodology

With Android being the platform with the biggest market share and the platform for which the most privacy apps are available the following analysis focuses on mobile apps for the Android OS. Based on the identified need for information in the four dimensions of privacy awareness, a first key word based search for apps that inform a user about privacy aspects was performed on the Google Play Store. A combination of the following key words was used: “privacy”, “management”, “inspection” and “information”. For the resulting list of apps, an additional backward search was applied by an analysis of the section about related apps to identify additional apps.

From the resulting list, only those apps which focus on informing the user about certain privacy-relevant issues were included into the next step of the analysis. That means security apps which only provide a password functionality or just focus on anti-virus functionalities were excluded. Another criterion was the availability of sufficient descriptions about the functionalities, so that a test could be performed.

Since the research was done over a period of one year the new Android 6 version was released during this time. Because of the big change of the permission management many applications that were based on it got obsolete or had to change. In order to get insights about the impact on mobile apps and changed or new functionalities the search was performed again.

The analysis of the 19 apps included three steps. First, the information in the Google Play Store was analyzed and documented. Second, the app was installed on a mobile device (Samung Galaxy S3). Third, the functionalities of the app were tested and the provided information was documented and crosschecked with the descriptions in the Google Play Store and also if available with the website of the app developer. After these steps, two experts went through the documented information and grouped them into information objects. The grouping itself combined similar pieces of information into one information object. If a piece of information was not fitting into an existing information object, a new one was created. This resulted in 11 different information objects (see columns in Table 2).

4.2 Analysis of mobile applications

Table 2 introduces each analyzed app. It can be observed that most apps have high download numbers (> 100.000) and high user ratings (for detailed information on download numbers, ratings and source links see Appendix I). This supports the assumption that mobile users have an interest in privacy related issues. Therefore, they are looking for apps that promise more insights. Figure 2 provides some examples of how the apps may look on the smartphone when installed.

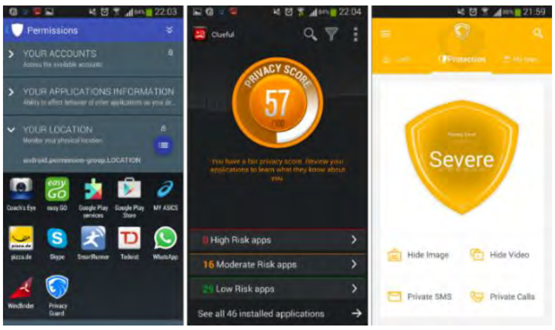


Figure 2: Examples (from left to right aSpotCat, Clueful Privacy Advisor and Leo Privacy Guard)

Information Object / Analyzed mobile Apps		Granted permissions	Risks of permissions	App grouping	Risk of Apps	System privacy level	Privacy related events	Recommendation	Third-party libraries	Social Media Links	Social Media Sharings	Data Value
1	LBE Privacy Guard (06/03/2012, deleted)	X	X				X					
2	Privacy Scanner for Facebook (12/09/2013, deleted)							X				
3	F-Secure App Permissions (30/04/2014, deleted)	X	X									
4	Privatsphäre Monitor (14/11/2013)	X	X	X	X							
5	App Ops (03/02/2014)	X		X			X					
6	Clueful Privacy Advisor (11/05/2014)	X	X	X	X	X						
7	Permission Master – Xposed (05/10/2014)	X										
8	SRT Privacy Inspector (10/10/2014)	X	X	X	X	X			X			
9	PrivacyFix (06/01/2015)							X		X	X	X
10	SnoopWall Privacy App (23/02/2015)	X		X								
11	Privacy Advisor (05/03/2015)	X	X	X								
12	Permission Friendly Apps (21/03/2015)	X	X		X							
13	aSpotCat (24/07/2015)	X	X	X								
14	MyPermissions- Privacy Shield (29/09/2015)	X		X						X		
15	OpenView Mobile - Permission (07/11/2015)	X	X	X			X					
16	Bitdefender Mobile Security & Antivirus (24/12/2015)	X	X		X	X						
17	LEO Privacy Guard (25/01/2016)					X		X				
18	SteelWorks Advanced Permis-sion Manager (27/01/2016)	X	X	X								
19	McAfee App Privacy Advisor (11/01/2016)	X			X			X				

Table 2: Information clusters to which the analyzed mobile apps contribute

The analyzed apps fit with their core functionalities and main purpose into one of the following groups. First, some apps just display the already available information from the Google Play Store in a more convenient and user-friendly way (e.g. aSpotCat). Second, some apps provide additional information and connect with a server where information from different sources is accumulated (e.g. Clueful Privacy Advisor). Third, some apps have a different stated purpose such as password management but include useful privacy-relevant information as an aside (e.g. Leo Privacy Guard).

Most of the analyzed apps focus on the permissions of the other installed apps. This is due to the restricted permission system for Android < 6.0 apps which follows an “all or nothing”-principle and makes it difficult to find out what permissions an app has after it has been installed. However, besides this permission-related information there are apps with special information objects. All of the identified information objects are presented in the next section (see Table 3).

Despite the fact that some of the permission focused apps like the Clueful Privacy Advisor or aSpotCat have given, also some more information like a risk score for certain permissions, certain applications or the whole system with all its apps, almost no app which has focused on giving information about permissions has been updated after the release of Android 6. On the comment site of the My Permissions – Privacy Shield app at least the developer stated that they are planning for changes accordingly to the new permission system.

5 Privacy related information in Mobile Business

The following section summarizes the results from the OS (section 3) and app analysis (section 4). First, the identified available information objects for privacy awareness are discussed for answering R1. The list of information objects is an artefact that may be used as a reference in further research when analyzing or implementing future apps or OS. Second, the dimensions of privacy awareness from section 2 are reviewed and the support of these dimension through OS and apps is presented for answering R2. The four dimensions together with the mapping of the information objects reveal some shortcomings. Third, possible directions for enhancing the privacy awareness by means of current technologies and research are discussed.

5.1 Information objects

Table 3 presents the identified information objects from section 4 with examples of the type of information that is generated for the user.

The identified information objects show that third-party apps can indeed complement the OS with functionalities that enhance the privacy awareness of the user. For example, some apps visualize the security log so that the user can see what kind of permission was used at what time. Other apps recommend different security setting for specified apps to increase the privacy level. There are also apps that analyze if third-party resources are used, that recognize social media links or that even try to estimate a financial value of shared social data.

Information Object	Description	Example
Granted Permissions	Information about the permissions an individual app has	aSpotCat gives the user information that a certain application has the permission to determine its location.
Risks of Permissions	More information on the single permissions, especially information about the privacy risk of each permission	The Clueful Privacy Advisor tells the user that the permission to read contact details is a permission with medium risk.
App grouping	Grouping of the apps by different factors like functionalities, risk ratings etc.	SteelWorks Advanced Permission Manager can list all applications that can make a direct call to a telephone number.
Risk of Apps	A calculated risk score for single apps based	The Clueful Privacy Advisor tells the user that Whatsapp is an app with a medium risk.
System Privacy Level	An overall privacy score for the whole system of the user	The LEO Privacy Guard gives the user an overall privacy score from zero to 100.
Privacy Related Events	Detailed information about certain privacy relevant actions.	LBE Privacy Guard gives the user information about what app has used what permission at what time. For example Whatsapp determined the location 10 minutes ago.
Recommendations	Recommendations for changes in certain settings either of single app settings, OS settings or even social media settings.	The McAfee App Privacy Advisor recommends the user to change the skype settings so that skype does not use your location.
Third-Party Libraries	Analyses if the apps use certain third-party libraries for marketing or analyzing the user's behavior.	The SRT Privacy Inspector gives the user information what kind of marketing libraries a certain app uses to get the in-app adds.
Social Media Links	Information about mobile apps and known social media platforms and networks.	The MyPermissions- Privacy Shield gives the user information that a certain application has a link with the user's Facebook account.
Social Media Sharings	Information about what kind of data the user shared on social media platforms and who has access to it.	The PrivacyFix App analyzes the information the user posted in certain social networks and shows who has access to it on the basis of the user's settings.
Data Value	Information about the value of certain data that was shared by the user or collected by a third-party app.	The PrivacyFix App calculates a value of the information the user shared in certain social networks. For example, the shared data on Facebook is worth 10 $.

Table 3: Identified information objects

5.2 Support of privacy awareness

The identified information objects can be matched to the privacy dimensions introduced in section 2 (see table 4). The information objects *Privacy Related Events* and Social *Media Sharing* refer to actual data requests or queries and therefore help the user to answer the question what data is actually collected or requested. The information objects *Granted Permissions*, *Risks of Permissions* and *App Grouping* all refer to certain permissions of the apps. These information help the user to understand to which extent an app can access the mobile phone. The information objects *Third-Party Libraries* and *Social Media Links* address the data consumption and possible contacts that can use the data. The information object *Recommendations* gives the user information about what to change in his or her behavior or in his or her settings which is part of the *Self-Profiling* dimension. The *Data Value* also put in the Self-Profiling dimension because its main purpose is to reflect his decisions from an economical perspective but it can also be argued that it is part of the data consumption dimension because it says something of the usage of the data and the value for a third-party player. The remaining two information objects

Risk of Apps and *System Privacy Level* represent aggregated information and can be enhanced by information objects from the other dimensions. However, in the analyzed apps the scores where mainly based on the permission dimension.

	Description	Matching information objects
Permission Rights	Summarizes and displays information about the rights that the customer and the service provider (often in form of the app) have in their relationship (e.g. the service provider has the permission to know your location). Provides a structured view of all given permissions with different sorting and search options. Also includes the calculation of certain risk levels and risk scores that allow a benchmarking with other devices or users	• Granted permissions • Risks of permissions • App grouping
Requested Data	Summarizes and displays information about the actual data that is requested or captured by apps and services (e.g. the user's location or the user's contacts). Provides what information the service providers know about the user.	• Privacy related events • Social Media Sharings
Data Consumption	Summarizes information about the actual data consumers (e.g. app providers, third-party advertisers) and about the way they use the data (e.g. for giving location based advertisement). Provides information about potential third-party users and gives information to evaluate the relevance and kind of services they offer. Furthermore gives information about the purposes the data is used for and along with that the effects which certain actions of the user could have.	• Third-party libraries • Social Media Links • (Data Value)
Self-profiling	Summarizes and displays information about the behavior of the user him- or herself. Provides information about possible contradictions between user preferences or statements and actual handling (e.g. the user could say that he or she does not want to share his or her location but installs and uses many apps that require location information). Also gives the user feedback of the value of his or her data.	• Recommendation • Data Value

Table 4: Privacy dimensions and available information objects from apps

The analysis illustrates that the information objects support the different awareness dimensions to a different degree. The permission dimension is covered by many apps which give more detailed information. This was also the dimension which was relatively well-covered by the OS. That indicates that generating information along this dimension a) has a strong demand and b) is possible with the actual technologies. The other dimensions are not that well-covered and have many blind spots for the user. Researchers and developers should put more attention on how to support these dimensions. The nature of these dimensions also calls for the introduction of additional information resources outside the mobile phone, such as service providers that state the purpose of the requested data or monitoring tools that show which marketing services are making use of the provided data. New technologies might also enhance the covering of these dimensions. There are several existing methods for generating additional information future apps or new OS versions could use.

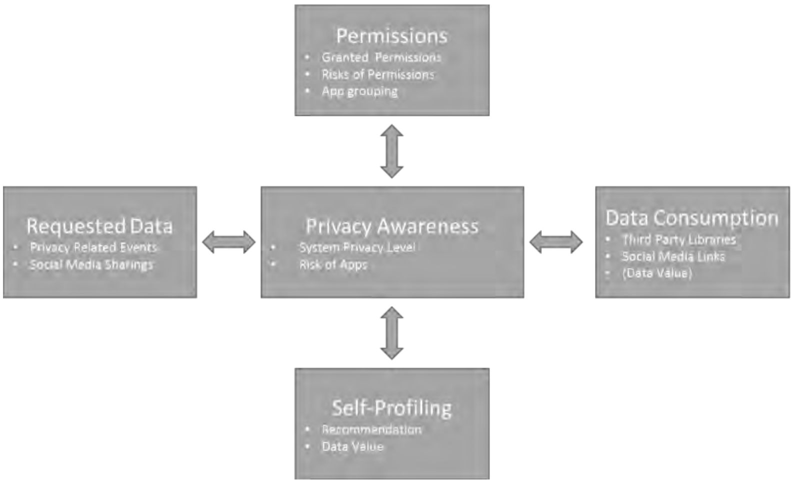


Figure 3: Dimensions of privacy awareness and available information

Regarding the *Self-Profiling*, there are methods for a better assessment of the value of personal data (Feijóo, Gómez-Barroso & Voigt, 2014; Li et al., 2014; OECD, 2013). These methods can be adopted for personal data in the mobile context and implemented in future apps in order to get more and better information about the value of the user's personal data. Letting the user state his disclosure preferences and comparing them with his actual behavior is the key for further improvement of the Self-Profiling. The needed technologies are available and should be used more widely in the future. Regarding the *Data Consumption* more research and collaboration between user and services provider seem necessary. Because it is not possible with the current infrastructure to physically track the personal data along with the whole data consumption, the Data Consumption dimension is difficult to address. One possibility is to include and motivate the service providers to provide information on how the user's data is handled, on why they are using the data and on the involvement and activities of third parties (Domingo-Ferrer et al., 2014). This proactive published information may increase the trust of customers and improve the company image, and can be documented by certificates or seals from third parties that document the following of privacy related rules (Domingo-Ferrer et al., 2014). The *Requested Data* dimension is again difficult to address by the app developer alone. It is necessary to observe which app accessed what information at what time. Furthermore, the communication over all the possible channels needs to be monitored so that the apps cannot share information unnoticed. A general monitoring tool anchored in the OS seems to be the best possible way to do this without giving a third-party app full control over the whole system.

5.3 Directions of app and OS development

During the writing of the paper the version 6 of the Android OS was released, which provides an opportunity to observe the impact on the available privacy enhancing apps. Sufficient information about the permissions were not available at first, afterwards provided by the analyzed apps and finally introduced in the OS itself. The three stages are summarized in Figure 4.

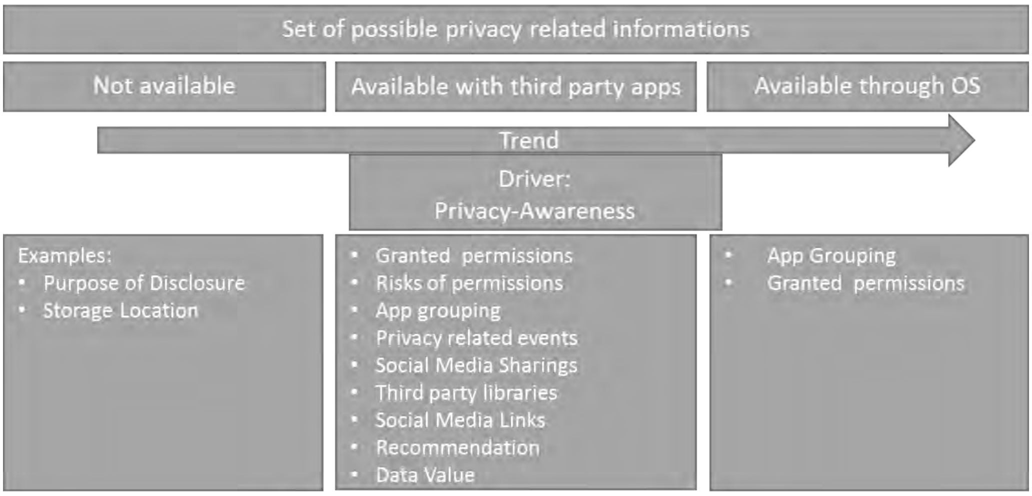


Figure 4: Evaluation stages of the support of privacy awareness

With the release of Android 6, not many apps have changed or new apps were released in the following months. One reason might be the required time for the development in the often community based development groups, but also the still incomplete understanding what functionalities users are looking for to increase their privacy awareness. Most of the providers didn't react on the impact of Android 6 in their app description, only one app provider stated that they are working hard on giving the user functionalities that go beyond the new functionalities of Android 6.

Since the apps and the OS always complement each other with functionalities, the development of the OS itself (see section 3) is also important for the future situation of mobile privacy management. Section 3 illustrates that Android took a big step into the direction of supporting privacy awareness. Together with its very detailed permission system the additional awareness and control features will make the privacy management easier for the user. Windows and iOS are a little bit behind because of the lack of such a detailed permission system, but there are also much less third-party apps that complement the OS features.

6 Conclusions

This research provides a first systematical analysis of privacy related mobile apps and the type of information they provide for users. The high download numbers of the analyzed apps and also the recent developments of the Android OS show the increasing interest of the market and users for such a comprehensive view. The findings show, that following the concept of privacy awareness more information than the permission system of mobile OS is necessary. The performed analysis identified 11 information objects (R1) in four dimensions that contribute to privacy awareness (R2) in mobile business. However, the existing OS and Apps offer only selected information and a comprehensive view is missing. The identified dimensions and information objects provide a first framework for a function based analysis of privacy awareness and may be used as a reference in further research.

The findings also illustrate, that the support of privacy awareness still seems in its infancy and is focused on protecting the user against the apps. The issue of a balance between protection and opportunities in mobile business and the perspective of the service providers is not discussed in detail. With respect to the literature review a lack of interdisciplinary research can be observed. First, many papers focus on technologies that protect the user from giving away data, while research about technologies that support a transparent and consent data use seems to be in the minority. Second, the value of data and a value based exchange of personal data is not discussed in relation to required technologies and the business value as well as necessity of such data are neglected. Both directions call for more interdisciplinary research, which combines the economic, legal and technological perspectives on privacy awareness and control.

For the development of future privacy awareness functionalities, the findings of this paper provide some insights regarding the necessary information for increasing the transparency. Researchers may use the findings of this research for the investigation of the requirements of privacy awareness and control. Because the insights derive only from the mobile domain, similar studies of desktop apps or social network apps could be performed and used to develop a general concept for information demands of privacy-aware users. A next step of the presented research will be an analysis of the options to increase transparency and how this enhanced transparency can be used to improve control. There are already apps that revoke permission rights and it would be worth exploring how other aspects could be influenced by the user. Supporting systems like coordination platforms for permissions rights or identity management systems may also benefit from more transparency and could be used to monitor the delegation of specific tasks by the users, thus supporting the adoption of such solutions.

Obviously this research has also some limitations. First, only a limited amount of Android apps was examined and more apps should be analyzed to uncover more information objects or to support the identified one. Second, the discussion on new technologies only gives a first direction and an in-depth analysis of current technologies should be performed in a next step. Third, the grouping should be repeated with a larger amount of experts and users to verify the grouping and to add usefulness and requirement dimensions.

References

Accenture (2010). Accenture Newsroom: Use of Smartphones by Bargain-Hunting Consumers is Changing the Customer-Retailer Relationship, Accenture Survey Finds, 13 Apr 2015; http://newsroom.accenture.com/article_display.cfm?article_id=5109.

Alt, R., Militzer-Horstmann, C., Zimmermann, H.-D. (2015). Electronic Markets and Privacy. Electronic Markets, 25(2), pp. 87-90.

Android Developers (2016). System Permissions | Android Developers, 07 Mar 2016; http://developer.android.com/guide/topics/security/permissions.html.

Au, K. W. Y., Zhou, Y. F., Huang, Z., Gill, P., & Lie, D. (2011). Short paper: A Look at SmartPhone Permission Models. In X. Jiang, A. Bhattacharya, P. Dasgupta & W. Enck (Eds.), the 1st ACM workshop: 63.

Brocke, J. v., Simons, A., Niehaves, B., Niehaves, B., Reimer, K., Plattfaut, R., & Cleven, A. (2009). Reconstructing the Giant: On the Importance of Rigour in Documenting the Literature Research. ECIS 2009 Proceedings.

Buhl, H. U. (2013). IT as Curse and Blessing. Business & Information Systems Engineering, 5(6): 377–381.

Buhl, H. U., & Müller, G. (2010). The "Transparent Citizen" in Web 2.0. Business & Information Systems Engineering, 2(4): 203–206.

Cavoukian, A. (2012). Operationalzing Privacy by Design: A Guide to Implementing Strong Privacy Practices. Ontario, Canada.

Christin, D., Reinhardt, A., Kanhere, S. S., & Hollick, M. (2011). A survey on privacy in mobile participatory sensing applications. Journal of Systems & Software, 84(11): 1928–1946.

Clarke, R. (2006). What's 'Privacy'?, 21 Feb 2016; http://www.roger-clarke.com/DV/Privacy.html.

Computer & Internet Lawyer (2012). Pew Study Sheds Light on App Users' Awareness of Privacy Issues, 29(12): 38–39.

Cooper, H. M. (1988). Organizing knowledge syntheses: A taxonomy of literature reviews. Knowledge in Society, 1(1): 104–126.

Document News (2012a). More Consumers Concerned About Companies Sharing Data than Government Surveillance Programmes, 30(5/6): 11.

Domingo-Ferrer, J., Hansen, M., Hoepman, J.-H., Le Métayer, D., Tirtea, R., Schiffner, S., & Danezis, G. (2014). Privacy and data protection by design - from policy to engineering. Heraklion: European Union Agency for Network and Information Security.

Enck, W., Gilbert, P., Han, S., Tendulkar, V., Chun, B.-G., Cox, L. P., Jung, J., McDaniel, P., & Sheth, A. N. (2014). TaintDroid: An Information-Flow Tracking System for Realtime Privacy Monitoring on Smartphones. ACM Transactions on Computer Systems, 32(2): 1–29.

Feijóo, C., Gómez-Barroso, J. L., & Voigt, P. (2014). Exploring the economic value of personal information from firms' financial statements. International Journal of Information Management, 34(2): 248–256.

Geneiatakis, D., Fovino, I. N., Kounelis, I., & Stirparo, P. (2015). A Permission verification approach for android mobile applications. Computers & Security, 49: 192–205.

Han, B., Wu, Y., & Windsor, J. (2014). User's Adoption of Free Third-Party Security Apps. Journal of Computer Information Systems, 54(3): 77–86.

Han, W., Fang, Z., Yang, L. T., Pan, G., & Wu, Z. (2014). Collaborative Policy Administration. IEEE Transactions on Parallel and Distributed Systems, 25(2): 498–507.

Hoffman, C. (2013). Android's Permissions System Is Broken and Google Just Made It Worse, 06 Mar 2016; http://www.howtogeek.com/177904/androids-permissions-system-is-broken-and-google-just-made-it-worse/.

IDC: Smartphone OS Market Share, 09 Feb 2016; http://www.idc.com/prodserv/smartphone-os-market-share.jsp.

Jin, B. S., Yoon, S. H., & Ji, Y. G. (2013). Development of a Continuous Usage Model for the Adoption and Continuous Usage of a Smartphone. International Journal of Human-Computer Interaction, 29(9): 563–581.

Karla, J. (2010). Can Web 2.0 Ever Forget? Business & Information Systems Engineering, 2(2): 105–107.

Konings, B., Schaub, F., & Weber, M. (2013). Who, how, and why? Enhancing privacy awareness in Ubiquitous Computing, IEEE International Conference on Pervasive Computing and Communications Workshops (PerCom Workshops 2013): 364–367.

Lessig, L. (2006). Code (2nd ed.). New York: Basic Books.

Li, C., Li, D. Y., Miklau, G., & Suciu, D. (2014). A Theory of Pricing Private Data. ACM Transactions on Database Systems, 39(4): 1–28.

Mylonas, A., Kastania, A., & Gritzalis, D. (2013). Delegate the smartphone user? Security awareness in smartphone platforms. Computers & Security, 34: 47–66.

Network Security (2014). Mobile Security: How to secure, privatize and recover your devices, 2014(2): 4.

Norberg, P. A., Horne, D. R., & Horne, D. A. (2007). The Privacy Paradox: Personal Information Disclosure Intentions versus Behaviors. Journal of Consumer Affairs, 41(1): 100–126.

OECD (2013). Exploring the Economics of Personal Data: A Survey of Methodologies for Measuring Monetary Value: OECD Digital Economy Papers.

Okazaki, S., Li, H., & Hirose, M. (2009). Consumer Privacy Concerns and Preference for Degree of Regulatory Control. Journal of Advertising, 38(4): 63–77.

Passerini, K. (2011). Privacy in a Wireless World: Issues and Opportunities of Mobile Technologies. Proceedings of the Northeast Business & Economics Association: 385.

Shapiro, S. S. (2010). Privacy by design. Communications of the ACM, 53(6): 27.

Spiekermann, S. (2012). The challenges of privacy by design. Communications of the ACM, 55(7): 38.

Stach, C., & Mitschang, B. (2013). Privacy Management for Mobile Platforms—A Review of Concepts and Approaches, 14th IEEE International Conference on Mobile Data Management (MDM): 305–313.

Sutanto, J., Palme, E., Chuan-Hoo Tan, & Chee Wei Phang (2013). Addressing the personalization-privacy paradox: an empirical assessment from a field experiment on smartphone users. MIS Quarterly, 37(4): 1141.

The Wall Street Journal (2010). What They Know - Mobile - WSJ, 13 Apr 2015; http://blogs.wsj.com/wtk-mobile/.

Winkler, T., & Rinner, B. (2012). User-centric privacy awareness in video surveillance. Multimedia Systems, 18(2): 99–121.

Appendix

Nr	App	Rating x/5.0	Downloads	URL
1	LBE Privacy Guard	3.0	100,000 – 500,000	(deleted)
2	Privacy Scanner for Facebook	4.3	100,000 – 500,000	(deleted)
3	F-Secure App Permissionn	4.1	100,000 – 500,000	(deleted)
4	Privatsphäre Monitor	4.3	1,000 – 5,000	https://play.google.com/store/apps/details?id=com.think_android.securitymonitor
5	App Ops	3.9	100,000 – 500,000	https://play.google.com/store/apps/details?id=com.findsdk.apppermission&hl=en
6	Clueful Privacy Advisor	4.2	100,000 – 500,000	https://play.google.com/store/apps/details?id=com.bitdefender.clueful&hl=e
7	Permission Master – Xposed	3.8	5,000 – 10,000	https://play.google.com/store/apps/details?id=com.droidmate.permaster&hl=e
8	SRT Privacy Inspector	3.7	10,000 – 50,000	https://play.google.com/store/apps/details?id=de.backessrt.privacyinspector&hl=e
9	PrivacyFix	4.2	1,000,000 – 5,000,000	https://play.google.com/store/apps/details?id=com.avg.privacyfix&hl=e
10	SnoopWall Privacy App	3.9	50,000 – 100,000	https://play.google.com/store/apps/details?id=com.snoopwall.privacyapp&hl=en
11	Privacy Advisor	4.3	5,000 – 10,000	https://play.google.com/store/apps/details?id=com.ashampoo.privacy.advisor
12	Permission Friendly Apps	4.4	100,000 – 500,000	https://play.google.com/store/apps/details?id=org.androidsoft.app.permission&hl=e
13	aSpotCat	4.3	100,000 – 500,000	https://play.google.com/store/apps/details?id=com.a0soft.gphone.aSpotCat&hl=en
14	MyPermissions - Privacy Shield	4.0	100,000 – 500,000	https://play.google.com/store/apps/details?id=com.mypermissions.mypermissions&hl=en
15	OpenView Mobile - Permission Manager	3.3	100,000 – 500,000	https://play.google.com/store/apps/details?id=com.ovmobile.appslauncher&hl=en
16	Bitdefender Mobile Security & Antivirus	4.4	1,000,000 – 5,000,000	https://play.google.com/store/apps/details?id=com.bitdefender.security&hl=en
17	LEO Privacy Guard	4.3	50,000,000 – 100,000,000	https://play.google.com/store/apps/details?id=com.leo.appmaster&hl=en
18	Advanced Permission Manager – SteelWorks	3.7	100,000 – 500,000	https://play.google.com/store/apps/details?id=com.gmail.heagoo.pmaster&hl=en
19	McAfee App Privacy Advisor	4.4	10.000 – 5.0000	https://play.google.com/store/apps/details?id=com.mcafee.advisory

29th Bled eConference

Digital Economy

June 19 - 22, 2016; Bled, Slovenia

Tablets Penetrate the Customer Advisory Process: *A Case from a Swiss Private Bank*

Rebecca Nueesch

Business Engineering Institute St. Gallen AG, Switzerland
rebecca.nueesch@bei-sg.ch

Thomas Zerndt

Business Engineering Institute St. Gallen AG, Switzerland
thomas.zerndt@bei-sg.ch

Rainer Alt

University of Leipzig, Germany
rainer.alt@uni-leipzig.de

Roberto G. Ferretti

University of Lugano, Switzerland
roberto.ferretti@usi.ch

Abstract

Ranging from customer service to board presentations, tablets increasingly penetrate the customer advisory process. Past research on mobile banking solutions focused on their potentials in an educational setting, on the advisory process, or on the design of a tablet solution in the retail banking sector. However, little research exists on the impact of tablets on the advisory process in private banking. We qualitatively examined the changes in the advisory process caused by the introduction of tablets in private banking. To that end, we describe the case of a Swiss Private Bank, which introduced tablets into its advisory process and underwent the transformation from a paper-based to a tablet-supported customer counselling.

Keywords: Mobile Banking, advisory process, tablets, hybrid customer interaction, case study

1 Introduction

Customer interaction is dynamic and diverse due to the application of innovative technologies (Brenner et al. 2014). In particular, merging of the digital and the physical world caused by the convergence of different technologies and electronic services such as smartphones, tablet computers (“tablets”) and the social web leads to new ways of customer interaction (Leimeister, Österle & Alter 2014). According to Birch (2012), the tablet is an important device to shift the interaction to a new level: “the tablet is really where we will begin to see this convergence. It has PC-like real estate with mobile-like ubiquitous connectivity” (Birch 2012, 1). The large screen and the low price supported fast adoption of this technology for operating purposes at banks. Ranging from customer service to board presentations, tablets are used indifferent situations. For example, Union Bank has started deploying tablets for operating purposes in 2011. The tablet, which is larger than a smartphone, but lighter than a laptop, provides an easy and fast way to access documents and gives customers quick loan information. It replaces folders and paper worksheets at meetings and enables taking notes and entering information in real time (Adams 2011). The question arises of how the tablet influences the advisory process.

Until now, research on tablets has focused on areas such as the business workspace (e.g. Harris, Ives & Junglas 2012), the educational situation of CIOs (e.g. Bonig 2011), the dialogue setting between doctor and patient, the advisory process with regard to the potentials tablets offer (e.g. Biernat 2014; Nueesch, Puschmann & Alt 2014; Adams 2011), or the design of a tablet solution (e.g. Ruf et al. 2015a; Ruf, Back & Weidenfeld 2015b). However, little research exists on the implication for the advisory process, on best practice of embedding tablets into an organization, or on the impact on the customer advisor’s work in the private banking industry (Nueesch, Puschmann & Alt 2014). In this paper, we describe the changes of the advisory process of a Swiss Private Bank caused by the introduction of tablets. From 2011 to 2014, we studied how the Swiss Private Bank embraced the complexities of implementation and obtained knowledge on how the bank embedded the technology in its organization and how that influenced the advisory process. This paper qualitatively analyzes a tablet-supported advisory situation from the perspective of the customer advisor in private banking and compares it to the previous paper-based advisory situation. We address the following research questions: How does the tablet influence the advisory process from a relationship manager’s perspective and how does the tablet-supported advisory situation differ from the paper-based process.

First, we consider related research regarding tablet-supported customer advisory situations. Second, we analyze the specific case of a Swiss Private Bank to investigate the impact of tablets on the customer advisory process in practice. Following analysis, we discuss the limitations of this study and provide an outlook on future research.

2 Related Research

In this section, we discuss the relevant theoretical background pertaining to the advisory process and to the value realized through a tablet-supported advisory situation, and provide an outlook on initial changes in the advisory process in a retail banking context.

Tablets are defined as information systems (IS) (see Silver, Markus & Beath 1995). The key elements of IS are people (persons that use the tablets), business processes (activities which are integrated and processed through tablets) and information technology (including software). Atkinson (2008, 2) defines tablets as "a form of mobile personal computer with large, touch-sensitive screens operated using a pen, stylus, or finger". According to Pitt, Berthon and Robson (2011), tablets exhibit some differences to traditional PCs. First, mobility: a tablet is easy to carry, fits into a bag and is quickly turned on. Second, presentation: in comparison to a laptop screen, a tablet screen is smaller, but, however, larger than a smartphone without being too heavy. Third, interaction and navigation: the touchscreen enables the users to navigate with their fingers.

2.1 Customer Advisory Process

Customer interaction relates to the processes between a company and its customers (Vandermerwe 2000), in which they share information in order to jointly solve specific customer needs (Dezinger 2010). Thus, customer advisory is "one interactive, collaborative information channel, available to an individual seeking assistance in reaching investment decisions" (Nussbaumer et al. 2009, 5). Based on several existing models of the advisory process in general (see Stryker 2011, Sadler 2001, Lippitt & Lippitt 1986, Keizer & Kempen 2006), the advisory process can be divided into six major phases: initiation (preparing the meeting), profiling (determining the target situation based on the customer's needs), concept (developing a solution based on the customer's situation and requirements), offer (presenting and discussing the specific offer), implementation (implementing strategies into product portfolios) and maintenance (monitoring and updating the customer's requirements and optimizing strategies) (see also Nueesch, Puschmann & Alt 2014).

Financial advisory is a longstanding strategic priority of the private banking industry and an important competitive differentiator (Schwabe & Nussbaumer 2009, Collette et al. 2015). Competitive differentiation can be achieved through an individualized advisory, which however is a complex process. Technology can facilitate this process by standardizing it and, thus make it more efficient and effective (Schwabe & Nussbaumer 2009; Buhl & Kaiser 2008). Our focus in this paper lies on the tablet as a salesperson-customer-shared technology, i.e. technology actively used by both customer and salesperson during the advisory (see Ahearne and Rapp 2010), and its effect on the advisory process from initiation to maintenance. The reason we focus on a salesperson-customer-shared technology lies in the present and future importance of a personal relationship in private banking (see e.g. KPMG 2015, Capco 2015, Capgemini 2015). The tablet solution, which is described in this paper, could not be used as pure self-service or "customer-centric" technologies due to its complexity (e.g. the simulations are not self-explanatory).

2.2 Initial Changes in the Advisory Process in the Retail Banking Context

A previous paper from Nueesch, Puschmann and Alt (2014) provides general insights about the major implications of the use of tablets on the advisory process in a retail banking context. However, it does not describe the changes along each advisory process step.

Implications on sequence. The customer takes a more interactive role in the advisory meeting. The process is no longer an inquiry-response process.

Implications on the number of process steps and on the automation of the process. All data are presented on the device. During the meeting, all information is immediately documented and archived. The documentation of the advisory meeting does no longer require a separate step.

The question arises of how the tablet influences the customer advisory process at each step. In section 4, we analyze that impact in more detail and describe the changes along each process step, before we compare the results to the paper-based advisory situation.

3 Research Methodology

This paper is part of a design science research project (see Hevner et al. 2004). Design science research aims to create and subsequently validate solution-oriented artefacts (methods, reference models, etc.).

In order to determine the qualitative impact of a tablet on the advisory situation and the working processes of customer advisors, we chose a case study approach. This method is particularly appropriate for exploratory research because the circularity of the research process allows for necessary redefinitions of concepts or adjustments of data collection methods in line with relevant findings (Yin 2003). The unit under study, the Swiss Private Bank, was selected because the investigators had intimate knowledge of the bank's initial situation. The investigators served as an innovation partner during a three-year project (2011-2014) which aimed for developing and implementing the tablet-solution at the Swiss Private Bank. The project documents including workshop protocols on the tablet's design requirements and scope as well as presentations and project-related progress reports were the data sources used to describe the changes of the advisory process and the transformation of the bank. This source was complemented by open-ended in-depth interviews (duration of each interview: 45 minutes) with five customer advisors as well as with a vice president from the Swiss Private Bank. The five customer advisors interviewed were change agents entrusted by the bank to support the implementation of the tablets in the advisory process. These change agents had a well-founded understanding of the solution with all its positive and negative aspects. The interviews took place at an early stage of the transformation process to allow for necessary adjustments. The interviewees received the interview guidelines beforehand via e-mail, together with information concerning the goal of the case study and the use of data as suggested by Myers and Newman (2007). The interviews were led by two interviewers to ensure comprehensiveness and to increase the validity of the field notes. The interview documents and interviewer notes were iteratively analyzed and interpreted during the data collection process (Eisenhardt 1989). The questionnaire used a three-point Likert scale (1) „low", (2) „intermediate", and (3) „high" (thesis-like questions; e.g. the integrated customer information provides a more holistic view and therefore the customer becomes more tangible (needs, goals, etc.)) as well as open questions. Two conditions were compared: the paper-based customer advisory process (without tablet) and the tablet-supported advisory process. The open questions focused on the effects of tablets on the advisory process itself and on the handling of the device by the customer advisor. The questionnaire was structured along the project goals like uniform branding, customer interaction, fulfilment of legal and compliance requirements, and standardization of the advisory process.

4 Introduction of Tablets into the Customer Advisory Process at the Swiss Private Bank

4.1 Initial Situation – Decision to Implement a Tablet-Supported Customer Advisory

The Swiss Private Bank specializes in asset management and related services for private and institutional clients. As a traditional private bank, it has focused so far on a personal, paper-based customer contact without any technological support during the advisory situation. Internal as well as external key drivers made a transformation in the direction of digitalization necessary. Therefore, the Swiss Private Bank decided to modernize its advisory situation by introducing tablets. The decision to introduce this technology as opposed to personal computers or laptops was motivated by the distinctive characteristics of tablets (see chapter 2).

The Swiss Private Bank started the transformation project at the end of 2011. It was decided to implement the iPad and to use iOS. The Swiss Private Bank's tablet solution focused mainly on Swiss customers. The transformation project was organized as an innovation project that involved more than fifty co-workers and comprised an innovation budget (external costs) of four hundred days of development. The Swiss Private Bank's transformation process is still ongoing. Considering the target return on investment of three years, the investment is profitable. In 2014, about 120 customer advisors used the device in a customer advisory situation. The aim of the project was to implement a standardized and holistic advisory process and to support different phases of the process with a tablet solution, as illustrated in Figure 1.

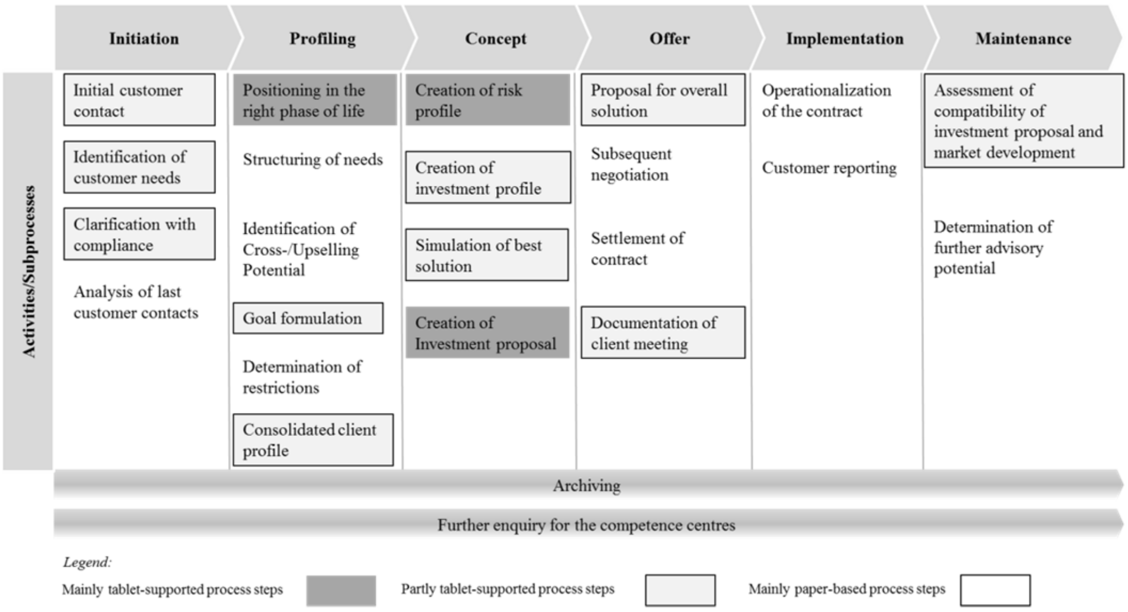


Figure 1: Customer advisory process of the Swiss Private Bank

The device supported only the most consulting-intensive process steps of the customer-bank-interaction. This was a decision made by the project management team with regard to the limited budget and in accordance with a cost-benefit-calculation.

4.2 Functionality of and Requirement for the Mobile Banking Solution for Private Banking

To achieve the goal of a holistic advisory, the integration of the device into the existing IT architecture of the Swiss Private Bank was required. The Swiss Private Bank decoupled their back-end from their front-end applications by using service-oriented front-end architecture. The back-end system was modularized and an integration layer (interaction engine handling data and workflows) linked the front- and back-end systems. Each step on the tablet was buffered in the front-end system. The tablet solution was designed as an app, which allowed fast implementation of new services on the device. The app included four main functionalities for serving the customer:

Dashboard. The entry page of an advisory session was the dashboard. The dashboard included different entry points (wealth balance sheet, risk profile etc.) that provided insights into the customer's financial situation and served as starting points for the advisory situation.

Wealth Balance Sheet (WBS). The WBS provided a holistic view of the customer's financial situation. It gave an overview of the assets and liabilities for internal as well as for external bankable assets and liabilities.

Risk profile. The advisor had the possibility to analyze the customer's portfolio based on the risk profile. It gave an overview of the specific risk tolerance and calculated if the customer goals matched with the current financial situation. The risk profile also included the investment horizon as well as the investment structure.

Investment proposition. The Swiss Private Bank's tablet solution was able to automatically generate fully customized investment propositions (based on model portfolios). The investment proposition, i.e., the customer received a solution to sign, was the main element of customer advisory. Furthermore, items included in the investment propositions automatically complied with legal requirements (e.g. Fidleg and Mifid II).

Each functionality of the tablet solution had to provide an added value (cost-benefit ratio) over the paper-based advisory. An automatically generated investment proposition, a risk profile and WBS providing a holistic view on the customer's financial situation was considered a benefit. In contrast, an automated goal analysis or event-based simulations could be useful, but they offered no additional benefit in relation to the costs of their implementation. In addition, the complexity of the functionalities of a tablet solution appeared to be critical. On the one hand, the customer can only handle a certain complexity. Therefore, simple functions seemed to be more useful than, e.g., complex simulations. On the other hand, simplification of some functionalities remains limited by compliance requirements.

4.3 Impact on the Advisory Process at Each Step of the Process

For the introduction of tablets, the standardization of the advisory process was a prerequisite. However, since both processes occurred at the same time, they could not to be considered and analyzed as being sealed off from one another. What could be done, though, was to compare the paper-based and the tablet-supported processes and to identify alterations which were due entirely either to the tablet implementation (tablet-specific changes (TS)) or to process standardization (process-specific (PS)), or to a combination of both. In the following, we examined those changes first by looking at the process as a whole, and then by examining the different process steps separately.

Due to the implementation of tablets, the Swiss Private Bank was able to implement a standardized advisory model and a new pricing model. Approximately a sixth of the customers are now willing to pay for advice because of the improvements in the advisory situation. Twenty-three percent of the advisory mandates were repriced due to the elimination of margins of retrocession.

As part of the expert interviews, we discussed the differences of a paper-based compared to a tablet-supported advisory situation from a qualitative point of view. Generally, the advisors agreed that the device provided a better user experience due to more transparency concerning the products and a higher degree of involvement of the customer. Additionally, the advisors were more motivated in the tablet-supported advisory situation because of less tedious paperwork. On the other hand, the tablet guided the advisor only partially through the process, because not each step of the advisory process was tablet-supported (see Figure 1). This led to a certain confusion regarding when it was appropriate to use the device or paper and what to do in case the tablet broke down. These uncertainties had to be addressed through special training.

By analyzing the advisory process together with customer advisors, we could evaluate the impact of tablets on each process step. The results are visualized in Figure 2 (paper-based advisory situation) and 3 (tablet-supported advisory situation) and subsequently interpreted in Table 1.

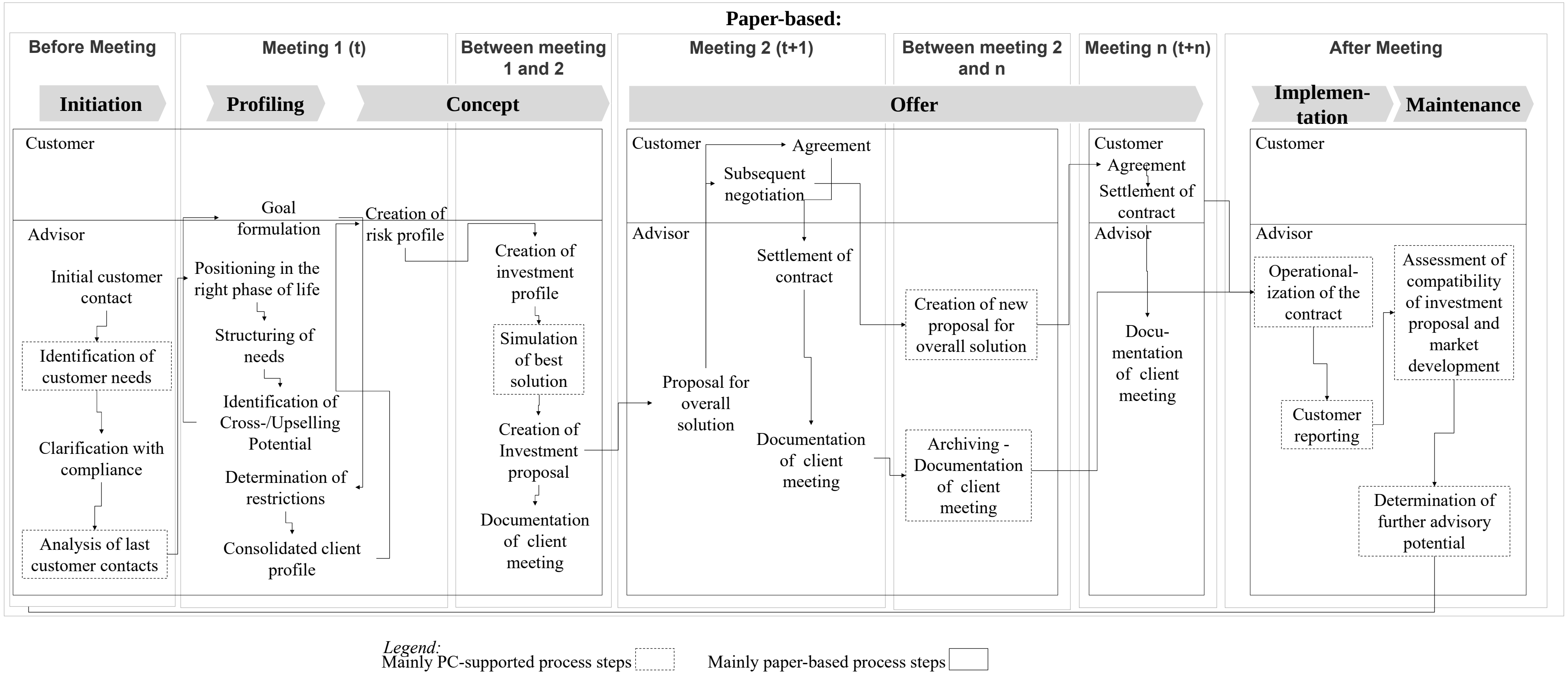


Figure 2: Paper-based advisory process

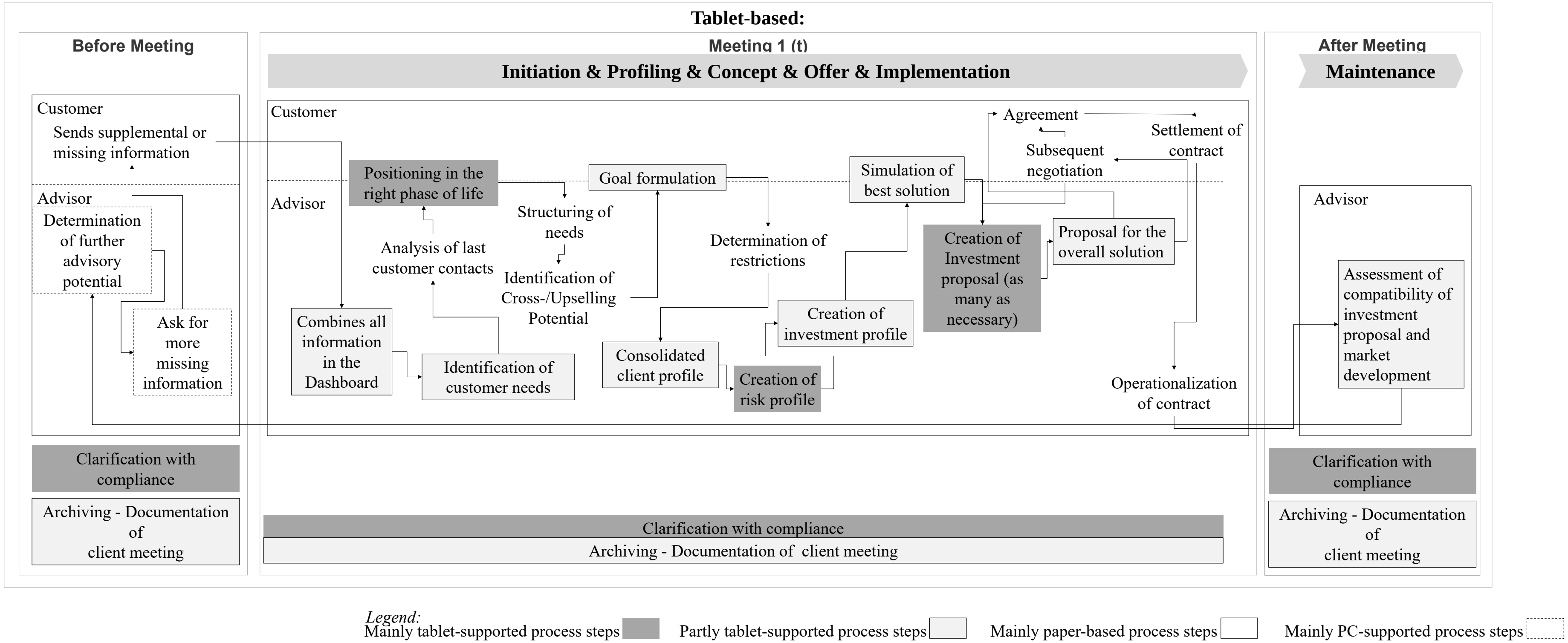


Figure 3: Impact of a tablet-supported customer advisory on the advisory process at each process step compared to a paper-based situation

<table>
<tr><th></th><th>Paper-based customer advisory</th><th colspan="4">Changes through the introduction of a tablet-supported customer advisory
(TS = tablet-specific, PS = process-specific*)</th></tr>
<tr><td>Initiation</td><td>• Identification of most important subjects and preparation of necessary documents
• Preparation of different proposals
• Identification of customer needs is partly automated and contains subjective interpretation of customer advisor</td><td>• All customer information is available electronically: the dashboard allows for the context-dependent development of the advisory situation (TS)
• Suggestions for implementing customer needs with an asset proposal are automated (TS)
• Simulations of proposals are generated during the meeting (TS)</td><td rowspan="5">The phases of Initiation, Profiling, Concept, Offer and Implementation all take place during one meeting (TS)</td><td rowspan="6">Continuous examination of compliance with regulations (TS)</td><td rowspan="6">Continuous documentation of advisory meeting (TS)</td></tr>
<tr><td>Profiling</td><td>• Analysis of customer needs by means of inquiry-response-process</td><td rowspan="3">• Increased flexibility to customize solution according to customer needs (TS, PS)
• Improved cross- and upselling potentials through better overview on customer’s data based on the WBS (TS)
• Enhanced visualization of comparison between target and actual situation (TS)
• Solution generation on the spot and without temporal delay on basis of model portfolios (TS)
• Customer signs paper-based contract during the same meeting (TS, PS)</td></tr>
<tr><td>Concept</td><td>• Solution is generated on basis of proposals prepared during initiation, new meeting is arranged to discuss reworked solution
• Advisor visualizes solution on paper
• Documentation of the meeting is done by the advisor after the meeting</td></tr>
<tr><td>Offer</td><td>• Customer advisor is responsible for ensuring compliance with regulations
• Offer is prepared after meeting
• Documentation of meeting
• Advisor physically presents offer at next meeting
• Customer signs paper-based contract</td></tr>
<tr><td>Imple-men-tation</td><td>• Implementation of solution depends on customer advisor</td><td>• Uniform guidelines concerning implementation of solution (TS, PS)</td></tr>
<tr><td>Main-tanance</td><td>• Monitoring und customer care depends on customer advisor: context-dependent analysis of individual customer profiles</td><td colspan="2">• Monitoring and customer care as a continuous process through automated recommendations (comparison with market development) (TS, PS)</td></tr>
<tr><td colspan="6">* All process-specific (PS) improvements stem from the standardization of the advisory process</td></tr>
</table>

Table 1: Paper-based compared to tablet-supported customer advisory situation

As Table 1 shows, we could identify the following mutations of the advisory process brought by the device (see also Figure 2 and 3):

Before the meeting. With the dashboard, the advisor had an overall view of all data (customer data as well as further advisory potential). In case some data were missing, the customer had the possibility to provide them digitally. The advisor could actively engage with the dashboard, which provided all the necessary financial information. Each step could be traced back. An automatic completeness monitoring ensured that all necessary data were entered.

Meeting 1. With tablet support, the process steps initiation, profiling, concept, offer, and implementation took place during one meeting. Without tablet support, a minimum of two meetings were required (see Figure 2). In the interim between the two meetings, the advisor prepared the investment proposal in order to discuss it with the customer in a meeting 2. At this point, we saw the greatest efficiency gain: the reduction of the number of meetings and the time between the meetings. Another advantage was the device's allowing for more customer interaction. Paper-based, the advisory was more of an inquiry-response process. In contrast, with the tablet the advisor adapted the process to the customer's specific needs and ensured a stronger interactive collaboration towards the solution, e.g. via the touchpad.

The investment proposition was automatically generated based on a model portfolio, which allowed for a customization of the solution. The portfolio was aligned with legal and regulatory requirements. Before implementing tablets, the advisor was responsible for assuring the portfolio's alignment with legal requirements, a task he had to accomplish between the customer meetings. The automation of this step was another efficiency gain. Furthermore, the transparency of the customer's investment situation by means of a target-performance comparison served to individualize the advisory and to adapt it to the customer's specific needs. The device supported the automatic fulfilment of the customer's requirements (targets were electronically stored, prioritized and quantified, which allowed for the matching of the investment proposition with the customer's requirements) and allowed at the same time to adapt the solution to the customer's performance. Better cross- and upselling possibilities arose due to different investment propositions and the overall view on the customer's data (based on the WBS). With a tablet the advisor was able to successively generate investment proposals until the customer's needs were satisfied. Without a tablet, the customer advisor had to arrange another meeting (meeting n), so that he had the time to generate a new investment proposition.

The device provided transparency and a holistic view of products and customer data. The interviewed customer advisors agreed that the customer participated in the solution process and could rely on being advised the right way because he saw each step of the advisory process. Therefore, the customer's acceptance of the investment proposition was higher because he saw the shift in the variance analysis (e.g. on position level). Furthermore, customer and advisor had access to the same data, which strengthened trust in the advisory solution. The customer advisor was more efficient because both the digital documentation of the meeting and its operationalization took place during the meeting. This led to the reduction of the number of meetings and the time between the meetings.

After the meeting. Operationalization was followed by maintenance. During the maintenance phase, the customer advisor monitored if the implemented solution developed according to plan and analyzed whether there was a requirement for another advisory meeting. This phase did not involve customer interaction.

5 Summary

We investigated the changes of the advisory situation caused by the implementation of tablets into the advisory process of a Swiss Private Bank. Our analysis was based on interviews with the responsible change agents who described how the advisory process was changed by the application of tablets compared to the previously used paper-based approach. In this study, we found the greatest efficiency gain for the customer advisor, i.e., the reduction of the number of meetings and the time between the meetings. The introduction of tablets was associated with comprehensive reorganization of the advisory approach, which enabled the Swiss Private Bank to implement a new pricing model and a standardized advisory model.

In general, the most important aspect of a tablet-supported advisory is the understanding how to involve the customer in the solution building. Guidance on tablet use is therefore important. By means of tutorials, the customer advisors have to be educated in the use of the new devices, especially regarding the question of how and when the tablet should replace paper-based advisory, which was a cause of uncertainty in the beginning. Apart from that, further research in this field is required placing the changes for the customers at the focus.

6 Limitations and Further Research

Within the constraints of the present paper, we prioritized the outcome of the transformation over the transformation process itself. The introduction of tablets into advisory situation altered the advisory process but could have modified also the enterprise architecture. This would be equally interesting to practitioners and should be a topic of further research.

The limited number of the interviewed change agents in this study in addition to their specific roles in the implementation process might have led to a bias in favor of the technology they were supposed to promote. Apart from validating the views of the interviewed change agents through more extensive interviews and surveys among advisors, further research will have to determine the level of customer acceptance of the new technology. Another important step would also be to quantify the effect of tablets in the advisory process, for example, by measuring the number of contracts signed and the overall revenue development (e.g. sales increase, kind of products sold, etc.). Furthermore, the implementation of a tablet-supported advisory needs to be analyzed in other industries in order to verify and possibly generalize our first results.

In this study, we compared the tablet solution with the established paper-based approach. However, another aspect that needs to be addressed by further research is the difference in customer experience between an advisory setting using a tablet or a PC or laptop. Most of the advantages brought by the use of tablets should also apply to a situation in which a laptop is used. According to Bonig (2011), there seems to be some agreement that tablets offset some of the disadvantages of laptops in an interactive setting; however, we need studies quantifying and directly comparing the effects of the use of laptops and tablets in an advisory setting to be able to precisely delineate the distinctions between their effects and formulate practical guidelines.

References

Adams, J. (2011). IPads and Tablets Invade the Enterprise. Bank Technology News. 24 (1), 26.

Ahearne, M. & Rapp, A. (2010). The Role of Technology at the Interface Between Salespeople and Consumers. Journal of Personal Selling and Sales Management 30 (2), 109–118.

Arwas, A. (2015). The Future of Private Banking. Retrieved December 3, 2015, from http://www.capco.com/uploads/articlefiles/640/file_0_1447086609.pdf

Atkinson P. (2008). A Bitter Pill to Swallow: The Rise and Fall of the Tablet Computer. Design Issues. 24(4), 3–25.

Biernat, B. (2014). New Technologies Enhance the Banking Experience. Banking New York. 31, 22–23.

Birch, R. (2012). Study: Channel Convergence “Coming Fast”. Credit Union Journal. 16 (14), 3.

Bonig, R. (2011). How iPads, Media Tablets and other mobile devices challenge higher education CIOs. Gartner Research. Retrieved Mar 15, 2015, from https://www.gartner.com/doc/1724665/ipads-media-tablets-mobile-devices

Brenner, W., Österle, H., Petrie, C., Uebernickel, F., Winter, R., Karagiannis, D., Kolbe, L., Krüger, J., Leifer, L., Lamberti, H.J., Leimeister, J.M., Schwabe, G. & Zarnekow, R. (2014). User, Use & Utility Research. Business Information Systems Engineering. 6 (1), 55–61.

Buhl, H.U. & Kaiser, M. (2008). Herausforderungen und Gestaltungschancen aufgrund von MiFID und EU-Vermittlerrichtlinie. Zeitschrift für Bankrecht und Bankwirtschaft. 20 (1).

Collette, B., Pion, D., Martino, P., Rimola-Durieu, L., Gilles, F., Dinari, M. (2015). Wealth Management and Private Banking: Connecting with Clients and Reinventing the Value Proposition. Retrieved June 13, 2016, from https://www2.deloitte.com/content/dam/Deloitte/lu/Documents/financial-services/lu-en-wp-efma-wealth-management-private-banking-032015.pdf

Dezinger, F. (2010). Kundeninteraktionskompetenz in Industriegütermärkten – Eine empirische Studie zur Interaktions- und Lernorientierung. Wiesbaden: Gabler.

Eisenhardt, K.M. (1989). Building Theories from Case Study Research. Academy of Management Review. 14 (4), 532–550.

Harris, J., Ives, B. & Junglas, I. (2012). IT Consumerization: When Gadgets Turn Into Enterprise IT Tools. MIS Quarterly Executive. 11 (3), 99-112.

Hevner, A.R., March, S.T., Park, J. & Ram, S. (2004). Design Science in Information Systems Research. MIS Quarterly. 28 (1), 75–105.

Keizer, J.A. & Kempen, P.M. (2006). Business Research Projects: A solution-oriented approach. Oxford: Butterworth-Heinemann.

KPMG (2015). The future of Swiss Private Banking. Retrieved May 5, 2015, from https://www.kpmg.com/ch/en/library/articles-publications/documents/financialservices/ch-pub-20150416-clarity-on-the-future-of-swiss-private-banking-en.pdf

Leimeister, J.M., Österle, H. & Alter, S. (2014). Digital services for consumers. Preface. Special Issue on „Digital Services for Consumers“. Electronic Markets. 24 (4), 255–258.

Lippitt, G. & Lippitt, R. (1986). The consulting process in action (2nd ed.). San Francisco: Jossey-Bass/Pfeiffer.

Myers, M. & Newman, M. (2007). The qualitative interview in IS research: Examining the craft. Information and Organization. 17 (1), 2–26.

Nueesch, R., Puschmann, T. & Alt, R. (2014). Realizing Value From Tablet-Supported Customer Advisory: Cases From the Banking Industry. In The 27th Bled eConference "eEcosystems", June 1–5, 2014. Available via AIS Electronic Library (AISeL). Retreived Apr 5, 2015, from http://aisel.aisnet.org/bled2014/34/

Nussbaumer, P., Slembek, I., Lueg, C., Mogicato, R. & Schwabe, G. (2009). Understanding Information Seeking behaviour in Financial Advisory. In ISI 2009, Apr 1–3, 2009. Regensburg: Hochschuleverband Informationswissenschaften.

Pitt L., Berthon, P. & Robson, K. (2011). Deciding when to use tablets for business applications. MIS Quarterly Executive. 10(3), 133–139.

Ruf, C., Back, A., Bergmann, R. & Schlegel, M. (2015a). Elicitation of Requirements for the Design of Mobile Financial Advisory Services – Instantiation and Validation of the Requirement Data Model with a Multi-Method Approach. In 48th Hawaii International Conference on System Sciences, Jan 5–8, 2015. Washington, D.C.: IEEE Computer Society.

Ruf, C., Back, A. & Weidenfeld, H.A. (2015b). Designing Tablet Banking Apps for High-Net-Worth Individuals: Specifying Customer Requirements with Prototyping. In Bled eConference 2015, 7–10 June 2015. Retrieved May 22, 2015, from https://domino.fov.uni-mb.si/proceedings

Sadler, P. (Ed.) (2001). Management consultancy: A handbook for best practice. London: Kogan Page.

Schwabe, G. & Nussbaumer, P. (2009). Why information technology is not being used for financial advisory. In 17th European Conference on Information Systems (ECIS 2009), June 8-10, 2009, Paper 450.

Silver M.S., Markus M.L. & Beath, C.M. (1995). The Information Technology Interactive Model: A Foundation for the MBA Core Course. MIS Quarterly. 9(19), 361–390.

Stryker, (2011). Principles and practices of professional consulting. Lanham: Government Institutes.

Vandermerwe, S. (2000). How Increasing Value to Customers Improves Business Results. Sloan Management Review. 42 (1), 27–37.

Wilson, D.P., Vakta, T. (2016). Wealth Management in the Digital Age: Understand demand for digital technology in wealth management, as well as cloud-based solutions for firms to transform their businesses. Retrieved March 18, 2016, from https://www.capgemini.com/resources/wealth-management-in-the-digital-age

Yin, R. (2003). Case Study Research: Design and Methods. Thousand Oaks, CA: Sage.

29th Bled eConference
Digital Economy
June 19 - 22, 2016; Bled, Slovenia

Seeing the Forest:
Applying Latent Semantic Analysis to Smartphone Discourse

Jacob Miller
LeBow College of Business, Drexel University, USA
JLM479@drexel.edu
David Gefen
LeBow College of Business, Drexel University, USA
gefend@drexel.edu
VK Narayanan
LeBow College of Business, Drexel University, USA
vkn22@drexel.edu

Abstract
We apply latent semantic analysis (LSA) to understand how media discourse and cognition about smartphones evolved over time. LSA is a useful method to take advantage of large amounts of available text, discern meaning within the text, and see how meanings change over time, across the media coverage in the sector. We explain the theory of LSA, the process, and apply it to a dataset of over 83,000 media articles to create a semantic model of document and word meanings. We measure how groups of documents differ and then visualize how the discourse changes over time. We find that LSA is useful for measuring how discourse shifts across this broad set of data. In our empirical case, we find that smartphone discourse went through four distinct periods, with different dynamics of transition and stability. These characteristics suggested particular theoretical bases which LSA is also well suited to examine.

Keywords: Latent Semantic Analysis, Smartphones, Text Analysis

1 Introduction

In December 2006, the elites of the business and political worlds were “addicted” to their “Crackberries.” Society knew what a smartphone was - a rather bulky mobile phone with a keyboard for email. However, 2007’s iPhone launch introduced a radical new design and a redefinition of the collective cognitive frames regarding the smartphone. By 2013, smartphones were for “apps,” keyboards were virtual on a capacitive touchscreen, and the formerly leading handset companies, Motorola, Nokia, and Research In Motion, were sold. The emergence of a dominant smartphone design in the early 2000s, and the subsequent transition to a new design were not just changes in technology, but the collective technological frames about the category (Orlikowski & Gash 1994). Changes in technology and markets are accompanied by changes in understandings of what the technology is, how it is used, and where it is going (Orlikowski & Gash 1994).

Traditionally, collective cognition has been studied either qualitatively, with some complex manual coding (e.g. Gamson & Modigliani 1989), or archivally with word counts and frequencies (e.g. Fiss & Hirsch 2005). However, qualitative methods are limited by the volume of text. Counts presume that words have consistent meanings and ignore synonyms.

We are faced with this question: how can we better understand shifts in collective cognition about technology, quantitatively and at a large scale? Our approach is to apply a series of analyses based on Latent Semantic Analysis (LSA) (Landauer, McNamara, Dennis, & Kintsch 2006) to study discourse. LSA's vector space model of word meaning can be used to compute distances between sets of text, which is theorized to approximate the meanings of the text. We use these distances to visualize and analyze how aggregate media discourse chances over time.

In this paper, we show how LSA can be used to study large volumes of text, preserving more of its meaning, and providing insights by comparing different texts. We first discuss LSA theoretically, and overview how to perform an analysis. We then apply LSA in the case of the development of smartphones as a context in which to demonstrate LSA-based analysis and interpretation. We build a semantic space, and use the distances of texts in a heatmap to visualize how media discourse shifted over the period from 1992-2010.

2 LSA Theory

Latent Semantic Analysis (LSA) attempts to model human cognition through mapping the meaning of language (Landauer 2006). Theoretically, LSA's model of meaning inference via word association has been claimed to correspond to the human language acquisition process (Landauer 2006). Word meanings are gathered primarily from relations to other words, not by looking up terms in a dictionary. As people encounter new concepts, they try to understand them in terms of concepts and language they already know. The language acquisition process is implicitly a communication process. Word associations are created by the writer or speaker, not the reader, thus this process is also one by which meaning is spread through groups.

LSA analyzes word usage patterns and theorizes that co-occurrences between groups of words have implies some sort of common meaning. LSA processes a large set of documents, and based on word co-occurrences, identifies the similarity and differences between texts (terms or documents) in terms of these appearances. Because words with similar meanings are theorized to be used in similar contexts, with other similar words, LSA theory suggests that this approach captures hidden meanings, and thus, is a semantic approach based on latent word meaning, rather than a lexical approach based on specific words or word counts, or dictionary definitions. It may be better capture the real meaning of a statement when compared to a keyword-oriented approach, since texts are typically evaluated at a statement, paragraph, or document level. For example, if an actor uses a rival's term, but does so in a statement that has meanings very different than the term "normally would," LSA's use of the aggregate spatial position of the larger text will better capture the true meaning of the text.

Compared to manual coding, LSA will likely be less precise, and miss certain nuances in communication. However, LSA allows the analysis of far more text, and is a reproducible process that is not subject (at least a priori) to subjective judgments. Both techniques will involve judgment in interpretation.

Documents that are relevant to the topic and representative of the knowledge of a target audience are processed to create a multi-dimensional semantic space. This space is theorized to represent the range of word meanings known to the audience (Landauer 2006). Sentences are composed of sets of words, and the meaning in the sentence arises largely from that combination. Documents and statements are then “projected” into the space for comparison and evaluation.

LSA has the potential to add a great deal to social science because it is a tool to quantitatively measure differences between texts, and at a large scale. With this capability, texts can be clustered based on semantic similarity, not simply word similarity. This may be useful to identify themes in the discourse. In addition, researchers can add metadata like dates and authors, to compare discourse across time or between different parties. Latent Semantic Analysis has been used in Information Systems literature as a means of indexing and information retrieval, but has not seen widespread adoption for text analysis (Evangelopoulos, Zhang, & Prybutok 2012).

In the rest of this section, we overview the LSA process, and discuss some caveats for interpreting the semantic model.

2.1 The LSA Process

To better understand how to apply Latent Semantic Analysis to social science issues, we will describe how to model the semantic space. LSA involves three major stages, followed by interpretation:

Collecting a corpus (database of text) that reflects the span of meanings and ideas under examination.

Generating a high-dimensional semantic vector space based on word associations in the corpus

Projecting additional documents into the space to identify differences between sets of documents

The first stage involves collecting the corpus of text that will be used as the basis of the semantic space. There are several potential issues regarding the content of the corpus (Quesada 2006). The corpus must be large enough to capture sufficient variety and meaning. A small corpus will also be overly sensitive to a small set of interrelated documents. The corpus must also be sufficiently representative of the concepts and topics to be studied, because unrepresentative corpora will not produce spaces that accurately represent the meanings that are the target of the model.

The second stage generates the semantic space. This process creates a document-term matrix (DTM), listing co-occurrences of all words in each document. A document, for the purposes of this matrix, may not be a “document” like an article, but a paragraph or sentence within an article. Since the LSA is a bag-of-words approach, the paragraph represents a “smaller bag” and because paragraphs themselves bound logical groups of meaning, it can be a good level at which to calculate associations (Quesada 2006).

When creating the DTM, it is common to omit numbers as well as very common words like “the” or “and.” These “stopwords” are used to structure sentences, rather than contain meaning independently. LSA, like other bag-of-words analysis, focuses on word meaning rather than sentence structure, and so typically omits them (Quesada 2006).
The DTM is typically weighted in a manner that increases the significance of rarer words, and diminishes the significance of common words. Then, the weighted DTM is decomposed using singular value decomposition, producing three matrices: a term-dimension matrix, singular matrix of dimension-to-dimension (with values on the diagonal, and otherwise zero), and a document-dimension matrix. The term-dimension matrix that is produced in this process is the semantic space.
Only a limited number of dimensions are retained, though there are not a priori heuristics to determine how many dimensions to retain (Quesada 2006). Different operations seem to have more satisfactory results with different numbers of dimensions. For large, general datasets, 300 dimensions seem to produce good results (Martin & Berry 2006), but more specialized sets seem to work better with fewer dimensions (Kontostathis 2007).
The third stage of LSA plots the position of the documents of interest, if they are different from the documents used to generate the space. Since the semantic space was created as an n-dimensional space, each term (word) in the corpus has a position in the space, represented as a vector. So, if a semantic space is generated with 30 dimensions, the term “app” would be represented in the space with a vector of length 30. Passages, often called psuedodocuments, can be created by adding all of the vectors of the constituent words together to produce a vector for the passage. In this way, larger passages can be plotted in the semantic space. The positions of text in the semantic space are valuable for research when used to compare between texts - to find similar terms and documents, or to measure distances (differences) in meanings.

2.2 Interpreting the Semantic Model

While LSA can be a powerful technique, there are a few conceptual issues to consider in interpreting the model. The first is: is what is, and is not, signified by LSA’s dimensions. When thinking about “dimensions of meaning” in LSA, it is important to understand that these orthogonal dimensions are not directly interpretable (Hu, Cai, Wiemer-Hastings, Graesser, & McNamara 2006). In social sciences, “dimensions” are often are a single concept on a continuum. A dimension in LSA does not represent a single concept, but layers of concepts that are empirically useful to differentiate texts. Singular value decomposition is sometimes used as the method to conduct Principal Component Analysis, and identifies components in the data that explain the most variance. One stream of research has emphasized the identification of factors in the data (e.g.Evangelopoulos et al. 2012, Ruef 2000, Sidorova, Evangelopoulos, Valacich, & Ramakrishnan 2008), and does rotate dimensions as is common in PCA or factor analysis. We suggest that there is great value in focusing on the distances between texts, as has been used as the basis for cluster analysis (e.g.Larsen & Monarchi 2004, Larsen, Monarchi, Hovorka, & Bailey 2008).
In a large dataset, there are many groupings of text, many different meanings within the documents, and a single dimension will have terms at various points. For example,

the classic social science approach might evaluate a “black-white” dimension. In LSA, “black” and “white” often have extremely similar positions since they are used together to describe a range of topics (e.g. color, race, dichotomizing, obviousness, etc.) The use of a single dimension to assess meaning can be useful when trying to determine whether there is some particular change from one text to another, (e.g. “in 2006, discourse flipped from high to low on dimension 15”). However, just as LSA dimensions each reflect a range of meanings, they are also not conceptually distinct individually. Analysis should generally emphasize the text’s position in space, which accounts for multiple dimensions simultaneously, and thus distinguishing between differences in meaning.

Since unrotated dimensions are not individually interpretable, the position of a single text in a semantic space is also not directly interpretable. However, knowing the position of a text in a semantic space is quite valuable when comparing to the position of other texts. In a well-built LSA model, texts that are similar in meaning will be close to each other in the semantic space, while very different ones will be far apart. While there are a variety of distance measures that could be used, cosine distance (e.g. Larsen & Monarchi 2004) is frequently used. Identical texts would have a cosine distance of 1, while entirely unlike texts would have a cosine of -1. Texts which were orthogonal would have a cosine of 0. In our empirical analysis, we will use cosine distances between speech in various periods to evaluate how smartphone discourse changes over time.

3 Empirical Analysis

The smartphone has become a significant technology. From the first mentions of “digital convergence” in the early 1990s to today, the “idea” of the smartphone evolved along with the technology. The form of the phone evolved, as a range of technologies were used as interfaces. Nokia’s Symbian operating system supported numeric keypads, a stylus-based touchscreen, and a keyboard/pointer (Tee & Iversen 2007), and the capacitive “multitouch” touchscreen is the dominant one today. However, the changes that came to smartphones were not simply within the products themselves, but in the technological frames that surrounded them. What is a smartphone *for* (Orlikowski & Gash 1994)? In 2006, a smartphone had a strong emphasis on email, and especially in a corporate setting. Consumer phones were becoming “smarter” with cameras and music functionality. Then, in January 2007, Steve Jobs took the stage at MacWorld and made a range of bold claims (Kast 2007). Announcing the first iPhone, he said that Apple was going to “reinvent the phone,” of competitors, “The most advanced phones are called smart phones. So they say… they’re not so smart,” and that these devices provided “the ‘baby Internet’” and a phone should have access to a full range of websites instead of specially limited ones. Some researchers have since argued that this web access was the first “killer app” for the iPhone design (West & Mace 2010).

Apple has a reputation for being a master of media and publicity. Their announcements are intensely covered by the media, with rumors before an announcement, and reporting afterward. With LSA as a tool, we can examine how the media covered the smartphone industry, and see how coverage changed over time.

LSA theory suggests that semantically similar texts should be near each other in the semantic space, and thus have high cosine similarity. Even beyond intentional attempts to shift collective cognition, discourse (e.g. product reviews) that happens within a common context (e.g. a consensus view of a technological frame like "phone is *for* email") should also have meanings in common and appear closer, relative to discourse from a different context (e.g. frames that hold that "phone is *for* apps"). In periods where a population has reached consensus about a topic, the discourse, on average, should be in the same region of the semantic space over time. However, when there are changes in the discourse - related to changes in how the population is thinking about the topic - we should see discourse move in the space.

For this exploration, we use Lexis/Nexis to generate a set of 83,532 news articles from 1992-2010 that dealt with smartphones or their predecessors. For the years 1992-2007, our search terms are "smartphone, smart phone, digital convergence, cameraphone, camera phone, pda phone, computer phone." For 2008-2010, searches were on the term "smartphone," as the term came into more consistent use. In addition, the Lexis/Nexis database contains metadata about the articles, including major themes and firms. As a result, the "smartphone" category may appear in the metadata even if the word is not present, and would thus be included in the search.

We used these articles to generate a semantic space, as well as to be our subject documents. We stemmed words, dropped standard stopwords (using the default list in R), but retained numbers. We kept all words that appeared in at least 6 different articles in the dataset. We initially created a space with 60 dimensions, but after some examination, we determined that 30 dimensions gave us a great deal of explanatory power. (More detail on this process is available on request.) Based on this semantic space, and the documents' positions within the space, we proceeded to examine how the discourse changed over time.

From the matrix of document vectors (a document/dimension matrix), we standardized each vector to have a magnitude of 1. This step gave each document in the set equal weight, rather than a weight that reflects its length. Then, we grouped the documents by the quarter in which they were released, and found the mean discourse position for all of the news articles released in that period. We then calculated the cosine distance between each period. Using the cosine distance, we then plotted heatmaps to examine how the discourse changed over the study period.

3.1 Heatmap

We then plotted the cosine distances between media discourse by quarter as a heatmap, in Figure 1. Each cell in the graphic indicates the cosine distance between the mean of articles in the quarter on the X axis and the quarter on Y. The color code ranges from dark red to yellow to white, as an increasingly hot fire. Darker colors are more distant, while lighter colors indicate more similar positions in the semantic space, based on relative similarity of this period to all others. The X axis marks all quarters (1992Q1-2010Q4) from left to right, while Y has them bottom to top. The diagonal indicates when a period is compared to itself. The heatmap shows four separate areas, each of which suggests that the discourse in the quarters in that region are much more similar to other quarters within that area compared to those outside the area.

The first period extends from 1992-1999Q3. Here, there is broad similarity between media coverage of this emerging market. This period is orange on the map, indicating that discourse in this period is generally similar, across a large number of quarters. Brighter, yellow spots on the diagonal indicate that discourse in these particular quarters was more distinct from others, because the coding scale is relative. All diagonal cells have a value of 1, so periods with less distinct discourse have comparisons to many other similar periods. Discourse seems to start shifting a bit in the late 1990s, The last quarter of 1999 and first of 2000 seem to be a transition point, closely related to each other, before the start of the second period.

The second major period is from 2000Q2-2002Q2. This period indicates some similarity to period 1, though it is distinct, and its quarters are clearly more related to each other than before or after, leading to a much brighter yellow within the period. In this period, there is much more consistency between media discourse in these quarters than in the first period.

A third period emerges in 2002Q3-2006, with an apparent transition from the second. The first five quarters also seem to be transitional, as these quarters relate more strongly to closely neighboring quarters, as indicated by the yellow band on the diagonal. If they were related, but not in transition, this would appear to be more squared-off, as we from 2003Q4-2006Q4.

The final period starts abruptly in 2007Q1 through the rest of the data, 2010Q4. This period's discourse is quite different from other periods. While this period is clearly distinct, it is not a squared off shape on the map, indicating that there are changes occurring in the discourse, even while the new discourse is a marked change from prior discourse. By using LSA to measure the distances between media statements in different periods of time, we are able to visualize changes of media discourse in text.

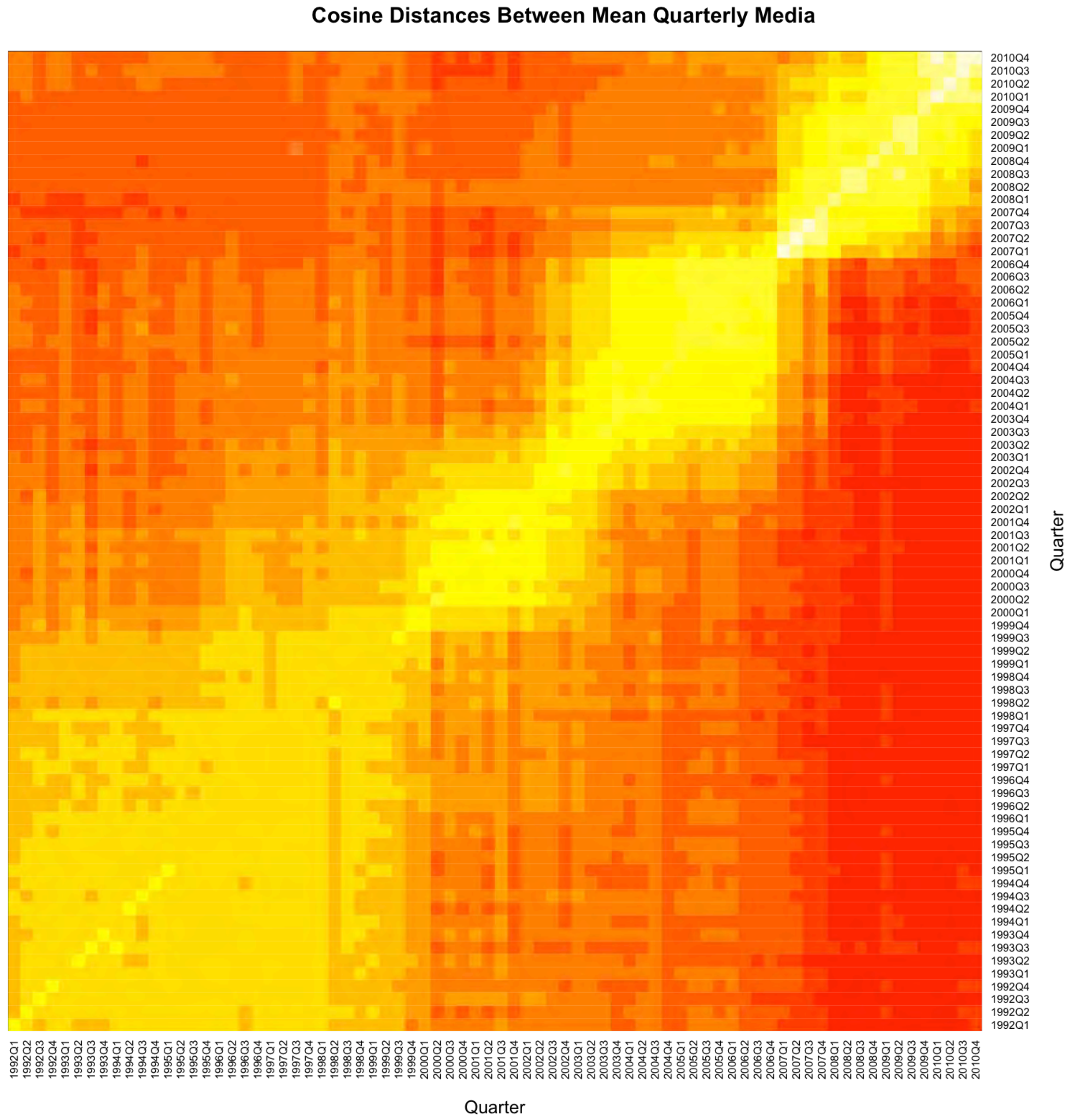


Figure 1: Heatmap of Quarterly Media Discourse Distances, 1992-2010

4 Discussion and Interpretation

From 1992-2010, our analysis shows that media discourse about smartphones and their predecessors went through four separate periods. Showing the LSA-derived distances in a heatmap lets us see these comparisons between a large number of datapoints, and see trends emerge in these comparisons.

In the first period, pundits were postulating the coming of "digital convergence." Discourse was broadly similar in these quarters, as this was before a true market emerged. This suggests that we may be identifying category emergence (Navis & Glynn 2010), wherein there is discussion about what the technology could or should or will be.

While the first “smartphone,” the Simon from IBM was marketed in 1994, the first real market for smartphones emerged around 2000, when we see the second period arise. We see a shift in the collective discourse, which remains consistent for about two years, suggesting that consensus emerged on the technology (Drazin, Glynn, & Kazanjian 1999). This is consistent with theory that holds that prototypes and products change how technology develops by affecting how people think and speak about it (Leonardi 2011, Suarez 2004).

In the third period, discourse shifts over a year, and then reaches a new, multi-year “stable” position. In the market, traditional handset companies took control of the market in this time (Canalys 2007) with media-centric consumer offerings with music and cameras, and email-centric business smartphones like the Blackberry (Gillette, Brady, & Winter 2013). Our study groups media by time period, and does not separately compare business media and consumer media. Therefore, it is likely that our mean position for media discourse conflates distinct media that might emphasize different aspects of different product lines. In addition, since consumer-focused phone publications are likely to be covered in a wide range of general purpose publications, while business products are likely to be more narrowly evaluated, our results likely skew toward the consumer product lines. An aggregation scheme that distinguishes groups between types of media outlet might produce somewhat different results.

The fourth period begins abruptly in 2007Q1, with discourse strongly shifting away from prior meanings. It seems likely that this is the result of the January 2007 announcement of the original iPhone, since the quantity of articles in the dataset rose from 1253 in 2006Q4 to 2362 in 2007Q1, and the stemmed term ‘iphon” appears in 962 of these. However, while the media intensively covered Apple, it did not automatically adopt Apple’s technology frames. The non-squared shape of the period on the heatmap suggest that the discourse evolved over time, and that it initiated a renewed debate about smartphones. Android’s appearance in 2008 (Tseng 2008) did not spark a new period of discourse, but may have shaped the evolution of the debate. It seems likely that “Android” became important to the evolving ideas about smartphones, but it did not have a key “moment” like the iPhone seems to have, since there we observe no sudden changes in the overall discourse, either at announcement, at product availability, or as it gained significant market share.

By using LSA, we are able to quantify relationships across large quantities of text. We are “seeing the forest” and “not just the trees” in this way. In the applied example of technology cognition, we are therefore able to identify four separate periods in our timeframe, and that the final period is different from the others in important ways. In this case, we are examining discourse at an aggregate level, which allows us to draw inferences about the overall movement of the market. So, the shape of discourse suggests support for a cognitive aspect to the technology lifecycle (Anderson & Tushman 1990, Suarez 2004, Suarez, Grodal, & Gotsopoulos 2015). The data also suggests that there may be market-wide framing contests built into these processes (Kaplan 2008), with the technological discontinuity representing a frame break for participants, driving new debate (Goffman 1974).

We use careful language in describing our results, because we are evaluating the semantic positions of collections of documents, which lets us visualize changes in discourse that then suggest underlying theoretical mechanisms. Although there is certainly strong circumstantial evidence based on timing for the impact of the iPhone announcement on discourse, at this aggregate level of analysis, we cannot claim specific mechanisms that drive the discourse. However, LSA is used to generate positions for individual words, and so can be used to evaluate positions in the semantic space at different theoretical levels. For example, researchers could compare how the meaning attached to a product category changes over time, or how company discourse shifts in meaning even with few changes in word usage. Semantic similarity can be used to categorize documents, or their identify meanings (Larsen & Monarchi 2004, Larsen et al. 2008). This can then be used to identify other theoretical constructs in the data.

LSA has the potential to be a useful tool in understanding meanings of text, however, it requires large amounts of text and appropriately representative text both to create the semantic space, and as the subject of analysis. A space built from text that does not represent an audience's inbound information will be distorted and produce incorrect distances. In this case, we were considering the overall, market-wide discourse, and used all available media throughout the period. By contrast, a study of meanings understood by IT managers might be better evaluated primarily through publications within vertically-targeted media, with a small sample of general media publications added because they do not work in a vacuum. The corpus required to produce a good semantic model will depend on the research question, and what is already understood about likely meaning in the data. In our data, the meaning of city names (Espoo, Waterloo, Cupertino) are nearly synonymous with the companies based there (Nokia, Research In Motion, Apple), which would be misleading for non-IT research contexts. An LSA research project on internal company documents should ideally use a space built using other internal documents so that firm-specific jargon would be reflected in the space.

LSA is not a perfect tool, as it can never capture the full range of potential nuance in a text, and indeed, explicitly ignores meaning embedded in language structure and syntax. It does, however seem to provide a useful lens into overall similarities and differences between texts, which we can apply to answer different kinds of questions.

5 Conclusion

In this paper, we used demonstrated the use of Latent Semantic Analysis for study of discourse and collective cognition in the market for an emerging technology. Through a multi-stage process, we examined how the media presented the evolving smartphone industry. We collected a large media coverage corpus, and built a semantic space from these documents. We then grouped media chronologically to expose trends in the discourse. We used a heatmap of semantic distances as a graphical exploratory tool to understand groupings of chronologically-related positions in the semantic space. Our results show distinct periods in the media coverage of smartphones, with distinct shifts in discourse, and with periods that demonstrate different dynamics of transition and stability.

We show how LSA can be used to gauge the direction of discourse automatically and, importantly, numerically. This *numeric* aspect allows both nuanced and sophisticated analysis of what is actually happening, across large sets of text. As has been attributed to Peter Drucker, "if you cannot measure it, you cannot manage it." LSA allows us to measure meanings in text, across a very broad range of publications and types of text. This exploratory work should be seen as preliminary in terms of the potential application of this method to this class of problem. By quantifying semantic distance, many of our existing quantitative methods can be applied to sets of text, allowing new kinds of questions on new sets of data. LSA can be applied to model the meaning of individual terms, or aggregated to study industry-wide trends as we do here, to better see "the forest of ideas" and not just a few highly-visible "trees."

References

Anderson, P. and M. L. Tushman. (1990) Technological Discontinuities and Dominant Designs: A Cyclical Model of Technological Change. Administrative science quarterly. pp. 604-633. 10.2307/2392832.

Canalys (2007) 64 Million Smart Phones Shipped Worldwide in 2006, in Over 20 million converged devices ship in final quarter of year, Reading, UK. Reading, UK: Canalys Research.

Drazin, R., M. A. Glynn, and R. K. Kazanjian. (1999) Multilevel Theorizing About Creativity in Organizations: A Sensemaking Perspective. Academy of Management Review. 24 (2), pp. 286-307. 10.2307/259083

Evangelopoulos, N., X. Zhang, and V. R. Prybutok. (2012) Latent Semantic Analysis: Five Methodological Recommendations. European Journal of Information Systems. 21 (1), pp. 70-86. 10.1057/ejis.2010.61.

Fiss, P. C. and P. M. Hirsch. (2005) The Discourse of Globalization: Framing and Sensemaking of an Emerging Concept. American Sociological Review. 70 (1), pp. 29-52.

Gamson, W. A. and A. Modigliani. (1989) Media Discourse and Public-Opinion on Nuclear-Power - a Constructionist Approach. American Journal of Sociology. 95 (1), pp. 1-37. 10.1086/229213

Gillette, F., D. Brady, and C. Winter (2013) The Rise and Fall of Blackberry: An Oral History [Electronic version]. Business Week.

Goffman, E. (1974) Frame Analysis: An Essay on the Organization of Experience: Harvard University Press.

Hu, X., Z. Cai, P. Wiemer-Hastings, A. C. Graesser, and D. S. McNamara (2006) Strengths, Limitations, and Extensions of Lsa, in T. K. Landauer, D. S. McNamara, S. Dennis, and W. Kintsch (Eds.) Handbook of Latent Semantic Analysis, Mahwah, NJ: Lawrence Erlbaum Associates.Mahwah, NJ: Lawrence Erlbaum Associates

Kaplan, S. (2008) Framing Contests: Strategy Making under Uncertainty. Organization Science. 19 (5), pp. 729-752. 10.1287/orsc.1070.0340.

Kast, B. (2008) Transcript – Iphone Keynote 2007. Retrieved Nov 22, 2014 from http://www.european-rhetoric.com/analyses/ikeynote-analysis-iphone/transcript-2007/

Kontostathis, A. (2007) Essential Dimensions of Latent Semantic Indexing (LSI) in 40th Annual Hawaii International Conference on System Sciences, 2007. Jan 3-6, 2007 (73-73). Waikoloa, HI: IEEE

Landauer, T. K. (2006) Lsa as a Theory of Meaning, in T. K. Landauer, D. S. McNamara, S. Dennis, and W. Kintsch (Eds.) Handbook of Latent Semantic Analysis, Mahwah, NJ: Lawrence Erlbaum Associates.Mahwah, NJ: Lawrence Erlbaum Associates

Landauer, T. K., D. S. McNamara, S. Dennis, and W. Kintsch (2006) Handbook of Latent Semantic Analysis, Mahwah, NJ: Lawrence Erlbaum Associates.

Larsen, K. R. and D. E. Monarchi. (2004) A Mathematical Approach to Categorization and Labeling of Qualitative Data: The Latent Categorization Method. Sociological Methodology. 34 (1), pp. 349-392.

Larsen, K. R., D. E. Monarchi, D. S. Hovorka, and C. N. Bailey. (2008) Analyzing Unstructured Text Data: Using Latent Categorization to Identify Intellectual Communities in Information Systems. Decision Support Systems. 45 (4), pp. 884-896. 10.1016/j.dss.2008.02.009.

Leonardi, P. M. (2011) Innovation Blindness: Culture, Frames, and Cross-Boundary Problem Construction in the Development of New Technology Concepts. Organization Science. 22 (2), pp. 347-369. 10.1287/orsc.1100.0529.

Martin, D. I. and M. W. Berry (2006) Mathematical Foundations Behind Latent Semantic Analysis, in T. K. Landauer, D. S. McNamara, S. Dennis, and W. Kintsch (Eds.) Handbook of Latent Semantic Analysis, Mahwah, NJ: Lawrence Erlbaum Associates.Mahwah, NJ: Lawrence Erlbaum Associates

Navis, C. and M. A. Glynn. (2010) How New Market Categories Emerge: Temporal Dynamics of Legitimacy, Identity, and Entrepreneurship in Satellite Radio, 1990-2005. Administrative Science Quarterly. 55 (3), pp. 439-471. 10.2189/asqu.2010.55.3.439.

Orlikowski, W. J. and D. C. Gash. (1994) Technological Frames: Making Sense of Information Technology in Organizations. ACM Transactions on Information Systems. 12 (2), pp. 174-207. 10.1145/196734.196745

Quesada, J. (2006) Creating Your Own LSA Space, in T. K. Landauer, D. S. McNamara, S. Dennis, and W. Kintsch (Eds.) Handbook of Latent Semantic Analysis, Mahwah, NJ: Lawrence Erlbaum Associates.Mahwah, NJ: Lawrence Erlbaum Associates

Ruef, M. (2000) The Emergence of Organizational Forms: A Community Ecology Approach. American Journal of Sociology. 106 (3), pp. 658-714. 10.1086/318963

Sidorova, A., N. Evangelopoulos, J. S. Valacich, and T. Ramakrishnan. (2008) Uncovering the Intellectual Core of the Information Systems Discipline. Mis Quarterly. 32 (3), pp. 467-482.

Suarez, F. F. (2004) Battles for Technological Dominance: An Integrative Framework. Research Policy. 33 (2), pp. 271-286. 10.1016/j.respol.2003.07.001.

Suarez, F. F., S. Grodal, and A. Gotsopoulos. (2015) Perfect Timing? Dominant Category, Dominant Design, and the Window of Opportunity for Firm Entry. Strategic Management Journal. 36 (3) pp. 437-448. 10.1002/smj.2225.

Tee, R. and E. Iversen (2007) Competing for Centrality–a Nested Hierarchy Approach for the Establishment of Core Components in the Smartphone Market, in DIME Conference on Demand, Product Characteristics and Innovation. Jena, Germany.

Tseng, E. (2008) The First Android-Powered Phone, in Google Officlal Blog, vol. 2016: Google.

West, J. and M. Mace. (2010) Browsing as the Killer App: Explaining the Rapid Success of Apple's iPhone. Telecommunications Policy. 34 (5), pp. 270-286. 10.1016/j.telpol.2009.12.002.

29th Bled eConference

Digital Economy

June 19 - 22, 2016; Bled, Slovenia

The applicability of Process Mining to determine and align process model descriptions

Maris, A.

HU University of Applied Sciences, Utrecht, Netherlands
arjen.maris@hu.nl

Bijvank, R.E.

HU University of Applied Sciences, Utrecht, Netherlands
roland.bijvank@hu.nl

Ravesteyn, J.P.P.

HU University of Applied Sciences, Utrecht, Netherlands
pascal.ravesteijn@hu.nl

Abstract

Within the HU University of Applied Sciences (HU) the department HU Services (HUS) has not got enough insight in their IT Service Management processes to align them to the new Information System that is implemented to support the service management function. The problem that rises from this is that it is not clear for the HU how the actual Incident Management process as facilitated by the application is actually executed. Subsequently it is not clear what adjustments have to be made to the process descriptions to have it resemble the process in the IT Service Management tool. To determine the actual process the HU wants to use Process Mining. Therefore the research question for this study is: 'How is Process Mining applicable to determine the actual Incident Management process and align this to the existing process model descriptions?' For this research a case study is performed using Process Mining to check if the actual process resembles like the predefined process. The findings show that it is not possible to mine the process within the scope of the predefined process. The event data are too limited in granularity. From this we conclude that adjustment of the granularity of the given process model to the granularity of the used event data or vice versa is important.

Keywords: Process Mining, Data analysis, ProM, BPMN, Incident Management

1 Introduction

Recently a new IT Service Management tool has been introduced at the HU, department HUS. HUS is responsible for handling the IT service incident records of at least 2.700 Full Time Employees (FTE) and almost 37.000 students (HU, 2014; HU, 2014b). HUS is looking for options to manage their business processes more rapidly according to a Plan, Do, Check, Act-cycle (Deming, 1982). With the new tool TOPdesk (the former was HP Service Desk) HUS wants to support their ITIL 'Information Technology Infrastructure Library' processes. However currently it is insufficiently known how well the ITIL processes are supported by the application. Therefore it is not clear what adjustments have to be made to the process descriptions (as part of ITIL) to fit to the IT Service Management tool. To align TOPdesk to the ITIL process descriptions HUS needs more insight into the actual processes. To determine the actual processes the use of Process Mining is proposed.

Process Mining is a discipline between machine learning and data mining on one side and process modeling and analysis at the other (Aalst, 2011). It is a relatively young field of study that enables the discovery, monitoring and improvement of processes. In Process Mining this is done by studying event logs, which are subsequently converted to a process model via Process Mining Software (Aalst, 2011). The results can then automatically be compared with existing process models (Aalst, 2011).

Because Process Mining is a relatively young field of study and never used before within the HUS, this research is focusing on the applicability of Process Mining for determining the actual processes within HUS. One of the processes of IT Service Management is focused on managing incidents (IT service incident records). The Incident Management (IM) process describes how to 'log', control and organize the following-up of service incident records (Bon, et al. 2007). The logging of incidents in HP Service Desk results in event data that is used in this study.

Based on the above the research question is: **How is Process Mining applicable to determine the actual Incident Management process and align this to the existing process model descriptions?**

The goal of this study is to create a list of relevant points of attention to make the applicability of Process Mining better.

The remainder of this paper is structured as follows, in the next section the research approach that was followed is described. In section 3 the concepts of this research: Business process, Process Mining and applicability are discussed. Section 4 describes the results of the case study. This includes the comparison between the described and actual process and subsequently the gap analysis that results in an enumeration of possible adjustments. Conclusions and recommendations for further research are provided in section 5 and the limitations are listed in section 6.

2 Research Approach

As mentioned above this research is intended to result in a validated enumeration of applicability factors. Since such an enumeration is essentially an artefact that requires designing, a design research approach was chosen (Hevner, et al. 2004). In Figure 1 the sub questions and corresponding results related to the research approach are shown.

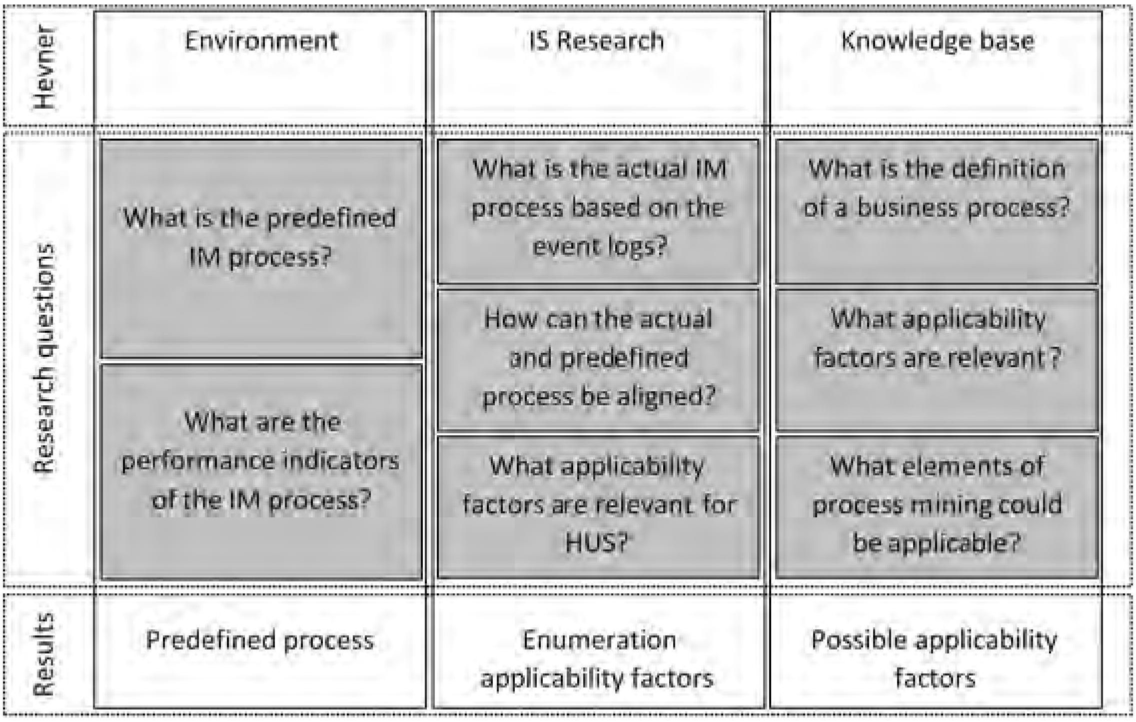


Figure 1 – Research approach (cf. Hevner, et al. 2004)

In relation to the design research method (Hevner, et al. 2004) the process owners and experts are representatives of the environment. The process owners and experts are interviewed to discover the predefined process as well as the currently defined performance indicators.

With the existing knowledge base (Hevner, et al. 2004) of this study the key elements of this research are operationalized: business process (predefined and actual), Process Mining and applicability. With a literature research these elements are defined and the applicability factors are listed. Also available within the organization is a sufficient amount of data that is needed for Process Mining. The data (event logs) used in this research is gathered during the 7 years that HP Service Desk was used (from 2008 – 2015).

After the key elements of this research are defined and the current process is described, the study continues with ‘discovering’ the actual process. For this the event logs are used for Process Mining. Subsequently ‘conformance checking’, i.e., “Is there a good match between the recorded events and the model?” (Rozinat & Aalst, 2008), is done to compare the actual process with the predefined process. The above describes the IS research phase of design science (Hevner, et al. 2004), here the findings of the environment will be compared with the results of the knowledge base. Based on this a list of Process Mining applicability factors is developed and validated.

3 Theoretical Foundations

In order to define the concepts of this research (Business process, Process Mining and applicability) a literature study is performed. Both scientific and professional literature was explored using different digital libraries available via the university and Internet.

3.1 Business Process

A business process is often shortly and succinctly defined (Lindsay, et al. 2003). Jacobson (1995) describes a business process as “The set of internal activities performed to serve a customer”. Hammer & Champy (1993) state that a business process is a “Set of partially ordered activities intended to reach a goal”, while Bon (2012) says that a process is made up of structured activities that create a certain goal. Yet another definition of process is given by Maříková, et al. (2015): “A business process is a set of activities that change input into output for other people or processes by using human resources and tools”.

For this research it is needed that both process descriptions (actual and predefined) have the following elements in common:

- The goal (IM process)
- The start and finish (Received and closed incident records)
- The set of activities

Based on this and the above definitions the following definition of a business process is formulated:

A business process is a set of activities, changes or functions that change input into output by using human resources and tools to reach a common goal.

Business processes can be described and modelled (Rolland, et al. 1999). For instance with BPMN, which is a Process Modelling Notation with the primary goal to be understandable by all stakeholders of the process (White, 2004).

3.2 Process Mining

To gain more insight into the information, activity and material flow within the process there are several methods such as mind mapping, assessments and audits (Brown, et al. 2011, Mento, et al. 2002). These methods need the input of, for instance, process owners and experts. Process Mining can be considered as a search for the most appropriate process out of the search space of candidate process models (Aalst, et al. 2005), or it can be seen as a tool in the context of Business Activity Monitoring and Business (Process) Intelligence (Dongen, et al. 2005). Process Mining uses event data as an input to discover process models and actor interaction networks (Caetano, et al. 2015). In this study the applicability of Process Mining is tested. Kettinger et al. (1997) say that there are methodologies, techniques and/or tools to manage Business Processes. Here we use the following definition of Process Mining:

Process Mining is a technique for analyzing event logs to discover a process model and to use the derived model for conformance checking (Aalst, et al. 2007; Aalst, 2011).

3.2.1 Types of Process Mining

Three types of Process Mining can be distinguished (Aalst, 2011; Aalst, 2011b):

1. Using event logs to discover a process (process discovery),
2. Using event logs to analyze differences between a discovered process and the predefined process (conformance checking),
3. Using event logs to repair / extend a predefined process (model enhancement).

During discovery the event logs of the process are ordered sequentially by unique events. By comparing or plotting the steps of the unique events (activities) a process model can be created. In this way an organization can depict an 'actual' process in an organization. With discovery it is possible to see which activities are visible in the data based on event logs (Aalst, 2011b).

The results of the discovery can be compared with the existing process model descriptions. In this comparison, the researcher looks for differences between the discovered process model (actual process model) and the predefined process model. So Conformance Checking gives the organization an insight if the organization is following the same path as the process model (Aalst, 2012).

When checking the process, one seeks for deviations between the actual process and the predefined process. In the improvement of the process, the data from the event logs is used to improve the process. In both scenarios, the event logs and the process model are compared. Finally according to Aalst (2011) there are two ways to improve processes with Process Mining:

1. Repair: adjusting the predefined process model to the actual process.
2. Extension: extent or adjust the predefined process model to the desired process.

3.2.2 Process Mining Software

Currently there are several tools for Process Mining available, amongst them Celonis, Disco and ProM. At the moment only ProM is commonly used for (scientific) research. ProM is being developed at the Technical University of Eindhoven. ProM is a framework for a wide range of Process Mining algorithms. The software tool is open source and not supported by a commercial party. In this study ProM is used, because of the rather large number of algorithms it provides for analysis and the fact that Conformance Checking is supported (Kebede, 2015).

Within ProM event data can be analyzed in different ways by the use of various plugins (packages) in the program. At present, ProM has packages in which different input types (for instance CSV files) can be converted into XES (Extensible Event Stream) within ProM. So there are less strict requirements for input data (event logs) compared with Celonis and Disco. In addition, there are ProM packages available that support the use of Business Process Model and Notation (BPMN). These packages are necessary if a conformance check must be made based on BPMN diagrams (Kebede, 2015). Another package is Inductive Visual Miner.

3.3 Applicability

HUS is looking for methodologies, techniques and/or tools (Kettinger, et al. 1997) to manage their business processes. Recently Business Process Management (BPM), a 'method' to manage business processes horizontal through an organization, is getting more attention, specifically the use of BPM Information Systems (Westelaken, et al.

2013). Process Mining is expected to fit the goals of HUS to rapidly analyze, design and simulate processes. Therefore the Process Mining techniques will be used to improve or redesign the IM process. Considering the three types of Process Mining (process discovery, conformance checking and model enhancement) the applicability of Process Mining can be tested for the 'plan, do and check' (Deming, 1982) stages. Subsequently the 'act' (choosing and realizing optimizations) will be performed by humans. This means that if the next three stages are known the applicability of Process Mining will be answered:

1. (plan) Which requirements are needed before process discovery is possible?
2. (do) Which requirements need to be fulfilled before conformance checking can be done?
3. (check) What needs to be known before process optimizations can be proposed?

4 Results

4.1 Incident Management Process and Indicators

To gather detailed information of the predefined process and performance indicators, qualitative research was done. Within HUS the responsibility for the IM process is appointed to one expert. Two interviews took place with this expert of approximately 1 hour each. The first interview was an explorative interview (semi-structured) to verify the predefined process in BPMN. The second interview was also semi-structured with the purpose to verify the outcomes of the actual process and to accumulate the Key Performance Indicators (KPIs) for the IM process. Besides these interviews a meeting with eleven stakeholders with interest in IT Service Management processes and contact with the Senior Advisor Process Management HU was organized to validate the process descriptions and to derive possible KPIs. Off all meetings minutes have been taken. The content of the minutes have been read and approved by the respondents. The minutes of these meetings are available in Dutch upon request to the authors.

4.1.1 Predefined process

The current processes are developed via several stakeholders meetings in 2013 that are organized by the HU 'process management team' (Process Table, 2015). These predefined processes show how the IM processes of the HU should look like according to the process stakeholders. Because all employees must understand the predefined process and not everyone can read a process modelling notation (Joku, 2015), the predefined processes of HUS are simple and displayed in a free format process notation.

ProM does not have the ability to read free format process models, but it has the ability to read BPMN diagrams. BPMN is ratified as an official industry standard through the standards body Object Management Group (Recker, 2012). The internal representation of BPMN diagrams within ProM are Petri Nets (Petri, 1962). A Petri Net is a directed bipartite graph which behaves like a Nondeterministic Finite Automaton (Hopcroft, et al. 2006).

Because of the above the predefined process is converted into BPMN. During the conversion, the contents (activities) of the predefined process have not been changed and the BPMN drafts were verified by the expert of HUS (Kramer, 2015). The verified predefined BPMN process model is attached in appendix 1.

4.1.2 Performance Indicators

To optimize the IM process it is important to establish a baseline with relevant KPIs. To determine these indicators this topic was part of the interview with the HUS expert (Kramer, 2015) and during a stakeholder meeting that was organized on the 25th of November 2015. In both the interview and the meeting it was determined that there are currently no (relevant) KPIs defined for the IM process. Therefore the annual report of the HU (HU, 2014) was analyzed to derive KPIs that are relevant for this research. Unfortunately no relevant KPIs were found (HU, 2014). Therefore it is not possible to determine which process optimizations will have the most impact based on KPIs.

4.2 Process Analysis and Alignment

4.2.1 HP Service Desk process

For the actual process model the event data of HP Service Desk is used. During the process of preparing the event data a selection is made to determine which database fields are exported. As HR and Security related information is sensitive (privacy issues) these were omitted. Furthermore as the predefined process was developed in 2013, only the data of 2014 and 2015 is used.

The output was a tab separated text file. Changing the text file to a semicolon CSV file is done in Microsoft Excel. A Python script is used to remove damaged lines. The script secures the possibility to edit every bit of data in the same way. The Python script is available upon request to the authors.

The filtered CSV files are imported in MySQL (version 5.6.24) database tables, separated by year. The structure for every table is the same, see appendix 2. VARCHAR 255 is used for almost every field to make sure every piece of data is correctly imported. To make sure no data is lost during the analyses process a view table is created to visualize and check the data. The query that is used for making the view table is added in appendix 2.

The database data is exported to a CSV file. The CSV file is imported in ProM 6.5.1. With the help of the Inductive Miner package a BPMN draft of the actual process is made (figure 2).

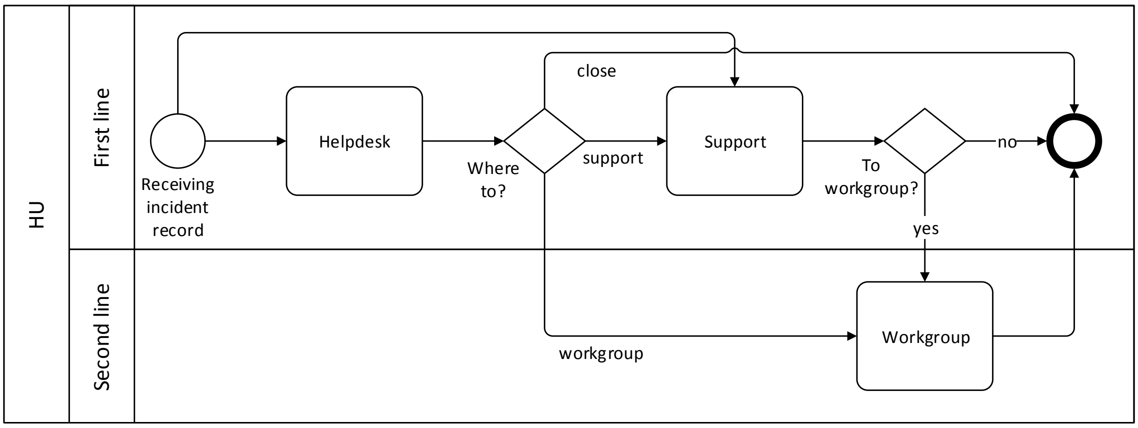


Figure 2 – Actual process based on the event data of HP service Desk from 2014 - 2015

Besides the actual process (figure 2) an overview of the main attributes that are logged in HP Service Desk is described, including an explanation.

Incoming incident

Incident records are received by phone, email or any other means of communication. This is logged within the event data. For the predefined process the used channel is not relevant, since every incident record must be handled in the same manner, despite the communication channel.

Assigning incident

When an incident record is logged by first line support, it could be assigned or re-assigned to a workgroup, this is called 'to workgroup'. It is not logged why it has been (re)assigned to a workgroup, therefore it is not possible to determine if the incident record was re-assigned due to a mistake or because it was needed to solve the incident by another department.

Logging status

A status change is logged, but it does not show where in the process an incident record is. For example, when the new status is 'waiting for customer', it might be the case that the incident record is waiting for input because of lack of information to solve the incident or the service desk employee needs the customer to confirm that the incident is fixed. It is possible to see when an incident record has to wait for a supplier or customer, but without reason it is impossible to say why a customer or supplier is needed.

Category

The attribute 'category' shows to which category the incident record belongs (for instance 'Incident', 'Question' or 'Procurement'). As changes of category are not logged it is not possible to determine if changes are made due to earlier mistakes or whether there is another reason.

4.2.2 Predefined and actual process

Evaluation of a model based on an event log analysis can only be done accurately if the behavior that the model allows is well-defined. 'Deviations' are a crucial part of the evaluation. They show precisely what parts of the model deviate with respect to the log or vice versa. Two types of deviations have been identified (Adriansyah, 2014): if a trace contains an event that is not allowed by the model, it is a *log move*; if the model requires an event that is not present in the trace, it is a *model move* (Leemans, et al. 2014).

Five differences can be described between the predefined and the actual process. These results were verified by the HUS expert (Kramer, 2015b) and by analyzing the categories in the event logs.

The following three model moves are found:

1. The event logs are not logging the reason why an incident record has been forwarded to another user or department. For example, when an incident record has been assigned to the wrong user or department. Or when the first assignee has done his job and needed to forward it to the next department to solve the incident. That is why it is not possible to say why an incident record has been forwarded to another user or department.
2. In the predefined process a distinction is made between the functional owner and other control groups. The actual process is not showing these distinctions, so it is not possible to say anything about the control groups.
3. It is possible to see when an incident record needs input from the customer, but the reason why is not logged. So it is not clear if the incident record needs more input about the incident or a user is asked whether the provided incident resolution has solved the problem.

The following two log moves are distinguished:

1. When an incident record is registered the communication channel is logged (for instance phone, or e-mail).
2. The event logs shows when an incident record needs to wait on a supplier.

5 Conclusion and discussion

For this study the following research question was formulated: 'How is Process Mining applicable to determine the actual Incident Management process and align this to the existing process model descriptions?'

As described in 3.3 the applicability op Process Mining is studied according to the three stages of Deming (1982). Based on this several results were found. First of all, if there is no strict process modeling language used to describe processes (such as e.g. BPMN) it cannot be imported into ProM (and many of the other tools). This means such processes need to be converted first before any analysis is possible.

In addition, in this case study differences between the predefined process and the event logs are found. Three elements are not displayed in the event logs and two elements are not displayed in the predefined process. It appears the data used for the actual process does not have enough depth. This is why a very small part of the predefined process is seen. The steps in the process that are seen, match more with an information flow as the ‘human’ steps in a process. The difference between the predefined and actual process is based primarily on a difference in granularity. The predefined process is developed with manual activities in mind while the actual (mined) process is based on the automated information flow. Based on this we conclude that the ‘quality’ of the data that is to be used for Process Mining is very important.

Furthermore this research shows that HUS has no (relevant) KPIs formulated for the IM process. Our advice would be to look for ITIL KPIs, for example via ITIL Wiki (Kempter & Kempter, 2007). KPIs are relevant for the Check stage of the PDCA cycle, because without baseline measurements improvements cannot be made visible.

We conclude that in this case study context three things need to change to improve the applicability of Process Mining:

1. (plan) The process models need to be described in a standard modelling notation such as a BPMN format.
2. (do) The event logs need to be aligned with the process so the process steps are logged besides the desired information and the ‘quality’ of the event data will improve.
3. (check) The KPIs of the process needs to be formulated. Without KPIs it is not possible to check (Deming, 1982) if the process is performing conform the expectations.

The results have been presented at the Process Table of January 2016 (Process Table, 2016). The stakeholders acknowledge the findings. So in the current situation Process Mining is not yet applicable. If HUS wants to use Process Mining techniques in the future, than HUS is advised to standardize their process descriptions. During this conversion the information layer with its specific data definitions should be taking into account. Each step of the process needs to be logged. Only then the entire process flow can be retrieved out of the event logs. Documentation should be written which explains what is logged, referring to the described process. Finally, HUS has to formulate KPIs, which can be used for decisions concerning optimization.

Because this research is based on a single case and validated within the scope (HUS), the results are not easily generalizable to a broader scope. Still the findings of this study include points of attention for other organizations that want to start with Process Mining. To create more knowledge on this topic we recommend further research on this matter within different environments. Also we suggest to do further research on how process steps can be logged within the IT systems. New developments (data visualizations, or use of statistics) can perhaps help on this matter.

6 Limitations

The data for this study is supplied by HUS without involvement of the researchers. The research team did not have direct access to the data. At all times the data gathering in the system had to be carried out by an intermediary. Therefore there might be issues with the data quality that cannot be determined by the researchers.

Another limitation is that the research group did not know which data was available. The only way to determine whether data was available was to inquire if certain data exists. Besides that, there is also data that was not provided. This is to protect the privacy of the staff, students and other stakeholders and prevent unintended spread of security issues. With this we refer to the data of HR group and log rules on the security of HU systems. Therefore the research team does not exactly know how much data is missing.

As stated this case study used only data from HUS. The statements are therefore about HUS and not about processes of Incident Management in general.

Acknowledgement

We would like to acknowledge the following students; Bos, A., Bakker, M.C.A., Smeets, R.D., and Spanbroek, E. They delivered a great contribution to this research.

References

Aalst, W.v.d., Alves de Medeiros, A.K. & Weijters, A.J.M.M. (2005). Genetic process mining. Springer-Verlag Berlin Heidelberg, 26th International Conference. ICATPN 2005, Miami, USA, pp.48-69.

Aalst, W.v.d. (2007). Business process mining: An industrial application. Science Direct. Information Systems 32, pp.713–732.

Aalst, W.v.d. (2011). Process Mining: Discovery, Conformance and Enhancement of Business Processes. Springer Publishing Company, Incorporated, 2011.

Aalst, W.v.d. (2011b). Using Process Mining to Bridge the Gap between BI and BPM. Computer, v.44 n.12, pp.77-80, December 2011.

Aalst, W.v.d. (2012). Process mining. Communications of the ACM, 55(8), 8–11.

Adriansyah, A. (2014). Aligning Observed and Modeled Behavior. Ph.D. thesis, Eindhoven University of Technology (2014)

Bon, J.v., Jong, A.d., Kolthof, A., Pieper, M., Tjassing, R., Veen, A.v.d. & Verheijen, T. (2007) Foundations van ITIL V3.0.

Bon, J.v. (2012). ITIL 2011 Editie - Pocketguide (NL). Van Haren Publishing B.V. Coursera (2015). Process Mining: Data science in Action.

Brown, R.A., Recker, J.C. & West, S. (2011). Using virtual worlds for collaborative business process modeling. Journal of Business Process Management, 17(3), pp.546-564.

Caetano, A., Pinto, P., Mendes, C., Mira da Silva, M. & Borbinha, J. (2015) Analysis of Business Processes with Enterprise Ontology and Process Mining. INESC-ID & IST, University of Lisbon.

Deming, W.E. (1982) Out of the Crisis. The Massachusetts Institute of Technology, Cambridge, Massachusetts: MIT Press.

Dongen, B.F.v., Medeiros, A.K.A.d., Verbeek, H.M.W., Weijters, A.J.M.M. & Aalst, W.v.d. (2005). The ProM Framework: A New Era in Process Mining Tool Support. Springer-Verlag Berlin Heidelberg, 26th International Conference. ICATPN 2005, LNCS 3536, pp.444–454.

Hammer, M. & Champy, J. (1993). Re-engineering the Corporation; A Manifesto for Business Revolution. Harper Business, New York.

Hevner, A.R., Park, J., March, S.T. & Ram, S. (2004). Design science in information systems research MIS Quarterly Vol.28 no.1/March 2004, pp.75-105.

Hopcroft, J.E., Motwani, R. & Ullman, J.D. (2006). Introduction to Automata Theory, Languages, and Computation. Pearson.

HU. (2014). Annual report HU 2014.

HU. (2014b). Annual accounts HU 2014.

Jacobson, I. (1995). The Object Advantage, ISBN0201422891, Addison-Wesley.

Joku, S. (2015). Interview Suzie Joku.

Kebede, M. (2015). Comparative Evaluation of Process Mining Tools.

Kempter, S., Kempter, A. (2007). 'ITIL Key Performance Indicators.' ITIL Key Performance Indicators. It Process Maps, n.d. Web. 04 Mar. 2016.

Kettinger, W.J., Teng, J.T.C. (1997). Business process change: a study of methodologies, techniques, and tools.

Kramer, H. (2015). Interview Hans Kramer. 10th of November 2015.

Kramer, H. (2015b). Interview Hans Kramer. 9th of December 2015.

Leemans, S.J.J., Fahland, D. & Aalst, W.v.d. (2014). Process and Deviation Exploration with Inductive visual Miner.

Lindsay, A., Downs, D. & Lunn, K. (2003). Business Processes - Attempts to Find a Definition. Information and software technology, 2003 – Elsevier.

Maříková, M., Rolínek, L., Kubecová, J. & Vrchota, J. (2015). Relationship between the extent of implementation of the process management principles and the legal form of the business and business activity. Serbian Journal of Management, 10(1), 109–116.

Mento, A.J., Jones, R.M. & Dirndorfer, W. (2002). A change management process: Grounded in both theory and practice. Journal of Change Management, Aug 2002, 3, 1, ABI/INFORM, Global, pp.45-59.

Petri, C.A. (1962). Kommunikation mit Automaten. (Ph. D. thesis). University of Bonn.

Process Table. (2015). Stakeholders meeting. 25th of November 2015.

Process Table. (2016). Stakeholders meeting. 28th of January 2016.

Recker, J.C. (2012). "Modeling with tools is easier, believe me" : the effects of tool functionality on modeling grammar usage beliefs. Information Systems, 37(3), pp.213-226.

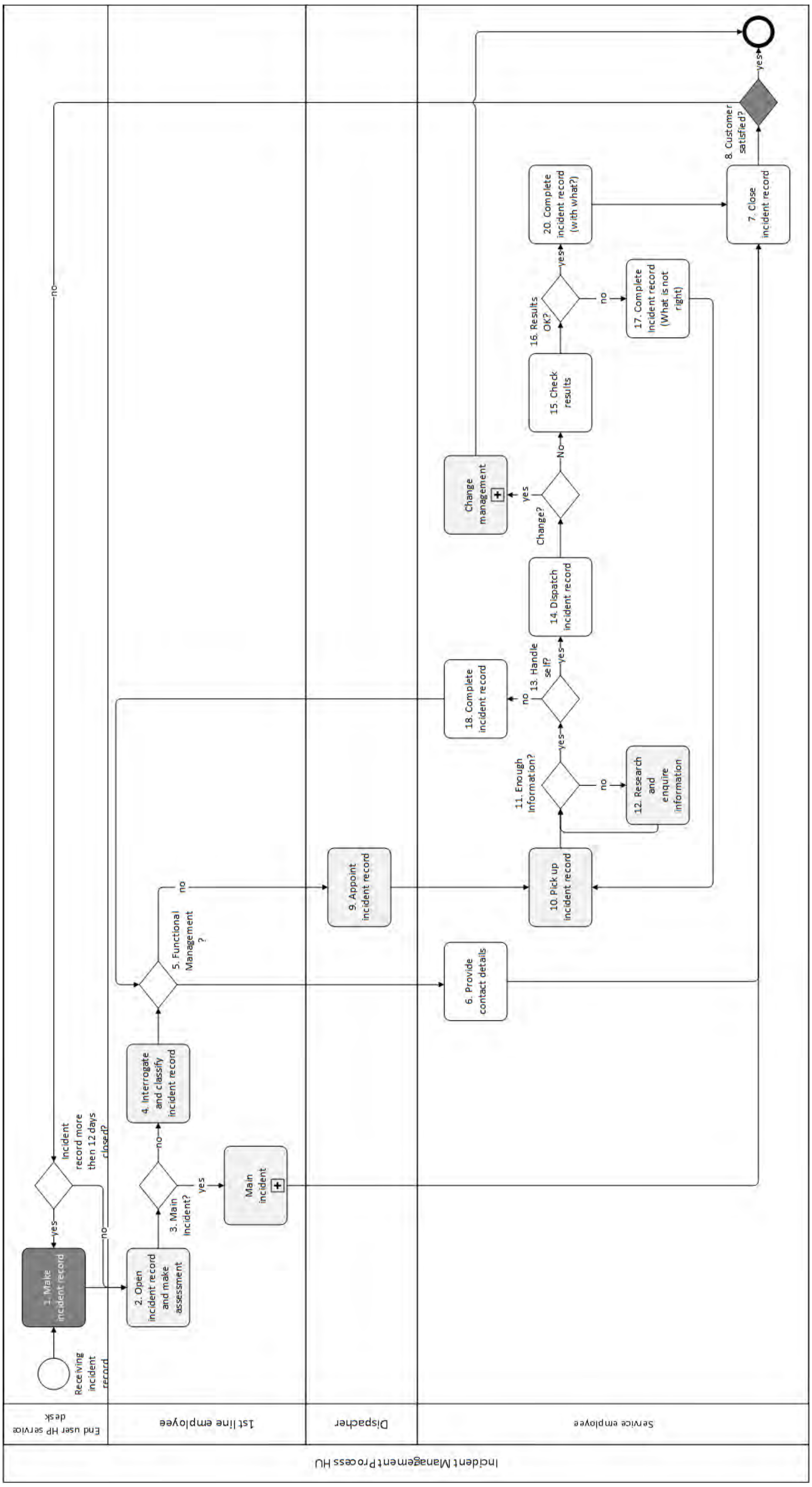
Rolland, C., Prakash., N. & Benjamen, A. (1999). A Multi-Model View of Process Modelling. Requirements Engineering. December 1999, Volume 4, Issue 4, pp.169-187.

Rozinat, A., Aalst, W.v.d. (2008). Conformance Checking of Processes Based on Monitoring Real Behavior, Information Systems 33 (1), pp.64-95.

White, S.A. (2004). Introduction to BPMN. BPTrends, 1–11. IBM corporation.

Westelaken, T.v.d., Terwee, B. & Ravesteyn, J.P.P. (2013). Method for Business Process Management System Selection. 24th Australasian Conference on Information Systems BPMS Selection Method 4-6 Dec 2013.

Appendix 1: Predefined process Incident Management BPMN



Appendix 2: Data

Name	Type
Servicecall.Id	int 11
Impact	varchar 255
Priority	varchar 255
Category	varchar 255
Closure Code	varchar 255
Creation (Date only)	varchar 255
Actual Finish (Date only)	varchar 255
Attribute Name	varchar 255
New Value	varchar 255
Created	varchar 255
Workgroup Name	varchar 255
Rel Changes.Id	varchar 255
Rel Incidents.Id	varchar 255
Description	varchar 255
Accountable Duration	varchar 255
Priority-Duration	varchar 255
Actual Finish (Date & Time)	varchar 255
Created (Date&Time)	varchar 255
Creation date (Date & Time)	varchar 255

Table 1: MySQL table structure

Name	Type
Servicecall.Id	int 11
Category	varchar 255
Event	text
Created	datetime

Table 2: Structure MySQL view table

```
select `hu`.`2015`.`Servicecall.Id` AS `Servicecall.Id`,`hu`.`2015`.`Category` AS `Category`,(case when (`hu`.`2015`.`New Value` like 'Steunpunt%') then concat(`hu`.`2015`.`Attribute Name`,' - ','Steunpunt') when (`hu`.`2015`.`Attribute Name` like 'Medium%') then convert(concat('Medium') using latin1) else concat(`hu`.`2015`.`Attribute Name`,' - ',`hu`.`2015`.`New Value`) end) AS `Event`,str_to_date(`hu`.`2015`.`Created`,'%d-%m-%Y %H:%i:%s') AS `Created`,`hu`.`2015`.`Workgroup Name` AS `Workgroup Name`,`hu`.`2015`.`New Value` AS `New Value` from `hu`.`2015` where ((`hu`.`2015`.`Created` is not null) and (not((`hu`.`2015`.`New Value` like 'No'))))
```

Table 3: Query MySQL view table

29th Bled eConference

Digital Economy

June 19 - 22, 2016; Bled, Slovenia

An Empirical Assessment of Researcher Perspectives

Roger Clarke

Xamax Consultancy Pty Ltd, Canberra, Australia
Visiting Professor, Research School of Computer Science, ANU, Canberra
Visiting Professor, UNSW Law, Sydney

Roger.Clarke@xamax.com.au

Abstract

The notion of researcher perspective refers to the viewpoint from which the object of study is observed. It appears to have to date attracted very little attention in the IS and cognate literatures. On the basis of preliminary studies undertaken in relation to a range of IS publishing venues, the author's contention is that the vast majority of IS research adopts the perspective of the system sponsor, with very little adopting the perspectives of users, usees or the environment, and very little of it reflecting the reality that stakeholders in information systems have distinct and often conflicting interests.

A review was undertaken of the perspectives adopted by researchers in papers presented at the Bled eConference. On the basis of a 20% sample, Bled papers were found to have been very strongly oriented to the interests of system sponsors. Although a larger proportion of papers at recent events have been on the social dimension, most studies of social media are motivated by the desire of corporations to exploit social media users. Few researchers rise to the considerable but important challenges of dual-perspective and multi-perspective studies. The quality of IS research can be much-improved if researchers give more careful consideration to the perspective(s) that they adopt in their work.

Keywords: Object of study, stakeholders, system-sponsor perspective, dual-perspective research, generic-perspective research, public policy research

1. Introduction

The term 'perspective' is often encountered in discussions of research methods. Most of those mentions, however, refer to the 'theoretical perspective' that the researcher is adopting, which provides the lens through which the phenomena of interest are observed. The sense in which 'perspective' is used in this paper is different. Rather than the lens, the concern here is about the angle from which the phenomena are viewed.

Hence:

> *By 'researcher perspective' is meant the viewpoint from which phenomena are observed*

Previous work has considered the influence of the researcher's perspective on the design, conduct and outcomes of research (Clarke 2015). This paper summarises those findings, and reports on an examination that was undertaken of a sample of the corpus of over 1,000 papers published in the Bled conference proceedings in the 28 years 1988-2015.

The following section provides an outline of the notion of perspective as developed in prior research and applied in this paper. The nature of the Bled Conference is then discussed, and the factors identified that were reflected in the research design. The results are presented, and their implications discussed.

2. The Notion of Perspective in Research

Interpretivism's point of departure is that "our knowledge of reality is gained only through social constructions such as language, consciousness, shared meanings, documents, tools, and other artifacts" (Klein & Myers 1999, p.69). Importantly for the current analysis, "the phenomenon of interest [is] examined ... from the perspective of the participants" (Orlikowski & Baroudi 1991 p.5). However, this is better expressed as 'from the perspective**s** of the participants', to avoid the presumption that all participants share the same view.

The acceptance of interpretivist approaches within the information systems (IS) discipline brought with it the insights that phenomena are subject to multiple interpretations, and hence that the perspective adopted by any one party is not determinative, but is merely one among many. This has important implications that have attracted far too little attention in the IS literature:

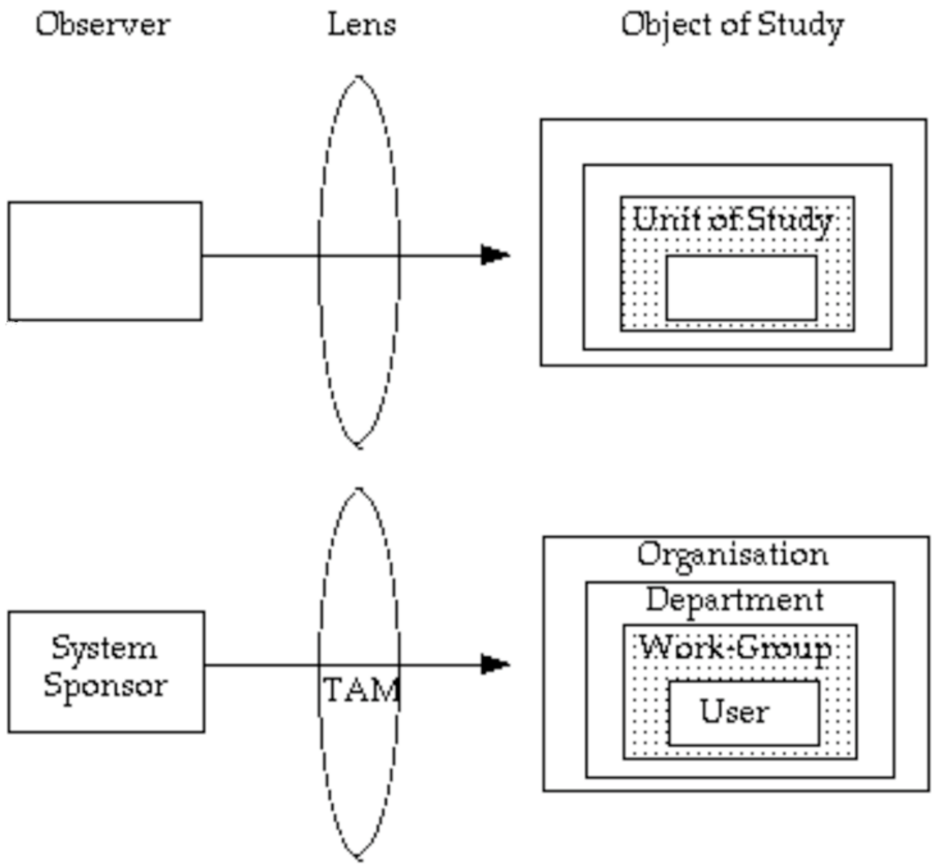
> *A perspective adopted by a researcher is specific rather than universal.*
>
> *The choice of perspective(s) influences the conception of the research and the formulation of the research questions, and hence the research design, the analysis and the results*

The categories of entity that have an interest in particular phenomena are commonly referred to as stakeholders, and the viewpoint that an IS researcher adopts is commonly that of one of the stakeholders. Many of the stakeholders are participants in the process or intervention, in such roles as investor, data source, technology provider, system sponsor or user (Seddon et al. 1999). Some stakeholders, however, are not participants, yet they are directly impacted by the process or intervention. The term 'usee' is sometimes applied to non-participant stakeholders (Clarke 1992). Some parties that are even more remote from the process or intervention may be indirectly affected by its implications, where for example a new information system has the effect of disintermediating a company, resulting in the cessation of business operations, layoffs, and economic hardship for employees' families, and perhaps for others in the regions in which the company operated. To achieve a comprehensive understanding of phenomena, indirectly-affected parties also need to be treated as stakeholders.

It is important to distinguish the concept of researcher perspective from those of the object of study and the unit of study. The 'object of study' is the set of phenomena that the researcher observes. The notion 'unit of study' refers to the level of granularity of the observation. Figure 1 provides a diagrammatic representation that draws out the distinctions. In textual form:

> *'a researcher adopts a perspective from which observations are made of an object of study, at a level of abstraction called the unit of study'*

Figure 1: Conceptual Model and Example



These ideas are presented in greater detail in Clarke (2015). In that paper, it was argued that researchers must make clear to their readers the perspective that they have adopted, in order to avoid readers overlooking the inevitable limitations of the work. This gives rise to obligations on researchers to appreciate the influence of the perspective that they adopt on the outcomes of their research, to consider alternative perspectives, and to be clear about which they have chosen and why.

Across the IS discipline, many categories of stakeholder can be identified, each with their own perspective, and they exist at different levels of abstraction. For example, a corporation or government agency has multiple sub-organisations, and individual roles within them; and the interests of humans affected by information systems can be considered at the level of each individual employee, of work-groups or of the employed workforce as a whole; or at the level of each individual external to the organisation, the communities with which they identify, or society, variously at the level of a region or a nation. Table 1 provides examples of perspectives that may be relevant to various kinds of IS research. They are categorised according to the dimensions on which they lie, and sequenced in descending order of generality.

Table 1: Dimensions and Levels of Abstraction of Alternative Researcher Perspectives
Reproduction of Table 1 from Clarke (2015)

EconomicDimension	**SocialDimension**	**EnvironmentalDimension**
World Economy	Humanity	The Planet
Supra-National Region (e.g. EU, NAFTA)		
Nation-State	A Society	The Troposphere
Regional Economy		
Sector / Value-Chain	A Community	The Biosphere
Strategic Partners		
Organisation	A Person	A Localised Ecology
Sub-Organisation		

In Clarke (2015), it was argued that the Economic Dimension dominates IS research, and that the Researcher Perspective adopted is in most cases that of the particular stakeholder that this author refers to as 'the system-sponsor'. By that term is meant the organisation that is developing, implementing or adapting a system, process or intervention, or for whose benefit the initiative is being undertaken. In some cases, however, the system sponsor may be a cluster or category of organisations.

The following examples indicate how different researcher perspectives give rise to different research questions, in this case in the currently-popular field of social media research:

- **Perspective: System-Sponsor**
  RQ: What proportion of social media subscribers need to authorise the provider to exploit their data to ensure that advertising-based business models are viable?
- **Perspective: Other Than the System-Sponsor's**
  RQ: What techniques and tools are available to social media subscribers to enable them to obfuscate, subvert or falsify their identities and locations, and how understandable and practicable are those techniques and tools?
- **Perspective: Dual-Perspective**
  RQ: How do the views of social media users and providers compare in relation to providers' Terms of Service and privacy features and policies; and to techniques and tools for user identity and location obfuscation, subversion and falsification?

- **Perspective: Generic-Perspective**
  RQ: What are the social and economic impacts of the current, exploitative business model for social media; and what benefits and disbenefits would accrue to which stakeholders if regulatory measures were imposed in order to achieve balance between the interests of providers and subscribers?

In Clarke & Pucihar (2013), it was argued that "The perspective of a single organisation is valid, but so too are those of industry segments and sectors, of regions, of nations and of supra-national economic collectives or blocs such as the EU, NAFTA and APEC. But in order to lift [electronic interaction] research beyond the economic to the social, it is necessary to also reflect the interests of not-for-profits, NGOs and associations, of communities, of consumer and citizen segments, of social groups, and of individuals". The survey reported here is part of a larger study being conducted in order to understand how authors in key IS venues approach the question of researcher perspective.

3. The Bled eConference

The results of IS research are published in many different venues, primarily journals, journal special issues and sections, and conference proceedings (but also edited volumes, sponsor-supported volumes and web-sites, institutional and personal repositories, and – far too rarely – magazines targeted at professionals and managers, and reports by and for business and government). Some venues solicit and publish contributions on any and all aspects of the information discipline, and the spread of researcher perspectives adopted in papers could reasonably be expected to reflect those evident in the discipline as a whole. Other venues are oriented to particular aspects of the discipline, to particular theories, particular research methods, or particular research domains.

The Bled eConference has been run annually since 1988 in Bled, Slovenia, hosted by the University of Maribor. It has been international in nature since its inception, and its standing in its field is high, with all papers during the 21 years commencing in 1995 fully-refereed, with all years since then giving rise to Special Sections in journals (primarily the A journals International Journal of Electronic Commerce and Electronic Markets), and with revised versions of many further papers subsequently appearing in a wide range of journals.

The Bled eConference is focussed on a research domain. Given the dynamic nature of the IS discipline and of electronic technologies during the last three decades, the way in which the conference's domain is perceived has adapted over the years. Analysis of the 1988-2011 events in Clarke (2012) noted the migration of the titles from EDI (5 years), via EDI and Inter-Organizational Systems (3 years) and Electronic Commerce (9 years) to 'the eConference' (for the 12th successive year in 2016). In Clarke & Pucihar (2013), the term 'eInteraction' was adopted as a unifying term, referring to "any form of communications facilitated by electronic tools, provided that they have the capability to support two-way communications".

The declared Conference Themes of the 29 events 1988-2016 are listed in Appendix 1. Many of the Themes were very specifically oriented to the needs of organisations, particularly for the first 13 events until 2000. By that time, however, it was apparent that extra-organisational systems (Clarke 1992) had become common, and that individuals and communities were becoming significant participants. The 14th event in 2001 included 'e-Household' and 'e-Democracy', in 2006 the title was 'eValues', in each of the three years 2009-11 'Society' figured prominently, and in 2015, 'eWellbeing'.

The notion of researcher perspective was mentioned in the Bled eConference opening sessions in 2014 and 2015. In 2016, the theme was set firmly on the Economic Dimension, as 'Digital Economy'. However, the perspectives of several categories of individuals were explicitly mentioned in the Call for Papers (emphasis added), as follows:

> *"We will focus on many aspects pertaining to the dawn of the Digital Economy ... we will examine issues such as how organizations can benefit from the Digital Economy ..., but* ***also from the perspective of the individual****, including: the empowered (ageing) citizen, the entrepreneur, the patient, the consumer, the student, the lecturer and the employee"*

This paper reports on a survey of papers in Bled eConferences whose purpose was to assess the perspectives adopted by authors of papers presented there. This author's impressions, supplemented by some pilot studies, suggested that, within the IS discipline as a whole, there has been a heavy leaning towards Researcher Perspectives on the Economic Dimension (~ 90%), a modest proportion on the Social Dimension (~ 10%), and almost none on the Environmental Dimension (~ 0%). Further, a very large proportion of the papers in the IS discipline at least include the interests of the System-Sponsor, with most being oriented solely that way (~ 90-95%). Of the papers that have Humans as the object of study, a large majority are neither on the Social Dimension, nor include the Perspectives of relevant individuals (~ 80-90% oriented to the System-Sponsor).

On the other hand, it would be reasonable to expect that the Bled eConference, since adopting the 'Electronic Commerce' tag in 1996, incorporating 'information society' into its Theme in 1998, and particularly since specifically adding in such topics as e-Household and e-Democracy since 2001, might feature a somewhat higher percentage of papers adopting a perspective other than that of the system sponsor.

4. The Research Method

This section commences with a description of the population of Bled papers, defines the research questions, and reports on pilot testing. This lays the foundations for explanations of the protocol and coding scheme, and the research design, with particular emphasis on the sampling strategy.

4.1. The Bled Proceedings

The Conference has run every June since 1988. There are 29 sets of Proceedings, one for each year 1988-2015 plus a special section of 9 papers for the 25th anniversary in 2012. All 16 sets since 2001 were published in CD form, and are accessible both on the Bled eConference site and in the AIS eLibrary. The 13 sets for 1988-2000, on the other hand, exist only in the form of printed and bound volumes. The papers from 1988-1994 were editted, but were not subjected to peer review. They totalled c. 147 papers. (The Proceedings for 1988 and 1989 were not readily available, and were estimated at 10 formal papers each). All 22 sets 1995-2015, totalling 953 papers, have been peer-reviewed.

Of the 29 sets of Proceedings, all 27 from the period commencing in 1990 were readily available, 16 of them in PDF on the Conference's own web-site (for 2001-15), and the remaining 11 in hard-copy form in the author's own library (for 1990-2000). In addition, an extract of the authors, titles and abstracts of the 786 papers in the 17 sets 1995-2011 is available at Appendix 3 to Clarke (2012).

4.2. Research Questions

The following specific questions were considered:

(1) What researcher perspectives are evident in papers published in Bled Proceeedings?

(2) What changes in researcher perspectives are apparent in Bled Proceedings over time?

4.3. Pilot Testing

Early in 2015, a protocol and a coding scheme were devised, and pilot testing was undertaken on several sets of papers. The first experiment was conducted on the Bled eConference Proceedings for 2014. Clarke (2015) reports on an examination of the 38 papers in the Australasian Journal of Information Systems (AJIS) Vol. 18 (2014), and a 20% sample of the Proceedings of the Australasian Conference in Information Systems (ACIS) for 2014, a total of 36 papers. Several further journal volumes and conference proceedings, and a journal Special Issue, have been subsequently examined.

4.4. The Protocol and Coding Scheme

Each phase of the pilot testing gave rise to extensions to and iterative refinements of the protocol and coding scheme, with the result that the author had confidence in the efficacy of the version adopted for the study reported here. The protocol used is in Appendix 2. Each paper was identified by a unique key, and then reviewed in its own terms. The research question was extracted or inferred, and expressed in the worksheet. In the case of constructive approaches such as action research and design science, rather than a 'research question', the term 'objective' was generally more appropriate. In some cases, the researcher's perspective is, if not explicit, at least apparent, from the phrasing of the research questions. In many cases, however, it is necessary to infer it from comments in the Introduction and Conclusions, and the audience to which the paper appears to be addressed (e.g. in the 'Implications for Practice' section).

The Researcher Perspective and the Dimension on which it lay were each classified, in a manner consistent with the descriptions provided earlier. Some IS research does not adopt the perspective of any stakeholder in the phenomena. Examples include discussions of research methods, testing of survey instruments and teaching cases. Such papers are accordingly not relevant to the study, and were categorised as 'Discipline-Internal'. Sufficient data about, and quotations from, each paper were captured to enable review and moderation of the coding, to provide contextual information and thereby support some degree of analysis of the results, and to enable the research to be subjected to audit.

4.5. Research Design

The pilot testing had found that:

- it is uncommon for authors to expressly declare the perspective they have adopted
- the assessment of papers requires broad knowledge of the field, and considerable concentration
- the analysis is resource-intensive
- some dimensions and perspectives are likely to be represented in very small numbers of papers

A survey of the entire population of 1,100 papers, or of the entire refereed corpus of 953 papers, was infeasible. From the pilot testing, it appeared likely that, for some of the attributes being measured, many papers would fall into one category – particularly the Economic Dimension and the System-Sponsor Perspective. This militated against the use of a small pseudo-random sample, because of the considerable likelihood that small sub-populations would be under-represented and might not even appear at all.

The approach was adopted of a stratified rather than random sample, by including within the sample all papers from particular sets. In addition, at least one set was to be from a conference whose Theme strongly implied that papers were encouraged that reflected interests broader than those of the system sponsor alone. The Special Section for the 25th anniversary event in 2012 comprised 9 papers that reviewed particular themes within the accumulated collection. Because of its reflective and to some extent self-referential nature, it was omitted from the sampling frame.

In order to gauge change over time, a longitudinal element was necessary, requiring that the sets of different years be selected. Change year by year may be small, whereas differences over a longer period may be more marked. It was therefore preferable for the sample years to be separated. Further, the assumption was made that change would be steady rather than abrupt, and hence it was desirable that the separation be by a consistent period.

It was uncertain how large a sample would be feasible given the resource and elapsed-time constraints. There was accordingly an advantage in selecting the spacing between sample-years in such a manner that the project could start with a sparse sample and later, if adequate resources were available, additional years could be selected, evenly spaced between those already sampled.

The strategy adopted was to define three possible rounds. The first was to examine the sets for 2015 and 2003 (12 years apart). The second round would first interpolate the set for 2009 (mid-way between them), and then 1997 (which would provide 4 sets spaced 6 years apart) and 1991 (5 sets, 6 years apart). To the extent feasible, the third round would interpose at 3-year intervals (initially 2012 and 2006 to increase the intensity for recent years, then 2000 and 1994). The choice of 2-year intervals instead of 3 appeared to be too resource-intensive, and to offer diminishing return on investment. The number of papers in each sample-year in each Round is shown in Table 2. The selection constraint was satisfied, in that the Theme for 2009 expressly focussed on 'eSociety'.

Table 2: The Sample

Rd	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	Total	Cum.
1																71												37	108	108
2				29						33												42							104	212
3							23						48						52						50				173	385
4	10	10	22		27	26		26	37		42	45		50	49		52	51		60	45		41	42		35	45		715	1100

5. Results

This section commences with an outline of the conduct of the study, and and assessment of the appropriateness of the protocol and coding scheme. An overview of the results is provided, including the distribution of the object of study. The distribution of papers across the Dimensions is analysed, and then the distribution across Researcher Perspectives. Particular attention is paid to the Perspectives adopted in the 26% of cases in which the object of study was humans.

5.1. Conduct

The available resources were sufficient for the completion of both Rounds 1 and 2, resulting in assessments of 212 of the c. 1,100 Bled papers 1988-2015 (19%), including 29 of the c. 147 unrefereed papers from 1988-1994 (20%), and 183 of the 953 refereed papers since 1995 (19%). 2003 was an exceptional year, in that the event was enlarged to 71 papers, whereas the other four sets averaged 35 papers, range 29-42. Five papers were coded as Discipline Internal in nature, as they did not adopt the perspective of any stakeholder in the domain under study. The number of papers relevant to the study was accordingly 207.

The coding scheme proved to be generally very workable, but a few boundary-cases needed to be managed, and managed consistently. For example, a number of papers contained very modest empirical content in support of theory development, and a somewhat arbitrary threshold was applied in order to assign the paper as Theoretical rather than Empirical. Another boundary-condition arose with a paper that was coded as being primarily Theoretical but was also methodological in nature and hence was arguably Discipline-Internal. One paper was coded on the Social Dimension, but from the System-Sponsor Perspective. (This was a study of an eHealth intervention to address worksite health risk factors). Two papers were expressly concerned with 'socio-economic' factors, but were coded on the Social Dimension. TAM research was coded as being from the Perspective of the System Sponsor, although consideration was given to allocating it to 'Discipline-Internal', because its significance to real-world stakeholders is very limited.

A further challenge for the coding technique arose from a small number of articles whose focus was on unincorporated business enterprises comprising a single individual, in each case in a developing country. The Dimension was coded as Economic and the Perspective as System-Sponsor. The questions arose as to whether the secondary concerns about social aspects were sufficiently significant to warrant the recording of multiple dimensions, and whether 'System Sponsor' is a suitable descriptor where the intended beneficiaries of the research are large numbers of self-employed craft-workers in a developing country.

The challenges encountered in terms of threshold and boundary judgements may have been more readily dealt with if a team-based approach to the research had been adopted, or if a panel of reviewers had been used. However, the number of such instances is sufficiently small that the choices made do not appear to have a material influence on the results.

5.2. Overview

The 1991 set of papers, as was natural for an event with a narrow focus on EDI, and that was specifically an industry-academe crossover event, contains straightforward papers on business processes and impacts. The refereed papers in the other four sets are both much stronger from a research perspective and rather more varied in their styles. The overall counts and percentages for the five sets are provided in Appendix 3.

Papers of a predominantly theoretical nature (i.e. in which there was no empirical content or it performed only a supportive role) dropped from 93% in 1991, via 48% and 45%, to 35% in each of the last two sets. Constructive research was very low in the first two sets (0 and 4%), growing to 10, 15 and 16%. This reflects the fact that Bled has historically attracted far more theoreticians and observers than system and software developers. Strongly empirical research, including both scientistic and interpretivist approaches, and both quantitative and qualitative data, was only 7% at the unrefereed event in 1991, but has been in the range 45-50% in all of the later four sets.

The following sub-sections consider each of the aspects discussed in the earlier part of the paper. The analyses primarily use percentage measures in order to avoid confusions arising from the varying sizes of the individual sets. Examples are drawn on in order to highlight particular aspects of the results.

5.3. The Object of Study

The published Themes of the first two sets were unequivocally oriented towards inter-organisational systems: 'EDI: Business Strategy for 90s' in 1991, and 'Global Business in Practice' in 1997. In 2003, the rather more ambiguous and multi-facetted Theme was 'eTransformation'. The 2009 event adopted a more inclusive Theme – 'eEnablement: Facilitating an Open, Effective and Representative eSociety'– and 2015's Theme was 'eWellbeing'. The migration in themes has reflected the capacity of ICT to reach beyond organisations to people, both as citizens and consumers, and to social groups at various levels of abstraction.

Across the sample as a whole, 63% studied organisations (131 of the 207 papers), 11% had a particular technology as the focal point (23), and 26% had humans as the object of study (53). As Table 3 shows, the focus on organisations as the object of study was intense in the early years, but the intensity has progressively reduced. The proportion of papers with humans as the object of study was zero in 1991, but interest emerged in 1997 soon after the advent of Internet access to services, especially the Web, and has grown steadily since then to almost half in 2015. Technologies *per se* have attracted far less attention in the last two sets than was the case in the first three.

Table 3: Object of Study

	1991	1997	2003	2009	2015		Mean
Organisations	86	70	59	63	49		63
Humans	0	12	28	32	49		26
Technologies	14	18	13	5	2		11

5.4. The Dimensions

Although the objects of study have changed significantly over time, both the Researcher Perspectives, and the Dimensions on which those Perspectives lie, have changed far less. As Table 4 shows, the proportion of research conducted on the Economic dimension was 91-100% across the first four sets, and an overall average of 93%.

Table 4: Dimension

	1991	1997	2003	2009	2015		Mean
Economic	100	91	99	93	84		94
Social	0	9	1	7	16		6
Environmental	0	0	0	0	0		0

The Social Dimension has averaged only 6% of papers. It emerged in 1997 with 9% (3 papers), faltered to 1% (1 paper) in 2003 (despite the implied invitation of the 'eTransformation' theme), recovered to 7% (3 papers) in 2009, and climbed to 16% (6 papers) in 2015. The 3 papers in 2009 were studies of social networking services, in two cases from the user perspective, and in the other taking into account the interests of both the user and the service-provider. In 2015, on the other hand, driven by the Theme of eWellbeing, all of the 6 Social Dimension papers were eHealth-related. Five considered the interests of people, either as users or usees, with one adopting the employer's perspective.

Not a single paper among the 207 across the five sets was on the Environmental dimension. Only 1% (2 papers) even considered environmental topics, and both were on the Economic Dimension – one on environmental sustainability practices, and the other (by this author) on the application of eCommerce theory and practice to carbon trading.

5.5. Researcher Perspectives

From Table 5, it is clear that the interests of the System Sponsor are just as dominant as in other segments of the IS literature – in 85% of papers as the sole perspective (175 of the 207, of which 180 were single-perspective papers), plus a further 8 percentage-points as one of the perspectives reflected (17 of the remaining 27 among the total of 207 papers). The proportion of sole-perspective System-Sponsor research has declined from 100% in 1991 to around 80% in 2009 and 2015. This is because the frequency of research that considers multiple perspectives was zero in 1991, but jumped to the range 13-19% from 1997 onwards. In the majority of multi-perspective studies, however, the System Sponsors' interests are among those considered, such that the measure remained in the range 90-97% for 1997, 2003 and 2009, dropping to 84% in 2015 as a result of the eWellbeing Theme.

Table 5: Researcher Perspective

	1991	1997	2003	2009	2015		Mean
System Sponsor	100	82	86	80	78		85
Other	0	3	1	5	3		2
Multiple	0	15	13	15	19		13
Total System Sponsor	100	97	90	95	84		92
O=Human Object & P=System-Sponsor	0	25	89	77	72		75

Previous papers have analysed the ways in which Bled conference papers have been particularly concerned with the organisational settings within which eInteraction technologies are used (Clarke 2012, Clarke & Pucihar 2013). Within the sample studied here, 74% fell into those categories. Of those, 90% of the studies of organisations were from the perspective of the System Sponsor (118/131), and 8% from multiple perspectives (11). The 2 studies from a single perspective other than the System Sponsor (<2%) were Wilde et al. (1997), which adopted the perspective of rural business enterprises as users of information and services from commercial websites, and de Campos Costa & Joia (2003), a survey of individual Brazilian investors who use Internet stockbrokers. Of the Multi-Perspective studies, 7/11 included the system sponsor's perspective, such that it was reflected in 95% of papers (125/131).

Of the studies of technologies, 74% were solely from the System Sponsor perspective (17/23), and none from any other single perspective (0%); but 26% recognised multiple perspectives (6). Of these, all included the System Sponsor perspective bringing that measure to 100% (23/23).

Of the papers that had humans as the object of study, in 75% of cases the perspective adopted was solely that of the System Sponsor (40/53). In 19% two or more Perspectives were adopted (10/53), and 6% reflected the interests of a single stakeholder other than the System Sponsor (3/53). Of the multi-perspective studies, 70% (7/10) included the interests of the System Sponsor, bringing that perspective to 89% (47/53).

5.6. Humans as the Object of Study

In 26% of the papers (53), the object of study was humans. A key motivation for the conduct of this research was the author's strong impression that the system sponsor's perspective dominates IS research. This has been borne out by the results of both pilot testing and the research reported in this paper. A corollary is that, where humans are the object of study, it is likely that the dominance of the system sponsor's interests is harmful to the interests of those people. This section accordingly probes more deeply into this aspect.

The papers were first assessed for the extent to which they reflected the System Sponsor's perspective. Of the 53 papers, in 40 cases (75%) the perspective was solely that of the system-sponsor. In 7 of the 10 multi-perspective papers, the system-sponsor's interests were among those considered (an additional 13%age points, making 89% in all). On the other hand, the human objects' interests were represented in only 3 single-perspective papers (6%), but also in all of the 10 multi-perspective papers (19%, making 25% in all). Table 6 summarises the results.

Table 6: Perspectives Where the Object of Study is Humans

Perspective	%	Count	1991	1997	2003	2009	2015
Other Than System Sponsor	**6%**	**3**	0	0	0	2	1
Multi-Perspective	**19%**	**10**					
Dual-Perspective	11%	6	0	2	1	1	2
Generic-Perspective	8%	4	0	1	1	0	2
System Sponsor Only	**75%**	**40**					
Reasonably Sensitive	47%	25	0	0	**14**	**9**	2
One-Sided	28%	15	0	1	2	1	**11**
		53	0	4	18	13	18
Total System Sponsor	89%	47					
Total the Humans Under Study	25%	13					
Total Other	8%	4					

The 3 papers that adopted **a single Perspective which was not that of the System Sponsor** were concerned with users of social networking services (Tuunainen et al. 2009), sight-impaired users of social networking services (Leahy & O'Brion 2009), and women employed in ICT (Berghi & Bielli 2015).

Two categories of **multi-perspective research** are usefully distinguished. **Dual-perspective research** most commonly observes the phenomena of interest from both sides of a provider-user or provider-consumer dyad. This is potentially highly valuable, but it is somewhat challenging and not often reported at Bled. Adie & Castleman (1997) brought industrial relations and sociology to bear on teleworking, from both employer and employee Perspectives:

> *"There are complex and paradoxical interests among the various parties in the employment relations context. ... Satisfactory resolution of the employment relations issues requires a recognition of the contradictory pressures and interests among employers and employees".*

Gattiker et al. (1997) investigated how respondents feel about invasions of privacy arising from e-mail and telephone marketing. The primary beneficiary was system-sponsors, but the perspective of consumers was also addressed – in this case as usees, i.e. individuals affected by the system. Similarly, the primary perspective of Schubert et al. (2003) was that of the system sponsor, but the interests of the student-users were also considered:

> *"Do [groupware systems] really improve collaborative processes? Do they save time or kill additional time? Do people like to work with such tools or is it an extra burden for them? Are these systems as user-friendly as their marketing leaflets claim them to be?"*

The paper by vom Brocke et al. (2009) considered adoption factors for social networking services from the viewpoints of both the provider and the user. Cruz-Cunha et al. (2015) outlined features of an e-Marketplace for services, from the perspectives of both elderly people and their caregivers (with only indirect implications for providers); and Mezei & Nikou (2015) examined benefits of recommender systems for both system sponsors and the young-elderly.

The term **'Generic-Perspective Research'** was applied to papers that in some manner reflected the interests of multiple stakeholders. At worst, papers of this kind can be vague about who is meant to benefit from the research. One 2003 paper on how young people are developing new and innovative ways of interacting using technology drew some inferences, but identified no clear implications for any particular stakeholder.

There were 3 papers, however, which either searched for policy implications, or examined specific policy implications, with the (in some cases implicit) aim of achieving economic and/or social betterment. The earliest, Schubert et al. (1997), was expressly concerned with socio-economic aspects of electronic markets:

> *"Relevant socio-economic aspects are the composition of society (social structure), the ongoing change in social patterns (social change), the phenomenon of new social formations of people (communities, genres), psychological aspects and the allocation of power on the basis of access to information (government and world politics)".*

In Binhadyan et al. (2015), proposals were made in relation to e-mental health services intended to address the needs of all stakeholders, and Carlsson & Walden (2015) considered the use of mobile technology to enhance wellness among the young elderly, considering also the public health and budgetary aspects relevant to society as a whole.

Almost half of the papers whose object of study was humans demonstrated at least some degree of **sensitivity to the interests of the particular category of people under study**. One positive example was Hawryszkiewycz (2003) which suggested a flexible approach to customizing learning spaces to learners' needs. Another was Head et al. (2003), which concluded that:

> *"A humanized approach to Website design would incorporate various human-centric elements, such as emotive textual descriptions, relevant pictures of people, appropriate audio and video clips, virtual communities, virtual and real shopping agents. ... If vendors are not able to instill customer trust in their e-Commerce operations, they are doomed to online failure"*

In Jutla & Bodorik (2003), the unusual proposition was put forward of 'a client-side business model':

> *"Strengthening the user perception of privacy and trust on the Internet will require user- focused technological approaches, enforceable privacy laws, and business interventions. We propose a novel user-focused business model for privacy with a supporting client-side e-privacy architecture"*

Similarly, Ng-Kruelle et al. (2003), in structuring a framework for analysing privacy sensitivity in relation to wireless applications, concluded that:

> *"It becomes necessary therefore to understand how privacy requirements from the end user works, and how the basic privacy principles can be best adapted for business development strategies to achieve consumer satisfaction"*

These 4 are, however, the only well-balanced examples. In 2003, 8/14, and in 2009 all 9/9 papers, were concerned with adoption factors, and regarded humans as an awkward object of study whose behaviour was subtle and hence needed careful examination in order that business enterprises could achieve their objectives.

The remaining 2/14 papers in 2003 were concerned with the behaviour of employees and online consumers. In 2015, only 2 papers showed a degree of sensitivity, although only marginally so. One evaluated requirements for a mobile financial advisory service and the other crowdsourced software development. In each case, the attitude evident to the humans under study was tending away from sensitivity towards manipulation.

The remaining category is at best **strongly biassed to the System Sponsor's interests**, and in some cases shows elements of authoritarian and exploitative attitudes. Fully 28% of the sub-sample (15/53 papers) was judged to be in this category. Lichtenstein & Swatman PMC (1997) studied the development by organisations of acceptable usage policies:

> *"The diffusion of the Internet within the workplace has introduced serious new organisational security concerns ... many employees have been misusing or abusing their employer-provided connection to the Internet"*

In the Outstanding Paper Award-winning paper that year, Koch & Möslein (2003), an argument was pursued for "user-centric global identity management":

> *"Personalization and community support are increasingly considered to be an important ingredient of successful (Web) applications for e-commerce and collaboration. ... The availability of user profile information will be important for future Internet based Electronic Commerce and Community Support services. Information about the users is needed ... "*

In Sigala (2003), the treatment of students was as objects whose attributes were to be improved:

> *"Findings provide useful suggestions for developing successful e-learning ... ... correction actions ... students should be assisted in becoming motivated, skilled and active members of online communities that can contribute to learning processes"*

Centralised electronic Customer Relationship Management (eCRM) was investigated by John et al. (2009) as a means of improving consumer 'loyalty', and this was followed by 4 papers in 2015 that discussed Social CRM in terms that were unambiguously supportive of business enterprises utilising social media as a means of manipulating consumer behaviour. In addition, 2 papers were concerned with the use of individuals' postings on social media as a means of conducting market surveillance.

Other 2015 papers examined worksite health risk factors, and misfit between individual KPIs and corporate objectives. More aggressively, Frank et al. (2015) proposed that functional features of first-person shooter (FPS) games were relatively unimportant, because hedonic motivations dominated gamers' adoption behaviour; and Derikx et al. (2015) studied means of "buying-off" users' privacy concerns in order to achieve more rapid adoption of mobility services.

Even more hostile to users' interests was Gand et al. (2015), which argued that lifetime electronic health records (LEHRs) should be imposed on individuals in order to gain (unproven and indeed contentious) benefits to public health, and asserted that "the collection of data from every necessary or available source should be considered as reasonable".

The Theme in 2015 was eWellbeing, and several authors rose to that challenge. Despite that, the 2015 set saw a substantial shift towards approaches hostile to human interests. An appreciable number and proportion of researchers went beyond merely assuming that the interests of individual users and usees were irrelevant to the research. Papers in 2015 on so-called 'social media' were almost entirely from the perspective of corporations, individuals were perceived as no more than an object of study, and their interests are considered if, and even then only to the extent that, they represented potential impediments to adoption or otherwise worked against corporations' interests. Some authors are actively working to assist corporations to exploit IT users; and one trio of authors adopted the position that the collectivist interest dominates that of the individuals who were the object of study.

6. Discussion

The patterns anticipated for the IS discipline as a whole were generally evident in the sample of Bled eConference papers. The Dimension was on average 93% Economic, 7% Social and 0% Environmental. The 2015 Proceedings showed a small increase in the proportion of papers on the Social Dimension, in response to a human-oriented Conference Theme.

In 85% of papers, the Researcher's Perspective was solely that of the system-sponsor, with a further 8% coming from the multi-perspective papers. In only 2.5% of cases was a single Perspective adopted that was other than that of the system sponsor.

Prior to 2000, Bled Themes were strongly focussed on organisations and technologies, but since then about one-third have had humans as the object of study. Among these, the dominance of the system-sponsor's Perspective is almost as great as for the population as a whole – (89% including 75% sole-Perspective, cf. 93% and 85%). Moreover, the proportion of the papers in which a reasonable degree of sensitivity was evident plummeted from 80-90% in 2003 and 2009 to only 15% in 2015. It may be that the single-mindedness of US business school thinking is migrating across the Atlantic and changing the flavour of European research into eInteraction.

Membership of IS professional associations generally brings with it moderately strong and comprehensive obligations in relation to society and human well-being, and to privacy in particular. To date, IS researchers have been subject to less stringent standards. Nonetheless, the AIS Research Code includes as "recommended ethical behavior" the following: "Give priority to the public interest, particularly when designing or implementing new information systems or other designed artefacts" (AIS 2015). There would appear to be a conflict between IS researchers' conduct and their nominal ethical responsibilties. This is arguably the case with any research that is conducted solely from the system-sponsor's Perspective, but it is very clearly so in the case of the human-hostile examples identified towards the end of the previous section.

The results of this study suggest that, in respect of the Bled eConference, but quite probably in respect of research into eInteractions quite generally, researchers' perspectives are dominated by the system sponsors' interests, to the extent that the interests of people and society are mostly treated as impediments to system sponsor's intentions. There are signs that the dominance may be turning into arrogance, with an increasing proportion of research being focussed on the exploitation of humans and their behaviour.

7. Conclusions

If, as this author argues, the dominance of system sponsor interests is at least undesirable, and even unconscionable, what is to be done about it? Calls for Papers need to expressly address, or at least include and encourage, research on Dimensions other than the economic, and from Perspectives other than that of system sponsors. It appears to be necessary for AIS to mature its Code beyond the protection of its members from inappropriate behaviour by other researchers, and impose specific obligations on its members in relation to the nature of the research they conduct, and in particular the perspectives that they adopt. A stronger hand is needed from editors and reviewers, in order to to weed out unduly insensitive, exploitative, manipulative and authoritarian approaches to research.

On a more positive note, the research on perspectives draws attention to opportunities for researchers on eInteraction at the Bled conference, and on IS generally, to improve the effectiveness of their work. Single-perspective research is entirely justifiable, but its limitations need to be appreciated and explained. Similarly, the system sponsor's perspective is entirely legitimate; but excessive focus on it, to the substantial exclusion of the interests of other stakeholders, is indicative of capture, and not an attribute of a healthy discipline.

Dual-perspective research is capable of offering far deeper insight into phenomena than one-sided studies. Too many people continue to pursue 'impediments' and 'barriers to adoption', despite that whole field of research being an aberration. If the IS discipline's scope and body of knowledge were well-balanced, there would be no such field of study. One way to achieve that, and consign 'impediments' to the dustbin of history, is by concentrating on dual-perspective research, reflecting both the system-sponsor and user / consumer views, and inter-relating them, to the benefit of both.

Beyond dual-perspective research, multi-perspective approaches need to be understood, their benefits appreciated, and appropriate research techniques adopted and matured. The IS discipline has for too long avoided research that has relevance to public policy issues. It needs to broaden its horizons, conduct policy-relevant research, and thereby contribute to economic, social and environmental wellbeing. But it can only do so if some proportion of researchers, in some of their projects, conduct their work other than on behalf of corporate sponsors, and lift their sights beyond single-perspective research to reflect multiple perspectives.

References

Adie J. & Castleman T. (1997) 'Employment relations issues for telework: occupational, organisational and public policy factors track: interorganisational systems and virtual organisations' Proc. Bled eConference, June 1997

AIS (2015) 'Code of Research Conduct' Association for Information Systems, March 2015, at http://c.ymcdn.com/sites/aisnet.org/resource/resmgr/Admin_Bulletin/AIS_Code_of_Research_Conduct.pdf

Alt R. & Zimmermann H.-D. (2014) 'Electronic Markets and general research' Editorial, Electronic Markets 24, 3 (September 2014) 161-164

Berghi R. & Bielli P. (2015) 'Women and ICT: exploring obstacles and enablers of a possible career' Proc. Bled eConference, June 2015, at https://domino.fov.uni-mb.si/proceedings.nsf/Proceedings/D34ED0D12F7B421AC1257E5B004AC2D0/$File/3_Berghi.pdf

Binhadyan B., Peszynski K. & Wickramasinghe N. (2015) 'The Effect of e-Mental Health Services on Saudi General Mental Health' Proc. Bled eConference, June 2015, at https://domino.fov.uni-mb.si/proceedings.nsf/Proceedings/D561E529539447FAC1257E5B0048AE04/$File/1_Binhadyan.pdf

Carlsson C. & Walden P. (2015) 'Digital Wellness for Young Elderly: Research Methodology and Technology Adaptation' Proc. Bled eConference, June 2015, at https://domino.fov.uni-mb.si/proceedings.nsf/Proceedings/BC6B26328325C066C1257E5B0049CD48/$File/1_Carlsson.pdf

Clarke R. (1992) 'Extra-Organisational Systems: A Challenge to the Software Engineering Paradigm' Proc. IFIP World Congress, Madrid, September 1992, PrePrint at http://www.rogerclarke.com/SOS/PaperExtraOrgSys.html

Clarke R. (1999) 'The Willingness of Net-Consumers to Pay: A Lack-of-Progress Report' Proc. 12th International Bled Electronic Commerce Conference, Bled, Slovenia, June 7 - 9, 1999, PrePrint at http://www.rogerclarke.com/EC/WillPay.html

Clarke R. (2002) 'The Birth of Web Commerce' Xamax Consultancy Pty Ltd, October 2002, at http://www.rogerclarke.com/II/WCBirth.html

Clarke R. (2006) 'A Major Impediment to B2C Success is ... the Concept 'B2C' Invited Keynote, Proc. ICEC'06, Fredericton NB, Canada, 14-16 August 2006, PrePrint at http://www.rogerclarke.com/EC/ICEC06.html

Clarke R. (2008) 'B2C Distrust Factors in the Prosumer Era' Invited Keynote, Proc. CollECTeR Iberoamerica, Madrid, 25-28 June 2008, pp. 1-12, PrePrint at http://www.rogerclarke.com/EC/Collecter08.html

Clarke R. (2012) 'The First 25 Years of the Bled eConference: Themes and Impacts' Proc. 25th Bled eConference Special Issue, PrePrint athttp://www.rogerclarke.com/EC/Bled25TA.html

Clarke R. (2015) 'Not Only Horses Wear Blinkers: The Missing Perspectives in IS Research' Invited Keynote, Proc. Australasian Conf. in Infor. Syst., Adelaide, December 2015, PrePrint at http://www.rogerclarke.com/SOS/ACIS15.html

Clarke R. & Pucihar A. (2013) 'Electronic Interaction Research 1988-2012 through the Lens of the Bled eConference' Electronic Markets 23. 4 (December 2013) 271-283, at http://link.springer.com/article/10.1007%2Fs12525-013-0144-4, PrePrint at http://www.rogerclarke.com/EC/EIRes-Bled25.html

Cruz-Cunha M.M., Ferreira Miranda I.M., Simoes R. & Varajão J. (2015) 'Aggregating Community Resources of Care and Assistance Services for the Elderly Population' Proc. Bled eConference, June 2015, at https://domino.fov.uni-mb.si/proceedings.nsf/Proceedings/3115167931479F47C1257E5B0049FC8C/$File/2_CruzCunha.pdf

de Campos Costa A.M. & Joia L.A. (2003) 'Critical Success Factors for Stock Brokerage over the Internet: An Exploratory Study in the Brazilian Market under the Perspective of the Investor' Proc. Bled eConference, June 2003, at https://domino.fov.uni-mb.si/proceedings.nsf/Proceedings/D6ECEBFEE3354903C1256EA1002CC5D6/$File/19Campos.pdf

Derikx S., de Reuver M., Kroesen M. & Bouwman H. (2015) 'Buying-off privacy concerns for mobility services in the Internet-of-things era: A discrete choice experiment on the case of mobile insurance' Proc. Bled eConference, June 2015, at https://domino.fov.uni-mb.si/proceedings.nsf/Proceedings/67D7DD86320663D0C1257E5B00499F54/$File/3_Derikx.pdf

Frank L., Salo M. & Toivakka A. (2015) 'Why Buy Virtual Helmets and Weapons? Introducing a Typology of Gamers' Proc. Bled eConference, June 2015, at https://domino.fov.uni-mb.si/proceedings.nsf/Proceedings/1165F4D4849AE7E4C1257E5B004D502C/$File/1_Frank.pdf

Gand K., Richter P. & Esswein W. (2015) 'Application of Lifetime Electronic Health Records: Are we ready yet?' Proc. Bled eConference, June 2015, at https://domino.fov.uni-mb.si/proceedings.nsf/Proceedings/D35140164A83AF20C1257E5B0049732C/$File/2_Gand.pdf

Gattiker U.E., Kelb J., Janz L., Holsten H., Greshake J., Schwenteck O. & Miller J. (1997) 'Direct marketing and privacy for telephone and internet users: a South African field study' Proc. Bled eConference, June 1997

Hawryszkiewycz I.T. (2003) 'Web Supported Competency Based Approach to Learning about eCommerce' Proc. Bled eConference, June 2003, at https://domino.fov.uni-mb.si/proceedings.nsf/Proceedings/6E90FD7D9AEF16BBC1256EA1002C383D/$File/12Hawrys.pdf

Head M., Hassanein K. & Cho E. (2003) 'Establishing eTrust through Humanized Website Design' Proc. Bled eConference, June 2003, at https://domino.fov.uni-mb.si/proceedings.nsf/Proceedings/A58CF8192D84B5FBC1256EA1002D4215/$File/27Head.pdf

John R.A., Simons L.P.A. & Bouwman H. (2009) 'Designing and Testing Service Experiences (Mobile, Web, Public Displays) for Airport Transit' Proc. Bled eConference, June 2009, at https://domino.fov.uni-mb.si/proceedings.nsf/Proceedings/7C6E6D1054189166C125760000418473/$File/40_Bouwman.pdf

Jutla D. & Bodorik P. (2003) 'A Client-Side Business Model for Electronic Privacy' Proc. Bled eConference, June 2003, at https://domino.fov.uni-mb.si/proceedings.nsf/Proceedings/AF5C3B583ABC3089C1256EA1002DB910/$File/34Jutla.pdf

Klein H.K. & Myers M.D. (1999) 'A Set of Principles for Conducting and Evaluating Interpretive Field Studies in Information Systems' MIS Quarterly 23, 1 (March 1999) 67-94

Koch M. & Kathrin Möslein K. (2003) 'User Representation in eCommerce and Collaboration Applications' Proc. Bled eConference, June 2003, at https://domino.fov.uni-mb.si/proceedings.nsf/Proceedings/0D3C8E07B3B0E092C1256EA1002EB4FD/$File/46Koch.pdf

Leahy D. & O'Broin U. (2009) 'Social Networking Sites and Equal Opportunity: The Impact of Accessibility' Proc. Bled eConference, June 2009, at https://domino.fov.uni-mb.si/proceedings.nsf/Proceedings/9C4E4805901AE1E5C12576000039A4E9/$File/2_Leahy.pdf

Lichtenstein S. & Swatman P.M.C. (1997) 'Effective Management and Policy in e-Business Security' Proc. Bled eConference, June 1997

Mezei J. & Nikou S. (2015) 'Fuzzy optimization to improve mobile wellness applications for young-elderly' Proc. Bled eConference, June 2015, at https://domino.fov.uni-mb.si/proceedings.nsf/Proceedings/85D9476492F8F724C1257E5B004A20E3/$File/3_Mezei.pdf

Ng-Kruelle G., Swatman P.A., Rebne D.S. & Hampe J.F. (2003) 'The Price of Convenience: Developing a Framework for Analysing Privacy Sensitivity in the Adoption of Wireless Applications' Proc. Bled eConference, June 2003, at https://domino.fov.uni-mb.si/proceedings.nsf/Proceedings/822EAE7325D996DAC1256EA1002DC71D/$File/35NgKrue.pdf

Orlikowski W.J. & Baroudi J.J. (1991) 'Studying Information Technology in Organizations: Research Approaches and Assumptions' Information Systems Research 2 : 1 (1991) 1-28

Schubert P., Leimstoll U. & Romano N.C. Jr. (1997) 'Internet Groupware Systems for Project Management: Experiences from a Longitudinal Study' Proc. Bled eConference, June 1997

Schubert P., Leimstoll U. & Romano N.C. Jr. (2003) 'Internet Groupware Systems for Project Management: Experiences from a Longitudinal Study' Proc. Bled eConference, June 2003, at https://domino.fov.uni-mb.si/proceedings.nsf/Proceedings/6BEA2A471439F7BDC1256EA1002E9015/$File/44Schube.pdf

Seddon P.B., Staples S., Patnayakuni R. & Bowtell M. (1999) 'Dimensions of Information Success' Communications AIS 2, 20 (November 1999)

Sigala M. (2003) 'Developing and Implementing eAssessment Strategies in Virtual Learning Environments' Proc. Bled eConference, June 2003, at https://domino.fov.uni-mb.si/proceedings.nsf/Proceedings/C9D96FA7E412A634C1256EA1002C1760/$File/10Sigala.pdf

Tuunainen V.K., Pitkänen O. & Hovi M. (2009) 'Users' Awareness of Privacy on Online Social Networking sites – Case Facebook' Proc. Bled eConference, June 2009, at https://domino.fov.uni-mb.si/proceedings.nsf/Proceedings/9B675B5E811394F0C125760000390664/$File/1_Tuunainen.pdf

vom Brocke J., Richter D. & Riemer K. (2009) 'Motives for using Social Network Sites (SNSs) – An analysis of SNS adoption among students' Proc. Bled eConference, June 2009, at https://domino.fov.uni-mb.si/proceedings.nsf/Proceedings/E867100E70B0D0FFC12576000039D082/$File/3_Richter.pdf

Wilde W.D., Swatman P.A. & Fong T.K. (1997) 'Virtual Communities in Rural Australia' Proc. Bled eConference, June 1997

Acknowledgements

Thanks to Robert Davison for the opportunity and the drive, to Frank Land for both the inspiration and the feedback, and to Doug Vogel for his constructive comments and encouragement. The comments of the anonymous reviewers were both supportive and very helpful in identifying several representational errors and clarifying aspects of the argument.

Appendix 1: Bled Conference Titles

Electronic Data Interchange (EDI)

1988 (01) – (Electronic Data Interchange)
1989 (02) – (Electronic Data Interchange)
1990 (03) – Electronic Data Interchange
1991 (04) – EDI: Business Strategy for 90s
1992 (05) – EDI: Interorganizational Systems in the Global Environment

EDI and Inter-Organizational Systems

1993 (06) – EDI: Strategic Systems in the Global Economy of the 90s
1994 (07) – Electronic Commerce, Electronic Partnership
1995 (08) – Electronic Commerce for Trade Efficiency

Bled Electronic Commerce Conference

1996 (09) – Electronic Commerce for Trade Efficiency and Effectiveness
1997 (10) – Global Business in Practice
1998 (11) – Electronic Commerce in the Information Society
1999 (12) – Global Networked Organisations
2000 (13) – Electronic Commerce: The End of the Beginning
2001 (14) – e-Everything: e-Commerce, e-Government, e-Household, e-Democracy
2002 (15) – eReality: Constructing the eEconomy
2003 (16) – eTransformation
2004 (17) – eGlobal

Bled eConference

2005 (18) – eIntegration in Action
2006 (19) – eValues
2007 (20) – eMergence: Merging and Emerging Technologies, Processes, and Institutions
2008 (21) – eCollaboration: Overcoming Boundaries Through Multi-Channel Interaction
2009 (22) – eEnablement: Facilitating an Open, Effective and Representative eSociety
2010 (23) – eTrust: Implications for the Individual, Enterprises and Society
2011 (24) – eFuture: Solutions for the Individual, Organisations and Society
2012 (25) – eDependability: : Reliable and Trustworthy eStructures, eProcesses, eOperations and eServices for the Future
2013 (26) – eInnovations: Challenges and Impacts for Individuals, Organizations and Society
2014 (27) – eEcosystems
2015 (28) – #eWellbeing
2016 (29) – Digital Economy

Appendix 2: Coding Protocol

For each paper:

1. Review the paper, with a particular focus on the Title, Abstract, research method, intended beneficiary and target audience
2. Select one from these CATEGORIES:
   - DI – Discipline-Internal, incl. research method, issues, teaching-related (DI papers are not relevant to the current study)
   - T – Theoretical, with at most a minor empirical component
   - E – Observational / With a significant Empirical component
   - C – Constructive, incl. Design Research, Action Research
3. For Categories T and E, extract or infer and capture the Research Question
   For Category C, extract or infer and capture the Objective
4. Select the DIMENSION on which the Perspective lies:
   - Ec – Economic
   - Soc – Social
   - Env – Environmental
5. Select the UNIT of STUDY:
   - O – Organisation(s)
   - H – Human(s)
   - T – Technology
6. Select the PERSPECTIVES:
   - SS – System Sponsor (sole or dominant)
   - O – Other-than-System-Sponsor (sole or dominant)
   - M – Multiple perspectives
7. For Perspectives O and M, capture the Perspective(s) in text form
8. Capture key quotations that are indicative of the Perspective
9. Assign code HSS if the article is both H (Human Unit of Study) and SS (System-Sponsor Perspective)

Appendix 3: The Results

		Dimension			Object of Study			Perspective				
Year		Ec	Soc	Env	Org	Hu-man	Tech	Sys Sp	Other	Multi	All SS	H & SS
1991	No.	28	0	0	24	0	4	28	0	0	28	0
	%	100	0	0	86	0	14	100	0	0	100	0
1997	No.	30	3	0	23	4	6	27	1	5	32	1
	%	91	9	0	70	12	18	82	3	15	97	25
2003	No.	68	1	0	41	18	10	59	1	9	61	16
	%	99	1	0	59	28	13	86	1	13	90	89
2009	No.	37	3	0	25	13	2	32	2	6	38	10
	%	93	7	0	63	32	5	80	5	15	95	77
2015	No.	31	6	0	18	18	1	29	1	7	31	13
	%	84	16	0	49	49	2	78	3	19	84	72
Totals	No.	194	13	0	131	53	23	175	5	27	190	40
	%	94	6	0	63	26	11	85	2	13	92	19

Appendix 4: Supplementary Materials

The coded data us available as follows:

- 1991 – http://www.rogerclarke.com/SOS/Persp-BledP-91.xls
- 1997 – http://www.rogerclarke.com/SOS/Persp-BledP-97.xls
- 2003 – http://www.rogerclarke.com/SOS/Persp-BledP-03.xls
- 2009 – http://www.rogerclarke.com/SOS/Persp-BledP-09.xls
- 2015 – http://www.rogerclarke.com/SOS/Persp-BledP-15.xls

29th Bled eConference
Digital Economy
June 19 - 22, 2016; Bled, Slovenia

Extending the Technology Acceptance Model with Personal Innovativeness and Technology Readiness: *A Comparison of Three Models*

Kerttuli Koivisto

University of Jyvaskyla, Finland
kerttuli.koivisto@jyu.fi

Markus Makkonen

University of Jyvaskyla, Finland
markus.v.makkonen@jyu.fi

Lauri Frank

University of Jyvaskyla, Finland
lauri.frank@jyu.fi

Janne Riekkinen

University of Jyvaskyla, Finland
janne.p.h.riekkinen@student.jyu.fi

Abstract

This study concentrates on the role of personal traits in technology acceptance by comparing which of the two personal trait constructs commonly used in IS research, personal innovativeness in the domain of information technology (PIIT) or technology readiness index (TRI), performs better in terms of promoting the explanatory power of the technology acceptance model (TAM). The comparisons are conducted in the case context of online services offered by electric suppliers, and the study is based on the data collected from 1,176 consumers through an online survey and analysed by using structural equation modelling (SEM). The findings of the study show that the inclusion of both PIIT and TRI into basic TAM promotes the explanatory power of the model especially in terms of perceived ease of use but also in terms of perceived usefulness and use intention. At the end of the paper, practical implications for electric suppliers and the adoption of their online services are also discussed.

Keywords: Technology Acceptance Model, Personal Innovativeness in the Domain of Information Technology, Technology Readiness Index, Online Service, Electric Supplier

1 Introduction

In information systems (IS), technology acceptance has traditionally been one of the most prominent research topics with high relevance for both theory and practice. For theoreticians, the main target has typically been to understand the antecedents that affect the acceptance decisions in general or in specific contexts, whereas practitioners have been more interested in applying this understanding to their offered products and services in order to advance their adoption and sales. One of the most influential theories of technology acceptance in IS has been the technology acceptance model (TAM) by Davis (1989), which postulates that our acceptance or use intentions and behaviours are determined by two antecedents: the perceived usefulness and the perceived ease of use of the technology. Over the years, several extensions to TAM have been suggested and the set of antecedents vastly augmented. However, these additional antecedents have typically been very similar to the original ones in terms that they have concentrated either on our perceptions of the technology or how we perceive ourselves in relation to it. In contrast, less attention has been given to the personal traits of the potential acceptors or users. Although these personal traits are not typically directly related to the technology, they often have a significant indirect influence on our perceptions of it, or at least how these perceptions ultimately affect our acceptance or use intentions and behaviours.

The two personal traits that seem to have so far gained most attention in IS research are the personal innovativeness in the context of information technology (PIIT) by Agarwal and Prasad (1998) and the technology readiness index (TRI) by Parasuraman (2000), which both basically refer to the propensity of an individual to accept new technologies. Both of these constructs have been successfully integrated into TAM and found to promote its explanatory power (e.g., Agarwal & Prasad, 1998; Yi, Fiedler & Park, 2006; Yi et al., 2006; Lin, Shih & Sher, 2007; Walczuch, Lemmink & Streukens, 2007; Jackson, Yi & Park 2013). However, no comparative studies have been made on which of them actually performs better in this respect. The present study aims to address this gap in prior research by conducting such a comparison in the case context of self-service technologies (SST), which have been a very common application context of both TAM and TRI (e.g., Dabholkar & Bagozzi, 2002; Curran & Meuter, 2005). As the specific SST, we selected the online services offered by electricity suppliers, which allow their customers, for example, to manage their electricity contracts or track their electricity consumption online. Such services have become increasingly common in the recent years and, thus, act an interesting and important research context also *per se* in addition to offering an excellent case context for our aforementioned comparisons.

This paper is sectioned as follows. After this brief introductory section, the theoretical foundation of the paper and the compared theoretical models are discussed in Section 2. After this, the methodology and results of the study are reported in Sections 3 and 4. The results are discussed in more detail in Section 5. Finally, Section 6 considers the limitations of the study and potential paths of future research.

2 Theoretical Foundation

2.1 Technology Acceptance Model

Deriving from the theory of reasoned action (TRA) by Fishbein and Azjen (1975, 1980), TAM explains the use intention and actual use of information systems by concentrating on the personal beliefs of their potential users about the perceived characteristics of the technology. According to TAM, as already mentioned in the introduction, use intention is determined by perceived usefulness (PU), defined as "the degree to which a person believes that using a particular system would enhance his or her job performance", and perceived ease of use (PEOU), defined as "the degree to which a person believes that using a particular system would be free of effort". In addition to use intention, PEOU also acts as an antecedent of PU. Use intention, in turn, determines actual use. (Davis, 1989; Davis, Bagozzi & Warshaw, 1989.) In many prior studies, TAM has been shown to be a valid and a very robust predictive model and, together with its simplicity, this has resulted in it becoming one of the most well-known and widely used theories in information systems (King & He, 2006). Because of its parsimony, the basic TAM illustrated in Figure 1 was chosen as the base model of our study over its extensions. For example, TAM2 (Venkatesh & Davis, 2000) and TAM3 (Venkatesh & Bala, 2008) include numerous additional antecedents whose effects on use intention and actual use are typically mediated by PU or PEOU. In turn, UTAUT (Venkatesh et al., 2003) and UTAUT2 (Venkatesh, Thong & Xu, 2012) include numerous moderating effects. Thus, they are all inherently more complex models, and their use would make it more difficult to isolate and compare the effects of the two constructs that we are mainly interested in this study: PIIT and TRI.

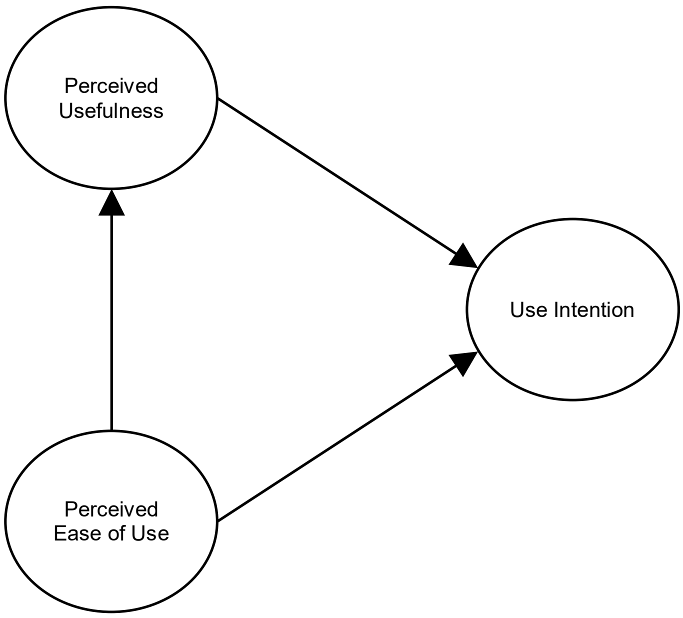


Figure 1: Technology acceptance model (TAM)

2.2 Personal Innovativeness in the Domain of Information Technology

Drawing from the innovation diffusion theory by Rogers (2003), Agarwal and Prasad (1998) have proposed a construct termed personal innovativeness in the domain of information technology (PIIT), which they define as "the willingness of an individual to try out any new information technology". The construct measures the innovativeness of an individual in a continuum from high to low, thus helping to identify individuals who are likely to adopt information technology innovations earlier or later than others. Although PIIT was originally proposed as a moderator of the effects of innovation characteristics on use intention (Agarwal & Prasad, 1998), the findings of Yi, Fiedler and Park (2006) have shown that individual innovativeness is actually an antecedent of PU, PEOU, perceived compatibility, and use intention rather than just a moderator of the effects between the constructs. Also Lewis, Agarwal and Sambamurthy (2003) as well as Jackson, Yi and Park (2013) have suggested PIIT to be an antecedent of innovation characteristics. Based on this, in our first comparison model illustrated in Figure 2, we hypothesise PIIT to act as a direct antecedent of all the three constructs of our base model: PU, PEOU, and use intention.

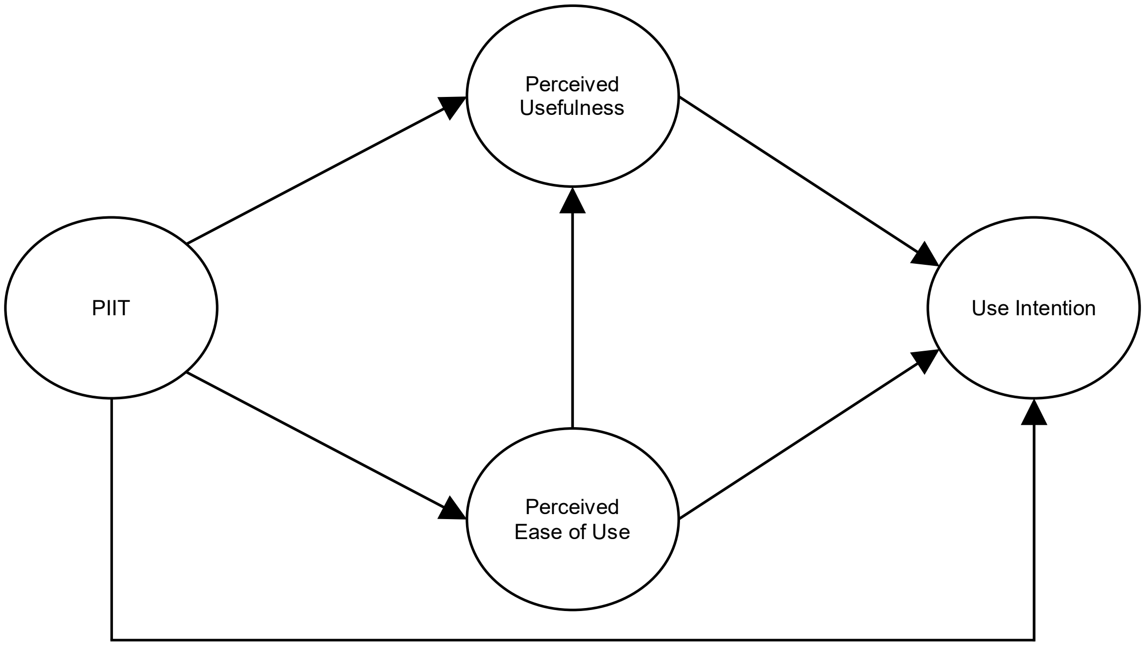


Figure 2: Integrative model of TAM and PIIT (TAM + PIIT)

2.3 Technology Readiness Index

TRI measures the readiness of an individual to use technology through a combination of positive and negative personal beliefs about technology in general, and it has been found to be a very robust predictor of technology-related intentions and behaviour, particularly in the e-services domain (Parasuraman & Colby, 2015). Proposed originally by Parasuraman (2000) and defined as "people's propensity to embrace and use new technologies to accomplish goals in home life and at work", technology readiness is typically seen as comprising of four co-existing dimensions, which in combination determine a person's general predisposition to use new technologies (Parasuraman & Colby, 2015):

- Optimism: "a positive view of technology and a belief that it offers people increased control, flexibility, and efficiency in their lives"
- Innovativeness: "a tendency to be a technology pioneer and thought leader"
- Discomfort: "a perceived lack of control over technology and a feeling of being overwhelmed by it"
- Insecurity: "distrust of technology, stemming from scepticism about its ability to work properly and concerns about its potential harmful consequences"

Of these, optimism and innovativeness are seen as drivers that increase technology readiness, whereas discomfort and insecurity are seen as deterrents that decrease it. TRI has also been successfully integrated into TAM in the technology readiness and acceptance model (TRAM) by Lin, Shih and Sher (2007), who examined the effects of the aggregate TRI construct on PU and PEOU and found the explanatory power of this integrative model to be superior in comparison to its component models. In some later studies, the effects of the four component constructs of TRI on TAM constructs have also been examined individually by hypothesising that optimism and innovativeness have a positive effect on PU and PEOU, whereas discomfort and insecurity have a negative effect on them (Godoe & Johansen, 2012; Walczuch, Lemmink & Streukens, 2007). In this study, we follow this latter approach by concentrating on the effects of the four component constructs rather than the effects of the aggregate TRI construct. Although Lin, Shih and Sher (2007) suggest that the effect of technology readiness on use intention is fully mediated by PU and PEOU, Lin and Chang (2011) have found that technology readiness affects use intention not only indirectly through PU and PEOU, but also directly. Based on this, in our second comparison model illustrated in Figure 3, we hypothesise the four component constructs of TRI to act as direct antecedents of not only PU and PEOU, but also use intention.

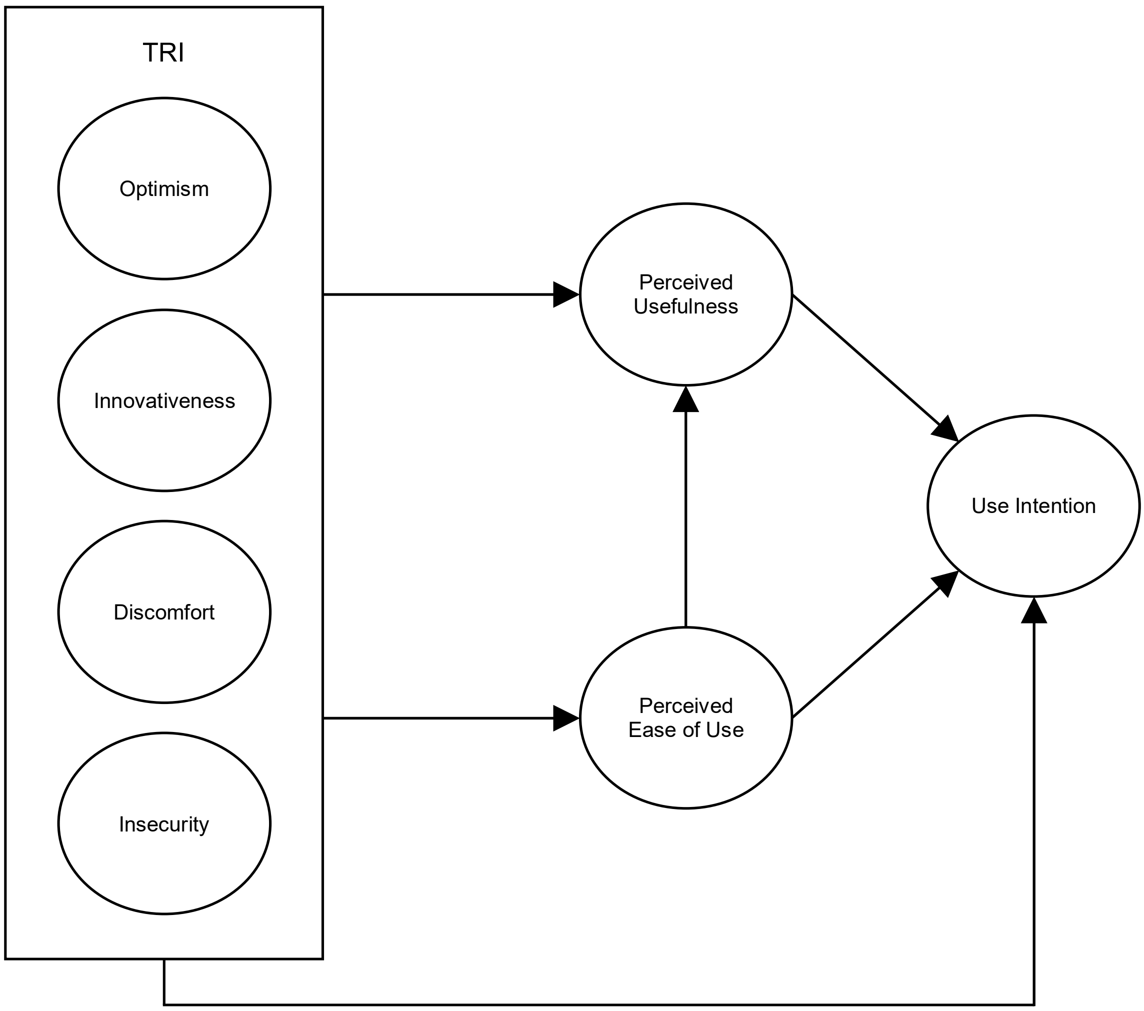


Figure 3: Integrative model of TAM and TRI (TAM + TRI)

3 Methodology

To compare the basic TAM model as well as the TAM + PIIT and TAM + TRI models, we conducted a self-administered online survey targeted at Finnish consumers between December 2015 and January 2016. Due to the case context of the study, the survey was promoted via the online channels of two electric suppliers (e.g., websites, social media, and newsletters) as well as via the internal communication channels of our university and several discussion forums. To raise the response rate, also several gift cards with a total worth of 356 € were raffled among the respondents.

The survey questionnaire contained three main sections related to TAM, PIIT, and TRI as well as questions concerning demographics and technology use experiences. The items measuring perceived usefulness, perceived ease of use, and use intention were derived from Davis (1989) as well as Davis, Bagozzi and Warshaw (1989), whereas the items measuring PIIT were derived from Agarwal and Prasad (1998) and the items measuring TRI were derived from the TRI 2.0 scale by Parasuraman and Colby (2015). However, a few minor wording changes were made to the items in order for them to better fit the case context of the study. The exact wording of each item, translated from Finnish to English, is presented in Appendix A. All the items were measured on a five-point Likert scale ranging from 1 = strongly disagree to 5 = strongly agree. The respondents were also able to skip individual items, which resulted in a missing value.

We analysed the collected data with the IBM SPSS Statistics 22 and Mplus version 7.11 software. SPSS was mainly used for data preparation and preliminary analysis, whereas Mplus was used for SEM analysis. As the model estimator, we used the MLR option of Mplus, which stands for maximum likelihood estimator robust to non-normal data. The potential missing values were handled by using the FIML option of Mplus, which stands for full information maximum likelihood and uses all the available data in the model estimation. More details about Mplus and the exact estimation methods can be found in the user's guide and technical appendices of Mplus (Muthén & Muthén, 2016).

4 Results

The conducted online survey was completed by a total of 1,370 respondents. However, to promote the quality of responses, 194 of them were excluded from the final sample in two phases. We first excluded 124 respondents who had not reported being customers of any electric supplier (e.g., adolescents living in student apartments) and, thus, were not likely to be able to give reliable assessments on their online services. This was followed by an exclusion of additional 70 respondents who had reported missing values in all the items that measured the basic TAM constructs. This resulted in a final sample size of 1,176 respondents to be used for model estimations. Descriptive statistics of this sample are reported in Table 1. All in all, the gender and age distributions of the sample corresponded quite well with those of the adult Finnish population in 2015 (Statistics Finland, 2016), which are also reported in Table 1. The main deviations were that the age group of 50–69 years was overrepresented and the age groups of 18–39 years and 70 years or older were slightly underrepresented. This was likely caused by how the survey was promoted. The age of the respondents ranged from 18 to 83 years, with the mean age being 50.4 years (SD = 15.5 years).

	Sample (N = 1,176)		Finland
	N	%	%
Gender			
Male	631	53.7	48.8
Female	545	46.3	51.2
Age			
18–29 years	171	14.5	18.3
30–39 years	137	11.6	15.9
40–49 years	153	13.0	15.1
50–59 years	319	27.1	16.8
60–69 years	313	26.6	17.1
70– years	83	7.1	16.8
Monthly net income			
–999 €	213	18.1	
1000–1999 €	351	29.8	
2000–2999 €	343	29.2	
3000– €	180	15.3	
No response	89	7.6	
Socioeconomic status			
Employed	532	45.2	
Unemployed	97	8.2	
Student	155	13.2	
Pensioner	332	28.2	
Other	60	5.1	

Table 1: Sample statistics

In the next three sub-sections, we first assess the reliability and validity of the construct indicators and the eight constructs included in the three compared models: use intention (INT), perceived usefulness (PU), perceived ease of use (PEOU), personal innovativeness in the domain of information technology (PIIT), optimism (OPT), innovativeness (INN), discomfort (DIS), and insecurity (INS). These assessments are based on a model that contains all the aforementioned constructs but does not yet hypothesise any regression relationships between them. This is followed by the actual comparison of the models in terms of their explanatory power as well as goodness of fit with the data.

4.1 Indicator Reliability and Validity

Indicator reliabilities and validities were evaluated by using the standardised loadings and residuals of the indicators, which are reported in Appendix B. In a typical case where each indicator loads on only one construct, it is commonly expected that the standardised loading (λ) of each indicator should be statistically significant and greater than or equal to 0.707 (Fornell & Larcker, 1981). This is equal to the standardised residual ($1 - \lambda^2$) of each indicator being less than or equal to 0.5, meaning that at least half of the variance of each indicator is explained by the construct on which it loads. As can be seen, the three indicators that were furthest from meeting this criterion were DIS1, INS4, and PIIT3, which all had standardised loadings of less than 0.6. Thus, after assessing that there would be no adverse effects on the content validity of the three constructs that they were measuring, we decided to eliminate them and to re-estimate the model. In the re-estimated model, all the indicators now met the criterion or at least were very close to meeting it (INN3 was furthest away from meeting it with a standardised loading of 0.665), meaning that the re-estimated model could be considered to exhibit satisfactory indicator reliability and validity.

4.2 Construct Reliability and Validity

Construct reliabilities were evaluated by using composite reliabilities (CR – Fornell & Larcker, 1981), with which it is commonly expected that each construct should have a CR greater than or equal to 0.7 in order for it to exhibit satisfactory reliability (Nunnally & Bernstein, 1994). The CR of each construct is reported in the first column of Table 2, and as can be seen, all the constructs met this criterion. Construct validities were evaluated by examining the convergent and discriminant validity of the constructs, which were evaluated by using the two criteria proposed by Fornell and Larcker (1981). They are both based on the average variance extracted (AVE) of the constructs, which refers to the average proportion of variance that a construct explains in its indicators. In order to exhibit satisfactory convergent validity, the first criterion requires that each construct should have an AVE greater than or equal to 0.5, meaning that, on average, each construct should explain at least half of the variance of its indicators. The AVE of each construct is reported in the second column of Table 2, and as can be seen, all the constructs except for DIS and INS met this criterion. However, their values were so close to meeting it that we decided not to eliminate them. After all, both the criteria proposed by Fornell and Larcker (1981) can be considered more as rules of thumb, the violations of which do not automatically have to result in any actions. However, if the violations are considerable, caution must be used when interpreting the results.

	CR	AVE	INT	PU	PEOU	OPT	INN	DIS	INS	PIIT
INT	0.951	0.865	**0.930**							
PU	0.881	0.712	0.722	**0.844**						
PEOU	0.894	0.738	0.594	0.870	**0.859**					
OPT	0.835	0.559	0.384	0.531	0.470	**0.748**				
INN	0.821	0.537	0.329	0.301	0.359	0.590	**0.733**			
DIS	0.730	0.474	-0.125	-0.288	-0.397	-0.397	-0.379	**0.689**		
INS	0.739	0.486	-0.152	-0.182	-0.200	-0.458	-0.420	0.638	**0.697**	
PIIT	0.847	0.648	0.334	0.316	0.372	0.620	1.006	-0.336	-0.450	**0.805**

Table 2: CRs, AVEs, square toots of AVEs and correlations of the model constructs

In order to exhibit satisfactory discriminant validity, the second criterion requires that each construct should have a square root of AVE greater than or equal to its absolute correlation with the other constructs. This means that, on average, each construct should share at least an equal proportion of variance with its indicators than it shares with the other constructs. The square root of AVE of each construct (on-diagonal cells) and the correlations between the constructs (off-diagonal cells) are reported in the remaining columns of Table 2. As can be seen, all the constructs met also this criterion with the exception of PU and PEOU, which correlated too strongly with each other. However, this cannot be considered dangerous because, as already mentioned in Section 2.1, TAM hypothesises PEOU to act as an antecedent of also PU in addition to INT. In addition, there was also an extremely strong correlation between INN and PIIT, which was expected and also cannot be considered dangerous as these constructs are not intended to be included into the same model.

4.3 Model Comparisons

Figure 4 presents the standardised estimation results of the basic TAM model, which was able to explain 52.9 % of the variance of INT. As expected, PU had a statistically significant and positive effect on INT. Contrary to expectations, the effect of PEOU on INT was negative, but quite weak and not statistically significant. However, PEOU had a statistically significant and positive effect on PU and was able to explain 75.8 % of its variance. In terms of the fit of the model with the data, the χ^2 test rejected the null hypothesis of the model fitting the data. However, instead of actual misfit, this may have been caused by the tendency of the χ^2 test to underestimate the fit especially in the case of large samples (Bentler & Bonett, 1980). For this reason, also four different fit indices were used to evaluate the fit: the comparative fit index (CFI), the Tucker-Lewis index (TLI), the root mean square error of approximation (RMSEA), and the standardised root mean square residual (SRMR). Their values clearly surpassed the commonly accepted cut-off criteria for a satisfactory fit (CFI ≥ 0.95, TLI ≥ 0.95, RMSEA ≤ 0.06, and SRMR ≤ 0.08 – Hu & Bentler, 1999), meaning that the model could be considered to exhibit a good fit with the data.

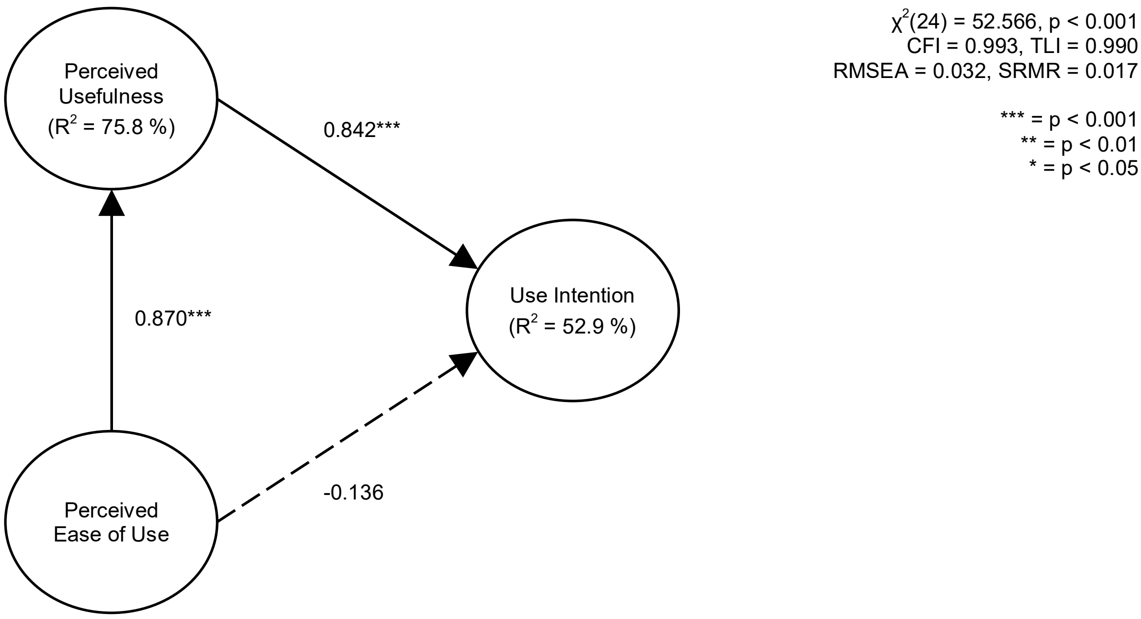


Figure 4: Standardised estimation results of TAM model

Figure 5 presents the standardised estimation results of the TAM + PIIT model. The performance of this integrative model was a bit better as compared to the TAM model in terms of explaining the variance of INT, with an explanatory rate of 54.2 %. PU had an approximately as strong an effect on INT as in the case of the basic TAM model, and also the effect of PEOU on INT was now slightly stronger and statistically significant, but still negative. In addition, PIIT had a statistically significant and positive effect on INT, although a weak one. PIIT additionally had a statistically significant and a somewhat stronger positive effect on PEOU, and it was able to explain 14.2 % of its variance. In contrast, PIIT did not have a statistically significant effect on PU, but PEOU still remained as an approximately as strong an antecedent of PU as in the case of the basic TAM model and was able to explain 75.8 % of its variance. Also the fit of the model with the data remained as approximately as good as in the case of the basic TAM model.

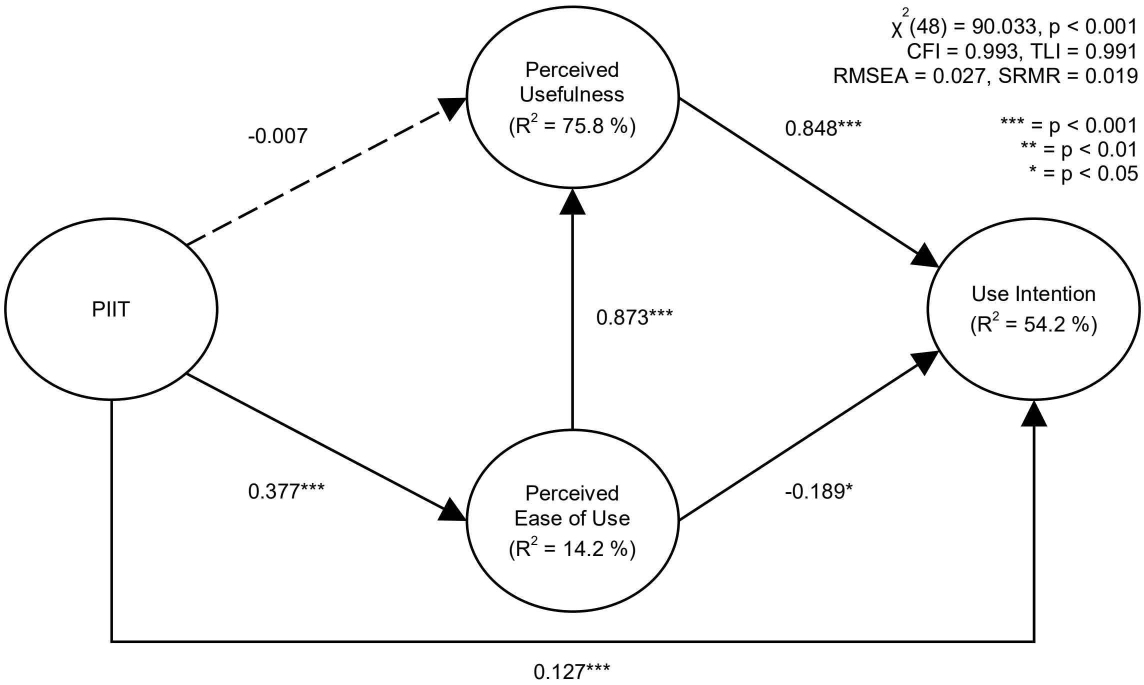


Figure 5: Standardised estimation results of TAM + PIIT model

Figure 6 presents the standardised estimation results of the TAM + TRI model, which performed best in terms of explaining the variance of INT, with an explanatory rate of 56.4 %. The effects of PU and PEOU on INT remained as approximately as strong as in the case of the basic TAM model. In addition, OPT, INN, and DIS of the TRI constructs were found having statistically significant effects on INT. The effect of INN was positive and about as strong as the effect of PIIT on INT in the case of the TAM + PIIT model. However, surprisingly, OPT had a negative and DIS had a positive effect on INT, although both of these effects were quite weak. An aspect in which the TAM + TRI model performed considerably better than the TAM + PIIT model was its ability to explain the variance of PEOU, with an explanatory rate of 31.2 %. All the four TRI constructs were found to have a statistically significant effect on PEOU, with OPT and DIS having the strongest effect and being followed by INS and INN. As expected, OPT and INN had a positive effect and DIS had a negative effect. However, the effect of INS was surprisingly positive. Three of the TRI constructs were also found to have a statistically significant effect on PU, with OPT having the strongest effect and being followed by INN and DIS. As expected, OPT had a positive effect, but surprisingly the effect of INN was negative and the effect of DIS was positive. However, both of these two latter effects were weak. PEOU still remained as an approximately as strong an antecedent of PU as in the case of the basic TAM and TAM + PIIT models and, together with the TRI constructs, they were able to explain 79.3 % of its variance. The fit of the TAM + TRI model with the data deteriorated slightly in comparison to the basic TAM and TAM + PIIT models, but remained at a good level in terms of all the four fit indices.

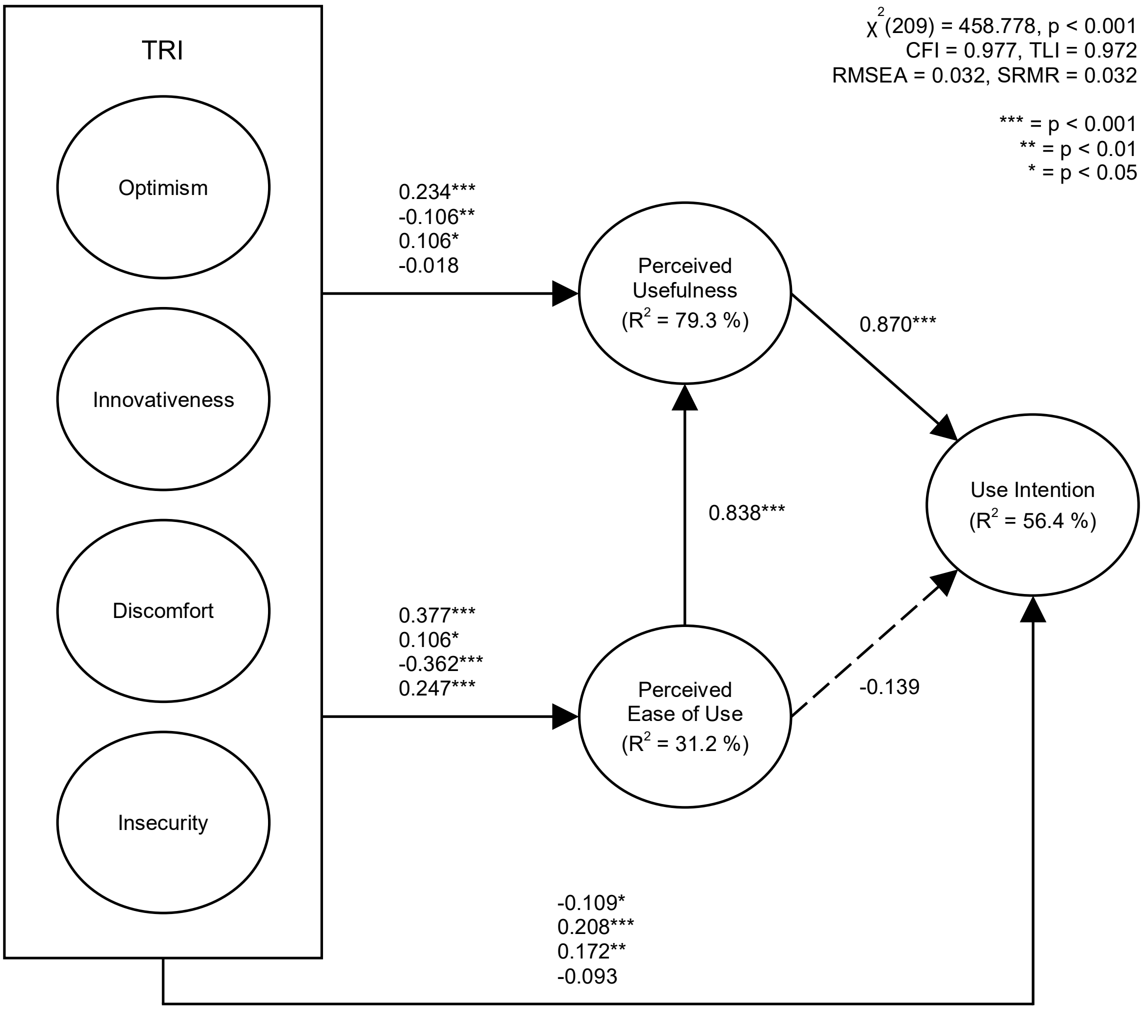


Figure 6: Standardised estimation results of TAM + TRI model

5 Discussion and Conclusions

From a theoretical perspective, this study contributes to technology acceptance research by comparing which of the two personal trait constructs commonly used as antecedents of technology acceptance or use intentions and behaviour in IS research, PIIT or TRI, actually performs better in terms of promoting the explanatory power of TAM. This was done by comparing the basic TAM model to the TAM + PIIT and TAM + TRI models, which comprise also the PIIT and TRI constructs, respectively. Of the three models, we found the TAM + TRI model having the best explanatory power in terms of use intention and perceived usefulness as well as a better explanatory power in terms of perceived ease of use in comparison to the TAM + PIIT model. Thus, in terms of pure explanatory power, TRI would seem to be a better choice than PIIT when thinking about which one of the constructs to add to the basic TAM model. However, at the same time, one must also consider whether the promotions in explanatory power are actually significant enough to justify the trade-off of having to use a more complex measurement instrumentation for the model. For example, in comparison to the basic TAM model, the TAM + TRI model with the four-dimensional TRI construct typically requires 4 x 4 = 16 additional items if using the TRI 2.0 scale by Parasuraman and Colby (2015), whereas the TAM + PIIT model with the one-dimensional PIIT construct typically requires only four additional items if using the original PIIT scale (Agrawal & Prasad, 1998). When taking this into consideration, our conclusion is that if one is interested in explaining only the use intention and perceived usefulness constructs, then the basic TAM model seems to be a sufficient option because both the TAM + PIIT and the TAM + TRI models were able to promote the explanatory in terms of these two constructs by only a few percentage points. In contrast, if one is interested in explaining also the ease of use construct, then the usage of the TAM + TRI model instead of the basic TAM model seems to be a justifiable option. However, if a simple measurement instrumentation is a priority, then also the usage of the TAM + PIIT model may suffice.

In addition, the study also makes a contribution to service research in which prior TRI studies have encountered problems in terms of identifying all the four dimensions of the TRI construct, especially discomfort and insecurity, thus questioning the validity of the original TRI scale (Gelderman, Ghijsen & van Diemen, 2011; Liljander et al., 2006; Taylor, Celuch & Goodwin, 2002). Being able to identify all the four dimensions in our present study provides support for the argument that Parasuraman and Colby (2015) have succeeded in their recent update of the scale and encourages the use of the TRI 2.0 scale in future studies.

From a practical perspective, the main contribution of this study is that it provides electric suppliers several valuable insights on the acceptance of their online services, which they can aim to use in supporting the future adoption these services among consumers. All in all, most of the effects observed in the compared models were found to be in line with the hypotheses of TAM and the findings of prior studies on PIIT and TRI. However, there are a few findings that merit a more detailed discussion. First of these concerns the positive effect of perceived ease of use on perceived usefulness. Although this effect is hypothesised also in TAM, we found it to be exceptionally strong in our case context, which suggests that even though perceived ease of use was found having only a weak direct effect on use intention, it can still be considered a critical indirect antecedent of use intention. This implies that electric suppliers should pay special attention on the usability and user friendliness of their online services in order to support their future adoption among consumers.

The second set of findings that merits a more detailed discussion concerns some of the effects of the PIIT and TRI constructs on the basic TAM constructs that were actually found to be opposite to what could have be expected based on the hypotheses and findings of prior studies. For example, we found the effects of discomfort on both perceived usefulness and use intention to be positive instead of negative. This seems to imply that the online services of electric suppliers have actually succeeded very well in addressing the needs of those consumers who are not so "technologically savvy" and are less comfortable with new technologies, because these consumers perceived the services as more useful and were more motivated to use them. In contrast, the more "technologically savvy" consumers, who are typically also more comfortable with new technologies, perceived the services as less useful and less motivating to use, suggesting that for them, a more advanced set of features beyond the current basic functionalities, such contract management and consumption tracking, should be added to the services in order to address their more sophisticated needs. Respectively, we found the effect of insecurity on perceived ease of use to be positive instead of negative. This could be explained by the fact that consumers who feel themselves less secure when using new technologies typically use them more cautiously and, for example, pay more attention to reading their instructions and manuals. This, in turn, may cause them to learn using these technologies, such as the online services of electric suppliers, more easily in comparison to those who just rush into using them by relying more on their own intuition as well as trial and error type of approaches. Finally, we also found the effects of innovativeness on use intention and perceived usefulness to be negative instead of positive. Of these, the finding concerning the effect of innovativeness on perceived usefulness is actually in line with the findings of Godoe and Johansen (2012) as well as Walczuch, Lemmink and Streukens (2007), who explain it with the fact that more innovative individuals typically also tend to be more critical towards new technologies, which causes them to have higher expectations towards them and perceiving their usefulness lower in comparison to less innovative individuals. A similar explanation can also be applied to the finding concerning the effect of innovativeness on use intention.

6 Limitations and Future Research

The main limitation of this study is that we concentrated on conducting the model comparisons only in the case context of online services offered by electric suppliers and by relying only on the responses from Finnish consumers, which obviously limits the generalisability of our findings and calls for replications of the present study in other case contexts and countries. In terms of SST, interesting case contexts could be, for example, e-banking and ticket self-purchasing services. In addition, the future studies may also benefit from conducting the model comparisons not only in the case of the basic TAM model, but also its extensions, such as UTAUT (Venkatesh et al., 2003) or UTAUT2 (Venkatesh, Thong & Xu, 2012).

References

Agarwal, R., & Prasad, J. (1998). A Conceptual and Operational Definition of Personal Innovativeness in the Domain of Information Technology. *Information Systems Research, 9*(2), 204–215. doi:10.1287/isre.9.2.204

Ajzen, I., & Fishbein, M. (1980). *Understanding Attitudes and Predicting Social Behavior*. Englewood Cliffs, NJ: Prentice-Hall.

Bentler, P. M., & Bonett, D. G. (1980). Significance Tests and Goodness of Fit in the Analysis of Covariance Structures. *Psychological Bulletin*, *88*(3), 588–606. doi:10.1037/0033-2909.88.3.588

Curran, J. M., & Meuter, M. L. (2005). Self-Service Technology Adoption: Comparing Three Technologies. *Journal of Services Marketing*, *19*(2), 103–113. doi:10.1108/08876040510591411

Dabholkar, P. A., & Bagozzi, R. P. (2002). An Attitudinal Model of Technology-Based Self-Service: Moderating Effects of Consumer Traits and Situational Factors. *Journal of the Academy of Marketing Science*, *30*(3), 184–201. doi:10.1177/0092070302303001

Davis, F. D. (1989). Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Quarterly, 13*(3), 319–340. doi:10.2307/249008

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1989). User Acceptance of Computer Technology: A Comparison of Two Theoretical Models. *Management Science, 35*(8), 982–1003. doi:10.2307/2632151

Fishbein, M., & Ajzen, I. (1975). *Belief, Attitude, Intention, and Behavior: An Introduction to Theory and Research*. Reading, MA: Addison-Wesley.

Fornell, C., & Larcker, D. F. (1981). Evaluating Structural Equation Models with Unobservable Variables and Measurement Error. *Journal of Marketing Research*, *18*(1), 39–50. doi:10.2307/3151312

Gelderman, C. J., Ghijsen, P. W. T., & van Diemen, R. (2011). Choosing Self-Service Technologies or Interpersonal Services – The Impact of Situational Factors and Technology-Related Attitudes. *Journal of Retailing and Consumer Services, 18*(5) 414–421. doi:10.1016/j.jretconser.2011.06.003

Godoe, P., & Johansen, T. S. (2012). Understanding Adoption of New Technologies: Technology Readiness and Technology Acceptance as an Integrated Concept. *Journal of European Psychology Students, 3*(1), 38–52. doi:10.5334/jeps.aq

Hu, L.-T., & Bentler, P. M. (1999). Cutoff Criteria for Fit Indexes in Covariance Structure Analysis: Conventional Criteria Versus New Alternatives. *Structural Equation Modeling*, *6*(1), 1–55. doi:10.1080/10705519909540118

Jackson, J. D., Yi, M. Y., & Park, J. S. (2013). An Empirical Test of Three Mediation Models for the Relationship between Personal Innovativeness and User Acceptance of Technology. *Information & Management, (50)*4, 154–161. doi:10.1016/j.im.2013.02.006

King, W. R., & He, J. (2006). A Meta-Analysis of the Technology Acceptance Model. *Information & Management, 43*(6), 740–755. doi:10.1016/j.im.2006.05.003

Lewis, W., Agarwal, R., & Sambamurthy, V. (2003). Sources of Influence on Beliefs about Information Technology Use: An Empirical Study of Knowledge Workers. *MIS Quarterly, 27*(4), 657–678.

Liljander, V., Gillberg, F., Gummerus, J., & van Riel, A. (2006). Technology Readiness and the Evaluation and Adoption of Self-Service Technologies. *Journal of Retailing and Consumer Services, 13*(3), 177–191. doi:10.1016/j.jretconser.2005.08.004

Lin, J.-S. C., & Chang, H.-C. (2011). The Role of Technology Readiness in Self-Service Technology Acceptance. *Managing Service Quality: An International Journal, (21)*4, 424–444. doi:10.1108/09604521111146289

Lin, C.-H., Shih, H.-Y., & Sher, P. J. (2007). Integrating Technology Readiness into Technology Acceptance: The TRAM model. *Psychology & Marketing, 24*(7), 641–657. doi:10.1002/mar.20177

Muthén, L. K., & Muthén, B. O. (2016). *Mplus Home Page*. Retrieved from http://www.statmodel.com

Nunnally, J. C., & Bernstein, I. H. (1994). *Psychometric Theory* (3rd ed.). New York, NY: McGraw-Hill.

Parasuraman, A. (2000). Technology Readiness Index (TRI): A Multiple-Item Scale to Measure Readiness to Embrace New Technologies. *Journal of Service Research, 2*(4), 307–320. doi:10.1177/109467050024001

Parasuraman, A., & Colby, C. L. (2015). An Updated and Streamlined Technology Readiness Index: TRI 2.0. *Journal of Service Research, 18*(1), 59–74. doi:10.1177/1094670514539730.

Rogers, E. M. (2003). *Diffusion of Innovations* (5th ed.). New York, NY: Free press.

Statistics Finland (2016). *Statistics Finland*. Retrieved from http://www.stat.fi

Taylor, S. A., Celuch, K., & Goodwin, S. (2002). Technology Readiness in the e-Insurance Industry: An Exploratory Investigation and Development of an Agent Technology e-Consumption Model. *Journal of Insurance Issues, 25*(2), 142–165.

Venkatesh, V., & Bala, H. (2008). Technology Acceptance Model 3 and a Research Agenda on Interventions. *Decision Sciences*, *39*(2), 273–315. doi:10.1111/j.1540-5915.2008.00192.x

Venkatesh, V., & Davis, F. D. (2000). A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies. *Management Science*, *46*(2), 186–204. doi:10.1287/mnsc.46.2.186.11926

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User Acceptance of Information Technology: Toward a Unified View. *MIS Quarterly, 27*(3), 425–478.

Venkatesh, V., Thong, J. Y. L., & Xu, X. (2012). Consumer Acceptance and Use of Information Technology: Extending the Unified Theory of Acceptance and Use of Technology. *MIS Quarterly*, *36*(1), 157–178.

Walczuch, R., Lemmink, J., & Streukens, S. (2007). The Effect of Service Employees' Technology Readiness on Technology Acceptance. *Information & Management, 44*(2), 206–215. doi:10.1016/j.im.2006.12.005

Yi, M. Y., Fiedler, K. D., & Park, J. S. (2006). Understanding the Role of Individual Innovativeness in the Acceptance of IT-Based Innovations: Comparative Analyses of Models and Measures. *Decision Sciences, 37*(3), 393–426. doi:10.1111/j.1540-5414.2006.00132.x

Yi, M. Y., Jackson, J. D., Park, J. S., & Probst, J. C. (2006). Understanding Information Technology Acceptance by Individual Professionals: Toward an Integrative View. *Information & Management*, *43*(3), 350–363. doi:10.1016/j.im.2005.08.006

Appendix A: Indicator Wordings

INT1 I intend to use the e-services in the following year.

INT2 I plan to use the e-services in the following year.
INT3 It is likely that I will use the e-services in the following year.
PU1 Using the e-services to manage my electricity affairs would be convenient.
PU2 Using the e-services would make it easier for me to manage my electricity affairs.
PU3 I would find the e-services useful in managing my electricity affairs.
PEOU1 I would find the e-services easy to use.
PEOU2 My interaction with the e-services would be clear and understandable.
PEOU3 Learning to use the e-services would be easy for me.
PIIT1 If I hear about a new information technology, I look for ways to experiment with it.
PIIT2 Among my peers, I am usually the first to try out new information technologies.
PIIT3 In general, I am hesitant to try out new information technologies.
PIIT4 I like to experiment with new information technologies.
OPT1 New technologies contribute to a better quality of life.
OPT2 Technology gives me more freedom of mobility.
OPT3 Technology gives people more control over their daily lives.
OPT4 Technology makes me more productive in my personal life.
INN1 Other people come to me for advice on new technologies.
INN2 In general, I am among the first in my circle of friends to acquire new technology when it appears.
INN3 I can usually figure out new high-tech products and services without help from others.
INN4 I keep up with the latest technological developments in my areas of interest.
DIS1 When I get technical support from a provider of a high-tech product or service, I sometimes feel as if I am being taken advantage of by someone who knows more than I do.
DIS2 Technical support lines are not helpful because they do not explain things in terms I understand.
DIS3 Sometimes, I think that technology systems are not designed for use by ordinary people.
DIS4 There is no such thing as a manual for a high-tech product or service that's written in plain language.
INS1 People are too dependent on technology to do things for them.
INS2 Too much technology distracts people to a point that is harmful.
INS3 Technology lowers the quality of relationships by reducing personal interaction.
INS4 I do not feel confident doing business with a place that can only be reached online.

Note: The questions of OPT, INN, DIS and INS comprise the Technology Readiness Index 2.0 which is copyrighted by A. Parasuraman and Rockbridge Associates, Inc., 2014. This scale may be duplicated only with written permission from the authors.

Appendix B: Indicator Loadings and Residuals

	Loading	Residual
INT1	0.952***	0.093***
INT2	0.903***	0.184***
INT3	0.935***	0.125***
PU1	0.868***	0.247***
PU2	0.837***	0.299***
PU3	0.825***	0.319***
PEOU1	0.887***	0.212***
PEOU2	0.871***	0.241***
PEOU3	0.817***	0.333***

	Loading	Residual
OPT1	0.750***	0.438***
OPT2	0.733***	0.462***
OPT3	0.761***	0.422***
OPT4	0.746***	0.444***
INN1	0.722***	0.479***
INN2	0.832***	0.307***
INN3	0.676***	0.543***
INN4	0.695***	0.516***
DIS1	0.582***	0.662***
DIS2	0.691***	0.522***

	Loading	Residual
DIS3	0.692***	0.521***
DIS4	0.650***	0.578***
INS1	0.690***	0.524***
INS2	0.695***	0.517***
INS3	0.667***	0.555***
INS4	0.511***	0.739***
PIIT1	0.779***	0.393***
PIIT2	0.834***	0.304***
PIIT3	0.503***	0.747***
PIIT4	0.791***	0.375***

*** = $p < 0.001$, ** = $p < 0.01$, * = $p < 0.05$

29th Bled eConference

Digital Economy

June 19 - 22, 2016; Bled, Slovenia

The Fuzzy Front-End of Digital Transformation: *Three Perspectives on the Formulation of Organizational Change Strategies*

Sabine Berghaus

Institute of Information Management, University of St.Gallen, Switzerland

sabine.berghaus@unisg.ch

Abstract

The fuzzy front-end describes the random and generally vague initial stages of an innovation project. Since digital transformation can be seen as innovation process of an organization, improving the initial stages can be beneficial for the entire process. This literature review takes the unique perspective of the fuzzy front-end within digital transformation. Characteristics of and challenges in formulating of organizational change strategies are reviewed in three different domains: information systems (IS), management & strategy (MS), and organization science (OS). The results show that within IS, the role of information systems has changed from a process-oriented to a more strategic role and digital technology skills become more important during strategy formulation. Within MS, there is a strong focus on interpreting external signals and reacting to them. In OS, the formulation of a change strategy is seen as a collaborative process between leadership and the workforce. The results from this review should encourage the research on digital transformation to focus to a greater extent on the initial phase of strategy formulation.

Keywords: Digital Transformation, Organizational Change, Strategy Formulation, Strategic Planning, Strategy Formation, Fuzzy Front-End, Literature Review

1 Introduction

In new product development, the initial phase of idea creation before the formal initiation of an innovation project is known as the fuzzy front-end (FFE) (Smith & Reinertsen, 1991). It is typical of the front-end stages of an innovation project, that the outcome is not clearly defined, there is no common vision, and there are various possible courses of action (Rhea, 2003). Yet, the initial phase is essential for several reasons. Firstly, it has often been shown that poor planning at the beginning results in more difficulties during the execution of the project and a less successful outcome (Smith & Reinertsen, 1991). Secondly, investing in research activities at the start of a project could lead to more significant innovations being created, rather than relying on the emergence of incremental innovations during the course of the project (Rhea, 2003). Ultimately, a greater consideration of the front-end instead of the execution phases can leverage the overall project success (Verworn, 2009).

A considerable body of research is available on strategies for improving the fuzzy font-end within the new product development domain (Alam, 2006; Koen et al., 2002; Reid & de Brentani, 2004; Rhea, 2003). However, to the best of our knowledge this concept has not yet been applied to organizational change processes that can be understood as innovation processes for an entire organization.

Digital business transformation is currently an important challenge for managers designing change towards the digital age (Matt, Hess, & Benlian, 2015). In this present paper, the term *digital business transformation* is defined as transformation at the organizational level that is disruptive, rather than a continuous learning process. It simultaneously affects multiple areas within the organization and requires a re-definition of the corporate strategy. The dynamic development of digital technologies means that an understanding of digital technology and its applications is no longer a task of the IT or digital business department alone (Horlacher & Hess, 2016; Reynolds & Yetton, 2015). Rather, it needs to be an integral part of corporate strategy (Drnevich & Croson, 2013). Sensing relevant digital innovations, creating an understanding of the impact of digital technologies, and formulating a new strategy for the digital age are important and pressing topics for managers (Carlo, Lyytinen, & Rose, 2012). However, the activities and outcome of digital business transformation are largely unclear and fuzzy. Many decision makers sense technological changes and the resulting competitive context shifts which can potentially have a profound impact on their organizations, but it is not yet clear, how they should prepare and what steps are needed in order to respond appropriately to these threats.

In order to better understand this front-end phase of digital business transformation, this paper takes the unique perspective of the fuzzy front-end within organizational change processes. Digital business transformation is a topic that is being worked on within different disciplines. The research objective is to explore whether and to what extent the front-end stages of organizational change processes are considered within information systems (IS), organization science (OS) and management and strategy (MS). The aim of this literature review is to systematically analyze the current knowledge on the front-end of organizational transformation processes in different disciplines, in order to better understand the phenomenon and inspire a body of knowledge on digital business transformation. The guiding research questions for this paper are: *To what extent is the FFE phase considered in the IS, ORG, and MS fields? What are the important characteristics and challenges within the FFE of digital business transformation within the IS, ORG and MS fields?*

2 Prior Research: Fuzzy Front-End of Strategy Formulation

In project management, the front-end describes the planning phases before the execution of a project. The front-end stage of a project, be it a new product development or organizational innovation project, is important, because most of the innovation is created during these stages (Rhea, 2003). However, this phase may also be seen as the beginning of a betting process. Only at the end will the participants be able to place the bet on a certain option, which during the process has been regarded as the most promising (Reinertsen, 1999). The term “fuzzy front-end” (FFE) describes the initial phase of innovation activity in the development of new products. The fuzzy front-end is the precursor of the actual new product development project and covers the stages from idea generation until the start of the formal project. During this phase, the outcome is unclear and the fuzzy front-end is often perceived as ill-defined, random and mysterious (Rhea, 2003; Smith & Reinertsen, 1991). In the product innovation domain, the concept of the fuzzy front-end is of great interest for researchers, since these very early stages provide an excellent opportunity for improving the overall innovation process (Verworn, 2009) and lead to competitive advantages (Reid & de Brentani, 2004). Several activities are part of the fuzzy front-end stage of a project, such as detecting technological development from the environment (de Brentani & Reid, 2012), or changes in customer interaction (Alam, 2006), assessing the potential, and developing a concept as to how they can be applied to the business (Montoya-Weiss & O’Driscoll, 2000). This phase of the innovation process relies heavily on information flows. A theoretical model of the structure and process of the FFE identifies the boundary (between organization and environment), gatekeeping (between innovators and decision makers) and project (between decision makers and project managers) as the most relevant interfaces in this process, in order to ensure a sufficient information flow and improve the FFE (de Brentani & Reid, 2012).

The front-end of strategy processes has been of interest in the literature on information-technology-enabled transformation (ITOT). Besson & Rowe (2012) identify several publications on the “phase of upheaval”, as it is referred to in the punctuated equilibrium (PE) model. In contrast to the idea of continuous change, the PE theory argues, that phases of relative stability are followed by phases of rather radical changes, before the organization again returns to a stable state (Romanelli & Tushman, 1994). However, the literature also reveals that the phase of upheaval receives relatively little attention among researchers (Besson & Rowe, 2012), compared to other phases in the strategy process.

Kurt Lewin’s three-stage model of change – unfreezing, changing and refreezing – also acknowledges the front-end stage of change within the unfreezing stage. This is when the company recognizes that there is a need to change and starts defining the concept (Lewin, 1963). The phase of unfreezing is also characterized by overcoming defense mechanisms within the organization, as it is necessary to recognize that established ways of thinking may not be appropriate or valuable in the new organizational context. Current patterns of operation cannot be applied, so that this phase is characterized by a certain confusion as to the best way forward (Mintzberg, Ahlstrand, & Lampel, 1998).

Davis et al. (2010) explicitly mention the front-end phase in their strategy model as the visioning phase. This phase comprises activities such as exploring different options for future directions, building a common vision, and risk assessment (Davis, Kee, & Newcomer, 2010). Within the strategy schools of Mintzberg et al. (1998), the creation of a vision as central part of the strategy formation process is acknowledged within the *entrepreneurial school*. However, within this school, the development of a vision is the task of a single leader, which does not recognize the establishment of a vision as a group effort. This is part of the *learning school*, which states that any informed individual within the organization can contribute to the strategy process (Mintzberg et al., 1998). Since the impact of digital business transformation can be sensed and evaluated in several business units, making sense of technological changes and their impacts on the organization are not the task of a single leader, but of potentially everybody in the organization, which may contribute to the "fuzziness" of the front-end phase.

3 Research Design

Digital transformation is a specific kind of organizational change. In order to determine to what extent the strategy formulation phase is considered in different disciplines, a systematic literature review has been conducted according to the principles of (Vom Brocke et al., 2009; Webster & Watson, 2002). Three baskets of journals have been compiled for the three disciplines that explore digital business transformation: Information systems (IS), Management & Strategy (MS), and Organization Science (OS). The baskets contain all journals that have been ranked as A+ / A in the "VHB Jourqual 3" ranking. The research was restricted to the top journals, as these are assumed to be representative of the general course of research within each discipline. In total, 39 journals were selected as the database for the literature search.

Basket	**Information Systems**	**Organization Science**	**Management & Strategy**
Search term	"organi?ational change" AND ("strategy formulation") OR ("strategy formation") OR ("strategic planning")	"organi?ational change" AND ("strategy formulation") OR ("strategy formation") OR ("strategic planning")	"organi?ational change" AND ("strategy formulation") OR ("strategy formation") OR ("strategic planning") AND (technology OR digital)
Relevant Results	34	16	62
Time frame	1980-2014	1978-2012	1969-2015

Table 1: Documentation of literature search

For the search string, the term "organizational change" was found to provide the best results, since this is the generic term for transformation / change programs. It was combined with the terms "strategy formation" / "strategy formulation" / "strategic planning", in order to identify papers that specifically consider the initial strategy-building phase of the change process. For the MS basket this search term yielded a much larger number of results. Therefore the terms "digital" OR "technology" were added, in order to restrict this number to specifically technology-induced changes. Conceptual papers with an exclusively theoretical research were omitted from analysis. Table 1 provides an overview of the search terms used and the results yielded in the respective baskets.

The result lists were exported and coded in Excel. Based on the information given in the title, abstract, and subject terms, the 112 papers were coded according to the scheme depicted in Table 2. The coding scheme for the strategy phases was derived from the phases mentioned in Davis et al. (2010) – vision, planning, and implementation. A fourth code "outcome" was added for publications that consider the results, impact, and effects of a strategy or organizational change process and not the process itself. The coding scheme for the type of change strategy was derived from Mintzberg's types (intended, deliberate, emergent) (Mintzberg & Waters, 1982), which acknowledge that there is both planned and unplanned change. The degree / scope of change was derived from the types of innovation, which acknowledges that there are types of evolutionary and radical change (Norman & Verganti, 2014).

Strategy Phase	**Type of change strategy**
• Vision • Planning • Implementation • Outcome	Intentionality • Intended • Emergent Degree / Scope • Radical / Disruptive • Evolutionary / Continuous

Table 2: Coding scheme for literature review

4 Findings

The retrieved overview of publications shows that the number of publications on organizational change and strategy formulation in A / A+ journals became more popular in the 1990s and has remained steady ever since (see Figure 1). The rising popularity of digital business transformation as a specific type of organizational change cannot be determined purely from the number of publications.

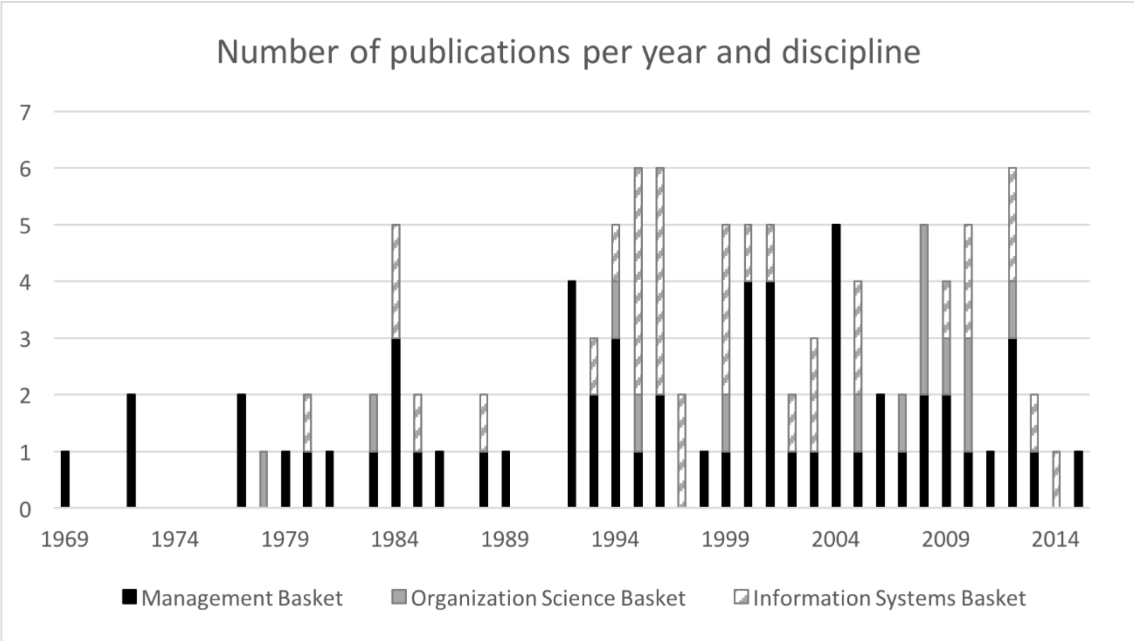


Figure 1: Number of publications on organizational change and strategy formulation in selected journals

The following table shows that the fuzzy front-end of the change strategy, which is the first phase of recognizing the need to initiate an organizational change process and build a common vision receives comparably little research attention. Most publications focus on the planning process and the implementation phase, regardless of the discipline.

	Vision	**Planning**	**Implementation**	**Outcome**
Information Systems	○	◍	●	○
Management & Strategy	◍	●	●	◍
Organization Science	○	◍	●	◍

Legend: ● Frequently covered ◍ Partially covered ○ Barely covered

Table 3: Analysis per basket of strategy phases considered

Digital business transformation can be seen as a major reorientation for the organization and therefore has an extremely wide scope and a disruptive impact. As can be seen from Table 4, research generally focuses rather on evolutionary changes that might occur more often and are therefore easier to observe. The same challenge probably applies to emergent strategies that are developed without being intended, but arise as the organization progresses

(Mintzberg & Waters, 1982). However, current changes due to the transition into the digital age provide an excellent environment for researching major, more radical organizational changes.

	Intended	Emergent	Radical	Evolutionary
Information Systems	●	●	◍	●
Management & Strategy	●	◍	◍	●
Organization Science	●	◍	○	●

Legend: ● Frequently covered ◍ Partially covered ○ Barely covered

Table 4: Analysis per basket of change strategy type

4.1 Information Systems (IS) Perspective

Within the IS domain, there is a clear focus on the relationship between information systems and organizational configuration. Therefore, many publications focus on the change process from the perspective of technology implementation, and its effects on organizational processes as well as user behavior, for instance in research on technology adoption (Venkatesh, Morris, Davis, & Davis, 2003).

The guiding research topic is strategic change that is enabled by information technology (Besson & Rowe, 2012; Cha, Hwang, & Gregor, 2015; Cha & Lee, 2013) or the introduction of disruptive digital technologies that force organizations to initiate a major strategic reorientation. As digital technology advances, highly innovative technologies have an impact on the project portfolio and product offerings of organizations. Therefore, there is a broad body of case study research on it-enabled digital transformation (Clemons & Hann, 1999; Harkness, Segars, & Kettinger, 1996; Sarker & Lee, 1999).

Regarding the front-end of transformation strategy, there has been a focus on IS-strategy. IS-strategy formulation is traditionally different from organizational strategic planning, as it focuses strongly on business processes instead of the organizational context (Burn, 1993). However, it has been generally acknowledged that business and IS-strategy should be integrated into a common digital strategy (Bharadwaj, El Sawy, Pavlou, & Venkatraman, 2013; Drnevich & Croson, 2013; Pagani, 2013). A reason for this is that IT has evolved from its traditional role as a support function into a more strategic role (Henderson & Venkatraman, 1993). This organizational emphasis on IT decisions affects top manager knowledge of IT, which also facilitates business manager participation in strategic IT planning (Bassellier & Benbasat, 2004; Kearns & Sabherwal, 2007). However, in many companies, the IS department lacks formal power to influence the organization's targeted change. Hence, IT executives need to act as change agents in order to gain support from top management (Ngwenyama & Nielsen, 2013; Sharma & Shanks, 2011) and work actively on the positive perception of IT value, so as to achieve consensus (Tallon, 2013). This goes even further than just aligning IT and business goals, requiring collaboration between IT and business departments. Developing a shared mindset between IS and business leaders is a precondition for making IT part of the strategic core (Hansen, Kraemmergaard, & Mathiassen, 2011; Qu, Oh, & Pinsonneault, 2010).

4.2 Management and Strategy Perspective

Guiding research on strategy formulation for organizational change within the management and strategy domain are the roles of the market, technological and competitive environment (Randolph & Dess, 1984), strategic adaptation, exploitation of market knowledge, and the role of top executives.

Radical change is often initiated as a reaction to a turbulent environment (Lant, Milliken, & Batra, 1992) that can be caused by technological innovation (Williams, 1983), competitors attacking the core business (Sanchez, 1995) or by market changes and practices that spread in other organizations (Gaba & Meyer, 2008). The changing behavior of customers is also part of the environment. Discovering customer needs and addressing them in the product offering may influence the success of a company (Christensen & Bower, 1996). The development and dynamics of the market, technological, and competitive environment cannot be predicted accurately, which contributes to the fuzziness of the initial phase of a transformation strategy. Therefore, in an unstable environment, companies have to carefully monitor the changes and continuously adjust their strategy. Instead of long-term strategic planning, companies generally prefer smaller steps of action and readjusting, thus incrementally adapting their strategy as they progress (Brown & Eisenhardt, 1997; Kiss & Barr, 2015). Exploiting knowledge on the environment is not only important for strategic planning, but also for the creation of innovative products, which is a key capability of a learning and continuously renewing organization (Dougherty, 1992). Also, the current strategy may influence future technology, as strategy and technology are intrinsically linked (Itami & Numagami, 1992). Technological innovations are found to have an effect on the scope of the corporate portfolio (Kaul, 2012). Therefore, knowledge of technology can be seen as an important capability in strategy work.

Making sense of industry signals is mostly seen as the task of top management (Williams, 1983), and to be strongly influenced by their belief structures (Kiss & Barr, 2015). While the effect of managerial learning on strategic reorientation is often researched (Lant et al., 1992), other publications stress that exploiting market knowledge for product innovation is not the responsibility of one organizational function, but requires a broader involvement of the workforce and thus a new sense of roles and responsibilities (Dougherty, 1992). The orientation of top management towards change is a key prerequisite for successful innovation (Zmud, 1984) and for knowledge transfer within the organization. Instead of only reacting to the environment, companies may use the first phase of the strategic planning process in order to proactively tackle the reorientation of the company and not only involve top management in this process (Mitroff, Barabba, & Kilmann, 1977).

Recognizing the need to change and to innovate, is only the first part of the strategic planning process. Many companies struggle to react swiftly and take appropriate action in the context of radical innovation. Dealing with organizational inertia is another major research stream within organizational change. One common reason for inertia is that although managers recognize signals from the environment, they fail to build the appropriate organizational capabilities (Tripsas & Gavetti, 2000). In this sense, it is also important to distinguish between radical and incremental innovation, whch require quite different strategies (Ettlie, Bridges, & O'Keefe, 1984).

4.3 Organizational Science Perspective

As can be seen from Table 4, research within the OS domain focuses on the entire change process, and the effects and challenges that occur. Very few publications within the scope of this research deal with the initial planning phases.

Within the OS domain, a stronger research focus on organizational change is directed towards the entire workforce rather than on the top management as responsible for executing the change. An organizational change strategy can also be designed and conducted by a dedicated team that is formed regardless of position and hierarchy (Higgins, Weiner, & Young, 2012). This perspective was often found to be missing within the IS and MS domains. Within the OS perspective, specifically the interplay of managers, leaders, and the workforce is of great interest (Waldman & Javidan, 2009). While top management is still important in terms of leading the process, employees shape organizational routines and behaviors (Becker & Zirpoli, 2008; Sagie & Koslowsky, 1994) that significantly influence how change processes are conducted. The ubiquity of technology has also led to a democratization of the innovation process, allowing more employees to participate in a distributed and heterogeneous innovation process (Yoo, Boland, Lyytinen, & Majchrzak, 2012).

The current context of change evidently does not play a big role in research, with change usually being seen an evolutionary process, and no publications specifically focusing on radical changes were found.

5 Discussion

The results from the literature review on strategy formulation in organizational change reveal some common elements, but also some differences across the domains.

Within the IS-domain, the perspective of information systems has changed from a solely functional and process-oriented one to a broader strategic role. Therefore, a solid understanding of the dynamic development of digital technologies and its utilization is required within the strategy formulation process. The perspective of the management & strategy domain of the fuzzy front-end is that it is often caused by external changes to which the company needs to react, whereby the top manager is mostly responsible for making sense of industry signals and initiating a viable strategy. However, organizational inertia often hinders the change process. The perspective of the OS domain is that strategy formulation is more a collaborative process than the task of the top executives.

This analysis has shown that the phase of recognizing the need to change, making sense of signals from the environment and initiating a change strategy is partially covered in research. Yet, this initial phase, although extremely important, since it builds the foundation for the implementation of change, receives comparably little attention from researchers. As a result, I propose that applying the concept of the fuzzy front-end (FFE) from the new product development domain into organizational change research can provide a fruitful new avenue for research. In digital transformation, a radical and disruptive change for the organization, a different strategy is needed than for evolutionary or incremental innovations (Ettlie et al., 1984).

The concept of the fuzzy front-end is appropriate for describing the initial phase of digital business transformation, as well as in product innovation, since the main characteristics are quite similar. The process is often perceived as ill-defined, random and mysterious (Rhea, 2003). This also applies to the initiation of a digital transformation strategy, where research is still needed to cover the specific requirements of digital transformation (Matt et al., 2015). In digital transformation and other organizational change processes, the first step is to understand the need for change and develop possible options. Many managers aim at continuous innovation and change within the organization (Brown & Eisenhardt, 1997), but in reality, it can be observed that innovative strategy appears in different cycles of "short sprints", as well as major reorientations (Mintzberg & Waters, 1982). Hence, a promising avenue for further research is to explore and explain patterns and procedures that may reduce the fuzziness and bring more clarity to the front-end stage of the transformation process. One step in improving the fuzzy front-end is understanding and improving the information flow and knowledge transfer, in order to improve the interpretation of external signals and ensure a sufficient information flow between hierarchies. Since this research has revealed that sense-making and information processing are of great importance in organizational change strategies, further contributions might look into how this can be applied to the specific requirements of digital transformation. Another promising field for more research might be to explore the appropriate roles and responsibilities in the fuzzy front-end of digital transformation strategies. In digital transformation, multiple areas of the organization are affected, and therefore, multiple roles and different hierarchies might be involved in this process and in strategy formulation.

6 Conclusion

Although practical experience demonstrates that the beginning of a transformation process is extremely important, this present research has exposed a gap in the body of knowledge on strategy formation. As a limitation, it should be stated that the research only took publications from highly ranked journals into account. While it can be assumed that the top publications are representative of the important topics generally discussed in each this may still lead to a restricted view, so that including more publications from other journals could possibly change the conclusions drawn. A second limitation is that the publications have been assessed based on their abstracts. Depending on the quality and the comprehensiveness of the abstracts, it may be that important information was omitted or that the paper was miscoded. However, hopefully the restriction to highly ranked publications will mean that in fact the quality of the abstracts is sufficient to correctly code the papers and ensure the soundness of this research.

Drawing on the perspective of the fuzzy front-end, a concept popular in product innovation, this paper has developed new avenues for further research on both organizational transformation and strategy development. Identifying patterns within the FFE may help decision makers to overcome the uncertainties and confusion characterizing this phase and to develop viable strategies for actively designing the transformation process.

References

Alam, I. (2006). Removing the fuzziness from the fuzzy front-end of service innovations through customer interactions. *Industrial Marketing Management*, *35*(4), 468–480.

Bassellier, G., & Benbasat, I. (2004). Business Competence of Information Technology Professionals: Conceptual Development and Influence on IT-Business Partnerships. *MIS Quarterly*, *28*(4), 673–694.

Becker, M. C., & Zirpoli, F. (2008). Applying organizational routines in analyzing the behavior of organizations. *Journal of Economic Behavior and Organization*, *66*(1), 128–148.

Besson, P., & Rowe, F. (2012). Strategizing information systems-enabled organizational transformation: A transdisciplinary review and new directions. *The Journal of Strategic Information Systems*, *21*(2), 103–124.

Bharadwaj, A., El Sawy, O. A., Pavlou, P. A., & Venkatraman, N. (2013). Digital Business Strategy: Toward a Next Generation of Insights. *MIS Quarterly*, *37*(2), 471–482.

Brown, S. L., & Eisenhardt, K. M. (1997). The Art of Continuous Change: Linking Complexity Theory and Time-Paced Evolution in Relentlessly Shifting Organizations. *Administrative Science Quarterly*, *42*(1), 1–34.

Burn, J. M. (1993). Information systems strategies and the management of organizational change--a strategic alignment model. *Journal of Information Technology (Routledge, Ltd.)*, *8*(4), 205.

Carlo, J. L., Lyytinen, K., & Rose, G. M. (2012). A Knowledge-Based Model of Radical Innovation in Small Software Firms. *MIS Quarterly*, *36*(3), 865–A10.

Cha, K. J., Hwang, T., & Gregor, S. (2015). An integrative model of IT-enabled organizational transformation. *Management Decision*, *53*(8), 1755–1770.

Cha, K. J., & Lee, Z. (2013). What Do We Mean by Information Technology Enabled Organisational Transformation? In *PACIS 2013 Proceedings* (p. Paper 235).

Christensen, C. M., & Bower, J. L. (1996). CUSTOMER POWER, STRATEGIC INVESTMENT, AND THE FAILURE OF LEADING FIRMS. *Strategic Management Journal*, *17*(3), 197–218. R

Clemons, E. K., & Hann, I.-H. (1999). Rosenbluth International: Strategic Transformation of a Successful Enterprise. *Journal of Management Information Systems*, *16*(2), 9–27.

Davis, E. B., Kee, J., & Newcomer, K. (2010). Strategic transformation process: Toward purpose, people, process and power. *Organization Management Journal*, *7*(1), 66–80.

de Brentani, U., & Reid, S. E. (2012). The Fuzzy Front-End of Discontinuous Innovation: Insights for Research and Management. *Journal of Product Innovation Management*, *29*(1), 70–87.

Dougherty, D. (1992). A Practice-Centered Model of Organizational Renewal Through Product Innovation. *Strategic Management Journal*, *13*, 77–92.

Drnevich, P. L., & Croson, D. C. (2013). Information Technology and Business-Level Strategy: Toward an Integrated Theoretical Perspective. *MIS Quarterly*, *37*(2), 483–509.

Ettlie, J. E., Bridges, W. P., & O'Keefe, R. D. (1984). Organization Strategy and Structural Differences for Radical Versus Incremental Innovation. *Management Science*, *30*(6), 682–695.

Gaba, V., & Meyer, A. D. (2008). Crossing the Organizational Species Barrier: How Venture Capital Practices Infiltrated the Information Technology Sector. *Academy of Management Journal*, *51*(5), 976–998.

Hansen, A. M., Kraemmergaard, P., & Mathiassen, L. (2011). Rapid Adaptation in Digital Transformation: A Participatory Process for Engaging IS and Business Leaders. *MIS Quarterly Executive*, *10*(4), 175–185.

Harkness, W. L., Segars, A. H., & Kettinger, W. J. (1996). Sustaining Process Improvement and Innovation in the Information Services Function: Lessons Learned at the Bose Corporation. *MIS Quarterly*, *20*(3), 349–368.

Henderson, J. C., & Venkatraman, H. (1993). Strategic alignment: Leveraging information technology for transforming organizations. *IBM Systems Journal*, *32*(1), 472–484.

Higgins, M. C., Weiner, J., & Young, L. (2012). Implementation teams: A new lever for organizational change. *Journal of Organizational Behavior*, *33*(3), 366–388. 3

Horlacher, A., & Hess, T. (2016). What Does a Chief Digital Officer Do ? Managerial Tasks and Roles of a New C-level Position in the Context of Digital Transformation. In *49th Hawaii International Conference on System Sciences* (pp. 5126–5135).

Itami, H., & Numagami, T. (1992). Dynamic Interaction Between Strategy and Technology. *Strategic Management Journal*, *13*(S2), 119–135.

Kaul, A. (2012). Technology and Corporate Scope: Firm and Rival Innovation as Antecedents of Corporate Transactions. *Strategic Management Journal*, *33*(4), 347–367.

Kearns, G., & Sabherwal, R. (2007). Strategic Alignment Between Business and Information Technology: A Knowledge-Based View of Behaviors, Outcome, and Consequences. *Journal of Management Information Systems*, *23*(3), 129–162.

Kiss, A. N., & Barr, P. S. (2015). New venture strategic adaptation: The interplay of belief structures and industry context. *Strategic Management Journal*, *36*(8), 1245–1263.

Koen, P. a, Ajamian, G. M., Boyce, S., Clamen, A., Fisher, E., Fountoulakis, S., … Seibert, R. (2002). *Fuzzy Front End: Effective Methods, Tools, and Techniques*. New York: Wiley.

Lant, T. K., Milliken, F. J., & Batra, B. (1992). The Role of Managerial Learning and Interpretation in Strategic Persistence and Reorientation: An Empirical Exploration. *Strategic Management Journal*, *13*(8), 585–608.

Lewin, K. (1963). *Feldtheorie in den Sozialwissenschaften. ausgewählte theoretische Schriften.* Huber, Bern.

Matt, C., Hess, T., & Benlian, A. (2015). Digital Transformation Strategies. *Business & Information Systems Engineering*, *57*(5), 339–343.

Mintzberg, H., Ahlstrand, B., & Lampel, J. (1998). *Strategy Safari Wilds of Strategic Management*. *Free Press*.

Mintzberg, H., & Waters, J. A. (1982). Tracking Strategy in an Entrepreneurial Firm. *Academy of Management Journal*, *25*(3), 465–499.

Mitroff, I. J., Barabba, V. P., & Kilmann, R. H. The Application of Behavioral and Philosophical Technologies to Strategic Planning: A Case Study of a Large Federal Agency, 24 Management Science 44–58 (September 1977).

Montoya-Weiss, M. M., & O'Driscoll, T. M. (2000). From experience: Applying performance support technology in the fuzzy front end. *Journal of Product Innovation Management*, *17*(99), 143–161.

Ngwenyama, O., & Nielsen, P. A. (2013). Using organizational influence processes to overcome IS implementation barriers: lessons from a longitudinal case study of SPI implementation. *European Journal of Information Systems*, *23*(2), 205–222.

Norman, D. A., & Verganti, R. (2014). Incremental and Radical Innovation: Design Research vs. Technology and Meaning Change. *Design Issues*, *30*(1), 78–96.

Pagani, M. (2013). Digital Business Strategy and Value Creation: Framing the Dynamic Cycle of Control Points. *MIS Quarterly*, *37*(2), 617–632.

Qu, W. G., Oh, W., & Pinsonneault, A. (2010). The strategic value of IT insourcing: An IT-enabled business process perspective. *The Journal of Strategic Information Systems*, *19*(2), 96–108.

Randolph, W. a., & Dess, G. G. (1984). The Congruence Perspective of Organization Design: A Conceptual Model and Multivariate Research Approach. *Academy of Management Review*, *9*(1), 114–127.

Reid, S. E., & de Brentani, U. (2004). The fuzzy front end of new product development for discontinuous innovations: A theoretical model. *Journal of Product Innovation Management*, *21*(3), 170–184.

Reinertsen, D. G. (1999). Taking the Fuzziness Out of the Fuzzy Front End. *Research Technology Management*, *42*(6), 25.

Reynolds, P., & Yetton, P. (2015). Aligning business and IT strategies in multi-business organizations. *Journal of Information Technology*, *30*(2), 1–18.

Rhea, D. (2003). Bringing Clarity to the "Fuzzy Front End." In B. Laurel (Ed.), *Design Research* (pp. 145–154).

Romanelli, E., & Tushman, M. L. (1994). Organizational Transformation as Punctuated Equilibrium: An Empirical Test. *Academy of Management Journal*, *37*(5), 1141–1666.

Sagie, A., & Koslowsky, M. (1994). Organizational attitudes and behaviors as a function of participation in strategic and tactical change decisions: an application of path -- goal theory. *Journal of Organizational Behavior*, *15*(1), 37–47.

Sanchez, R. (1995). Strategic Flexibility in Product Competition. *Strategic Management Journal*, *16*, 135–159.

Sarker, S., & Lee, A. S. (1999). IT-enabled organizational transformation: a case study of BPR failure at TELECO. *The Journal of Strategic Information Systems*, *8*(1), 83–103.

Sharma, R., & Shanks, G. (2011). The role of dynamic capabilities in creating business value from IS assets. In *17th Americas Conference on Information Systems*.

Smith, P. G., & Reinertsen, D. G. (1991). *Developing products in half the time.* New York, NY Van Nostrand Reinhold.

Tallon, P. P. (2013). Do you see what I see? The search for consensus among executives' perceptions of IT business value. *European Journal of Information Systems*, *23*(3), 306–325.

Tripsas, M., & Gavetti, G. (2000). Capabilities,Cognition, and Inertia: Evidence from digital imaging. *Strategic Management Journal*, *21*(10), 1147–1161.

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly*, *27*(3), 425–478.

Verworn, B. (2009). A structural equation model of the impact of the "fuzzy front end" on the success of new product development. *Research Policy*, *38*(10), 1571–1581.

Vom Brocke, J., Simons, A., Niehaves, B., Riemer, K., Plattfaut, R., & Cleven, A. (2009). Reconstructing the giant: On the importance of rigour in documenting the literature search process. In *ECIS 2009 Proceedings* (pp. 2206–217).

Waldman, D. A., & Javidan, M. (2009). Alternative forms of charismatic leadership in the integration of mergers and acquisitions. *Leadership Quarterly*, *20*(2), 130–142.

Webster, J., & Watson, R. T. (2002). Analyzing the past to prepare for the future: Writing a literature review. *MIS Quarterly*, *26*(2), xiii–xxiii.

Williams, J. R. (1983). Technological evolution and competitive response. *Strategic Management Journal*, *4*(1), 55–65.

Yoo, Y., Boland, R. J., Lyytinen, K., & Majchrzak, a. (2012). Organizing for Innovation in the Digitized World. *Organization Science*, *23*(5), 1398–1408.

Zmud, R. W. (1984). An Examination of "Push-Pull" Theory Applied to Process Innovation in Knowledge Work. *Management Science*, *30*(6), 727–738.

Appendix 1 – Selected journals for the literature review

Information Systems Basket	**Organization Science Basket**	**Management / Strategy Basket**
European Journal of Information Systems	Organization Science	Science
Information Systems Journal	Journal of Applied Psychology	American Economic Review
Information Systems Research	Journal of International Business Studies	Econometrica
Journal of Information Technology	Organizational Behavior and Human Decision Processes	Academy of Management Journal
Journal of Management Information Systems	Journal of Public Administration Research and	Journal of Political Economy
Journal of Strategic Information Systems	Journal of Labor Economics	Administrative Science Quarterly
Journal of the Association of Information Systems	Organizational Research and Methods	Academy of Management Review
MIS Quarterly	Journal of Economic Behavior and Organization	Management Science
Mathematical Programming	(The Journal of Strategic Information Systems)1	Strategic Management Journal
INFORMS Journal on Computing	Personnel Psychology	The RAND Journal of Economics
SIAM Journal on Computing	Journal of Organizational Behavior	Journal of Industrial Economics
	Leadership Quarterly	Experimental Economics
		Academy of Management Annals
		Journal of Management
		Journal of Management Studies
		Journal of Economics & Management Strategy
		Organization Studies

1 The Journal of Strategic Information Systems is listed for both IS and OS baskets. The author decided to consider it as an IS journal for this research, therefore duplicate publications have been removed from the OS basket.

29th Bled eConference
Digital Economy
June 19 - 22, 2016; Bled, Slovenia

Data Portability and Online Platforms
The Effects on Competition [Extended Abstract]

Barbara Engels

Cologne Institute for Economic Research, Germany
engels@iwkoeln.de

Abstract
This paper examines the potential effects of data portability among online platforms on competition, providing policy recommendations for the preservation of innovative, undistorted competitive markets. Based on a platform-data model, it is illustrated how users, data and the products and services of a platform are related. Platform markets which entail an especially high risk of market power abuse are determined. It is concluded that the right to data portability as in the EU's General Data Protection Regulation has to be interpreted in a nuanced fashion in order to avoid adverse effects on competition and innovation.

Keywords: Data Portability, Online Platforms, Regulation

1 Introduction

The EU's General Data Protection Regulation (GDPR), which will become effective in 2018, contains the user's right to data portability between online platforms. The main goal of this regulation is to give data subjects more control over their personal data by reducing switching costs and the probability of lock-in. However, data portability presumably also affects the level of competition in a market.

This extended abstract examines the effects of the right to data portability on competition, providing policy recommendations for the preservation of innovative, undistorted competitive digital markets. The original paper is forthcoming in the journal Internet Policy Review. In order to assess data portability from a competition-policy perspective, this paper examines how data, users, and platform services are related and how these relations change under data portability. Different platform-data model specifications are distinguished depending on whether the platforms in question offer substitute or complementary products. In a second step, this paper discusses in which platform markets the risk of an abuse of market dominance is particularly high. Based on this assessment, platform markets are determined where the right to data portability is indeed likely to foster competition and innovation. As a consequence, a nuanced interpretation of the GDPR's right to data portability is suggested.

2 The concept of data portability

Data portability is the possibility for users to transfer their personal data to different online platforms. The easier it is for the user to transfer his data, the lower are his costs to switch to another platform and the lower is the probability of customer retention (Shapiro & Varian, 1999). Platform operators need to use at least interoperable data formats and templates to provide data portability. Without data portability, contacts cannot be transferred to another platform and information that has once been shared, i.e. data that the user has directly or indirectly invested such as messages, photos, reputation and search histories, remain with the original platform. The user is therefore more likely to stay with the platform that he initially provided his data to, although rival platforms might otherwise be more attractive to him. This might harm competition since competitors might not have an incentive to innovate and offer better services, knowing that users will nevertheless remain with the incumbent platform. The GDPR contains a general right to data portability[1] independent of a platform's size and market.

3 Platform-data model

Two specifications of a platform-data model are developed that illustrate the relationships between platforms, users and products. The first one includes the case of two platforms that offer essentially the same products (substitutes). The second one illustrates the case of two platforms that offer complementary products (e.g. a trading and a payment platform). Generally, the number of users is positively correlated with the volume and quality of data. Volume and quality of data are positively correlated with the variety and quality of the offered products or services, since companies can offer better products by analysing "more" consumer behaviour. Similarly, the variety and quality of products is related to the number of users: The more users, the more and better services are offered. More and better services again attract more users.

3.1 Platforms offering substitutes

The platform market is determined by two platforms A and B that offer substitutive products (see figure 1). A is the incumbent and B tries to enter the market or otherwise gain market share by offering a better product than A. Data portability is given.

If B enters the market and offers a better product than A, the number of users of B will increase, while the number of users of A will decrease: because of data portability, users can easily switch to B. The volume and quality of personal data that is extracted from the users will increase for B and decrease for A. Product quality will increase for B and decrease for A (indicated in figure 1 by the height of triangle). B will be able to offer more services than before (higher variety indicated by broader triangle), since more users imply more heterogeneity in preferences and a higher demand for services. The variety of products and services will not decrease for A unless it experiences a major consumer loss which revokes the efficiency of certain products. All in all, when, under data portability, platform A is deprived of a given customer because a competitor offers

[1] The legal text as contained in article 20 of the GDPR is as follows: "1.The data subject shall have the right to receive the personal data concerning him or her, which he or she has provided to a controller, in a structured, commonly used and machine-readable format and have the right to transmit those data to another controller without hindrance from the controller to which the personal data have been provided, where: (a) the processing is based on consent pursuant to point (a) of Article 6(1) or point (a) of Article 9(2) or on a contract pursuant to point (b) of Article 6(1); and (b) the processing is carried out by automated means. […]"(European Parliament and Council, 2016)

a better product and the customer switches to this competitor, A will not only lose the revenue from that customer but will also suffer a loss in the overall value of the platform.

If data portability is not guaranteed, A can potentially preclude B from entering the market or from gaining a higher market share since users can only switch platforms at high costs if they cannot transfer their data. Without data portability, all effects depicted in figure 1 would be significantly smaller, if they existed at all.

Therefore, data portability is desirable in the substitute case if market dominance is abused. If there is no abusive anticompetitive conduct, data portability might harm competition. Platform A then runs the risk of losing customers whenever a competitor with a marginally better product emerges. This might reduce the incentive to innovate due to smaller returns on investment. Also, B might not enter the market under data portability because of prohibitively high investments required for data to be portable.

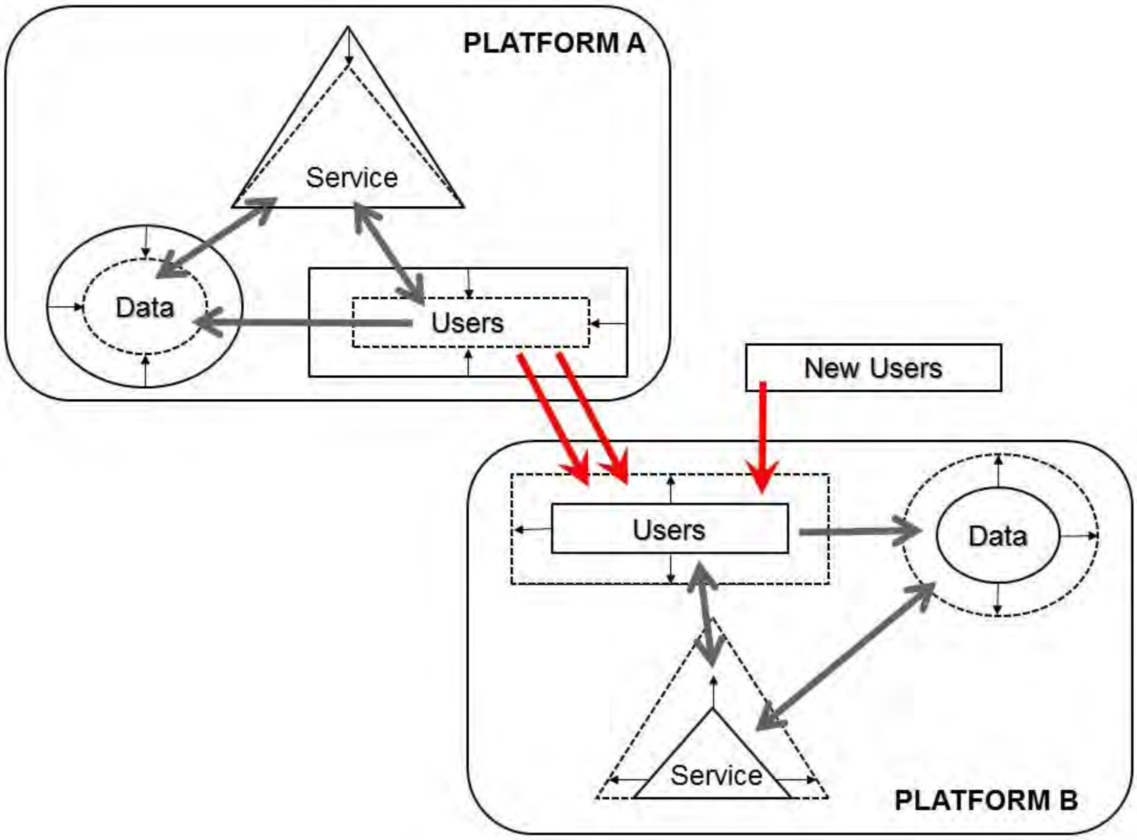


Figure 1: The platform-data model for substitutes. Solid lines show the initial situation. Dashed lines indicate the situation after platform B has gained market share. Thick arrows show dependencies. Qualitative illustration.

3.2 Platforms offering complements

The platform market is determined by two platforms A and B that offer complementary products (see figure 2). A is again regarded as the incumbent. B gains market share by offering a product that is complementary to A's product.

In theory, platforms offering complementary products should have an interest in making their data portable in order to be able to extract positive synergy effects. However, this is often prevented by information asymmetries.

In the model, under data portability, if the number of users of B increases, it is likely that the number of users of A will increase as well, since it becomes more attractive to use A's products in combination with B's products. Users can easily transfer data back and forth between both platforms. There might also be a significant amount of new users that both platforms benefit from. Accordingly, the volume and quality of data will increase for both platforms. The products of both platforms will gain in quality (higher triangle) and variety (broader triangle). Apart from the mutual benefit of A and B, the emergence of new business models is probable.[2] Without data portability, it can be expected that the increase in users for A and B will be significantly less pronounced, if positive spill-overs exist at all. Potential mutual benefits are lost.

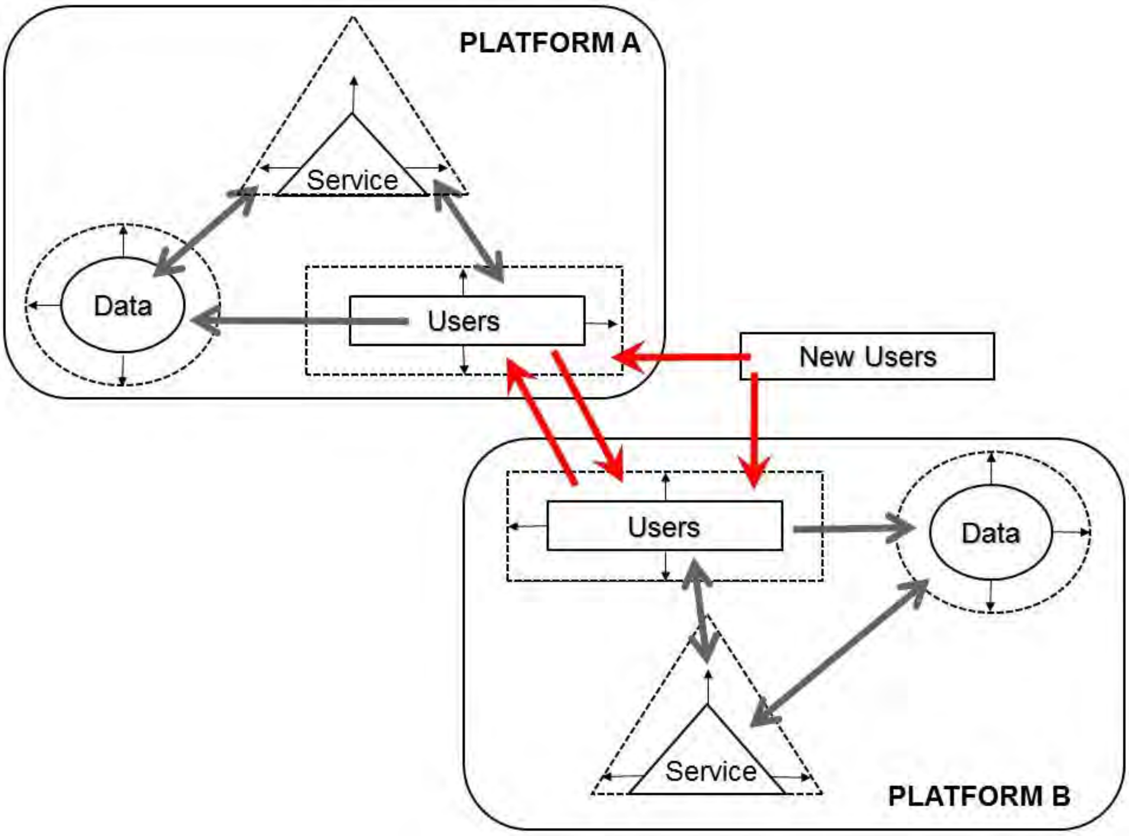


Figure 2: The platform-data model for complements. Solid lines show the initial situation. Dashed lines indicate the situation after platform B has gained market share. Thick arrows show dependencies. Qualitative illustration.

Therefore, it is recommendable or at least not harmful to competition to strictly interpret and follow the GDPR's right to data portability for platforms offering complementary products or those offering substitute products and abusing their market dominance. In order to provide a coherent policy recommendation, it needs to be

[2] An example for a potential new business model based on data portability is an energy-price comparison platform that could make recommendations based on the exact usage pattern of the respective household which is transferred to the platform by smart home technologies.

identified what determines anticompetitive conduct and in which platform markets the risk for anticompetitive conduct is high.

3.3 Detecting anticompetitive behaviour

Anticompetitive behaviour in online markets implies exploiting the peculiarities of platform markets, namely the concentration forces network effects, economies of scale, congestion, differentiation and switching costs (Evans & Schmalensee, 2007). In markets where the potential concentration is high, the risk that a company exploits market concentration forces is high as well. Table 3 summarizes the expected degree of market concentration forces for online marketplaces, social networks, and search engines. Based on the strength of the concentration forces, a so-called concentration score is determined that indicates the average degree of market concentration and hence the likelihood of its abuse.[3] In the original paper, the reasoning behind the scores is thoroughly explained.

	Effect on concentration	Search engines	Online marketplaces	Social networks
Direct network effects	+	low 1	low	high
Indirect network effects	+	high 3	high	medium
Economies of Scale	+	high 3	high	medium
Differentiation	–	low 3	high	high
Congestion	–	low 3	medium	medium
Switching Costs	+	medium 2	high	high
Market concentration (score)		high (2.5)	medium (2.17)	medium (2.17)

Table 3: Market Concentration Forces. Strength of market concentration forces for different types of platform markets. The concentration score indicates the degree of market concentration, with 1 ≤ score < 1.75 indicating low market concentration, 1.75 ≤ score < 2.5 indicating medium market concentration, and 2.5 ≤ score < 3 indicating high market concentration.

All in all, the degree of market concentration and hence the risk of dominance abuse is particularly high in search engine markets. In online marketplaces and social network markets, the degree of market concentration is medium. In these markets, the appropriateness of the right to data portability should be decided upon case-wise, depending on the size of the company in question, since the potential to abuse market dominance increases with firm size.

---

[3] Effects highly enforcing concentration are rated with a score of 3, effects only weakly enforcing concentration are rated with a score of 1. For example, as congestion leads to less concentration, low congestion implies higher concentration than high congestion and is therefore rated with a score of 3.

4 Policy recommendations

According to the above analysis, data portability is recommended in cases where platforms offer complementary products and in cases where platforms offer substitute products and the risk of anticompetitive conduct is high, i.e. in search engine markets. In all other cases, a strict interpretation of the GDPR's right to data portability is not warranted. On the contrary, this would likely constrain the development of new business models and hamper innovation by requiring firms to share their main asset, personal data, for free. Thereby, it would eventually harm competition instead of fostering it, protecting competitors instead of competition (Swire & Lagos, 2013).

Multi-sided platform issues should be approached with more humility, relying on the self-correcting powers of the market provided that certain values such as privacy and security are protected by flanking policy frameworks.

References

European Parliament and Council. (2016). REGULATION (EU) 2016/679 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation), from http://ec.europa.eu/justice/data-protection/reform/files/regulation_oj_en.pdf

Evans, David S. & Schmalensee, Richard. (2007). The Industrial Organization of Markets with Two-sided Platforms. Competition Policy International. Volume 3 (1), pp. 151–179. DOI 10.3386/w11603.

Shapiro, Carl & Varian, Hal R.. (1999). Information Rules: A Strategic Guide to the Network Economy. Boston, MA: Harvard Business Press.

Swire, Peter & Lagos, Yianni. (2013) Why the right to data portability likely reduces consumer welfare: Antitrust and privacy critique. Maryland Law Review. Volume 72 (2), pp. 335–380. DOI 10.2139/ssrn.2159157.

29th Bled eConference

Digital Economy

June 19 - 22, 2016; Bled, Slovenia

A Framework for Traceability of Legal Requirements in the Dutch Governmental Context

Koen Smit

HU University of Applied Sciences Utrecht, Nijenoord 1, 3552 AS Utrecht, the Netherlands, koen.smit@hu.nl

Martijn Zoet

Zuyd University of Applied Sciences, Havikstraat 5, 6135 ED Sittard, the Netherlands, martijn.zoet@zuyd.nl

Matthijs Berkhout

HU University of Applied Sciences Utrecht, Nijenoord 1, 3552 AS Utrecht, the Netherlands, matthijs.berkhout@hu.nl

Abstract

In the past decades, research and practice focused a lot of attention towards traceability in the context of software requirements, food supply chains, manufacturing, and aviation industry. As legislation and regulations in software systems become increasingly relevant, traceability of legal requirements is of great importance. In this study, we aimed to create a framework in which the basis for traceability of legal requirements is addressed. To be able to do so we conducted five case studies at five Dutch governmental institutions, which was followed by a three-round focus group. The resulting framework comprises 22 (layered) traceability elements in relation to three domains that offers a reference model to determine how traceability can be applied in software system design, in the context of the Dutch government.

Keywords: *Traceability, Legal Requirements, Legal Sources*

1 Introduction

An industry that is influenced by changes in laws and regulations comprises the governmental institutions that deliver public administration services. As more and more public administration services are offered digitally, the need to trace the delivered services to their legal sources, laws and regulations, becomes more complex. This type of traceability is absent in most of the current public administration services (Van Engers & Nijssen, 2014).

To be able to create new or change existing public administration services that adhere to laws and regulations, these legal sources need to be interpreted and transformed from natural language into specifications for computer-executable business rules (van Engers & van Doesburg, 2015). These activities are often defined in a specific process to guide and structure the transformation of legal requirements into software systems. An example of this is the '*agile execution of law',* developed and employed by the Dutch Tax and Customs Administration (Boer & Van Engers, 2013). In these processes, traceability is a core capability.

However, currently, traceability is often of secondary importance when a public administration service is designed. This influences the transparency governmental institutions can provide when a service is delivered to a customer. The importance of traceability usually changes when errors are made providing the services (Van Engers & Nijssen, 2014). The main reason for this delay is that the implementation of adequate design and management of traceability often costs a significant amount of organizational resources, which should be justified by a proper business case (Cleland-Huang, Gotel, Huffman Hayes, Mäder, & Zisman, 2014). In this paper, we propose a traceability framework which enables governmental institutions to select what form of traceability and to what extend traceability should be implemented. Moreover, our traceability framework enables governmental institutions to choose what elements to utilize in software systems design, based on what elements are usual when addressing traceability of legal requirements. To be able to do so, we addressed the following research question: "*Which elements are useful to trace with regards to legal requirements in the context of the Dutch government*"

The remainder of this paper is organized as follows: First, we provide insights into how traceability is intertwined with software systems design and how it affects decision making as part of public administration (e-)services. This is followed by the research method used to construct the traceability framework. Furthermore, the collection and analysis of our research data are described. Subsequently, our results which led to our traceability framework are presented. Finally, we discuss which conclusions can be drawn from our results, followed by a critical view of the research methods utilized and results of our study and propose possible directions for future research.

2 Background and related work

In the previous decades, much research focused on traceability. For example, traceability in food supply chains (Opara, 2003) and manufacturing chains in the aviation industry (Ngai et al., 2007). Furthermore, traceability is utilized in the context of requirements (Gotel & Finkelstein, 1994), software artifacts (Gao, Zhu, Shim, & Chang, 2000), model-engineering (Jouault, 2005), jurisprudence (ECLI) (van Harten & Jansen, 2013), and the protection of copyrighted material (Staddon, Stinson, & Wei, 2001). As laws and regulations need to be transformed and processed into software systems of governmental institutions, we focus on traceability of legal requirements in the context of software artifact traceability.

Software artifact traceability is defined as: "*Software artifact traceability is the ability to describe and follow the life of an artifact (requirements, code, tests, models, reports, plans, etc.) developed during the software lifecycle in both forward and backward directions*" (Gotel & Finkelstein, 1994). A proper implementation of software artifact traceability can provide insights into system development and evolution, assisting in both top-down and bottom-up program comprehension, impact analysis, and reuse of existing software artifacts, and is therefore defined as a critical success factor in software development (Domges & Pohl, 1998). In this context, traceability knows two dimensions. The first dimension comprises vertical and horizontal relations. Horizontal relations refer to traceability relations that associate elements of the same type of artifact (i.e. relationships between facts) while vertical relations refer to associations from an artifact towards different type of artifacts (i.e. a relationship between a decision and its underlying business rule) (Lindvall, Tvedt, & Costa, 2003). The second dimension comprises pre and post-traceability, which is also referred to as forward and backward traceability (Gotel & Finkelstein, 1994). Pre-traceability refers to the relations between requirement specifications and the sources that have given rise to these specifications, i.e. the stakeholders that have expressed the views and needs which are reflected in them while post-traceability refers to the relations between requirement specifications and artifacts that are created in subsequent stages of the software development life cycle.

A lot of research is performed on software artifact traceability (Lucia, Marcus, Oliveto, & Poshyvanyk, 2012; Lucia, Fasano, Oliveto, & Tortora, 2007; Sundaram, Hayes, Dekhtyar, & Holbrook, 2010). However, a recent study by Cleland-Huang et al. (2014), who analyzed the knowledge base regarding software artifact traceability, still uncovered research directions that are not adequately covered by current research effort. For example, traceability strategizing, creation of intuitive forms of query mechanisms, and visualization of trace data. Their study resulted in a collection of research directions that are defined as useful for both complementations of the body of knowledge and applicability in practice. One of those research directions is that of the development of traceability reference models to guide the design of traceability solutions. Cleland-Huang et al. (2014) state that, to date, most research on traceability reference models focused on the creation of a reference model for standard (generalized) projects. According to (Ramesh & Jarke, 2001), a traceability reference model can be defined as: "*A traceability reference model specifies the permissible artifact types and permissible link types that can form a trace on a project, and is derived from an analysis of the queries that the resulting traceability is intended to answer.*" The problem with most of the currently proposed traceability reference models is that none of them are universally accepted of widely used in industry, due to the fact that most of them are too general of nature (Cleland-Huang et al., 2014). An example of a traceability reference model which is tailored for application in a specific domain is the work of Katta (2012), which proposed a traceability reference model for use in the highly-regulated nuclear domain. One of the key factors of its acceptance by the industry was that the creation and tailoring of the traceability reference model were driven by the industry itself.

This particular study was initiated and driven by five executive governmental institutions. These institutions are responsible for delivering public administration services. Due to this, traceability between software systems and legal sources is an important component in their software development lifecycle. An example of a Dutch public administration service which is offered as an e-service would be, on a yearly basis, the declaration of taxes. For this e-service, it is essential that the decision-making is transparent and thus, all components that are part of the e-service are linked to legal sources. This ensures a legally valid execution of decision-making that is supported by software systems and/or executed in a fully automated manner. In this study, we define a legal source as a source of law or regulation, stated by supranational, national, regional or local stakeholders within the legal rights to do so (Tarantino, 2008). Examples of legal sources are 1) international treaties on human rights, 2) the European Community Law, 3) national laws and regulations, 4) civil rights, and 5) internal policies. Moreover, we also utilize the concept of a legal requirement, which we define as a requirement that is extracted from a legal source which influences software system design. Legal requirements are different from conventional software requirements in three distinct ways (Breaux, 2009): 1) legal requirements govern multiple industries, goods, and services, whereas traditional practice focuses on software requirements target specific systems, 2) Legal requirements are not elicited by engineers from stakeholders, they are codified in legal language and interpreted therefrom, and 3) Ambiguity cannot be removed from legal requirements by software engineers, it can only be classified and interpreted in the context of organizational practices, goods, and services. An example of a method that is tailored to the definition of legal requirements based on legal sources is the Frame-Based Requirements Analysis Method (FBRAM), see (Breaux & Antón, 2007) and (Breaux, 2009).

3 Research method

The goal of this research is to propose a validated traceability framework which can guide the design of the traceability capability at governmental institutions. In addition to the goal of the research, also, the maturity of the research field is a factor in determining the appropriate research method and technique(s). In this study, traceability is considered in combination with the research field of legal requirements. The maturity of the traceability research field, in general, is very mature. Still, research on traceability reference models is less mature (Cleland-Huang et al., 2014). The research areas of legal requirements and business rules management, in general, is less mature to nascent (Kovacic, 2004; Nelson, Peterson, Rariden, & Sen, 2010; Anonymous, 2014). Focus of research in nascent research fields should lie on identifying new constructs and establishing relationships between identified constructs (Edmondson & Mcmanus, 2007). Summarized, to accomplish our research goal, a research approach is needed in which elements that should be traced and the actual traces are explored and combined into one traceability framework. To achieve our goal, we analyze traceability demands regarding legal requirements in five case studies at five governmental institutions. Based on this round of data collection a traceability framework is constructed and proposed. Then, to increase the generalizability of the traceability framework, three rounds of validation are conducted in the form of a focus group where experts of all five case study organizations participated.

Case study research is selected so that the researchers were able to gather data on how traceability is implemented. Therefore, the case studies are exploratory of nature. The organizations are selected from a pool of Dutch governmental institutions that provide public administration services based on laws and regulations that are provided by the Dutch legislative governmental branches. Our study comprised a holistic case study approach, featuring one context, traceability of legal requirements, and five cases within this context. The unit of analysis are the traceability demands of the individual case organizations. As the case study approach is exploratory of nature, the data collection and analysis consisted of secondary data and semi-structured interviews, which is a combination of first and third-degree data collection. This approach has several advantages and is thoroughly discussed in (Runeson & Höst, 2009).

Adequate research methods to explore a broad range of possible ideas and/or solutions to a complex issue and combine them into one view when a lack of empirical evidence exists consist of group-based research techniques (Delbecq & Van de Ven, 1971; Okoli & Pawlowski, 2004; Ono & Wedemeyer, 1994). Examples of group based techniques are Focus Groups, Delphi Studies, Brainstorming and the Nominal Group Technique. The main characteristic that differentiates these types of group-based research techniques from each other is the use of face-to-face versus non-face-to-face approaches. Both approaches have advantages and disadvantages, for example, in face-to-face meetings, provision of immediate feedback is possible. However, face-to-face meetings have restrictions with regard to the number of participants and the possible existence of group or peer pressure. To eliminate the disadvantages, we combined the face-to-face and non-face-to-face technique by means of applying case studies and three focus group meetings.

4 Data collection and analysis

Data for this study is collected over a period of six months, between August 2014 to February 2015, through five case studies and three rounds of focus groups. Between each round of the focus group, researchers consolidated the results. Both methods of data collection are further discussed in the remainder of this section.

4.1 Case Studies

Over a period of three months, between August 2014 and November 2014, five case studies were conducted by a group of seven researchers. The case studies were performed in two phases. The first phase comprised the collection and analysis of secondary data. The second phase comprised the semi-structured interviews. The selection of the participants should be based on the group of individuals, organizations, information technology, or community that best represents the phenomenon studied (Strauss & Corbin, 1990). For this study, the phenomenon studied is represented by organizations and individuals that deal with traceability of legal requirements. Such organizations are often financial and government institutions. The organizations that agreed to cooperate with the focus group meetings were the: 1) Dutch Tax and Customs Administration, 2) Dutch Immigration and Naturalization Service, 3) Dutch Employee Insurance Agency, 4) Dutch Education Executive Agency, Ministry of Education, Culture and Science, and 5) Dutch Social Security Office.

First, the experts of the case study organizations were prompted to gather and send all relevant and available documentation to the research team to analyze in advance of the semi-structured interviews. As this yielded a large amount of secondary data, the researchers needed a month to structure the data so that it was understood by the researchers and that it could serve as a basis for the semi-structured interviews, in terms of topics to be discussed.

Second, we conducted two semi-structured interviews with subject-matter experts at each case organization. The subject-matter experts were in all cases responsible for the traceability capability at the case organization and had more than five years of experience. Based on our findings from the first phase, an interview protocol was followed, comprising the following questions: 1) "Are all elements and traces described correctly?", "2) Do I want to remove an element or a trace?" 3) "Do we need additional elements or traces?", and 4) "Does the element or trace contribute to the traceability of legal requirements throughout software systems design?" The interviews were all audio-taped and were protocolled and consolidated on the same day.

4.2 Focus Group

Subsequently to the case studies, the focus groups were prepared and conducted between November 2014 to February 2015. Before a focus group is conducted, first, a number of key issues need to be considered: 1) the goal of the focus group, 2) the selection of participants, 3) the number of participants, 4) the selection of the facilitator, 5) the information recording facilities, and 6) the protocol of the focus group.

The goal of the focus group was to assemble and validate a traceability framework. We utilized the same selection of Dutch governmental institutions which collaborated in the case study phase, also to increase generalizability. Based on the written description of the goal and consultation with employees of each government institution, participants were selected to take part in the three focus group meetings. In total, thirteen participants took part who fulfilled the following positions: four business rule architects, three business rule analysts, two project managers, one IT architect, one enterprise architect, one software engineer, and one tax advisor. Each of the participants had, at least, five years of experience with traceability and traceability issues in practice. Each focus group was chaired by one experienced facilitator. Besides the facilitator, five additional researchers were present during the focus group meetings. One researcher participated as 'back-up' facilitator, who monitored if each participant provided equal input, and if necessary, involved specific participants by asking for more in-depth elaboration on the subject. The remaining four researchers acted as a minute's secretary taking field notes. They did not intervene in the process. All focus groups were video and audio recorded. A focus group meeting took on average one and a half hours. Each focus group meeting followed the same overall protocol, each starting with an introduction and explanation of the purpose and procedures of the meeting, after which ideas were generated, shared, discussed and/or refined.

Prior to the first round, participants were informed about the purpose of the focus group meeting and were invited to study the traceability model of their corresponding organization, derived from the case study results. In addition, the first version of the traceability framework that was constructed from the results of the case studies was also included. All participants were asked to bring any comments, which came up while studying the results, with them to the first focus group meeting. The first round started with the presentations of the individual traceability models derived from the case study results. After the individual presentations, participants discussed the usefulness of each traceability element. Also, additional traceability elements were proposed. For each proposed traceability element, the name, description, rationale, domain, and organization-specific examples were discussed and noted. After the first focus group, the researchers consolidated the results. Consolidation comprised the construction of the first version of the traceability framework and detection of double traceability elements (conceptually equal). The results of the consolidation were sent to the participants of the focus group two weeks in advance for the second focus group meeting. During these two weeks, the participants assessed the consolidated results in relationship to four questions: 1) "Are all elements and traces described correctly?", "2) Do I want to remove an element or a trace?" 3) "Do we need additional elements or traces?", and 4) "Does the element or trace contribute to the traceability of legal requirements throughout software systems design"?" This process of conducting focus group meetings, consolidation by the researchers and assessment by the participants of the focus group was repeated two more times (round 2 and round 3). After the third focus group meeting (round 3), saturation within the group occurred, leading to a consolidated traceability framework.

5 Results

In this section, the results of the case studies and the focus group are presented. First, we report on the results of the case studies conducted. This is followed by the results from the comparative analysis in which the case study results are compared. Lastly, we report on the results of the focus group meeting, which had the goal to validate our findings and come to a traceability framework a basis for traceability of legal requirements in software systems.

5.1 Case Study Results

As mentioned in section three, five case studies were conducted. Based on the analysis of both the secondary data and interview results a traceability map is created that visualizes the traceability elements deemed important per case study, see for example figure 1. To improve the readability of this section, we label the Dutch Tax and Customs Administration as case A, the Dutch Immigration and Naturalization Service as case B, the Dutch Employee Insurance Agency as case C, the Dutch Education Executive Agency as case D, and the Dutch Social Security Office as case E. In our results we refer to elements and traces as a singular form, while, in practice, it is possible that elements are referred to in the plural form.

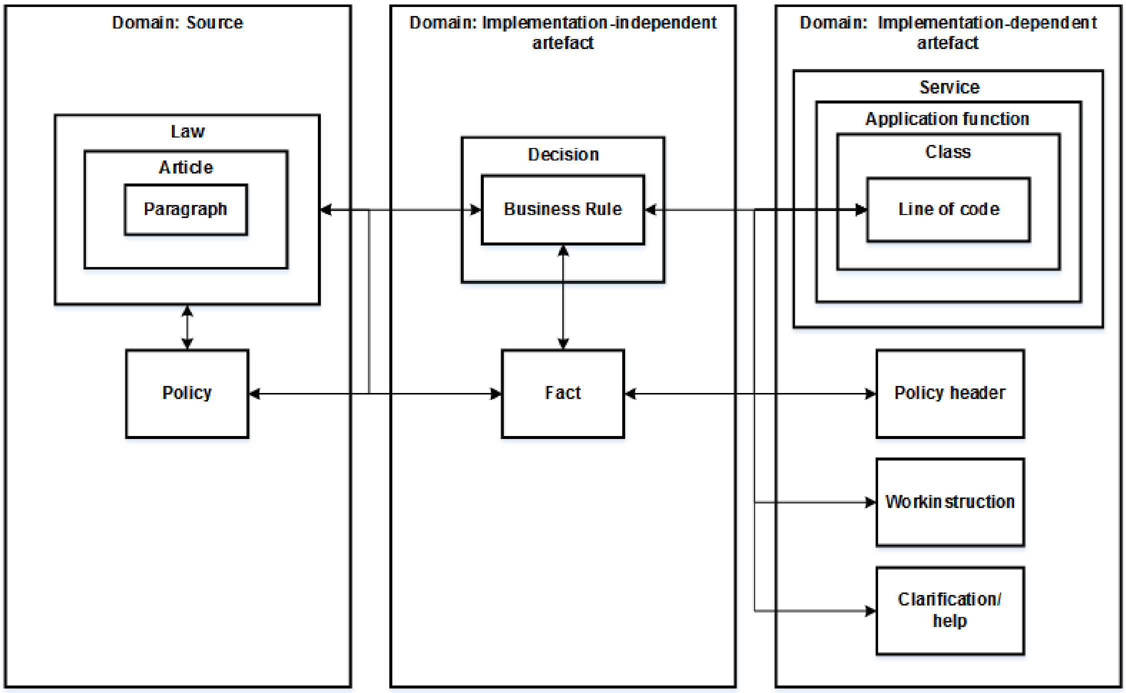


Figure 1: Example traceability model of the Dutch Education Executive Agency.

A similarity that we identified was that all five cases utilize three domains in which elements are managed and traces are implemented. Additionally, all five case organizations utilize those domains to trace between as well. The first domain is the source domain. This domain comprises the laws and regulations as defined by the legal writers of the house of representatives of the Netherlands. The second domain is defined as the implementation-independent artifact domain. This domain comprises artifacts that are established without incorporating language or properties that are affiliated to the use of specific technology (i.e. from specific vendors). The third domain comprises the implementation-dependent artifacts domain. This domain utilizes, for example, vendor specific instantiations of artifacts. An example of this would be the use of knowledge models specifically created and used in the application BeInformed.

In total, the results of the case studies identified multiple similarities and differences between the involved case organizations. However, due to space limitations, we do not cover each individual difference but summarize the differences. In summary, there were seven elements that were included by all case organizations, four elements that were included by all but one case organization, two elements that were included by all but two case organizations, and four elements were included by two of five case organizations.

Further summarized, our findings show some noteworthy design decisions by the case organizations regarding traceability demands. First, we identified a difference in the traceability towards laws and regulations in the source domain. Case A and B reported to trace to the lowest level possible; individual words, whilst case C, D and E report to trace on the level of paragraphs. Case A and B indicate to require these extra levels of traceability due to the fact that both organizations need process less structured laws and regulations compared to case C, D, and E (i.e. often lacking structuring in articles or paragraphs). Moreover, case A also required lower levels of traceability to be able to compare words as concepts in laws and regulations.

Case A and C trace business rules, while case B, D and E utilize decisions as parent elements for business rules which are also traced. Case A indicates to do so because it allows them to execute a more precise form of traceability. Case C motivation for this design decision is that they are still designing their solution and experimenting with the required precision of traceability. Case B, D, and E utilize decisions as parent level of business rules because it enables them to build business rule architectures with the purpose to structure a large amount of business rules as part of a decision.

Moreover, case C and E include a data-model in addition to the common vocabulary-model (i.e. an Entity Relationship Diagram). Case E needs to trace this element due to the fact that their software systems require a data-model in processing legal requirements and providing their public administration services.

Similarly, both case C and E include implementation-dependent data models, whilst case A, B, and D did not want to trace data related models in the implementation-dependent domain. Case E reported utilizing implementation-dependent data models for the execution of their public administration services, bound to a specific software system supplier.

Lastly, case B reported to not trace to either software systems, services, components, classes or a line of code, while case A, C, D, and E did express the necessity to trace to these elements. This is due to the fact that the chosen software system of case B is built upon design principles that do not adhere to layers as, for example, software systems, services, components. Also, case E was the only organization which reported to also trace towards process activities as part of their Business Process Management System due to their integration with a specific software system supplier.

5.2 Focus Group Results

Based on the case study results the researchers prepared the first focus group session. The goal of these focus group sessions was to, based on the participant's input and feedback, assemble the traceability framework. Also, as described in section 4, the participants focused on further refinement of the elements to trace in terms of label and description and vertical traceability demands regarding the traceability framework.

The participants agreed in the first focus group round on the consolidated source domain. For this domain two traceability elements were split into different levels of elements to trace; delegated legislation and jurisprudence. Delegated legislation is added due to the fact that the executive organizations of the government are also able to extend or further define constraints for the implementation of laws and regulations. As this kind of regulation can influence how software systems are designed the executive organizations should be able to trace it. Jurisprudence is in this case defined as judgments or decisions by judges from various legislative levels. As these judgments or decisions can influence how the executive organizations should execute laws and regulations (i.e. by constraining them to judge negatively in specific situations which were previously allowed by law), jurisprudence should be traced as well.

Furthermore, little variety was identified regarding the elements in the implementation-independent domain. The participants agreed to split a traceability element into two elements; object model and use-case. An object model is utilized as an Entity Relationship Diagram, serving as a frame of reference how data is used in decision services by the executive organizations. The way the data is structured and used in decision making affects software systems design, and thus should be traced. Furthermore, use cases are important to trace due to the fact that these contain specific end-user scenario's coupled with certain laws and regulations.

Moreover, the participants had the most discussion regarding the implementation-dependent domain. This was due to the fact that the software systems are very diverse (i.e. most suppliers impose self-developed languages or solutions). However, although most consensus amongst the participants was required for the traceability elements in this domain, no additional element was included op top of the elements deducted from the case studies.

5.3 Traceability Framework

To select the elements to be included in the final traceability framework, multiple methods of agreement can be applied, for example, nominal comparison, ordinal comparison or narrative appraisal. In our research, we applied the method of agreement to compare the different cases and to be traced elements. However, a traceable element was added to the framework even it occurred only once. The reason for this is that the framework provides organizations all possibilities to choose from. Therefore also situations that occur only once in the selected organizations can be applicable to other organizations. The final traceability framework derived from the focus groups is built out of three domains, which are elaborated upon in section 5.1. Summarized, each of the domains comprises three or more high-level traceability elements which we will elaborate in this subsection if not already addressed in the previous subsections. Regarding the source domain, a policy refers to internal procedures or protocols inherent to the specific organization.

Regarding the implementation-independent domain, the high-level traceability elements are a scope, fact type model, object model, and use-case. A scope is defined as any unit of analysis, stated by the organization. Examples of this are a selection of business rules part of a specific decision service or one decision with all its underlying business rules. The number of contexts in a scope can vary but consists of a minimum of one context. A decision is built from one or more business rules. The fact type model serves as a domain model containing all possible terms that are utilized in decision making, which are labeled as facts.

Regarding the implementation-dependent domain, the high-level traceability elements are a software system, work instruction, and specification. The software system is built from one, but usually multiple (shared) services. Services are built from (shared) components. A component can be further dissected into classes, and on the lowest possible level, a Line of Code (LoC) that can be traced. The relationships between the different elements are all identical: many to many relationships. Summarized, the consolidated traceability framework is presented in Figure 2.

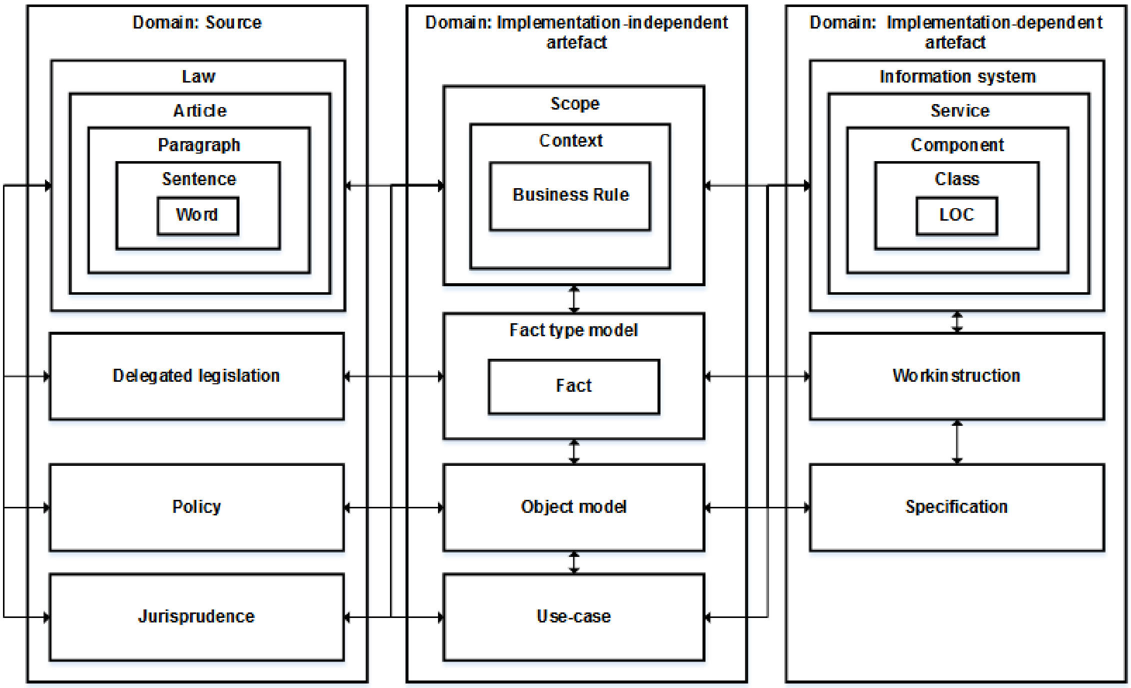


Figure 2: Final traceability framework.

6 Discussion & Conclusion

In this paper, we aimed to find an answer to the following question: "*Which elements are useful to trace with regards to legal requirements in the context of the Dutch government*". To accomplish this goal, we conducted a study conducting five case studies and a three round focus group. Both were applied to retrieve traceability elements from participants, 41 in total, employed by five executive governmental agencies. Our rounds of data collection and analysis resulted in a traceability framework which can be utilized when designing or improving the traceability capability of governmental organizations that execute laws and regulations. From a research perspective, our study provides a fundament for traceability principles and traceability elements focused on the implementation of laws and regulations in software systems design. From a practical perspective, executive governmental organizations could utilize the results of this study to guide the (re)design of traceability of legal requirements in software systems. With this in place organizations can ensure the adequate level of transparency towards legislative branches of the government, judges and judicial systems, and no less significant, towards citizens and businesses. Furthermore, another practical implication of our results could be that the governmental organizations now have a common frame of reference to communicate when addressing traceability. Therefore, our proposed traceability framework can be useful when executive governmental branches need to collaborate in a single chain of services.

Several limitations may affect our results. The first limitation concerns the sampling and sample size. The sample group of case organizations and participants is solely drawn from government institutions in the Netherlands. While we believe that government institutions are representative for organizations implementing traceability of legal requirements to implementation systems design, further generalization towards non-governmental organizations, amongst others, is recommended. Taken the sample size of five case studies and 41 participants into account, this number needs to be increased in future research. This research focused on identifying new constructs and establishing relationships given the current maturity of the traceability research field. Although the research approach chosen for this research type is appropriate, research focusing on further generalization should apply different research methods, such as quantitative research methods, which also allow us to incorporate larger sample sizes to validate our findings.

References

Boer, A., & Van Engers, T. (2013). Legal knowledge and agility in public administration. *Intelligent Systems in Accounting, Finance and Management*, *20*(2), 67–88.

Breaux, T. (2009). *Legal requirements acquisition for the specification of legally compliant information systems*. ProQuest.

Breaux, T. D., & Antón, A. I. (2007). A Systematic Method for Acquiring Regulatory Requirements: A Frame-Based Approach. In *Sixth International Workshop on Requirements for High Assurance Systems (RHAS-6)*.

Cleland-Huang, J., Gotel, O. C., Huffman Hayes, J., Mäder, P., & Zisman, A. (2014). Software traceability: trends and future directions. In *Proceedings of the on Future of Software Engineering* (pp. 55–69). ACM.

De Lucia, A., Marcus, A., Oliveto, R., & Poshyvanyk, D. (2012). Information retrieval methods for automated traceability recovery. In *Software and systems traceability* (pp. 71–98). Springer London.

Delbecq, A. L., & Van de Ven, A. H. (1971). A group process model for problem identification and program planning. *The Journal of Applied Behavioral Science*, *7*(4), 466–492.

Domges, R., & Pohl, K. (1998). Adapting Traceability Environments to Project Specific Needs. *CACM*, *41*(12), 54–62.

Edmondson, A. C., & Mcmanus, S. E. (2007). Methodological Fit in Management Field Research. *Proceedings of the Academy of Management*, *32*(4), 1155–1179.

Gao, J., Zhu, E. Y., Shim, S., & Chang, L. (2000). Monitoring software components and component-based software. In *The 24th Annual International Computer Software and Applications Conference* (pp. 403–412). IEEE.

Gotel, O. C., & Finkelstein, A. C. (1994). An analysis of the requirements traceability problem. In *Proceedings of the First International Conference on Requirements Engineering* (pp. 94–101). IEEE.

Jouault, F. (2005). Loosely coupled traceability for ATL. In *Proceedings of the European Conference on Model Driven Architecture (ECMDA) workshop on traceability* (pp. 29–37).

Katta, V., & Stålhane, T. (2012). *Traceability of safety systems: approach, meta-model and tool support*.

Kovacic, A. (2004). Business renovation: business rules (still) the missing link. *Business Process Management Journal*, *10*(2), 158 – 170.

Lindvall, M., Tvedt, R. T., & Costa, P. (2003). An empirically-based process for software architecture evaluation. *Empirical Software Engineering*, *8*(1), 83 – 108.

Lucia, A. D., Fasano, F., Oliveto, R., & Tortora, G. (2007). Recovering traceability links in software artifact management systems using information retrieval methods. *ACM Transactions on*

Software Engineering and Methodology (TOSEM), *16*(4), 13–23.

Nelson, M. L., Peterson, J., Rariden, R. L., & Sen, R. (2010). Transitioning to a business rule management service model: Case studies from the property and casualty insurance industry. *Information & Management*, *47*(1), 30–41. http://doi.org/10.1016/j.im.2009.09.007

Ngai, E. W. T., Cheng, T. C. E., Lai, K. H., Chai, P. Y. F., Choi, Y. S., & Sin, R. K. Y. (2007). Development of an RFID-based traceability system: Experiences and lessons learned from an aircraft engineering company. *Production and Operations Management*, *16*(5), 554–568.

Okoli, C., & Pawlowski, S. D. (2004). The Delphi method as a research tool: an example, design considerations and applications. *Information & Management*, *42*(1), 15–29.

Ono, R., & Wedemeyer, D. J. (1994). Assessing the validity of the Delphi technique. *Futures*, *26*(3), 289–304.

Opara, L. U. (2003). Traceability in agriculture and food supply chain: a review of basic concepts, technological implications, and future prospects. *Journal of Food Agriculture and Environment*, *1*(1), 101–106.

Ramesh, B., & Jarke., M. (2001). Toward reference models of requirements traceability. *IEEE Transactions on Software Engineering*, *27*(1), 58–93.

Runeson, P., & Höst, M. (2009). Guidelines for conducting and reporting case study research in software engineering. *Empirical Software Engineering*, *14*(2), 131–164.

Staddon, J. N., Stinson, D. R., & Wei, R. (2001). Combinatorial properties of frameproof and traceability codes. *IEEE Transactions on Information Theory*, *47*(3), 1042–1049.

Strauss, A., & Corbin, J. M. (1990). *Basics of qualitative research: Grounded theory procedures and techniques*. Sage Publications, Inc.

Sundaram, S. K., Hayes, J. H., Dekhtyar, A., & Holbrook, E. A. (2010). Assessing traceability of software engineering artifacts. *Requirements Engineering*, *15*(3), 313–335.

Tarantino, A. (2008). *Governance, Risk, and Compliance Handbook: Technology, Finance, Environmental, and International Guidance and Best Practices*. John Wiley & Sons.

van Engers, T. M., & van Doesburg, R. (2015). At your service, on the definition of services from sources of law. In *Proceedings of the 15th International Conference on Artificial Intelligence and Law* (pp. 221–225).

van Engers, T., & Nijssen, S. (2014). Connecting People: Semantic-Conceptual Modeling for Laws and Regulations. *Electronic Government*, 133–146.

van Harten, H. J., & Jansen, R. H. (2013). How do Judges Learn EU Law? A Dutch Narrative. *Review of European Administrative Law*, *6*(2), 57–83.

29th Bled eConference

Digital Economy

June 19 - 22, 2016; Bled, Slovenia

Towards a Model of Heterogeneity in IT Service Value Networks: Results from a Literature Review

Robert Heininger

Technical University of Munich (TUM), Germany

robert.heininger@in.tum.de

Loina Prifti

Technical University of Munich (TUM), Germany

prifti@in.tum.de

Markus Böhm

Technical University of Munich (TUM), Germany

markus.boehm@in.tum.de

Helmut Krcmar

Technical University of Munich (TUM), Germany

krcmar@in.tum.de

Abstract

At the dawn of the Digital Economy, companies are facing with dematerialization and digitization of products and the trend towards service delivery. By supporting specialization and modularization of service providers, cloud computing involves the trend towards distributed service generation. Hence, multi-vendor networks arise and IT departments have to handle heterogeneous IT Service Value Networks (ITSVN). This research paper analyzes the concept of heterogeneity in ITSVN. Based on a literature review, this paper introduces a model of heterogeneity in ITSVN. Elements of this model are applications, platforms, infrastructures, actors, technologies, interfaces, and tools. Heterogeneity is caused by the diversity and alterity of the attributes of these elements. This article offers a fundamental understanding of the effects of heterogeneity in ITSVN, a definition of heterogeneity in ITSVN, and a model of influencing factors on heterogeneity in ITSVN.

Keywords: Cloud computing, heterogeneity, literature review, IT service, value network

1 Introduction

Cloud computing is both an important driver of digitization and a basis for developing new business models (Böhm, Koleva, Leimeister, Riedl, & Krcmar, 2010). Thus, it is important to understand the impact of cloud computing on value creation. Actually, with cloud computing the way of generating and delivering IT services changes fundamentally towards service value networks (Böhm, Herzog, Riedl, Leimeister, & Krcmar, 2010). Cloud computing leads to an increase in modularization and specialization in the IT industry (Böhm, Herzog, et al., 2010, p. 50), it transforms IT services from vertically integrated services to complex IT supply cloud chain models (Ferguson & Hadar, 2011, p. 1) and induces the emergence of multi-stage supply relationships and value networks (Böhm, Herzog, et al., 2010, p. 50). These multi customer-supplier relationships result in heterogeneous IT service landscapes (Knittl & Lauchner, 2010), whose impact in the value creation process have not often been on the focus of past research (Heininger, Böhm, & Krcmar, 2013). Next, hybrid clouds involving both private cloud and public cloud (Chang, Walters, & Wills) and thus, IT service landscapes nowadays are often composed by the use of common IT services and cloud services.

However, emerging service value networks lead to an increase in the complexity of managing IT service landscapes. The term IT service landscape describes the holistic end-to-end consideration of an IT service. Complexity can be defined as the number and the heterogeneity of components and relations (Schütz, Widjaja, & Gregory, 2014). Heterogeneity is related to the variety of IT elements (Widjaja, Kaiser, Tepel, & Buxmann, 2012). In practice, IT departments are facing problems resulting from increasing heterogeneity in IT service landscapes and by becoming service aggregators, the IT departments of tomorrow will have to aggregate modularized services into value-added, complex solutions (Böhm, Koleva, et al., 2010, p. 7). Therefore, a deeper understanding of heterogeneity and their effects on IT service landscapes is needed. Provisioning IT services nowadays means, among others, to orchestrate several vendors and therefore leads to supply chain management problems in the field of IT service management (ITSM) (Ferguson & Hadar, 2011, p. 1).

The relevance of heterogeneity increases, especially when more flexibility in the information systems of the organizations is required (Widjaja et al., 2012). In addition, the requirements of the business organization towards IT also increase, demanding more information processing capability (March, Hevner, & Ram, 2000). In a preliminary literature search[1], we were not able to find publications that integrate the concept of heterogeneity and the generic value network framework as proposed by Böhm, Koleva, et al. (2010). Furthermore, we could find neither a definition of heterogeneity in service value networks nor a description of factors influencing heterogeneity in service value networks.

In order to gain a better understanding of heterogeneity and service value networks as well as how both of these aspects are interrelated with each other, developing a model seems to be a success-promising concept which will make a contribution to fill this research gap. This model may be useful to strengthen and structure the research concerning the mechanism, the management, and the controllability of heterogeneity in service value networks. Therefore, we will answer the following research question:

What are the main influence factors of heterogeneity in IT Service Value Networks?

[1] The search engines used for the search process were Web of Knowledge (WoK) and Google Scholar (GS). The terms that we searched for were: definition, characterization, description, and clarification of heterogeneity or homogeneity. The search was conducted in February 2014. The total number of results after the search was 159. Three researchers read and categorized the papers and all results were discussed in order to identify the relevant papers. After the filtering process the number of relevant papers left was 19. Based on these 19 papers a concept matrix including 39 aspects of heterogeneity was created. By grouping these 39 aspects, the following seven aspects related to heterogeneity were derived: differences, categories, communication, characteristics, components, levels, and variability.

The remainder of this paper is structured as follows. At first, the terms IT service, IT service value network and heterogeneity are defined. The following section will give a short description of the literature review process. Subsequently, the results from the literature review are analyzed, synthesized and interpreted. Further, we introduce a model of heterogeneity in IT service value networks. The final section provides a short conclusion and an outlook.

2 IT Service and IT Service Value Network

Considering the idea of a service value network, the term IT Service Value Network (ITSVN) will be introduced to describe multi-stage supply relationships across a set of IT service landscapes. IT services can be defined as "[…] *services whose delivery relies on information systems and result in an IT-supported organizational element, i.e. a process or a function of the service customer*" (Schermann, Böhmann, & Krcmar, 2006, p. 3). They are intangible, perishable, and heterogeneous (Kim & Nam, 2009, p. 4). "*A value network is any web of relationships that generates both tangible and intangible value through complex dynamic exchanges between two or more individuals, groups, or organizations*" (Alee, 2003, p. 192). Bensch, Schrödl, and Turowski (2011) define a value network as "[…] *an integrated combination of companies to solve a customer-specific problem as a whole, economically and technically*" (Bensch et al., 2011). Due to the complexity of value networks, they cannot be managed without information technology support (Bensch et al., 2011). With regard to IT services, a value network is a "*set of relatively autonomous units that can be managed independently, but operate together in a framework of common principles and service level agreements (SLAs)*" (Peppard & Rylander, 2006). On the other side, cloud computing consists from a business viewpoint of different actors, playing different roles on different levels of the cloud ecosystem (Böhm, Koleva, et al., 2010). By analyzing a dataset of 2628 cloud services, Böhm, Koleva, et al. (2010) discovered eight generic roles and arranged them into a generic value network of cloud computing. This network presents a business perspective on cloud computing and constitutes the ecosystem that has developed around cloud computing. However, companies also may combine cloud services with other forms of outsourcing and traditional in-house IT service provisioning by building an IT service landscape which cloud be also named as hybrid cloud. The IT service delivery network in this landscape is the ITSVN. By combining all of this aspects, we define ITSVN as follows:

> *An IT Service Value Network is a multi-staged construct of networked but autonomous service suppliers whose delivery relies on information systems which generates a tangible and intangible value for an IT service consumer through complex dynamic exchanges between all participants of the network.*

3 Heterogeneity

Heterogeneity has been widely discussed in IT literature (Widjaja et al., 2012) and it is a topic of highly practical relevance. Nevertheless, there is only few research conducted about heterogeneity in ITSVN (e.g. Bensch et al., 2011; Bucchiarone & Presti, 2007; Castro, Villagra, Fuentes, & Costales, 2014; Liu & Datta, 2010). The majority of publications concerning heterogeneity in IT focus on technological aspects. In fact, there are various publications concerning heterogeneity of e.g. systems, data or applications, but only few publications are dedicated to the topic of heterogeneity itself (Widjaja et al., 2012). However, we identified a research gap in the field of heterogeneity in value networks. Especially in connection with the particular characteristics of a service value network e.g. distributed service generation, increasing modularization and an increase of actors working together. As shown in a preliminary literature review, heterogeneity in value networks is not researched in general and there is no holistic approach concerning the effects of heterogeneity in service value networks.

Heterogeneity can be defined in general as the outcome of components which communicate with each other at different levels and have variable characteristics. Widjaja et al. (2012) define heterogeneity in an IT landscape as a statistical property referring to the diversity of attributes of elements in the IT landscape. Diversity describes the amount of differences of the elements in an ITSVN. Apart from diversity, we also assume the relevance of the alterity of the ITSVN elements. Alterity is about the degree of distinction of the differences of the ITSVN elements. If we focus on an international team, the amount of different native languages could be understood as diversity. Alterity refers to the differences between those languages. For example, the differences between English and Chinese are greater than the differences between English and German. To summarize, heterogeneity is caused by the diversity and alterity of the attributes of the elements which builds the ITSVN. In a later chapter, we introduce an extended definition of heterogeneity in an ITSVN based on the results of our literature review.

4 A Literature Review on Aspects of Heterogeneity in the ITSVN

Following the recommendation from vom Brocke et al. (2009) we adapted their five step framework. According to the taxonomy of Rowe (2014), the literature review aimed to gain a better understanding of heterogeneity in ITSVN. At first, we defined the taxonomy of the literature review as recommended by Cooper (1988). In order to understand heterogeneity in ITSVN in general, the focus were set to the research outcomes and the application of the research results. Against this background, we aimed to integrate and synthesize the past literature. We also wanted to identify central issues of heterogeneity in ITSVN. The representation of the results was neutral, but this will not preclude taking a strong position based on cumulative evidence (Cooper, 1988). We conducted an exhaustive search including the entire literature or most of it (Cooper, 1988). Therefore, our search extended to both the six major IS databases (IEEE Explorer, Science Direct, ACM Digital Library, EBSCO Host, Emeralds, and AIS Electronic Library) and the 22 A-ranked journals based on WI-Association (2008).

To conceptualize the topic of the literature review and to identify the key terms which are relevant to our topic, we did a preliminary literature search (see footnote 1) as recommended from vom Brocke et al. (2009). Using the seven attributes from this step and the terms from the ITSVN as described by Böhm, Koleva, et al. (2010), we built search strings consisting of up to three terms as shown in Figure 1. The search was conducted within the abstract, title, and keywords. Although the search brings up a large amount of publications, only a very small number of them turned out to be relevant. Therefore, in each case only the first 100 hits were considered for a detailed analysis of the abstract. Most of the publications were dealing with heterogeneity only peripherally and concerning e.g. mathematics formulas. Although some of the search terms (see Term 2 in Figure 1) were derived from cloud computing, most of the search strings (e.g. 'heterogeneity' & 'value' & 'communication') were very general and do not only focus on cloud computing. The search in the six databases and 22 a-ranked journals using the described search string in the abstract, title and keywords leads to a number of approximatively 40,000 search hits.

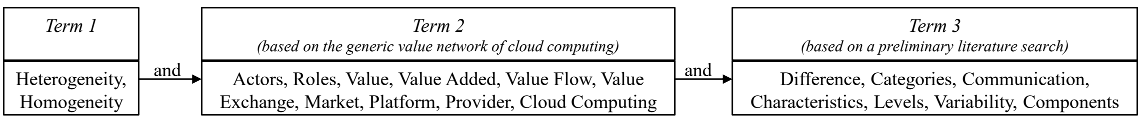


Figure 1: Search Terms (own illustration)

At first we screened the title, abstract and keywords for information related to heterogeneity in IT. During the second screening, we analyzed the full text of the remaining publications. In doing so, we recognized, that most of the publications mention heterogeneity in the context of cloud computing but do not provide any concept or analysis of heterogeneity in itself. After the forward and backward search as recommended by (Webster & Watson, 2002) we identified 61 relevant scientific articles related to the subject of heterogeneity in ITSVN in total.

Thus, in total we analyzed and synthetized 61 publications. In the first step, we extracted and categorized the information from the publications regarding heterogeneity in IT. Two researchers reviewed the 61 publications independently and assigned them to thematic groups. In the next step, the results where compared and the differences have been discussed carefully. Based on these results we identified seven main elements of the ITSVN where heterogeneity can occur and arranged them within a model (see next chapter). We used object-oriented system analysis methods (Goll, 2011) to identify entity objects and their attributes. Finally, we discussed the results and each of the identified elements and attributes in a group consisting of four researchers. In several increments, we consolidated this concept matrix and finally derived seven elements of an ITSVN.

5 Factors Influencing Heterogeneity in ITSVN

The publications describe different aspects of heterogeneity in different parts of the IT (service) landscape by also proposing frameworks for managing it. In order to answer the research question, we describe the main factors influencing heterogeneity in ITSVN and develop a model for heterogeneity in ITSVN by describing the elements of the model and their attributes.

	Elements							Sources of literature (extract)																								
Attributes	Applications	Platforms	Infrastructures	Actors	Technologies	Interfaces	Tools	Al-Hazmi et al. (2012)	Amato et al. (2013a)	Amato et al. (2013b)	Bensch et al. (2011)	Böhm et al. (2010b)	Bucchiarone and Presti (2007)	Castro et al. (2014)	Demchenko et al. (2013)	Gonidis et al. (2013)	Grabowski et al. (1999)	Guillén et al. (2013)	Hartmann et al. (2013)	Kertesz et al. (2012)	Liu and Datta (2010)	Machado et al. (2013)	Maximilien et al.(2009)	Moscato et al. (2011)	Nair et al. (2010)	Quinton et al. (2013)	Sanaei et al. (2014)	Suneja et al. (2011)	Tordsson et al. (2012)	Xia et al. (2004)	Yeo and Lee (2011)	Zhonghong et al. (2013)
Pricing policy				x				x		x												x							x			
Service level / Quality of Service	x	x	x					x	x												x											
Resource type	x	x	x					x																		x						
Standardization	x	x	x	x	x	x	x	x								x								x				x		x		
Federation	x	x	x					x												x												
Technology level		x	x		x				x																							
Metrics							x			x																						
SLA Terms				x						x							x							x								
Interoperability	x	x	x							x					x								x									
Portability	x	x								x					x																	
Service/Resource location	x	x	x					x					x																			
Access mode					x									x			x										x			x		
Communication					x	x									x		x															
Performance			x										x															x				
Compatibility	x	x	x		x											x			x					x	x							
Tool obligation		x																x					x									
Interfacing mechanisms						x	x												x													
Constraints (Resources, Spez.)				x																	x								x			
Service interface				x		x																x							x			
Security level	x	x	x																			x										
Service functionality	x	x	x																			x										
Terminology				x																				x								
Version	x	x	x			x	x																				x				x	x
Ecosystem		x	x	x																					x				x			
Requirements (Purpose)				x													x															
Role				x						x		x													x				x			
Procurement process				x							x																					
Data	x	x	x																			x					x					

Table 1: Concept matrix (extract) with elements and attributes of heterogeneity in ITSVN

Following Merriam-Webster Dictionary (2014), a model is a "*description or analogy used to help visualize something*". By focusing on the relevant aspects only, a model represents a segment of reality (cf. Krcmar, 2015). Therefore, a model representing heterogeneity in ITSVN should be composed of elements and their attributes.

According to Webster and Watson (2002), we synthesize the literature in a concept matrix by identifying the terms regarding to heterogeneity in ITSVN. We identified seven elements of an ITSVN where heterogeneity can occur: *applications*, *platforms*, *infrastructures*, *actors*, *technologies*, *interfaces*, and *tools*. We also identified several attributes for these elements. Table 1 shows an extract of the final results of this consolidation process as well as the assignment of the attributes to the sources of literature. This concept matrix represents an intermediate step towards a model of heterogeneity in ITSVN.

As mentioned before, the elements are influenced by their *diversity* and *alterity*. If we focus on the attribute version of the element application, for example, *diversity* means how many different versions of an application are part of the ITSVN. *Alterity* means in which degree these different versions differ from each other and to what extent they interoperate, respectively causing mutual obstructions. Thus, we introduce an extended definition of heterogeneity in an ITSVN:

> *Heterogeneity in an ITSVN can be defined as the diversity and alterity of the attributes of the summed applications, platforms, infrastructures, actors, technologies, interfaces, and tools of the ITSVN.*

Figure 2 shows a model consisting of the seven elements and their attributes representing the influencing factors. In the following text, these elements are described.

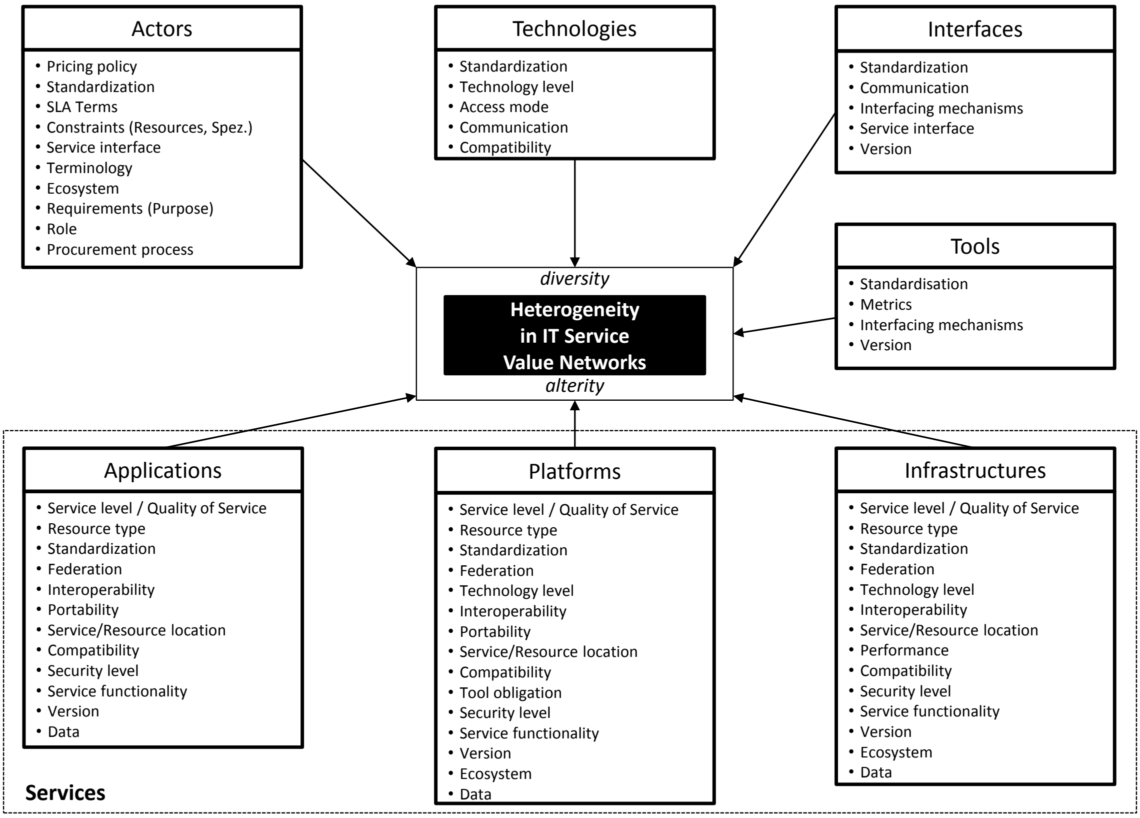


Figure 2: Model with elements and attributes of heterogeneity in the ITSVN (own illustration)

Applications: Application is one of the elements of the ITSVN where heterogeneity arises. In an ITSVN, applications are all the software components that are part of the network. Different publications focus on different aspects of the applications that cause heterogeneity. The most mentioned aspect that causes heterogeneity between the applications is compatibility (Gonidis, Simons, Paraskakis, & Kourtesis, 2013; Hartmann et al., 2013; Moscato, Aversa, Di Martino, Fortis, & Munteanu, 2011; Nair et al., 2010). Further aspects are service levels (Al-Hazmi, Campowsky, & Magedanz, 2012; A. Amato, Cretella, Di Martino, & Venticinque, 2013; Liu & Datta, 2010), interoperability (A. Amato et al., 2013; Demchenko et al., 2013; Maximilien, Ranabahu, Engehausen, & Anderson, 2009) and the different versions (Sanaei, Abolfazli, Gani, & Buyya, 2014; Yeo & Lee, 2011; Zhonghong et al., 2013) of applications. Other reasons that cause heterogeneity between applications are also portability (A. Amato et al., 2013; Demchenko et al., 2013), the service or resource location (Al-Hazmi et al., 2012; Bucchiarone & Presti, 2007), security level (Machado, Bocek, Ammann, & Stiller, 2013) and service functionality (Machado et al., 2013).

Platforms: A platform comprises the entire environment in which applications can run, which includes hardware infrastructure, operating systems and also different libraries. Platforms are also part of the ITSVN infrastructure where heterogeneity can arise because of different reasons. Since platforms are the basis on which the applications run, the attributes assigned to the platforms are similar to the attributes of the applications. Once again the mentioned aspects are: compatibility (Gonidis et al., 2013; Hartmann et al., 2013; Moscato et al., 2011; Nair et al., 2010), service levels (Al-Hazmi et al., 2012; A. Amato et al., 2013; Liu & Datta, 2010), interoperability (A. Amato et al., 2013; Demchenko et al., 2013; Maximilien et al., 2009), different versions (Sanaei et al., 2014; Yeo & Lee, 2011; Zhonghong et al., 2013) of platforms, portability (A. Amato et al., 2013; Demchenko et al., 2013), the service or resource location (Al-Hazmi et al., 2012; Bucchiarone & Presti, 2007), security level (Machado et al., 2013), and service functionality (Machado et al., 2013). Furthermore, other typical reasons for heterogeneity in platforms are tool obligations from the provider (Guillén, Miranda, Murillo, & Canal, 2013; Maximilien et al., 2009) and also the ecosystem (Nair et al., 2010; Tordsson, Montero, Moreno-Vozmediano, & Llorente, 2012) of the platform.

Infrastructures: In an ITSVN, the infrastructure includes the whole hardware ecosystem that supports the service delivery. They build the basis for platforms to operate. For this reason the factors causing heterogeneity in the infrastructures are partly similar to those causing heterogeneity in the applications or platforms. These are compatibility (Gonidis et al., 2013; Hartmann et al., 2013; Moscato et al., 2011; Nair et al., 2010), service levels (Al-Hazmi et al., 2012; A. Amato et al., 2013; Liu & Datta, 2010), different versions (Sanaei et al., 2014; Yeo & Lee, 2011; Zhonghong et al., 2013) of infrastructure components, the service or resource location (Al-Hazmi et al., 2012; Bucchiarone & Presti, 2007), security level (Machado et al., 2013), service functionality (Machado et al., 2013) and the ecosystem (Nair et al., 2010; Tordsson et al., 2012). Performance (Bucchiarone & Presti, 2007) is also a further aspect where heterogeneity can arise with regard to infrastructure.

Services: As analyzed above, most of the attributes of the application, platform and infrastructure are similar. The three categories could also be named as Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS), and Software-as-a-Service (SaaS), which are the most common cloud service models (Mell & Grance, 2011). Therefore, we grouped these three elements in a higher-level element named *service*. Thus, service stands not for an element but for the group of the three elements applications (SaaS), platforms (PaaS), and infrastructures (IaaS).

Actors: Actors are all the interacting members of the ITSVN. They could be the customers, the service providers, service brokers, service integrators etc. The different roles (A. Amato et al., 2013; Böhm, Koleva, et al., 2010; Nair et al., 2010; Tordsson et al., 2012), the defined constrains (Liu & Datta, 2010) in form of resources or specifications, the used terminology (Moscato et al., 2011), the pricing policy (Al-Hazmi et al., 2012; A. Amato et al., 2013; Machado et al., 2013; Tordsson et al., 2012), the SLA terms (Alba Amato, Di Martino, & Venticinque, 2013; Grabowski et al., 1999; Moscato et al., 2011), the standardization (Al-Hazmi et al., 2012; Gonidis et al., 2013; Moscato et al., 2011; Xia, Gang, & Miki, 2004) and also the requirements (Grabowski et al., 1999) that the actors set for the system can bring heterogeneity in the ITSVN. Other factors that can bring heterogeneity to the actors in an ITSVN are the offered service interfaces (Machado et al., 2013; Tordsson et al., 2012), the defined procurement processes (Bensch et al., 2011) and also the ecosystem (Nair et al., 2010; Tordsson et al., 2012) where they act.

Technologies: Technologies in an ITSVN include all the used capabilities and communication and exchange methods that are used from providers like communication technologies etc. In the used technologies heterogeneity can arise regarding standardization (Al-Hazmi et al., 2012; Gonidis et al., 2013; Moscato et al., 2011; Xia et al., 2004), access modes (Castro et al., 2014; Grabowski et al., 1999; Sanaei et al., 2014; Xia et al., 2004), communication (Demchenko et al., 2013; Grabowski et al., 1999) and compatibility (Gonidis et al., 2013; Hartmann et al., 2013; Moscato et al., 2011; Nair et al., 2010).

Interfaces: The interfaces in the ITSVN include all the offered access possibilities to the offered service. The offered service interface (Machado et al., 2013; Tordsson et al., 2012) and interfacing mechanisms (Hartmann et al., 2013) can cause heterogeneity in the ITSVN. Furthermore, the interface version (Sanaei et al., 2014; Yeo & Lee, 2011; Zhonghong et al., 2013), the communication (Demchenko et al., 2013; Grabowski et al., 1999) and the standardization (Al-Hazmi et al., 2012; Gonidis et al., 2013; Moscato et al., 2011; Xia et al., 2004) are also factors responsible for bringing heterogeneity in the ITSVN.

Tools: Tools include both the resources that a provider offers to facilitate the use and application of the provisioned service and the resources the actors of the ITSVN use to manage the service delivery. However, different tools boost heterogeneity in the ITSVN e.g. by having different standardization (Al-Hazmi et al., 2012; Gonidis et al., 2013; Moscato et al., 2011; Xia et al., 2004), metrics (A. Amato et al., 2013), interface mechanisms (Hartmann et al., 2013) and versions (Sanaei et al., 2014; Yeo & Lee, 2011; Zhonghong et al., 2013).

6 Conclusion and Outlook

This paper analyzes the concept of heterogeneity in ITSVN. We showed that there is only limited research regarding heterogeneity in ITSVN. By conducting a literature review, we found and analyzed 61 publications that treat aspects of heterogeneity in different levels of the ITSVN. We summarized these publications and presented a structured overview. Based on the results from these publications we extracted the main influence factors of heterogeneity in the ITSVN and proposed a model for heterogeneity in ITSVN consisting of seven elements where heterogeneity can occur. Additionally, we assigned attributes to these elements. Next, we defined heterogeneity in an ITSVN as the diversity and alterity of the attributes of the summed *applications*, *platforms*, *infrastructures*, *actors*, *technologies*, *interfaces*, and *tools* of the ITSVN.

Although this research is based on a thorough and comprehensible literature search, the model was derived by analyzing 61 publications and therefore makes no claim to completeness. Hence, further studies should be conducted in order to validate and further extend the model of heterogeneity in ITSVN.

In order to verify and review the model, it should be assessed by a group of experts. To do so, we are planning to initiate a cognitive process by using the Delphi Study method (Schmidt 1997). An anonymous survey will be conducted by using a universal computer-based questionnaire system. The questions of the questionnaire will be derived from the model of heterogeneity in ITSVN. Finally, the results from the Delphi Study will be built into the model of heterogeneity in ITSVN. Doing so, a revised version of the model of heterogeneity in ITSVN and a weighted list of influence factors on heterogeneity in ITSVN will be derived. Based on this list, we are planning to develop guidelines and best practices for handling heterogeneity in ITSVN.

However, by providing a state-of-the-art of heterogeneity in the ITSVN derived from a literature review, this research contributes to theory by the model for heterogeneity in ITSVN. The model may be useful to strengthen and structure research about the management and controllability of heterogeneity in ITSVN. Next, the model for heterogeneity in ITSVN, the implications of heterogeneity, and the weighted list of influence factors "[…] provides an explanation of how, why, and when things happened" (Gregor, 2006, p. 619). Thus, a greater understanding and insight by others into heterogeneity in ITSVN will be promoted. According to Gregor (2006, p. 619), this thesis complies with the explanation goal of theory. Next, our model may be useful to strengthen and structure research about the management and controllability of heterogeneity in ITSVN. Possible approaches may be found in the fields of ITSM or service governance.

7 Acknowledgments

The authors would like to thank their students Arled Kerciku and Cristian Dragnea for supporting the literature review. Next, the authors thank the anonymous reviewers for their very helpful suggestions and comments. Their inputs have significantly helped to improve this publication.

References

Al-Hazmi, Y., Campowsky, K., & Magedanz, T. (2012). *A monitoring system for federated clouds.* Paper presented at the IEEE 1st International Conference on Cloud Networking (CLOUDNET) 2012.

Alee, V. (2003). *The Future of Knowledge: Increasing Prosperity Through Value Networks* Boston, MA, USA: Butterworth-Heinem.

Amato, A., Cretella, G., Di Martino, B., & Venticinque, S. (2013, 25-28 March 2013). *Semantic and Agent Technologies for Cloud Vendor Agnostic Resource Brokering.* Paper presented at the 27th International Conference on Advanced Information Networking and Applications Workshops (WAINA) 2013.

Amato, A., Di Martino, B., & Venticinque, S. (2013). *Cloud brokering as a service.* Paper presented at the 8th International Conference on P2P, Parallel, Grid, Cloud and Internet Computing (3PGCIC).

Bensch, S., Schrödl, H., & Turowski, K. (2011). *Beschaffungsmanagement für hybride Leistungsbündel in Wertschöpfungsnetzwerken - Status Quo und Gestaltungsperspektiven*. Paper presented at the Wirtschaftsinformatik 2011, Zurich, Switzerland.

Böhm, M., Herzog, A., Riedl, C., Leimeister, S., & Krcmar, H. (2010). Cloud Computing als Treiber der IT-Industrialisierung? Ein Vergleich mit der Automobilbranche. *IM, 25*(4), 46-55.

Böhm, M., Koleva, G., Leimeister, S., Riedl, C., & Krcmar, H. (2010). *Towards a generic value network for cloud computing.* Paper presented at the 7th International Workshop on Economics of Grids, Clouds, Systems and Services (GECON), Ischia (Italy).

Bucchiarone, A., & Presti, L. (2007). *QoS Composition of Services for Data-Intensive Application.* Paper presented at the 2nd International Conference on Internet and Web Applications and Services, 2007 (ICIW '07), Morne, Mauritius

Castro, A., Villagra, V. A., Fuentes, B., & Costales, B. (2014). A Flexible Architecture for Service Management in the Cloud. *IEEE Transactions on Network and Service Management, 11*(1), 116-125. doi:10.1109/TNSM.2014.022614.1300421

Chang, V. I. C., Walters, R. J., & Wills, G. B. (2014). Cloud Computing and Frameworks for Organisational Cloud Adoption *Delivery and Adoption of Cloud Computing Services in Contemporary Organizations*. Soton, UK: IGI Global.

Cooper, H. M. (1988). Organizing knowledge syntheses: A taxonomy of literature reviews. *Knowledge in Society, 1*(1), 104-126.

Demchenko, Y., Ngo, C., de Laat, C., Rodriguez, J., Contreras, L. M., Garcia-espin, J. A., . . . Ciulli, N. (2013, 25-28 March 2013). *Intercloud Architecture Framework for Heterogeneous Cloud Based Infrastructure Services Provisioning On-Demand.* Paper presented at the 27th International Conference on Advanced Information Networking and Applications Workshops (WAINA) 2013, Barcelona, Spain.

Ferguson, D. F., & Hadar, E. (2011, 2-3.11.2011). *Optimizing the IT Business Supply Chain Utilizing Cloud Computing.* Paper presented at the 8th International Conference on Emerging Technologies for a Smarter World (CEWIT2011), Hyatt Regency Long Island.

Goll, J. (2011). *Methoden und Architekturen der Softwaretechnik*. Wiesbaden: Vieweg+Teubner Verlag.

Gonidis, F., Simons, A. J. H., Paraskakis, I., & Kourtesis, D. (2013). *Cloud application portability: an initial view.* Paper presented at the 6th Balkan Conference in Informatics (BCI), Thessaloniki, Greece.

Grabowski, C., Bjerring, L., Peykarimah, S., Sorensen, L. B., Bracht, R., O'Hara, J., . . . Karp, H. (1999, 1999). *Integration architecture of multi-technology management systems.* Paper presented at the Integrated Network Management, 1999. Distributed Management for the Networked Millennium. Proceedings of the Sixth IFIP/IEEE International Symposium on, Boston, MA, USA.

Gregor, S. (2006). The Nature of Theory in Information Systems. *MIS quarterly, 30*(3), 611-642.

Guillén, J., Miranda, J., Murillo, J. M., & Canal, C. (2013). A service-oriented framework for developing cross cloud migratable software. *Journal of Systems and Software, 86*(9), 2294-2308. doi:10.1016/j.jss.2012.12.033

Hartmann, H., Keren, M., Matsinger, A., Rubin, J., Trew, T., & Yatzkar-Haham, T. (2013). Using MDA for integration of heterogeneous components in software supply chains. *Science of Computer Programming, 78*(12), 2313-2330. doi:10.1016/j.scico.2012.04.004

Heininger, R., Böhm, M., & Krcmar, H. (2013). *Managing Heterogeneity in IT Service Management: Towards a Research Agenda*. Paper presented at the SIG SVC 2013 pre-ICIS-Workshop, Milano, Italy.

Kim, Y. J., & Nam, K. (2009). *Service Systems and Service Innovation: Toward the Theory of Service Systems.* Paper presented at the 15th Americas Conference on Information Systems (AMCIS '09), San Francisco, CA, USA.

Knittl, S., & Lauchner, A. (2010). Hybrid-Cloud an der Technischen Universität München - Auswirkungen auf das IT-Management. In K.-P. Fähnrich & B. Franczyk (Eds.), *INFORMATIK 2010: Service Science - Neue Perspektiven für die Informatik* (Vol. 1, pp. 757-762). Bonn: Gesellschaft für Informatik.

Krcmar, H. (2015). *Informationsmanagment* (6 ed.). Berlin, Heidelberg: Springer Gabler.

Liu, X., & Datta, A. (2010, 9-12 Oct. 2010). *On trust guided collaboration among cloud service providers.* Paper presented at the 6th International Conference on Collaborative Computing: Networking, Applications and Worksharing (CollaborateCom) 2010.

Machado, G. S., Bocek, T., Ammann, M., & Stiller, B. (2013, 21-24 Oct. 2013). *A Cloud Storage overlay to aggregate heterogeneous Cloud services.* Paper presented at the IEEE 38th Conference on Local Computer Networks (LCN) 2013.

March, S., Hevner, A., & Ram, S. (2000). Research commentary: an agenda for information technology research in heterogeneous and distributed environments. *Information Systems Research, 11*(4), 327-341.

Maximilien, E. M., Ranabahu, A., Engehausen, R., & Anderson, L. (2009). *IBM altocumulus: a cross-cloud middleware and platform.* Paper presented at the 24th ACM SIGPLAN conference companion on Object oriented programming systems languages and applications, Orlando, Florida, USA.

Mell, P., & Grance, T. (2011). The NIST definition of cloud computing.

Merriam-Webster Dictionary. (2014). Model. Retrieved from http://www.merriam-webster.com/dictionary/model

Moscato, F., Aversa, R., Di Martino, B., Fortis, T., & Munteanu, V. (2011). *An analysis of mOSAIC ontology for Cloud resources annotation.* Paper presented at the 2011 Federated Conference on Computer Science and Information Systems (FedCSIS).

Nair, S. K., Porwal, S., Dimitrakos, T., Ferrer, A. J., Tordsson, J., Sharif, T., . . . Khan, A. U. (2010, 1-3 Dec. 2010). *Towards Secure Cloud Bursting, Brokerage and Aggregation.* Paper presented at the IEEE 8th European Conference on Web Services (ECOWS) 2010.

Peppard, J., & Rylander, A. (2006). From a Value Chain to Value Network: Insights for Mobile Operators. *European Management Journal, 24*(2-3), 128-141.

Rowe, F. (2014). What literature review is not: diversity, boundaries and recommendations. *European Journal of Information Systems, 23*(3), 241-255.

Sanaei, Z., Abolfazli, S., Gani, A., & Buyya, R. (2014). Heterogeneity in Mobile Cloud Computing: Taxonomy and Open Challenges. *Communications Surveys & Tutorials, IEEE, 16*(1), 369-392. doi:10.1109/SURV.2013.050113.00090

Schermann, M., Böhmann, T., & Krcmar, H. (2006). *Integration of IT Services: Towards a pattern-based approach for eliciting service integration requirements*. Paper presented at the 12th Americas Conference on Information Systems (AMCIS '06), Acapulco, Mexico.

Schütz, A., Widjaja, T., & Gregory, R. W. (2014). *Escape from Winchester Mansion - Toward a Set of Design Principles to Master Complexity in IT Architecture.* Paper presented at the International Conference on Information Systems (ICIS 2014), Milan, Italy.

Tordsson, J., Montero, R. S., Moreno-Vozmediano, R., & Llorente, I. M. (2012). Cloud brokering mechanisms for optimized placement of virtual machines across multiple providers. *Future Generation Computer Systems, 28*(2), 358-367. doi:10.1016/j.future.2011.07.003

vom Brocke, J., Simons, A., Niehaves, B., Riemer, K., Plattfaut, R., & Cleven, A. (2009). *Reconstructing the giant: On the importance of rigour in documenting the* *literature search process*. Paper presented at the European Conference for Information Systems (ECIS), Verona, Italy.

Webster, J., & Watson, R. T. (2002). Analyzing the past to prepare for the future: Writing a literature review. *MIS quarterly, 26*(2), 13-23.

WI-Association. (2008). WI-Orientierungslisten. *Wirtschaftsinformatik, 50*(2), 155-163.

Widjaja, T., Kaiser, J., Tepel, D., & Buxmann, P. (2012). *Heterogeneity in IT Landscapes and Monopoly Power of Firms: A Model to Quantify Heterogeneity.* Paper presented at the International Conference on Information Systems (ISIC 2012), Orlando, USA.

Xia, G., Gang, W., & Miki, T. (2004). End-to-end QoS provisioning in mobile heterogeneous networks. *Wireless Communications, IEEE, 11*(3), 24-34. doi:10.1109/MWC.2004.1308940

Yeo, S., & Lee, H.-H. (2011). Using mathematical modeling in provisioning a heterogeneous cloud computing environment. *Computer, 44*(8), 55-62.

Zhonghong, O., Hao, Z., Lukyanenko, A., Nurminen, J. K., Pan, H., Mazalov, V., & Yla-Jaaski, A. (2013). Is the Same Instance Type Created Equal? Exploiting Heterogeneity of Public Clouds. *IEEE Transactions on Cloud Computing, 1*(2), 201-214. doi:10.1109/TCC.2013.12

29th Bled eConference

eLiving

June 19 - 22, 2016; Bled, Slovenia

Online Romance Scam: Expensive e-Living for romantic happiness

Christian Kopp

Federation University, Australia

ckopp@students.federation.edu.au

James Sillitoe

Federation University, Australia

j.sillitoe@federation.edu.au

Iqbal Gondal

Internet Commerce Security Laboratory, Australia

Iqbal.gondal@federation.edu.au

Robert Layton

Internet Commerce Security Laboratory, Australia

r.layton@federation.edu.au

Abstract

The Online Romance Scam is a very successful scam which causes considerable financial and emotional damage to its victims. It is based on building a relationship which establishes a deep trust that causes victims to voluntarily transfer funds to the scammer. The aim of this research is to explore online dating scams as a type of e-Living which initially creates happiness for the victim in a virtual romantic relationship, but tragically then causes the victim to be separated from his or her savings. Using narrative research methodology, this research will establish a model of the romance scam structure and its variations regarding human romantic attitudes, and will develop a theory which explains how the victim is moved through the phases of the scam. Findings of this research will contribute to the knowledge of the Online Romance Scam as e-Crime and provide information about the structure and the development of the modus operandi which can be used to identify an online relationship as a scam at an early phase in order to prevent significant harm to the victim.

Keywords: Online Romance Scam, e-Living, e-Crime, online relationship

1 Introduction

Online dating has now evolved to a mainstream social practice, and is increasingly being used to initiate relationships (Edelson, 2003). One in ten Americans have used an online dating site or mobile dating app, and of these users, 66% have gone on a date with someone they have met this way. Further, 23% of these users have eventually met a spouse or long term partner through these sites (Smith & Duggan, 2013). It is estimated that the industry is today worth more than £2bn globally (Magrina, 2014; Wendel, 2015).

Given the popularity of the online dating market and its significant economic potentialities, it is perhaps not surprising that this vehicle has become a key focus of fraudsters and scammers (Fair, Tully, Ekdale, & Asante, 2009; Rathinaraj & Chendroyaperumal, 2010; Singh & Jackson, 2015). In 2014, it was reported that dating and romance scams remained in the number one position in terms of financial losses, showing an estimated loss of $27 million, but it has since increased more than 10 per cent in 2015 (Australian Competition and Consumer Commission, 2015).

This crime is different to marriage-impostors, where the swindlers aim at women's savings through a fraudulent proposal of marriage (Bromberg & Keiser, 1938), and is done by approaching the victim as a real person. By contrast, the online dating scammer cannot move into reality; this is because first, the presented ‘identity’ does not exist, and second because the virtual circumstances are used to maintain a fluid situation in which advantage can be taken of the unwitting victim.

Adding to the concerns regarding this practice, it is becoming apparent that financial loss is not the only damage caused by romance scams, since it has been reported that it has serious social and psychological implications (Ross & Smith, 2011).

In order to prevent such mass-marketing frauds, it is essential to understand the dynamics of each scam to identify them quickly and provide a plausible and justified note of warning to potential victims.

We argue that the romance scam can be explained by a combination of the Theory of Love Stories (Sternberg, 1999) with the Transtheoretical Model (Prochaska & DiClemente, 1992), and we substantiate this claim in a case study which presents analysis of reported scams based on a narrative research methodology.

Narrative inquiry is based upon the notion that information of interest can be obtained from real experiences as told as ‘stories’ by selected individuals (Ollerenshaw & Creswell, 2002). Usually, a researcher gathers this data through interviews or informal conversation (Ollerenshaw & Creswell, 2002), but in this research we utilised stories from scam victims through data available from public sources.

When individuals tell stories, a clear sequence is often missing or not logically developed and it is therefore part of the researcher’s task to provide the causal link among the ideas (Cortazzi, 1993). This study uses the Problem-Solution-Approach drawn from narrative inquiry, which focuses on problematic issues identified from literary theory and the classic elements of a plot structure, and relates the attempts made by the respondent to solve the (apparent) problem (Ollerenshaw & Creswell, 2002).

This process uses ‘retelling’ or ‘restorying’ (Ollerenshaw & Creswell, 2002) which includes reading the transcripts, analysing them for the narrative key elements such as the problem, characters, setting, actions and resolution and then rewriting the story to place it within a chronological sequence.

In this paper we present first a suggested model of this e-crime. Then we explain how we analysed scam reports according the presented theory followed by the findings from the analysis.

The results of this work provide understandings which:

- Give a detailed analysis of the structure and the development of the Online Romance Scam as a facet of e-Living, where a happy online relationship is built using internet social channels;
- Reveal and further investigate the main techniques used in these scams, particularly as informed by models of human behaviour described in existing research as ‘personal love stories’.

Findings of this research will help to understand why people become trapped in this sort of scam. Additionally, it may help to explain why, when some people come to know it is a scam, they still hold on to the dream and search for contact with the scammer, or in some cases, even refuse to accept the fact that it is a scam.

2 Romance Scam

Budd and Anderson (2009) describe the Romance Scam as one type of consumer scam which involves initiating a false relationship through online dating websites, social websites or via email where the aim is clearly to defraud the victim.

Whitty (2013) has conducted a recent study regarding the anatomy of the Romance Scam. In this detailed work, she established that there are five distinct stages of this crime. There are the development of an *attractive profile*, the *grooming time* and *the sting,* which together build the main part of the scam. This is followed by the *continuation*, where the scammer repeatedly requests funds, and finally by *sexual abuse* and *re-victimization* which is an additional attempt to further humiliate and exploit the victim by blackmailing them and applying a follow-up scam (Federal Trade, 2015).

The scammers post false profiles on legitimate dating websites (Budd & Anderson, 2009), using high quality, professional looking photos in combination with an attractive profile description to attract potential victims (Rege, 2009). Once the contact is established, the scammer will try to deepen the relationship and to build the trust of the victim (Budd & Anderson, 2009).

At the same time, the scammer will casually report events related to another invented story which will be suitable for building a plausible frame for a subsequent request for money (Budd & Anderson, 2009). This request comes when the scammer thinks the victim is ready and is introduced with an unexpected 'emergency' or tragic reason such as a sudden death in the family (Rege, 2009).

3 Model of the Online Dating Scam

In order to get a better understanding of this scam this research presents a model which is based on the assumption that the scammer influences the victim to engage in two mainstreams of social behaving. The first is the fostering of motivation in the victim to establish a romantic relationship and consequently to develop a deep level of trust, while the second is to engineer the transfer of funds to the virtual partner. These behavioural streams are established by confronting the victim with two parallel event sequences, which requires the portrayal of the victim as a partner in a virtual love story which can be used to self-justify their motivation to behave according to the wish of the scammer.

We call the first stream the building of the 'Relationship Story', which serves to initiate and gradually deepen the virtual relationship. Whilst this relationship is clearly not the primary goal of the scammer, it is the goal of the victim and therefore its establishment is necessary for the scam to be effective. For the scammer, this first story must be created to support the second story, which is designed to motivate the victim to willingly transfer funds. We call this second stream the 'Fund Story', as its purpose is to build a level of self-justification in the victim to make available the requested funds.

A significant factor for the crafting of the relationship story is the identification of a personal love story of the victim. This personal story reflects a personal affinity of the victim related to love and relationships, and it is therefore important for the scammer to identify the victim's psychological circumstances. Thus, for our purposes, it is important to clearly understand the spectrum of affinities which represents the 'working background' for the scammer. In this respect, Sternberg looked at the different types of common relationships in his book *Love is a Story* (Sternberg, 1999). Here, he suggests that personal relationships often follow certain relatively well-defined plots which are revealed in these love stories, and these plots control the development of relationships (Sternberg, 1995). In this way, well-known stories are very important for forming the way relationships are built and it is claimed that they are involved in all personal aspects of our lives (McAdams, 1993). It is further claimed that everybody has an 'array of scripts' which are heard in the course of personal interactions with people (Schank & Abelson, 1977), and these are modified to fit into our own situation. Further, it is suggested that there are multiple scripts which build these stories; the themes come from our childhood and from interactions with people around us such as parents, grandparents, brothers and sisters and friends. In particular, attachment styles developed in infancy are important as antecedents of romance stories, whilst an avoidant individual creates stories that emphasize distance and a resistant individual creates stories about rejection (Bowlby, 1997; Shaver, Hazan, & Bradshaw, 1988). Everybody has a personal story which is instrumental in forming relationships, and it is this story which gives the relationship contextual meaning; this implies that each person interprets actions or events in terms of their personal story (Sternberg, 1999).

The scammer creates online identities reflecting certain love stories to attract a range of victims. Once contact is established, the relationship story is developed by obtaining clues to the victim's personal love story and it then is tailored to suit the situation. We argue that both the invented stories in the scam, that is the relationship story and fund story, guide the victim through normal phases of human behaviour, which can be described using the Transtheoretical Model.

The Transtheoretical Model was developed by Prochaska and DiClimente (1992), and according to this scheme, human behaviour follows six (gradual) stages of change (Nutbeam, Harris, & Harris, 1999):

1. Precontemplation: The individual has no intention to change behavior;
2. Contemplation: The individual considers changing behavior;
3. Determination/Preparation: The individual makes commitment to change;
4. Action: The individual makes a change;
5. Maintenance: The individual maintains the change. Repeats the behavior;
6. Termination: The individual stops the behavior.

People are seen to move in a predictable way through these stages, during which they can self-initiate change but also respond to external stimuli. This model is often used in health area to influence a patient to change a behaviour which has negative effect on their health. In similar way, it can be used to understand other developmental areas, and it has been used in this investigation to explain the (often surprising) behaviour change of Romance Scam victims.

4 Scam Analysis

Following our assertion that Romance Scams can be explained by a theory which combines the "Love Story Theory" with the "Transtheoretical Model" (Nutbeam, Harris, & Harris, 1999), we have integrated these perspectives in an innovative analysis approach which supports the use of narrative research methodology. In order to prepare data for this analysis, we took sequential elements of the raw data and presented them in a plot structure.

Table 1: Plot Structure Table

Characters	Settings	Problem	Actions	Resolution
Individual's personality, behaviours, style and patterns	Context, environment, conditions, place time	Question/ problem	Movements through the story. Characters thinking, feelings, interactions, actions and reactions.	Answers the question and explains what caused the turning point or the character to change

Table 1 presents five elements which Ollerenshaw and Creswell (2002) suggest underpin any successful plot structure: these are the individual characters; the story's setting, which involves the context of the underlying stories; the focus question or problem which engages the protagonists; the actions and interactions of the protagonists as the story develops; and the resolution of the problem.

In the second step, we organised the elements into a sequence of events as suggested by the Transtheoretical Model (Figure 1).

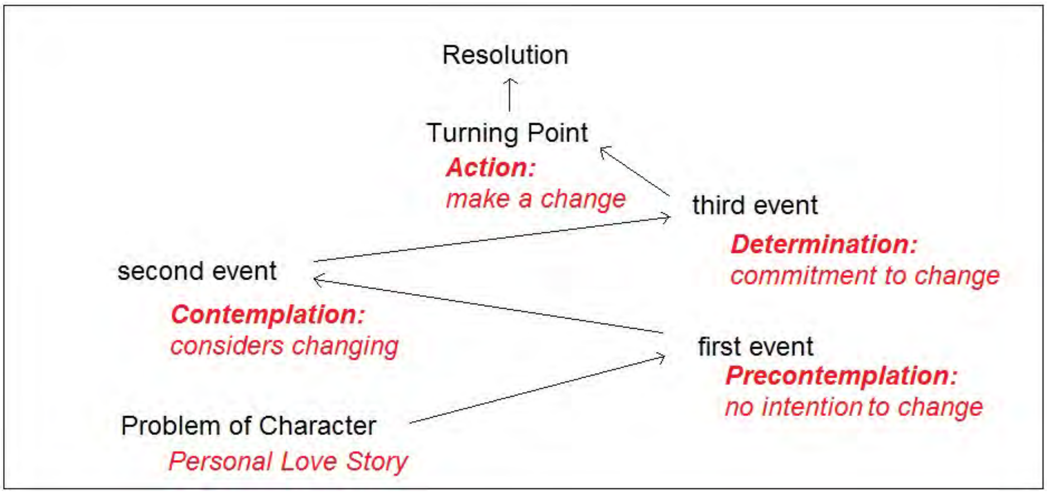


Figure 1: Sequencing the events into the Problem-Solution Narrative Structure.

In combining the two theoretical approaches and applying to the analysis of suitable public data, the following steps were undertaken:

1. First, the events of the underlying stories of relationship and fund story were worked out;

2. Then the sequences were ordered in the logical right order;

3. With the better understanding of the reported data, we identified the underlying love story; using the 'Love Stories Scale' from Sternberg (2012), to narrow down the drafted love story.

In the next step, we combined the results of the narrative research investigation with the Transtheoretical Model by mapping the key events to the model's phases (bold red on Figure 1). With this structure in place, we were able to more clearly identify common features, patterns and combinations between the reported scam materials.

4.1 Report selection

Our study is based on reported instances of Romance Scams from victims, which were published on an internet help forum for these individuals. Seventeen reports were selected for analysis following a system developed through a theoretical sampling framework. The framework is built with a structure containing several levels defined by generic attributes such as gender, skin colour, nationality and the age of the victim.

To ensure that the data is rich in detail, examples were only collected if they qualified against the following criteria:

1. The report contains a detailed description of the background of the victim and their profile;
2. The report explains how the contact was established;
3. The narrative report is presented over at least one cohesive paragraph, and it contains the main phases of a fraudulent relationship, namely building a plot and the request for money.

Scam data was then collected and combined in one file for analysis. This data source provides a varied population of reports with sufficient quality to allow meaningful analysis. By utilising the Problem-Solution-Approach in this research, an objective analysis can be instituted, and enables us to extract embedded plot elements and create a chronology of the events from the field texts to allow us to confidently apply the theory of the 'Transtheoretical Model' to the structure of the scam.

It is the creation of the scam chronology, with an emphasis on the embedded sequence of developmental steps that sets this approach apart from other research approaches. We therefore anticipated that the features of the Romance Scam technique can be made visible using this field data. While this study provides preliminary findings, a deeper investigation is anticipated to strengthen the results by expanding the research with additional sources and reports.

The limitations of this approach arise from ethical considerations related to the usage of the public available data from the internet for research (Kopp, Sillitoe, Gondal, & Layton, 2015). Following ethical guidelines, the approach imposes restrictions in order to conform to the three principles of Autonomy, Benefits against Risks and Justice, proposed by the influential Belmont Report (1979).

5 Findings

In all analysed reports, we identified two parallel stories, showing clear events related to the relationship development (relationship story) and to the request for funds (fund story). When considering the 'relationship development' stories, it was evident that events were only related to starting, forming and intensifying the relationship between the victim and the scammer. Our analysis showed that, in this phase, the events showed 'normal' behaviour which would be expected to appear in a real-world relationship. In the 'fund story' the events were focused on the gradually intensifying requests to transfer funds to the scammer to help in a personal situation or to an emergency.

5.1 Findings related to the relationship story

We are asserting here that a relationship with a scammer is similar to a real relationship, even though in a scam one of the players is not honest and is only playing a role; thus we hypothesise that the development of the relationship follows similar rules as a real world instance.

Whilst it has been observed that we typically create stories for ourselves and our partners in a romantic relationship Lee (Lee, 1977) and Sternberg (Sternberg, 1999) go further to claim that there is a role for constructed stories in controlling how these relationships actually develop. They claim that once we have created a story about someone and have a relationship with them, we try to continue it in a consistent way, interpreting new events in terms of the old story. The constructed story therefore largely controls the way we perceive the actions of others, which then in turn, confirms that story. It is claimed that the constructed story significantly influences the way we perceive everything our partner does, and how we in turn, react to these actions.

Sternberg (Sternberg, 1999) presents five major groups of stories:

1. Asymmetrical stories
2. Object stories
3. Coordination stories
4. Narrative stories
5. Genre stories

Each of these groups contains a set of similar subtypes of stories. In this study, we are assuming that variants of these stories play an important role in initially trapping a victim in a romance scam. It is further assumed that a detailed understanding of the mechanics of these stories will be the key to helping us determine what lies behind the behavior of a victim when they are influenced to send money to the scammer.

In this study, we have identified the following love story categories:

Object stories **(12 Stories)**

- Recover (7 Reports)
- Religion (4 Reports)
- House + Home (1 Report)

Asymmetry Story **(2 Stories)**

- Teacher/Student (2 Reports)

Coordination Stories **(2 Stories)**

- Business (2 Reports)

Narrative **(1 Story)**

- Fantasy (1 Report)

Using the standardised events, we grouped the reports according to their similarities and found a small group of common structures which allowed us to identify the underlying love story and thus to group the reports accordingly. The results are presented in the summarised plot structures in Table 2 on page 9, which shows the key elements for the identified love story.

In Table 2, the reports which were grouped in the category ‘recovery story’ showed common elements related to characters, the setting, the problem and the resolution. They were presented by victims, who had presented themselves as a sensitive person, who had just undergone a bad experience/situation (e.g. divorce) from which they are trying to recover.

The scammer was described as an understanding character who has had a very similar experience to the victim. They were able to ‘understand’ the pain of the bad experience and thus were able to provide counselling advice. In all reports, the victim indicated that the scammer helped them to surmount the crisis.

Table 2: Grouped Plot Structure Table

Story	Characters	Setting	Problem	Resolution
Recovery	Sensitive	Recently hurt	Recovery needed	Full recovered
Religion	Religious	Religious setting	Search for salvation	Full salvation
House and home	Care providing needing	Lonely	Search for security	Real friendship
Asymmetry	Student Instructor	Exotic setting	Legal problems	Access to legal properties
Business	Business	Interesting business	Business duties	Successful business
Fantasy	Rescuer Beauty	Unpleasant area	Distress	Rescue

The reports which were grouped into the type of 'religion story', were presented by victims who presented themselves as a person with a religious attitude. The scammer was also described as a person with a strong belief in God. The victims reported to achieve full salvation through the scammer or the relationship with the scammer. According Sternberg (1999), in an 'object story' the partner or the relationship is treated as an object. In these cases the scammer was seen as this object, a kind of 'guru' who promised to deliver help and advice to allow the victim to reach full salvation.

One report was grouped in the category of 'house and home' story. The victim self-presented as a careful, sensitive person looking for familiarity and friendship. The scammer consequently played the role as a needy care recipient. The relationship was based on deep trust-building conversations which created the impression of the development of a real friendship.

In the reports which were grouped in the category of an 'asymmetry story', the victims appeared very passive and followed the clear instructions of the scammer. The instructions were related to the solution of legal problems to gain 'genuine' family properties. The victim followed the instructions from the scammer in the expectation that the virtually-profiled partner will overcome these problems, and thus be able to start a meaningful relationship.

Two reports were grouped in the category of a 'coordination story' (particularly as a business story). The victims described themselves as being in successful professional positions. The scammer was then described as business person in high position or managing a big business enterprise. The victim soon clearly indicated that they were attracted by the (faked) profession or business in which the scammer was involved. The scammer tried to put the victim in the joint role of a fiancé and business partner. In a 'coordination story', the partners try to achieve something together (Sternberg, 1999). The basis for the relationship in the business story is the common enterprise. In the investigated cases, the victims were initially impressed by the scammer's presented profession and were eager to find out more details and participate in the enterprise. The scammer was not able to maintain this impression and the scam was terminated.

One story was grouped in the category of a 'narrative story' (fantasy). It was a typical setting of a fantasy story with a 'beauty in distress' and the victim put in the role as a 'rescuer' from the 'miserable situation'.

5.2 Findings related to the fund story

The fund story is based on the sequence of events which fit the context of the relationship story. We extended the previous table with an explanation of why the funds are required which is the resolution for the fund story.

In the recovery story, as described earlier, the scammer helps the victim to overcome a previous bad experience. It is easy for the scammer to draft a parallel story in the background, where he faces drawbacks related to his own recovery and thus needs additional funds to overcome these new problems. By this time, he has established enough trust with the victim through the relationship story, that the victim understands the need and is willing to help with funds.

Table 3: Extended grouped Plot Structure Table

Story	Characters	Setting	Problem	Explanation for requested funds
Recovery	Sensitive	Recently hurt	Recovery needed	Funds are needed to further recover
Religion	Religious	Religious setting	Search for salvation	Funds are a reward or duty
House and home	Care providing needing	Lonely	Search for security	Care recipient or need of care because of certain circumstances
Asymmetry	Student Instructor	Exotic setting	Legal problems	Funds are needed to solve legal problems
Business	Business	Interesting business	Business duties	Funds are business investments
Fantasy	Rescuer Beauty	Unpleased area	Distress	Fund are needed to rescue

In the religion stories, the scammer provides so much 'salvation' that it gradually generates in the victim a strong feeling of a need to reciprocate. It is easy then for the scammer to ask for a financial favour. In another version of the religious story, the scammer creates a terrible emergency. Because the victim has openly committed to be a real God-believing person earlier in the relationship story, it becomes a shared 'natural duty' to help, whatever it costs. In these cases, the victim often shows concerns about the honesty of the funds request, but still decides to pay because based on a religious evaluation it is more terrible "not to help in a real emergency situation" compared to lose funds due to a scam.

In the house and home story, the scammer builds a relationship based on 'true' friendship which should be the basis upon which to build a beautiful home together. When he creates an 'emergency' in the Fund story, he is appealing to the victim's responsibility as real friend and plays the role of the care recipient in the relationship. In one case, a daughter was introduced in addition to other family members, and an impression was created of a beautiful family where the victim was to be accepted and included. By creating an 'emergency related to his daughter' the scammer appealed to the victim's responsibility as 'family member' to help.

In the asymmetry stories, which come here in form of a teacher/student story, the scammer pretends to be of a wealthy background, but needs to get access to family properties. The properties give the victim a sense of security to be paid back or to benefit from it in the later upcoming relationship. This made it easy for the victim to follow the clear instructions of the scammer to enter the action phase and transfer funds.

For the business stories, the victim chooses the relationship because of the presented interesting professional background. The scammer reveals, in the fund story, a new lucrative upcoming business opportunity where he is involved, and the following scam is then build around this enterprise where the victim is motivated to invest in the enterprise or to help in a crisis. In both variations, the victim is offered a lucrative reward.

The fantasy story follows the classic scenario of a 'beauty' in need of help, and the victim is chosen to be the one who plays the role as 'rescuer' (with payments). In the case studies, the victim was a male, and we assume that this type of scam might be more successful using male victims and following a primarily gendered narrative which prescribes superiority for men and dependence for women.

5.3 Phases of the Transtheoretical Model in the relationship story

So far, we have looked at the use of personal love stories. In this section, we explain how a victim is moved through the phases of the scam.

In the phases *considering change* and *determination*, we found signs for the underlying love story. The victim, who is first only generally interested in the scammer's profile, is moved quickly to a strong interest. In these situations, the driver for the increasing interest is the presented relationship story which resonates with the victim's own personal love story. Often, the victim emphasises the key matching points why he/she was so interested in the scammer's profile, and these clues provide clear hints to the development of the love story. Considering that the victim has not previously physically met the person with which he/she is communicating, this relation is developed on the basis of the virtual impression created by the scammer. This impression is carefully moulded to fit the hints provided, perhaps unintentionally, by the victim, and is intended to mirror the development of an impression as it would happen in the beginning of a normal relationship.

The following *action* phase shows regular deepening factors, as gifts and deeper communications about personal similarities are shared, as also happens in normal relationships. In this phase, the victim gets used to the virtual relationship and enters into the following *maintenance* phase. This phase shows the effort to 'live the relationship' by building and holding onto established habits as regular contact, but also by transferring funds on the basis of what is discussed later. This is the time of e-Living, where the victim experiences strong romantic happiness. It has been noticed that the victim keeps on holding to the relationship despite noticing regular inconsistencies and getting more suspicious. These suspicions do not prevent them staying in the relationship, but can catalyse them to start investigating more carefully the scammer's profile, which leads to the *termination* phase. This happens when the victim finally gets serious information about the scam and the scammer, but, even knowing that it was a scam, many victims admit that they are still in love with the scammer and they still hesitate to terminate the contact and the beautiful experience of e-Living.

5.4 Phases of the Transtheoretical Model in the fund story

In the beginning of the scam, we can safely assume that the victim has no intention to transfer funds to a scammer. Thus the fund story typically starts with events where the victim is informed about happenings or additional characters, such as family members which fit the scammer's profile, but where the victim is not yet affected or involved. The fund story is developed carefully beside the relationship story and fitted into its context. It slowly moves the victim into the *considering* phase by building sufficient background information which encourages the victim to consider that there is a responsibility to help or interfere in some way due to an obvious rising problem. This can be a sick family member or growing financial complications within the virtual family. Such activity goes in parallel with a growing trust and responsibility build up through the relationship story at the same time.

To check if the victim is prepared enough and therefore ready to move into the *determination* phase, the scammer starts "testing the water" by asking for small favours. When the victim responds positively, the scammer tries to move the victim into the action phase as fast as possible. This is the most difficult step, in which most unsuccessful scams find an end. To increase the likelihood of success, the scammer puts more pressure on the victim by creating guilt or appealing to their responsibility, combined with a short reaction time to respond to the request. After the first successful funds transfer, a second quickly follows, and additional requests mount as the victim enters the *maintenance* phase. The act of transferring funds becomes a habit integrated with all the other comfortable habits of the e-Living experience which gives the victim the feeling to do something for the relationship and to be closer to the virtual partner.

The termination phase comes eventually through direct information or personal realisation, where the victim clearly understands they are being scammed and accepts that there is no chance to get any money back, and also that the relationship is non-existent. Then comes the need to terminate any contact.

6 Conclusion

This article contributes to existing knowledge by analysing the structure and the development of the Online Romance Scam as an e-Living experience. We have described this as a scam which is built by two virtual stories, each of which builds its own scam. Further, the paper describes structures of the scam which are derived from human behaviour in form of so called 'personal love stories'. The analysis shows that the personal love story is clearly a factor in the development of the scam. The most common type was the 'recover story", where the scammer builds the character, the setting and the relationship according to the victims' personal love story. The study also showed that the scam is built by two parallel virtual stories. The first story is to build the online relationship while the second story is to justify the request for funds. The first story is built and developed around the victim's personal love story. The second story is embedded in the context of the online relationship story, but has its own events. The study also showed that both stories go through the phases of human behaviour according to the 'Transtheoretical Model', where the victims' motivation to behave according to the scammers' wish is slowly developed.

This study faces certain limitations. First, the sample size is somewhat restricted. However the selected data source provides a sufficiently varied population of reports to allow meaningful analysis. Second, the usage of publicly available data from the internet raises ethical restrictions in its usage for analysis and publishing. The limitation of being unable to gain consent of the report's authors imposes boundaries on the selection of the material for analysis. It is also impractical to inquire for further clarification in cases of lack of clarity in the reports, which could lead to some misinterpretation.

Thus the following studies could be undertaken under different circumstances using interviews to avoid these limitations, and to be able to further analyse the phases of the crime. This will allow a deeper investigation of the scam phase in relation to the phases of the 'Transtheoretical Model' based on the victims' experiences.

References

Australian Competition and Consumer, Commission. (2015). *Targeting scams: Report of the ACCC on scam activity 2014*. Retrieved from http://www.accc.gov.au/publications/targeting-scams-report-on-scam-activity/targeting-scams-report-of-the-accc-on-scam-activity-2014

Belmont, R. (1979). *Ethical principles and guidelines for the protection of human subjects of research.* Washington, DC: Department of Health, Education, and Welfare.

Bowlby, J. (1997). *Attachment and loss*: Vol. 1. Loss. New York: Basic Books.

Bromberg, W., & Keiser, S. (1938). The psychology of the swindler. *American Journal of Psychiatry, 94*(6), 1441-1458.

Budd, C., & Anderson, J. (2009). Consumer fraud in ausralasia: Results of the australasian consumer fraud taskforce online australia surveys 2008 and 2009. *Technical and Background Paper, 43*

Cortazzi, M. (1993). *Narrative analysis,* Falmer Press, London and Washington, DC.

Edelson, E. (2003). *The 419 scam: Information warfare on the spam front and a proposal for local filtering*. Computers & Security, 22(5), 392-401.

Fair, J. E., Tully, M., Ekdale, B., & Asante, R. K. B. (2009). *Crafting lifestyles in urban africa: Young ghanaians in the world of online friendship*. Africa Today, 55(4), 28-49.

Federal Trade, C. (2015). *Refund and recovery scams*. Retrieved from http://www.consumer.ftc.gov/articles/0102-refund-and-recovery-scams

Kopp, C., Sillitoe, J., Gondal, I., & Layton, R. (2015). *Ethical considerations when using online datasets for research purposes*. In Layton, Robert, and Paul A. Watters. *Automating open source intelligence: Algorithms for OSINT*, Syngress, 131-158.

Lee, J. A. (1977). *A typology of styles of loving*. Personality and Social Psychology Bulletin, 3(2), 173-182.

Magrina, E. (2014). *Online dating: Growth, regulation, and future challenges.* Retrieved from http://inlinepolicy.com/2014/online-dating-growth-regulation-and-future-challenges

McAdams, D. P. (1993). *The stories we live by: Personal myths and the making of the self*. The Guilford Press, New York.,

Nutbeam, D., Harris, E., & Harris, E. (1999). *Theory in a nutshell: A guide to health promotion theory.* McGraw-Hill Sydney, Australia.

Ollerenshaw, J. A., & Creswell, J. W. (2002). *Narrative research: A comparison of two restorying data analysis approaches.* Qualitative Inquiry, 8(3), 329-347.

Prochaska, J. O., & DiClemente, C. C. (1992). *The transtheoretical approach*. Handbook of Psychotherapy Integration*, 2*, 147-171.

Rathinaraj, D., & Chendroyaperumal, C. (2010). *Financial fraud, cyber scams and India–A small survey of popular recent cases*. Available at SSRN: http://ssrn.com/abstract=1605165 or http://dx.doi.org/10.2139/ssrn.1605165

Rege, A. (2009). *What's love got to do with it? Exploring online dating scams and identity fraud.* International Journal of Cyber Criminology, 3(2)

Ross, S., & Smith, R. G. (2011). *Risk factors for advance fee fraud victimisation.* (No. 420). Canberra: Australian Government: Australian Institute of Criminology.

Schank, R. C., & Abelson, R. P. (1977). *Scripts, plans, goals and understanding: An inquiry into human knowledge structures* Lawrence Erlbaum Associates Hillsdale, NJ.

Shaver, P., Hazan, C., & Bradshaw, D. (1988). *Love as attachement: The integration of three behavioral systems*. In R.J. Sternberg & M.L. Barnes (Eds). *The Psychology of Love,* (New Haven, CT: Yale University Press.), 68-99.

Singh, M., & Jackson, M. (2015). *Online dating sites: A tool for romance scams or a lucrative e-business model?* Paper presented at the *28th Bled eConference,* 482-488.

Smith, A., & Duggan, M. (2013). *Online dating & relationships.* Retrieved from http://www.pewinternet.org/2013/10/21/online-dating-relationships/

Sternberg, R. J. (1995). *Love as a story.* Journal of Social and Personal Relationships, 12(4), 541.

Sternberg, R. J. (1999). *Love is a story: A new theory of relationships.* Oxford University Press, USA.

Sternberg, R. J. (2012). *What's your love story?* Retrieved from http://www.psychologytoday.com/articles/200007/whats-your-love-story?page=3

Wendel, M. (2015). *An analysis of the online dating industry and how startups can compete.* Retrieved from http://inlinepolicy.com/2014/online-dating-growth-regulation-and-future-challenges

Whitty, M. T. (2013). *Anatomy of the online dating romance scam.* Security Journal Advance Online Publication, February 11, 2013; Doi:10.1057/sj.2013.4.

29th Bled eConference
Digital Economy
June 19 - 22, 2016; Bled, Slovenia

Instagram's *'Fitspiration'* Trend and Its Effect on Young Women's Self-Esteem

Dee Goldstraw
Manchester Metropolitan University, UK
d.goldstraw@mmu.ac.uk
Brendan James Keegan
Manchester Metropolitan University, UK
b.keegan@mmu.ac.uk

Abstract

Increasingly, sports and fitness brands are using a variety of social media platforms. Instagram has come to the fore in the area of fitness, asserting itself as the *de facto* channel for users to catalogue their athletic activities, and offering inspirational training advice to followers. Considering this increasingly-popular '*fitspiration*' trend, we see a significant impact upon young female users self-esteem, specifically in relation to their perception of body imagery. Hence, this paper will develop understanding of fitness brands' social media activities by investigating the impact of Instagram upon the self-esteem of young women. Nascent literature has examined influence upon self-esteem among women throughout a variety of advertising mediums, however, none have explored the connection between self-esteem and social media. Accordingly, semi-structured interviews with female sports enthusiasts are proposed to uncover opinions and perceptions relating to their use of Instagram. Initial findings reveal a strong correlation between participant perception of the '*fitspiration*' social media accounts they subscribe to, as well as the impact upon their self-esteem. Ultimately, this paper makes two theoretical contributions relating to the effect of social media upon female self-esteem, as well as contributing to a wider debate of body image within a modern digital economy.

Keywords: Instagram, fitspiration, women's self-esteem, body imagery, digital economy

1 Introduction

Female digital natives are familiar with technology from a young age and engage in "a culture of participation … to share content from reviews, ratings, photos, stories and more." (Soloman and Tuten, 2015:6). Instagram is one of the social media platforms at the forefront of this participation culture, claiming that 80 million photos are shared on its platform each day (Moth, 2015). Of its 400 million monthly active users, it is most popular with younger women aged between 16 and 24 (Moth, 2015). According to Instagram (2016) it is "*a fun and quirky way to share your life with friends through a series of pictures. Snap a photo with your mobile phone, then choose a filter to transform* *the image.*" It is this transformation of the photo using an editing function and applying filters (e.g., alterations to colour, texture and lighting) that has come under criticism for its ability to distort the story the photo is telling (Bevan, 2012). Arguably, this manipulation alters young women's perspective of reality, especially when they spend up 27 hours per week online, 14% of which is on Instagram (Ofcom, 2015). Equally, Instagram is renowned for extremely high levels of engagement amongst users when compared to other social platforms, such as Twitter (Moth, 2015). According to Morrison (2015) Instagram provides its users with the ability to connect with and develop communities with similar interests via the use of hashtags.

A recent trend, which has emerged on Instagram, has generated the name '*fitspiration',* an amalgamation of the words fitness and inspiration. Users post photos to the hashtag '*fitspiration'* to promote health, fitness, nutrition and exercise. Williamson (2013) and Adams (2014) both argue it is promoting thinness, suggesting it could cause anorexia, depression, body dissatisfaction and lowered self-esteem rather than inspiring young women. This is further compounded by women's mainstream media, which informs readers about "inspiring fitness girls to follow on Instagram" (Fisher, 2015). Conversely, Elle magazine has explored women's feelings about being bombarded with perfect, flawless images and the pressure these exert (Fleming, 2014). New trends like *'fitspiration'* develop quickly on social media and companies try hard to keep one-step ahead (DeMers, 2015). As brands aim to join in with this latest trend, there is a blurring of lines between fitness brands marketing communications, and the *'fitspiration'* trend. Hence, it is necessary to understand how this trend is affecting consumers, and in particular young women. To this effect, this study explored *'fitspiration'* imagery posted by fitness brands on Instagram, and its effects upon young females. Specifically, we sought to uncover whether through this imagery, young women experience a discrepancy between their 'ideal self' and actual self, as well as impacting their self-esteem.

2 Literature Review

Instagram's *'fitspiration'* phenomenon displays hundreds of thousand images of women in gym wear and swimwear daily, all displaying highly toned figures. As this paper is exploring imagery in a marketing context, it is important to understand that this is not a unique concept to Instagram. Imagery is utilised extensively as part of marketing campaigns, with each image carefully chosen, cropped and edited to carry symbolic and emotional meaning (Branthwaite, 2002). There have been many previous studies into more established social media sites, like Facebook and Twitter exploring the impact on self-esteem (Vogel *et al*., 2014; Kende *et al*., 2015). However, empirical studies of Instagram are limited to date.

Gerbner and Gross' (1976) Cultivation Theory, could go some way to explain why Instagram is so influential. Their original work sought to explain why people watching a lot of television had a distorted perception of reality. Their work found views of reality shifted based on what was portrayed in television programmes, rather than 'real world' experiences. This even held true despite these programmes being acknowledged as fictional (Gerbner and Gross, 1976). Further work by Bryant and Zillmann (1986:6) found that extensive use of television means society: "*cannot avoid absorbing or dealing with its recurrent patterns, probably many times each day*." A similar premise to social media consumption in today's society, with young people spending vast amounts of time online. Windahl *et al.*(1992) found regular television viewers viewed the world differently to those who do not watch television as extensively. While no work to date has directly addressed the relevance of Cultivation Theory in a social media environment, Morgan and Shanahan (2010) argue it is more applicable today than ever before. This study aims to extend this theme in a modern social media environment, investigating whether constant exposure to *'fitspiration'* images has any significant effect on young women's perception of reality.

One of the key features of Instagram is the ability to distort the reality depicted in the photos with options to manipulate photos via editing and filters (Araujo *et al.,* 2014). Interestingly Dumenco (2012) made an excellent point when he stated: "deep down [society knows] that the digitally manipulated lie is more appealing than the truth". It was interesting to explore via this paper whether young women all very aware of the manipulation of images were still affected by them.

Another theory that goes some way to explaining what happens when women see a picture of another woman is Social Comparison Theory. Still applicable today, Festinger and Katz (1954) found that humans will evaluate themselves by comparison with another. In particular, Bessenoff (2006) found people who have body dissatisfaction or internalise the media's depiction of the thin ideal are especially vulnerable to social comparison. Upward comparisons to people far more advantaged can result in a person left feeling more positive or a person feeling more negative (Krizan and Gibbons, 2014). For example, a person could be left feeling proud or even inspired by the person they are looking up to, or instead feel inferior, worthless, envious or discouraged. It is possible these negative comparisons could be linked or have an effect on self-esteem, which is susceptible to change as self-esteem is based on how we feel (Carlock, 1999). Self-esteem is developed by: *"the people who surround you, the groups and organisations to which you belong, the subcultures with which you identify, and world events"* (Carlock, 1999: 145). Furthermore, work by Maiz-Arevalo and Garcia-Gomez's (2013) suggests that social media is one of the elements which people may base their self-esteem on. They explored compliments and conversations on social media and their effect on users. In addition, body image is also strongly related to self-esteem, as Carlock (1999:207) explains: "*women in particular are persecuted for their weight*" due to what the media depicts as being ideal, and importantly *"the more congruent our real and ideal selves are, the higher our self-esteem".*

Furthering our knowledge of self-esteem is the theoretical area self-discrepancy, a concept whereby individuals have an idyllic identity (ideal self) they would like to achieve, and a separate view of how they see themselves at present time (actual self) (Higgins 1987). According to Bessenoff (2006), people who have body dissatisfaction or who internalise the media's depiction of the thin idea, are commonly known to take part in social comparison. Finally, Richins (1991) found if a female model is viewed by another woman, the model provides a standard to compare themselves to. Moreover, an array of theoretical standpoints exist from which to investigate the impact of '*fitspiration'* imagery upon the self-esteem and notions of body image among young women today.

3. Research Method

The nature of the research objectives lend themselves to qualitative interviews that study interviewees' perceptions as well as the observable reality. Initially, a short, structured interview was conducted to ascertain that interviewees actually used Instagram and were aware of the *'fitspiration'* trend, prior to their participation in a semi-structured interview. Additionally, a repertory grid technique based on Kelly's (1955) personal construct theory was proposed to elicit further data from the interviewee. The repertory grid technique was used to explore the participants' personal constructs with regards to the positive or negative effects of *'fitspiration'* imagery on Instagram. Individual questions within the semi-structured interviews were based around how much time the interviewees spent on Instagram, how real they believed images on Instagram to be and their opinions of the *'fitspiration'* trend. A variety of images taken from Instagram of the *'fitspiration'* trend were shown to all interviewees, to inspire comments and probe discussions surrounding each participant's thoughts and feelings on the images, see figure 1 below. A convenience sample of 12 young women aged between 18 and 24 was established, based in the North West of England for consistency of views within a localised area. Primary data collected was therein analysed thematically.

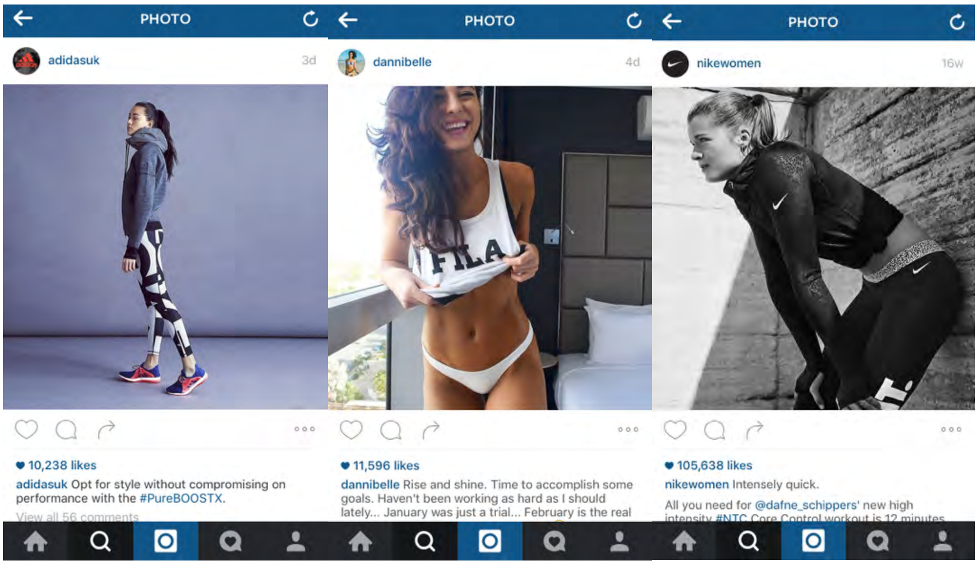


Figure 1: Examples of *'fitspiration'* imagery shown to the interviewees

4. Findings

Data collected so far indicates a strong correlation between engaging with *'fitspiration'* imagery and interviewees self-esteem. Firstly, all interviewees reported a high degree of regularity in viewing '*fitspiration*' accounts, on their mobile devices, often checking every few minutes of the day, for example P8 admitted they logged in: 'm*ultiple times a day, more than I should to be honest.*' *(P8)* The amount of time spent observing these accounts is consistent with the initial findings of earlier work supporting Cultivation Theory (Gerbner and Gross, 1976; Bryant and Zillmann, 1986), whereby a high degree of media consumption was found with participants, yet their perception of reality of the imagery perceived through programming was observed. Furthermore, analysis of findings also reveals a range of perceptions around the artificial nature of contrived imagery of athletic women on Instagram, namely: Optimistic (3 participants), Pragmatic (3 participants) and Realist (6 participants).

The Optimist view refers to the participant views which celebrated the positive outcomes of the fitspiration accounts, citing the benefit of motivations to get fitter, obtaining health tips, and offering targets for their training, as P6 explains in this illustrative account: *'I like these pictures as they give some women something to aspire to'* (P6). In this manner social media is the vehicle offering the Optimistic view of fitness to recreate a positive 'reality' through *'fitspiration'*, and can share this lifestyle digitally because she can't do it in real life. This viewpoint is further reflected by a number of participants who referred to a system of fitness goals, in their viewpoint of fitspiration: *'At the end of the day reality is what we live in… people dream, and have goals it's never actually the real thing. An Instagram account is like, goals' (P8).*

Whereas, a Pragmatist view of *'fitspiration'* was also observed, alluding to the false nature of the constructed imagery, and adopting a critical view of the concept as a whole, despite partaking in the trend on a daily basis. Accounts of *'fitspiration'* showed a perception, which questioned its reality. Interestingly, when asked about their self-esteem, and image, the Pragmatist view was that it did not affect them: '*It's not real, it's not achievable, it doesn't affect me because, that wouldn't be me. I'm not too bothered.'*(P5). On the other hand P10, in their Pragmatist view went as far as normalising the false nature of the *'fitspiration'* accounts by only viewing video content on the accounts as she: '*prefers looking at the videos because it's a lot harder to edit them'* (P10). Furthermore, a cautionary tone emerged from another Pragmatist who claimed: '*it's a bit fake sometimes and I think it's giving girls the wrong impression*.'(P12)

Finally, the majority of interviewees adopted a Realist viewpoint when discussing their interactions with *'fitspiration'* accounts. Often being described in terms of objective realism, P1 describes how it is: '*all a bit too perfect' (P1)*, whereas P4 explained how she: '*doesn't identify with them because they are in a lot better shape than me – they look like fitness models rather than real people who train.'(P4).* Noteworthy is the definition of realism in terms of ordinary people who train, and professional fitness models reflects the aspects of Cultivation Theory in effect. P7 extends this notion that she was: *'not a fan of six packs on women, I can't really see anyone with curves on these pictures, like with hip curves or hourglass; none of them are hourglass they're all straight down. I mean, I would love to have a body like that but I also prefer curves'* which suggests the tendency to rely upon traditional body shapes as a realistic viewpoint when viewing *'fitspiration'* imagery.

4.1 Social Media Moderation Behaviour

Interestingly, while all three perspectives accepted the artificial nature of *'fitspiration'*, it was observed that a number of interviewees displayed a mature approach to curating the behaviour of their younger siblings in following '*fitspiration*'. P10 describes for us how she manages the Instagram account for her younger sister as she believed: *'it's unhealthy at that age to be constantly bombarded with (fitspiration) images like these, I know obviously we are older but to a 12 year old girl, she doesn't need that.'* The maturity to P10's actions in moderating another's behaviour, while also engaging with the same social media suggests a realisation of the dangers of the concept, while also adopting the same behaviours. This level of sophistication in terms of social media adoption is also reflected by P9, who described how social media can also have significant dangers for young women. '*I think everything is emphasized now through social media, in the olden days you wouldn't be that bullied if you were fat because there wasn't that extra social media to do it. But I do think social media is a part of the pressures that some people might feel.*'

4.2 Self Esteem

During the interviews, *'fitspiration'* images were used to elicit any perceived changes to self-esteem when viewing images through a simple rating system. A range of viewpoints were expressed by the sample however the majority of respondents (six) reported initial low self-confidence, which was not affected by the imagery observed. Moreover, five respondents reported a drop in their self-confidence, and only one reported a positive influence after viewing fitspiration imagery.

Participant	Initial Rating	Reported Affect
1	5	No
2	6	Yes – negative
3	5	Yes - negative
4	5	No
5	3	No
6	5	Yes - negative
7	4	No
8	7	Yes - positive
9	5	Yes - negative
10	4	No
11	5	Yes - negative
12	6	No
Summary: No Affect = 6, Negative Affect = 5, Positive Affect = 1		

Table 1: Reported Alterations to Self Esteem

5. Summary

In summary, millennial generation fitness enthusiasts were observed to engage with *'fitspiration'* on a daily, and hourly basis for a variety of motivations. Their perception of the reality of this concept, and the impact upon their self-esteem are the two key outcomes of this study. Cultivation Theory (REF) considers alterations to persons perceptions of reality, as cultivated by the media imagery they consume. In this manner, participants within this study admitted looking at *'fitspiration'* images altered their perspective of reality despite admitting it's artificial constructedness. Optimistic, Pragmatic and Realist perspectives were observed from analysis of the findings coupled with alterations to their self-esteem were shown when viewing *'fitspiration'* imagery. Indeed, social media offers a platform for millennial fitness enthusiasts to engage with the concept of '*fitspiration'* with varying degrees of critical reflection, while at the same time impacts upon their self-esteem.

Acknowledgement

The authors wish to acknowledge the contribution from Jo Emily McGrann for her assistance with data collection.

References

Adams, R. (2014). *Why 'Fitspo' Should Come With A Warning Label*. [online] The Huffington Post. Available at: http://www.huffingtonpost.com/2014/07/17/fitspo-fitspiration_n_5574150.html [Accessed 5 Feb. 2016].

Araujo, C., Damilton. Correa, L., Couto da Silva, A., Oliveira Prates, R. and Meira Jr., W. (2014). It is not just a picture: Revealing some user practices in Instagram. In: *9th Latin American Web Congress*. [online] Minas Gerais: IEEE, pp.19 - 23. Available at: http://ieeexplore.ieee.org.ezproxy.mmu.ac.uk/stamp/stamp.jsp?tp=andarnumber=7000167 [Accessed 3 January 2016].

Bessenoff, G. (2006). Can the Media Affect Us? Social Comparison, Self-Discrepancy, and the Thin Ideal. *Psychology of Women Quarterly*, [online] 30(3), pp.239-251. Available at: http://pwq.sagepub.com.ezproxy.mmu.ac.uk/content/30/3/239.full.pdf+html [Accessed 4 January 2016].

Bevan, K. (2012) Instagram is Debasing Real Photography. *The Guardian* [Online]. Available at: http://www.theguardian.com/technology/2012/jul/19/instagram-debasing-real-photography [Accessed 4 January 2016].

Branthwaite, A. (2002). Investigating the power of imagery in marketing communication: evidence-based techniques. *Qualitative Market Research: An International Journal*, [online] 5(3), pp.164-171. Available at: http://www.emeraldinsight.com.ezproxy.mmu.ac.uk/ [Accessed 1 December 2015].

Bryant, J. and Zillmann, D. (1986). *Perspectives on Media Effects*. Hillsdale, N.J.: Lawrence Erlbaum Associates, pp.1-6.

Carlock, C. (1999). *Enhancing Self Esteem*. 3rd ed. New York: Routledge.

DeMers, J. (2015). *The Top 7 Social Media Marketing Trends That Will Dominate 2016*. [online] Forbes. Available at: http://www.forbes.com/sites/jaysondemers/2015/09/28/the-top-7-social-media-marketing-trends-that-will-dominate-2016/#6b620ad8115b [Accessed 5 Apr. 2016].

Dumenco, S. (2012). Instagram is OK, but Photoshop is evil? The truth about digital lies. *Advertising Age*, 83(22).

Festinger, L. and Katz, D. (1954). *Research methods in the behavioral sciences*. Staples Press.

Fisher, L. (2015). *21 Inspiring Fitness Girls To Follow On Instagram*. [online] Harper's BAZAAR. Available at: http://www.harpersbazaar.com/beauty/diet-fitness/g4018/inspiring-fitness-girls-on-instagram/ [Accessed 29 October 2015].

Fleming, O. (2014). *'Why Don't I Look Like Her?': How Instagram Is Ruining Our Self Esteem*. [online] ELLE. Available at: http://www.elle.com/beauty/tips/a2531/how-instagram-is-ruining-our-self-esteem/ [Accessed 29 October 2015].

Gerbner, G. and Gross, L.(1976). 'Living with television: The violence profile'. *Journal of Communication.* 26:172-94.

Gerbner, G., Gross, L., and Morgan, M. (2002). Growing up with television: Cultivation processes. In J. Bryant and D. Zillman (Eds.), *Media effects: Advances in theory and research* (2nd ed., pp. 43–67). Mahwah, NJ: Erlbaum.

Grabe, S., Ward, L. and Hyde, J. (2008). The role of the media in body image concerns among women: A meta-analysis of experimental and correlational studies. *Psychological Bulletin*, [online] 134(3), pp.460-476. Available at: http://ovidsp.tx.ovid.com.ezproxy.mmu.ac.uk/sp-3.18.0b/ [Accessed 2 January 2016].

Henderson-King, E. and Henderson-King, D. (1997). Media Effects on Women's Body Esteem: Social and Individual Difference Factors. *Journal Applied Social Pyschology*, 27(5), pp.399-417.

Higgins, E. (1987). Self-discrepancy: A theory relating self and affect. *Psychological Review*, [online] 94(3), pp.319-340. Available at: http://ovidsp.tx.ovid.com.ezproxy.mmu.ac.uk/sp-3.18.0b/ [Accessed 4 January 2016].

Instagram.com, (2016). *Instagram*. [online] Available at: https://www.instagram.com/about/faq/ [Accessed 9 February 2016].

Kelly, G.A., 1955. *The Psychology Of Personal Constructs*, New York: Norton.

Kende, A., Ujhelyi, A., Joinson, A. and Greitemeyer, T. (2015). Putting the social (psychology) into social media. *European Journal of Social Psychology*, 45(3), pp.277-278.

Križan, Z. and Gibbons, F. (2014). *Communal functions of social comparison*. Cambridge: Cambridge University Press.

Maiz-Arevalo, C. and Garcia-Gomez, A. (2013). 'You look terrific!' Social evaluation and relationships in online compliments. *Discourse Studies*, [online] 15(6), pp.735-760.

Available at: http://dis.sagepub.com.ezproxy.mmu.ac.uk/content/15/6/735.full.pdf+html [Accessed 1 January 2016].

Morgan, M. and Shanahan, J. (2010). 'The state of cultivation.' *Journal of Broadcasting & Electronic Media.* 54: 337-55.

Morrison, K. (2015). *Instagram Is Becoming a Fitspiration Destination*. Adweek [online] Available at:http://www.adweek.com/socialtimes/instagram-is-becoming-a-fitspiration-destination/627895 [Accessed 29 October 2015].

Moth, D. (2015). *20+ Instagram stats marketers need to know*. Econsultancy [online] Available at:https://econsultancy.com/blog/65939-20-instagram-stats-marketers-need-to-know/ [Accessed 29 October 2015].

Ofcom (2015). *Adults Media Use and Attitudes.* [online] available at: http://stakeholders.ofcom.org.uk/binaries/research/media-literacy/media-lit-10years/2015_Adults_media_use_and_attitudes_report.pdf. [Accessed: 10th May 2016].

Richins, M. (1991). Social Comparison and the Idealized Images of Advertising. *Journal of Consumer Research*, [online] 18(1), p.71. Available at: http://www.jstor.org.ezproxy.mmu.ac.uk/stable/2489486?pq-origsite=summonandseq=2#page_scan_tab_contents [Accessed 27 December 2015].

Ryan, G.W. and Bernard, H.R., 2000. Data Management And Analysis Methods. In *Handbook Of Qualitative Research*. Thousand Oaks: Sage Publications Ltd.

Solomon, M.R. and Tuten, T.L. (2015). *Social Media Marketing*. London: Sage.

Thomson, W. (2015). Depression, Neuroticism, and the Discrepancy Between Actual and Ideal Self-Perception. *Personality and Individual Differences*, 88, pp.219-224.

Vogel, E., Rose, J., Roberts, L. and Eccles, K. (2014). Social Comparison, Social Media, and Self-Esteem. *Psychology of Popular Media Culture*, [online] 3(2160-4134), pp.206–222. Available at: http://ovidsp.tx.ovid.com.ezproxy.mmu.ac.uk/ [Accessed 3 November 2015].

Williamson, H. (2013). *Beware of the dangerous fetishising of fitness on social media*. [online] Telegraph.co.uk. Available at: http://www.telegraph.co.uk/women/womens-life/10376945/Beware-of-the-dangerous-fetishising-of-fitness-on-social-media.html [Accessed 29 October 2015].

Windahl, S., Signitzer, B. and Olson, J. (1992). *Using Communication Theory*. London:

Sage Publications, p.215.

29th Bled eConference
Digital Economy
June 19 - 22, 2016; Bled, Slovenia

The Antecedents of Consumer-Generated Media Adoption for Travel Planning: A Literature Review

Dandison C. Ukpabi
University of Jyväskylä, Finland
ukpabison@yahoo.com

Heikki Karjaluoto
University of Jyväskylä, Finland
heikki.karjaluoto@jyu.fi

Abstract

Web 2.0 provides different platforms through which tourists can share text, photos and videos of their travel experiences. Consumer-generated media (CGM) are considered honest and are thus trusted more than marketer-generated content. Different factors account for why tourists adopt CGM. This study aims to review extant studies on CGM to identify the antecedents of CGM adoption for travel planning and the theories, models and frameworks used in these studies; it also seeks to analyze the strengths of these antecedents in predicting the adoption of CGM for travel planning. A total of 54 studies from 2005-2016 were found. The study found that distinct and heterogeneous theories and frameworks were used with 61 different antecedents to predict intentions. The technology acceptance model (TAM) was the most commonly used model. Trust predicted attitude more than the other antecedents. Implications and research directions are suggested.

Keywords: Web 2.0, consumer-generated media, travel planning, TAM

1. Introduction

Recently, there has been broad interest in social media as an important platform for disseminating information on products or services (Lu & Stepchenkova, 2015). Marketers use social media platforms to share information and attract traffic to their offerings. Equally, social media platforms have become powerful tools consumers use to spread word-of-mouth (WOM). In the tourism and hospitality services industries, consumer-generated media have become effective tools used by tourists to gather information to make travel decisions. Tsao et al. (2015) found that approximately 80% of travelers maintain that they read reviews about a hotel before embarking on a trip, and 53% say that they do not book a hotel that has no reviews. By sharing travel experiences through text, pictures and videos, free information for potential travelers regarding new markets, new topics and sensitive issues is enhanced (Tsao et al., 2015).

Some studies have attempted to review existing research on social media in the tourism industry (Leung et al., 2013; Zeng & Gerritsen, 2014; Lu & Stepchenkova, 2015). These reviews represent comprehensive attempts to understand the methods used in these studies. However, a review of CGM adoption in travel planning is still lacking. Therefore, this study has been conducted to fill this gap in the literature. It aims to understand the factors that influence the adoption of CGM in travel planning based on a review of existing studies. Specifically, the study objectives include (1) identifying the antecedents of CGM adoption in travel planning; (2) identifying the theories, models and frameworks used in these studies; (3) and analyzing the strengths of the antecedents in predicting CGM adoption in travel planning. The present review, in line with Okoli & Schabram (2010), will serve as solid theoretical background for subsequent research by providing a synthesis of theories from the reviewed studies. Additionally, in line with Webster & Watson's (2002) concept-driven review methodology, we also include an examination of the path coefficients in this review. We believe that this will serve as a pool for subsequent research in the field. The remainder of the study is organized as follows: section 2 provides the background information; section 3 describes the research methods; section 4 presents the results; and section 5 provides the contributions, limitations and future research directions.

2. Background Information

Consumers express their satisfaction or dissatisfaction with a product or service through word-of-mouth (WOM). The advent of social media (SM) has enhanced WOM. SM offers opportunities for people to socialize and form communities of interest by creating and sharing content (Chung & Koo, 2015). Consumer-generated media (CGM) enables other consumers to read, learn and share in the experiences of others. CGM is defined as "media impressions created by consumers, typically informed by relevant experience and archived or shared online for easy access by other impressionable consumers" (Gretzel et al., 2008, p. 100). In trip planning, consumers search for information from marketers and fellow consumers. Consumers rely more on CGM because they are judged to be sincere and honest and to convey the creator's real experience(s) (Wang, 2012). They are also perceived to be more influential because they reflect the performance of typical tourism products, thus making them more persuasive than marketer-generated content (Sparks & Browning, 2011).

CGM platforms vary in terms of their use and applications, thus prompting different classifications (Fotis et al., 2012; Lu & Stepchenkova, 2015). From the tourism and travel perspective, Fig. 1 depicts CGM platforms and examples of specific applications.

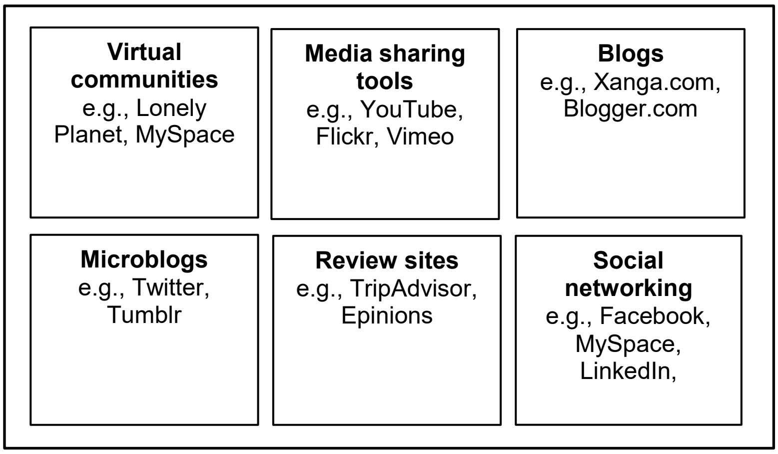


Figure 1: Consumer-generated media platforms

Consumers use CGM for variety of reasons such as service quality and price evaluations (Liu & Lee, 2016) and identifying the best attractions, including food and destinations (Lee et al., 2012). Others search for social acceptance (Khan & Khan, 2015), enjoyment (Ayeh et al., 2013), communal feeling (Ku, 2011) and involvement (Sotiriadis & van Zyl, 2013). However, the authenticity of CGM has recently come under close scrutiny (Ayeh et al., 2013). Some consumers may post a review as in for betrayal (Sparks & Browning, 2011), and some of these are legally defamatory (Ayeh et al., 2013). Despite the presence of such reviews, it is established in literature that many consumers post reviews as a result of altruism (Wang, 2015), and these have helped in pre-trip planning decisions. In this study, 'adoption' refers to the intention to use CGM, which is important because online third-party advice has proven to be a very reliable source of information for travelers (Tsao et al., 2015). Additionally, consumers' preferences for independent discussion boards, such as TripAdvisor and Lonely Planet, have allowed these sites to remain popular among travelers.

3. Research Methods

3.1 Literature Search and Selection

Following the review approach of Shaikh and Karjaluoto (2015), we drew up a plan based on the recommendations of previous reviews. First, we identified the keywords that would form the basis of the literature search and extraction. Second, we established the literature inclusion criteria. Based on these keywords and inclusion criteria, we used the following search terms, among others; "social media adoption in tourism", "e-WOM in tourism and travel", "Web 2.0 adoption in tourism and travel", "consumer-generated media in tourism and travel", "social networking in tourism and travel", "blogs in tourism and travel", "online communities in tourism and travel", and "virtual communities in tourism and travel". We conducted our search on Google Scholar and other databases, such as Science Direct, SAGE, Wiley, Springer, Emerald, JSTOR, IEEE, Taylor & Francis and Inderscience. To find more studies, the search was expanded to conference proceedings and working papers. To avoid duplication, all the studies were saved in one folder with the title of the study as the file name; a file that appeared more than once was easily detected and deleted. The inclusion criteria required that the study be consumer-based and empirical, include measures for independent and dependent variables, have a defined sample size and provide detailed results of the data analysis. The exclusion criteria disregarded conceptual or theoretical and firm-based studies. As suggested by Tranfield et al. (2003), inclusion is subjective and based on the researcher's interests and objectives. A total number of 54 studies - 51 articles from 28 journals, one conference paper and two PhD dissertations published from 2005 to 2016 - were used.

4. Results

4.1 Theories, Frameworks and Models

The 54 reviewed studies, presented in Table 1, reveal the use of 22 distinct and heterogeneous theories, frameworks and models. The table also presents the antecedents and path coefficients of their relationships. The technology acceptance model (TAM) was used in 14 (26%) of the studies. The identified weaknesses of the TAM model in predicting technology adoption at the individual level (Chau & Hu, 2001) required some studies to combine the theory with other models (e.g. Casaló et al., 2011) and to extend the theory by adding other constructs (Ayeh et al., 2013). The theory of planned behavior (TPB) was used in five (9%) studies; the elaboration likelihood model (ELM) in three (5%) studies; and the theory of reasoned action (TRA) in three (5%) studies. Only one (1.8%) study used the unified theory of acceptance and use of technology (UTAUT). Because CGM draws fundamentally from the traditional e-WOM literature, most of the studies borrowed constructs from other models and used e-WOM as a framework (e.g. Wang, 2012; Zhao et. al., 2015).

CGM is derived from e-WOM (Ye et al., 2011), which has its roots in the traditional WOM literature (King et al., 2014). The fundamental assumption of WOM is that WOM episodes involve two parties – the sender and the receiver. Our framework (Figure 2) is based on the classification of the reviewed literature. The classifications are based on the assumption that intrinsic and extrinsic factors have an impact on tourists' adoption of CGM for travel planning. While the intrinsic factors capture the characteristics of the tourist, the extrinsic factors depict the external influences on CGM adoption. Additionally, CGM adoption is moderated by factors such as content novelty, valence (positively or negatively framed), argument quality, and information quantity.

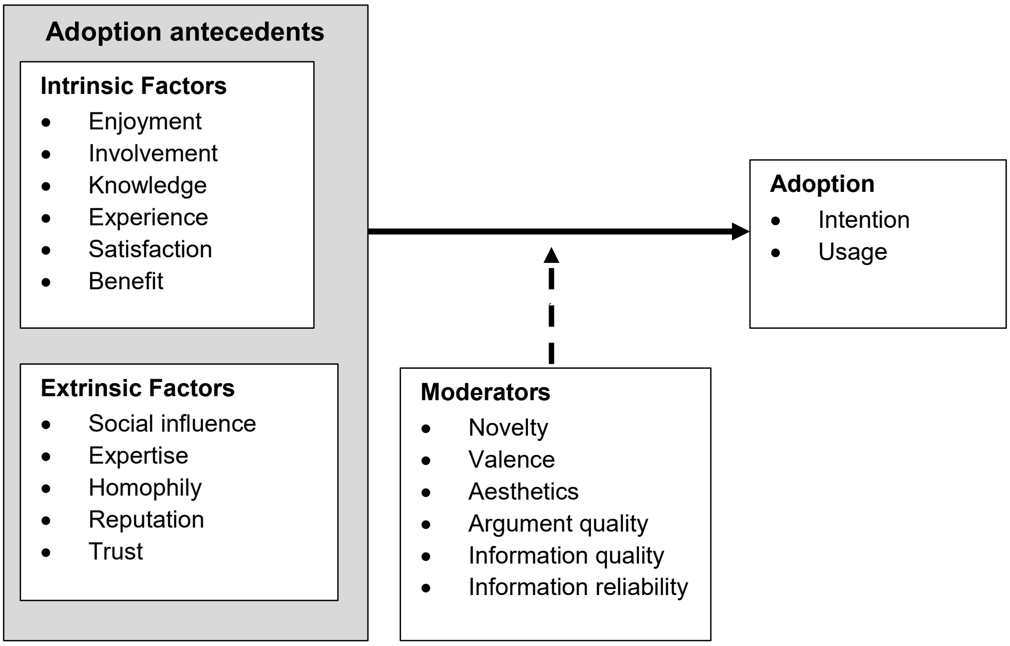


Figure 2: Proposed conceptual framework

Similarly, 20% (11 out of 54) of the studies were published in tourism-based journals, while 33% (18 out of 54) appeared in non-tourism-based journals. Of the 54 studies, 35 (64.8%) were conducted between 2013 and 2015. No study was published in 2008 or 2009. The geographic distribution of the studies was as follows: one (1.8%) study in Africa, 28 (51.8%) in Asia, two (3.7%) in Australia/Oceania, 13 (24%) in Europe and 11 (20%) in North America. Most studies were conducted in the following countries: Taiwan with 11 (20%), the United States with 10 (18%), China with six (11%) and Spain with six (11%). In terms of data collection, as stated earlier, all of the studies were quantitative; however, two (3.7%) studies utilized an experimental approach and one (1.8%) used panel data. Over half (63.6%) used online (web-based, email) survey methods to obtain responses, while 17 (31.5%) used field-based surveys. One study combined online and field-based methods of data collection (Zhao et al., 2015). Table 1 contains the 54 reviewed studies, the antecedents and path coefficients of their relationships, and the theories, models and frameworks used.

No	Author(s)	Path coefficients (β)	Theory
1	Filieri & McLeay (2014)	NA	ELM
2	Parra-López et al. (2011)	COS→INT (.01); BEN→INT (.44); INC→INT (.36)	INT
3	Book et al. (2015)	NA	CDT
4	Casaló et al. (2010)	PU→ATT (.218); PU→INT (.301); PU→TRU (.547); TRU→ATT (.600); TRU→INT (.306)	TPB, TAM, SIT
5	Ayeh et al. (2013)	HM→TRU (.455); HM→EX (.473); TRU→ATT (.422); TRU→INT (.126); EX→ATT (.218);	SC

		EX→INT (.037) ATT→INT (.649)	
6	Wang (2011)	EA→INT (.168); GE→INT (.223); PI→INT (.16); DK→INT (.097); PG→INT (.15); SI→INT (.139); CI→INT (.200)	e-WOM
7	Wang (2012)	GE→DI (.158); EA→DI (.148); DK→DI (.026); PG→DI (.275); SI→DI (.195); CI→DI (.199); DI→INT (.248)	e-WOM
8	Sparks et al. (2013)	ATT→INT (.73); TRU→INT (.61)	ATT
9	Hosany & Prayag (2013)	NA	CNTT
10	Ayeh et al. (2013)	PEOU→EN (.79); PEOU→INT (.131); PEOU→ATT (.177); PU→INT (.117); PU→ATT (.186); TRU→ATT (.334); TRU→INT (-.046); EN→INT (.256); EN→ATT (.256); ATT→INT (.292)	TAM
11	Ku (2011)	NA	TAM
12	Chen et al. (2014)	NC→US (.306); RC→US (.027); UC→US (.177); IC→US (.289); US→INT (.333)	e-WOM
13	Jalilvand & Samiei (2012)	ATT→INT (.65); EWOM→SN (.88); EWOM→PBC (.84); PBC→INT (.69); SN→INT (.95)	TPB
14	Sparks & Browning (2011)	NA	e-WOM
15	Hsiao et al. (2013)	PEST→EMP (.25); NS→EMP (.498); SR→EMP (.215); PEST→ATT (.506); EMP→ATT (.372); ATT→INT (.739)	TRA
16	Casaló et al. (2010)	PU→ATT (.164); PEOU→ATT (.379); ID→ATT (.609); ATT→INT (.350); SN→INT (-.087); PBC→INT (.471)	TAM
17	Zhao et al. (2015)	PU→INT (.197); RE→INT (.275); NOR→INT (.305); TOR→INT (.230); VOR→INT (.300); POR→INT (.112); COR→INT (.295)	e-WOM
18	Wang (2015)	AQ→ATT (.173); AQ→INT (.192); ATT→INT (.149)	ELM, TPB
19	Lin (2007)	IQ→PU (.19); SQ→PU (.31); SQ→PEOU (.24); SERQ→PU (.25); SERQ→PEOU (.20); PU→SOB (.33); PEOU→SOB (.27); SOB→INT (.41)	TAM
20	Wu & Chang (2005)	ENJ→INT (.26); TD→INT (-.02);	FLOW
21	Chung & Koo (2015)	PV→US (.188); IR→PV (.331); IR→US (-.024), ENJ→PV (.437); ENJ→US (.449); COMPL→PV (-.115); COMPL→US (.088); EFF→PV (.167); EFF→US (.035)	VAM
22	Chung, Han & Koo (2015)	AQ→PU (.199); SC→PU (.397); SC→SR (.143); PU→SR (.330); PU→INT (.597); SR→INT (.162)	ELM
23	Zarrad & Debabi (2015)	E-WOM→ATT (.766); E-WOM→INT (.547); ATT→INT (.501)	e-WOM
24	Tsao et al. (2015).	NA	UGC
25	Bilgihan et al. (2016)	SN→SC (.422); PEOU→SN (.383); PEOU→UTIL (.309); PEOU→BII (.294); UTIL→BII (.235); SN→BII (.115); BII→INT (.525); PEOU→INT (.254); SC→INT (.037)	TAM, OSN
26	Kang & Schuett	ID→ENJ (.61); INTL→ENJ (.45); COMPC→ENJ	SIT

	(2013)	(-.16); ENJ→ATS (.36); ENJ→US (.37); ENJ→LEX (.18); US→ATS (.10)	
27	Sotiriadis & van Zyl (2013)	NA	e-WOM
28	Jalilvand et al. (2013)	E-WOM→ATT (.870); E-WOM→INT (.320); ATT→INT (.290)	e-WOM
29	Ladhari & Michaud (2015)	NA	e-WOM
30	Munoz-Leiva et al. (2012)	PU→ATT (.06); PU→INT (.44); PEOU→PU (.06); PEOU→ATT (.09); PEOU→INT (.47); PEOU→TRU (.10); ATT→INT (.26); TRU→PU (.25); TRU→ATT (.22); TRU→INT (.47)	TAM
31	Herrero et al. (2015)	NA	e-WOM
32	Huang et al. (2010)	NA	e-WOM
33	Albarq (2014)	E-WOM→ATT (.046); E-WOM→INT (.051); ATT→INT (.041)	e-WOM
34	Munar & Jacobsen (2014)	NA	e-WOM
35	Khan & Khan (2015)	NA	e-WOM
36	Cheng et al. (2006)	ATT→INT (.587); SI→INT (.694); PBC→INT (1.00)	TPB
37	Zhang et al. (2014)	NA	CLT
38	Liu & Lee (2016)	MP→INT (.316); WOM→INT (.396); BP→INT (.112)	SQ
39	Őz (2015)	NA	UGC
40	Lee et al. (2012)	ATT→INT (.86); PU→PEOU (.88); PEOU→ENJ (.69); VAL→PU (.10); VAL→PEOU (.46); VAL→ENJ (.21); ENJ→ATT (.73)	TAM
41	Alcazar et al. (2014)	ADI→INT (.633); CDI→INT (.486); CDI→ADI (.556); UGC→CDI (.367)	UGC
42	Aluri et al. (2015)	INF→SAT (.525); ENJ→SAT (.203); SI→SAT (.074); ENJ→INT (.335); SI→INT (.116); SAT→INT (.510)	UGA
43	Leung & Bai (2013)	MOT→INV (.42); OPP→INV (.15); INV→INT (.70)	MOA
44	Ayeh (2015)	ATT→INT (.538); PU→INT (.266); TRU→ATT (.257); TRU→PU (.248); PEOU→ATT (.416); PEOU→PU (.461)	TAM, SCT
45	Pietro & Pantano (2013)	PU→INT (.82); PEOU→INT (.31); PEOU→E-WOM (.26); E-WOM→INT (.76); ENJ→E-WOM (.37); ENJ→INT (.41)	TAM, E-WOM
46	Ayeh (2012)	CR→PU (.161); CR→ATT (.327); CR→INT (.045); ENJ→PEOU (.797); ENJ→ATT (.241); PU→ATT (.134); PU→INT (.321); PEOU→ATT (.259); PEOU→PU (.435); ATT→INT (.474)	TAM

47	Aluri (2012)	NA	UGA
48	Yang (2013)	PU→INT (.55); PEOU→INT (.08)	TAM, E-WOM
49	Wang (2015)	NA	MT
50	Ozturen (2013)	NA	TRUST
51	Duhan & Singh (2014)	NA	TAM, TRA
52	Chong & Ngai (2013)	PE→INT (.16); EE→ INT (.16); SI→ INT (.14); FC→ INT (.19); HM→ INT (.20); HT→ INT (.12); PV→ INT (.17); MIE→ INT (.06); RA→ INT (.01); INT →US (.39)	UTAUT2
53	Ting et al. (2014)	PU→ATT (.32); REP→ATT (.36); ALT→ATT (.27); TRU→ATT (.34), SI→INT (.25); ATT→INT (.67)	TRA, TPB, TAM
54	Filiery et al. (2015)	NA	e-WOM

Abbreviations for the constructs: EX – Expertise; APP – Appeal; IM – Image; KNW – Knowledge; GUI – Guides, CI – Cybercommunity Influence; ID – Identification; AQ – Argument quality; COS – Cost; INC – Incentives; BEN – Benefits; HMP – Homophily; NC – Novelty of content; RC – Reliability of content; UC – Understandability of content; IC – Interestingness of content; AES – Aesthetics; NS – Narrative structure; SR – Self-reference; NOR – Negative online reviews; TIM – Timeliness; VOL – Volume; POR – Positive online review; COMPH – Comprehensiveness; IQ – Information quality; SQ – Service quality; SOB – Sense of belonging; TD – Time distortion; VA – Value; IR – Information reliability; COMPL – Complexity; EFF – Effort; SR – Social relationships; BII – Belief in integrity; UTIB – Utilitarian beliefs; COMPC – Compliance; PR – Price; VAL – Valence; ADI – Affective dimension of image; CDI – Cognitive dimension of image; INF – Informativeness; SAT – Satisfaction; MOT – Motivation; INV – Involvement; OPP – Opportunity; PE – Performance expectancy; EE – Effort expectancy; FC – Facilitating condition; HM – Hedonic motivation; PV – Price value; MIE – Mobile internet experience; ALT - Altruism

Abbreviations for theories: TAM – Technology Acceptance Model; ELM – Elaboration Likelihood Model; TRA – Theory of Reasoned Action; TPB – Theory of Planned Behavior; INT - Intention to Use Social Media; CDT – Cognitive Dissonance Theory; UTAUT – Unified Theory of Acceptance and Use of Technology; ATT – Attitude; CNTT – Cognitive-Normative Tourism Typology; SERVQUAL – Service Quality Model, VAM – Value-Based Adoption Model; OSN – Online Social Networks; SIT – Social Influence Theory; CLT – Construal Level Theory; UGA – Uses and Gratification Approach; SCT – Source Credibility Theory; MT – Motivational Theory; IAM – Information Adoption Model; FT – Flow Theory; TRUST – Trust Theory; E-WOM – Electronic Word of Mouth; UGC – User-Generated Content.

Table 1: Theories and models with path coefficients

4.2 Main Antecedents of CGM Adoption

The review uncovers approximately 61 antecedents of CGM adoption in tourism and travel. The most commonly used antecedents are contained in Table 2 with their frequencies, that is, total number of times used in all reviewed papers. Other antecedents were used only once or twice (see Table 1). Drawing from the TAM model, an individual's intention to use a particular technology is determined by PU and PEOU. PU is defined as the extent to which the person believes that using the technology will enhance his/her job performance, while PEOU is defined as the extent to which the person believes that using the technology is free of effort (Davis, 1989). The dependent variable used varies between attitude, intention and usage. Variables such as intention, attitude, perceived usefulness and ease of use have received considerable attention in the technology adoption literature (Lee et al. 2012). In terms of CGM in travel planning context, attitude has been found to positively influence intention and usage (Casaló et al., 2010). However, findings conflict regarding whether PU or PEOU better predicts attitude and intention (Casaló et al., 2010; Muñoz-Leiva et al., 2012; Ayeh et al., 2013).

Code	Construct	Frequency
ATT	Attitude	16
PU	Perceived usefulness	13
PEOU	Perceived ease of use	11
TRU	Trust	8
SI	Social influence/subjective norm	8
ENJ	Enjoyment	8
EMP	Empathy	3
PBC	Perceived behavioral control	3
SC	Source credibility	3

Table 2: Most common antecedents of CGM adoption

An analysis of the average path coefficients' effect sizes has been conducted to explain the strengths of antecedents in predicting dependent variables (Shaikh and Karjaluoto (2015). Shaikh and Karjaluoto analyzed the strengths of the most frequently used antecedents to explain attitude, intention to use and usage in mobile banking. In this study, we analyzed the path coefficients of the effect sizes of the R-values of the most frequently used relationships (Table 3); relationships used in three studies and above were included. The results indicate that trust has the strongest effect on attitude. Additionally, attitude has the strongest effect on intentions, which is understandable because attitude has been found to be the most commonly used antecedent.

Constructs	Number of studies	Attitude	Number of studies	Intention
Attitude	-	-	15	.511
Perceived usefulness	6	.180	10	.432
Trust	6	.362	6	.352
Perceived ease of use	5	.264	5	.347
Subjective norm/social influence	-	-	6	.343
Enjoyment	-	-	3	.335

Table 3: The average path coefficients' effect sizes

5. Discussion

The aim of our study was to provide a review of the literature on consumer-generated media in tourism and travel. Through rigorous search criteria, we identified 54 articles from both tourism- and non-tourism-based journals. We analyzed the articles and proposed a framework for consumer-generated media adoption. We also identified 22 heterogeneous and distinct theories, models and frameworks with 61 different antecedents and path coefficients of their relationships. We also analyzed the articles based on a geographical spread representing where the survey respondents lived.

The experiences shared by fellow tourists are perceived to be sincere, believable and trustworthy (Sparks et al., 2013). Tourism and travel information can be shared among members of the same social network, those who do not belong to the same networks, and even those who are geographically distant (Muñoz-Leiva et al., 2012). When content is shared by those who do not belong to the same network, source credibility becomes an important determinant of the believability of CGM. Source credibility includes trustworthiness and expertise (Ayeh et al., 2013). Trustworthiness implies the confidence in the source and the source's reliability, while expertise implies the source's knowledge about the destination. Tourists seeking travel information will regard the CGM of those who have similar interests to be more trustworthy and credible.

Travel information differs based on valence (negatively or positively framed content). Reading positive reviews can have a positive effect on travelers' inclination to conform (Tsao et al., 2015). However, some studies have generated conflicting results regarding the influence of positively and negatively framed content on travelers' intentions (Sparks & Browning, 2011; Zhao et al., 2015). When tourists seek travel information, the novelty and understandability elements of CGM are seen to positively influence booking intentions (Chen et al., 2014). In a virtual world, information quality, which includes accuracy, timeliness, completeness and currency, is perceived to influence trust and booking intentions (Filieri & McLeay, 2014).

In traditional social media contexts, intentions to use social media are directly influenced by perceived benefits (functional, psychological, hedonic and social) (Parra-López et al., 2011). In the context of tourism and travels, benefit-seeking behaviors in terms of the availability of best destinations, attractions, hotels, transportation, food, beverage and price explain the use of CGM (Öz, 2015). Most of the reviewed studies found that CGM positively influences tourists' intentions to book and visit a destination. Some studies also reveal that social influences, involvement, enjoyment and experience are important determinants of CGM adoption for travel and tourism (Chung & Koo, 2015).

5.1 Contributions of the Study

Our study contributes to existing knowledge in many ways. First, our framework identified antecedents that predict the adoption of consumer-generated media in tourism and travel. These antecedents were based on intrinsic and extrinsic characteristics of the user and on moderating factors. The intrinsic factors were circumstances related to the user, while extrinsic factors relate to the sender. The moderating factors were elements of the content such as novelty, valence, aesthetics, argument quality, information quality and reliability. This finding is in line with Cheung & Thadani (2012): e-WOM adoption is based on the receiver, sender and stimuli.

Second, the identified theories and the antecedents with their path coefficients from different studies provide a solid theoretical background for subsequent research (Okoli & Schabram, 2010); thus, this work provides a ready source for scholars wishing to undertake research in this area. Third, the contributions of scholars from the information systems field as evidenced from non-tourism based journals show that research on social media in tourism and travel is growing, and not only within the domain of management science. Fourth, the identification of trust as having the strongest effect on attitude is in line with earlier studies in which trust has been identified as an important criterion for using CGM (Parra-López et al., 2011; Ayeh et al., 2013). Finally, analysis of the geographical spread of the studies reveals a substantial number of studies in Asia (mainly from China and Taiwan), Europe and North America. Only one study is from Africa, and none are from South America. This research gap does not reflect the burgeoning use of the internet and social media in these emerging markets (Internet World Stats, 2015).

5.2. Limitations and Future Research Directions

One of the limitations of the study is that it was based on quantitative studies; therefore, it did not incorporate qualitative research. Second, the review was based on CGM and did not incorporate marketer-generated media. Marketer-generated media could offer more insights into the adoption of online content for trip planning. Fourth, the review only covered the period from 2005 to 2016. Relevant studies that were published before this period could impact the review.

Among the emerging markets, only China and Taiwan were substantially reflected, with one study in Africa. Thus, we recommend studies in important emerging markets such as India and countries in Africa and South America that have witnessed rapid rates of internet subscriptions and social media adoption. Additionally, Facebook and Twitter were the most commonly studied social media platforms. Other platforms such as YouTube, Delicious, Digg, and Lonely Planet are also very important for travel and tourism; further research should seek to incorporate these networks into the CGM literature.

References (Selected)

Ayeh, J.K., Au, N. & Law, R. (2013). “Do We Believe in TripAdvisor?” examining credibility perceptions and online travelers’ attitude toward using user-generated content. *Journal of Travel Research* 52(4), 437–452. doi:10.1177/0047287512475217.

Casaló, L.V., Flavián, C. & Guinalíu, M. (2010). Determinants of the intention to participate in firm-hosted online travel communities and effects on consumer behavioral intentions. *Tourism Management* 31(6), 898-911. doi:10.1016/j.tourman.2010.04.007.

Chau, P.Y.K. & Hu, P.J. (2001). Information technology acceptance by individual professionals: A model comparison approach. *Decision Sciences* 32(4), 699-719. doi:10.1111/j.1540-5915.2001.tb00978.x.

Chen, Y., Shang, R. & Li, M. (2014). The effects of perceived relevance of travel blogs’ content on the behavioral intention to visit a tourist destination. *Computers in Human Behaviour* 30, 787-799. doi:10.1016/j.chb.2013.05.019.

Cheung, C.M.K. & Thadani, D.R. (2012). The impact of electronic word-of-mouth communication: A literature analysis and integrative model. *Decision Support Systems* 54(1), 461-470. doi:10.1016/j.dss.2012.06.008.

Chung, N. & Koo, C. (2015). The use of social media in travel information search. *Telematics and Informatics* 32(2), 215-229. doi:10.1016/j.tele.2014.08.005.

Davis, F.D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly* 13(3), 319-339. doi:10.2307/249008.

Filieri, R. & McLeay, F. (2014). E-WOM and accommodation: an analysis of the factors that influence travelers’ adoption of information from online reviews. *Journal of Travel Research* 53(1), 44-57. doi:10.1177/0047287513481274.

Fotis, J., Buhalis, D. & Rossides, N. (2012). Social media use and impact during the holiday travel planning process, in: Fuchs, M., Ricci, F., Cantoni, L. (Eds.), Information and Communication Technologies in Tourism 2012. Springer-Verlag, Vienna, pp. 13-24.

Gretzel, U., Kang, M. & Lee, W. (2008). Differences in consumer-generated media adoption and use: A cross-national perspective. *Journal of Hospitality & Leisure Marketing* 17(1-2), 99-120. doi:10.1080/10507050801978240.

Huang, C., Chou, C. & Lin, P. (2010). Involvement theory in constructing bloggers' intention to purchase travel products. *Tourism Management* 31(4), 513-526. doi:10.1016/j.tourman.2009.06.003.

Internet World Stats (2015). Internet Usage Statistics for Africa. Available at: http://www.internetworldstats.com/stats1.htm; Accessed: 16th February, 2016.

Khan, G. & Khan, F. (2015). Motivations to engage in eWOM among Muslim tourists: a study of inbound Muslim tourists to Malaysia. *International Journal of Islamic Marketing and Branding* 1(1), 69-80. doi:10.1504/IJIMB.2015.068150.

King, R.A., Racherla, P. & Bush, V.D. (2014). What we know and don't know about online word-of-mouth: a review and synthesis of the literature. *Journal of Interactive Marketing* 28(3), 167-183. doi:10.1016/j.intmar.2014.02.001.

Ku, E.C.S. (2011). Recommendations from a virtual community as a catalytic agent of travel decisions. *Internet Research* 21(3), 282-303. doi:10.1108/10662241111139318.

Lee, W., Xiong, L. & Hu, C. (2012). The effect of Facebook users' arousal and valence on intention to go to the festival: applying an extension of the technology acceptance model. *International Journal of Hospitality Management* 31(3), 819-827. doi:10.1016/j.ijhm.2011.09.018.

Leung, D., Law, R., van Hoof, H. & Buhalis, D. (2013).Social Media in tourism and hospitality: A literature review. *Journal of Travel & Tourism Marketing* 30(1–2), 3-22. doi:10.1080/10548408.2013.750919.

Leung, X.Y. & Bai, B. (2013). How motivation, opportunity, and ability impact travelers' Social Media involvement and revisit intention. *Journal of Travel & Tourism Marketing* 30(1–2), 58-77. doi:10.1080/10548408.2013.751211.

Liu, C.S. & Lee, T. (2016). Service quality and price perception of service: influence on word-of-mouth and revisit intention. *Journal of Air Transport Management* 52, 42-54. doi:10.1016/j.jairtraman.2015.12.007.

Lu, W. & Stepchenkova, S. (2015). User-generated content as a research mode in tourism and hospitality applications: topics, methods, and software. *Journal of Hospitality Marketing & Management* 24(2), 119-154. doi:10.1080/19368623.2014.907758.

Muñoz-Leiva, F., Hernández-Méndez, J. & Sánchez-Fernández, J. (2012). Generalising user behaviour in online travel sites through the Travel 2.0 website acceptance model. *Online Information Review* 36(6), 879-902. doi:10.1108/14684521211287945.

Okoli, C. & Schabram, K. (2010). A guide to conducting a systematic literature review of information systems research. Sprouts work. Pap*. Information Systems* 10, 26.

Öz, M. (2015). Social media utilization of tourists for travel-related purposes. *International Journal of Contemporary Hospitality Management* 27(5), 1003-1023. doi:10.1108/IJCHM-01-2014-0034.

Parra-López, E., Bulchand-Gidumal, J., Gutiérrez-Taño, D. & Díaz-Armas, R. (2011). Intentions to use social media in organizing and taking vacation trips. *Computers in Human Behaviour* 27(2), 640-654. doi:10.1016/j.chb.2010.05.022.

Shaikh, A.A. & Karjaluoto, H. (2015). Mobile banking adoption: A literature review. *Telematics and Informatics* 32(1), 129-142. doi:10.1016/j.tele.2014.05.003.

Sotiriadis, M.D. & van Zyl, C. (2013). Electronic word-of-mouth and online reviews in tourism services: the use of twitter by tourists. *Electronic Commerce Research* 13(1), 103-124. doi:10.1007/s10660-013-9108-1.

Sparks, B.A. & Browning, V. (2011). The impact of online reviews on hotel booking intentions and perception of trust. *Tourism Management* 32(6), 1310-1323. doi:10.1016/j.tourman.2010.12.011.

Sparks, B.A., Perkins, H.E. & Buckley, R. (2013). Online travel reviews as persuasive communication: the effects of content type, source, and certification logos on consumer behavior. *Tourism Management* 39, 1-9. doi:10.1016/j.tourman.2013.03.007.

Tranfield, D., Denyer, D. & Smart, P. (2003). Towards a methodology for developing evidence-informed management knowledge by means of systematic review. *British Journal of Management* 14(3), 207-222. doi:10.1111/1467-8551.00375.

Tsao, W., Hsieh, M., Shih, L. & Lin, T.M.Y. (2015). Compliance with eWOM: the influence of hotel reviews on booking intention from the perspective of consumer conformity. *International Journal of Hospitality Management* 46, 99-111. doi:10.1016/j.ijhm.2015.01.008.

Wang, H. (2012). Investigating the determinants of travel blogs influencing readers' intention to travel. *The Service Industries Journal* 32(2), 231-255. doi:10.1080/02642069.2011.559225.

Wang, H.-Y. (2015). Predicting customers' intentions to check in on Facebook while patronizing hospitality firms. *Service Business* 10(1), 201-222. doi:10.1007/s11628-014-0265-7.

Webster, J. & Watson, R.T. (2002). Analyzing the past to prepare for the future: writing a. *MIS Quarterly* 26(2), 13-23.

Ye, Q., Law, R., Gu, B. & Chen, W. (2011). The influence of user-generated content on traveler behavior: an empirical investigation on the effects of e-word-of-mouth to hotel online bookings. *Computers in Human Behavior* 27(2), 634-639. doi:10.1016/j.chb.2010.04.014.

Zeng, B. & Gerritsen, R. (2014). What do we know about social media in tourism? A review. *Tourism Management Perspectives* 10, 27-36. doi:10.1016/j.tmp.2014.01.001.

Zhao, X.(, Wang, L., Guo, X. & Law, R. (2015). The influence of online reviews to online hotel booking intentions. *International Journal of Contemporary Hospitality Management* 27(6), 1343-1364. doi:10.1108/IJCHM-12-2013-0542.

29th Bled eConference
Digital Economy
June 19 - 22, 2016; Bled, Slovenia

Business Challenges of News Media Companies on Digital Platforms

Noora Pinjamaa
Aalto University School of Business, Finland
noora.pinjamaa@aalto.fi
Aleksandre Asatiani
Aalto University School of Business, Finland
aleksandre.asatiani@aalto.fi

Abstract

Prior research suggests that digital platforms, such as Facebook and Twitter, serve as a channel between news media companies and their customers. In this view, the role of digital platforms is to aggregate user-generated content in order to attract more users and advertisers to a platform. However, rapid growth of digital platforms and proliferation of platform-based content, such as Snapchat Discovery, Facebook Instant Articles and Youtube channels, challenge the status quo, between news media companies and digital platforms. In this qualitative study we focus on exploring the challenges of news media companies operating on digital platforms. By conducting semi-structured interviews with news media companies we derive three key themes and provide a conceptual model for explaining how digital platforms are becoming a marketplace for distributed contribution of news sourced from a wide array of contributing news media. We conclude with future research propositions.

Keywords: Multi-sided markets, digital platforms, newspapers, news media, social media, Facebook

Introduction

With the tremendous pool of professional- and amateur-created online news, digital platforms such as Facebook, Twitter and Google, play an increasingly important role in navigating consumers through the sea of media content. Already now, 61% of American Millennials read news on Facebook (Mitchell & Page, 2015). Many newspaper and digital-only news media companies have adjusted to this environment by first publishing news content on the media's own website and then use digital platforms to amplify their message and spread the news around the World Wide Web to attract new readers (Bernoff & Li, 2010).

Earlier research looked at this symbiotic relationship between news media companies and digital platforms. Existing knowledge suggests that the relationship is similar to a producer-distributor relationship (Águila-Obra, Padilla-Meléndez, & Serarols-Tarrés, 2007), where digital platforms serve as a channel between news media and their customers. In this view, the role of digital platforms is to aggregate user-generated content in order to attract more users and advertisers to a platform. However, rapid growth of digital platforms and the proliferation of platform-based content, such as Snapchat Discovery, Facebook Instant Articles and Youtube channels, challenge the status quo between news media companies and digital platforms. As the audience of digital platforms grows, these platforms start to gain leverage on news media companies, expanding their roles beyond mere distribution channels.

Motivated by these changes in the newspaper industry, we will address the following questions in this article:

RQ1: What are the business challenges of news media companies on digital platforms?

RQ2: How should news media companies address these challenges?

To tackle these questions we conducted an exploratory study combining pre-existing academic knowledge with qualitative enquiry. Our results reveal three themes related to the challenges of news media companies operating on digital platforms.

Theoretical Background

Traditionally, news media companies relied on content created by professionals that was distributed through a conditional-access medium, such as newspapers and TV channels (Berman, Battino, & Feldman, 2011). This created high entry barriers for independent content creators and allowed established news media companies to keep a captive audience engaged with curated, professional content. The Internet, and mobile devices disrupted the status quo, transforming the way news are consumed and produced. The access to easy-to-use digital publishing platforms such as Wordpress and Tumblr empowered individuals to create their own content (Lublin, Efrati, & Ante, 2013). While concurrently, social media platforms such as Facebook enabled content creators to distribute their work to a larger audience at a relatively low cost. Thus, users of these platforms became simultaneously creators and consumers of media content. This challenged the media companies as their traditional customers now had a vast pool of professional- and user-generated content on their fingertips (Meraz, 2009).

In contrast to traditional news media business models, online news media business models are mainly built around the online news product (often freely distributed) funded by banner ads and native, or branded online advertising (Mitchell & Page, 2014). One of the earliest, digital publishing media success stories was the Huffington Post that started with non-paid bloggers aggregating other news sites' content, with the goal of creating a large community (Bakker, 2012). Such a model differed from prior news publishing models in the sense that the company was able to safeguard the high quality of the content despite merely assuming the role of content-curator (Bakker, 2012).

Despite challenges, the Internet also offered media outlets new opportunities, from using web analytics to understanding the way readers interact with stories published online (Tandoc, 2014a, 2014b), to organizing large-scale, real-time interactjon with an audience (Bivens, 2008). Moreover, digitalization brought a change in the news medium. As a consequence of these changes, the print newspaper artifact has been partially or sometimes completely transformed into digital (Utesheva, Cecez-Kecmanovic, & Schlagwein, 2012).

News media companies possess the experience of using different systems, such as the web, TV and radio, as channels to improve the delivery of content (Veglis, 2008). However, there is no consensus with regards to how news media companies should manage social media activities and how these activities should be organized within the media companies (Godes, 2013). As more and more people turn to mobile devices and the Internet to consume news, one low-cost effort for traditional news media companies to reach their audiences has been to share their content on social media platforms. Many of the modern digital platforms are characterized by employing a multi-sided market model to run their business (Ghazawneh & Henfridsson, 2013). Platforms on multi-sided markets are characterized by network effects, generated by the presence of both sides of the market, which ultimately benefit the participants of the platform (Armstrong, 2006; Haucap & Heimeshoff, 2014; Rochet & Tirole, 2003).

Social media platforms have allowed companies to create online communities around media brands (Weinberg & Pehlivan, 2011). Platforms can also be used to communicate directly with current and future potential customers, create word-of-mouth for content (Luo, Zhang, & Duan, 2013), and sometimes even to co-create content (Wikström & Ellonen, 2012) and/ or to share articles published on a media brand's website. However, news media companies often invest resources into increasing article views on social media without a clear business model (Ju, Jeong, & Chyi, 2014). The combination of a widespread adoption of digital platforms and challenges news media companies face in transforming their business calls for a new research to investigate these issues.

As consumers are spending more and more time online, media companies need to establish a strategy on how to distribute news on digital platforms. More specifically social media platforms allow media companies to drive traffic to their websites (Holm, Günzel, & Ulhøi, 2013). The tremendous size of audience on social media platforms has gotten news media companies pushing their content to these platforms with the goal of attracting subscribers to their content (Ju et al., 2014) and growing their audiences.

The relationship between the two parties is not yet however firmly established and as the influence of digital platforms grows, there is potential for tensions related to aspects such as revenue sharing, customer data and customer ownership (Smyrnaios, 2012). To the best of our knowledge – there is no prior research that would consider the ways with which multi-sided platforms are transforming the newspaper media ecosystem.

Methods

To learn how news media companies use digital platforms, we conducted 10 semi-structured interviews with employees from online news media companies during spring 2015 (see Table 1). To ensure that the companies had an online presence on one or more digital platforms, we performed a thorough background analysis of the companies online. The position of informants included journalists, editors, product managers, as well as top management. All companies are based in the United States, however the majority operates worldwide. Each interview lasted from 30 to 65 minutes, with an average length of 40 minutes.

Informant	Description	Position
Informant 1	Sports media	Manager
Informant 2	Sports media	Manager
Informant 3	Media for millennials	Editor
Informant 4	Technology media	Senior Editor
Informant 5	Media for millennials	Manager
Informant 6	Business media	Executive manager
Informant 7	News platform provider	Executive manager
Informant 8	News platform provider	Executive manager
Informant 9	News media lab	Editor
Informant 10	News platform provider	Executive manager

Table 1: Informant profiles.

We followed an inductive, exploratory approach with a high-level interview protocol – leaving room for the interviewees to interpret the questions (Karlsen & Stavelin, 2014). The interview protocol consisted of four sections. In the first section, informants were asked background questions, about their experience, their position in the company, and general company activities. In the second section, we made specific inquiries about the business operations of the company, the business model and the competitive landscape on the market. In the third section, we asked about the use of social media platforms in their operations and their impact on both editorial policies and their business model. In the fourth sections, we explored the interviewees' vision on the future developments of the media industry and the role of technology.

We primarily used an inductive interpretive approach for our analysis as described by Walsham (2006), learning from the data, constantly recording and discussing interview impressions and observing emerging themes from the data. Using elements of analysis from grounded theory (Glaser & Strauss, 1967), we proceeded with creating an iterative coding procedure. To improve accuracy and to decrease bias, two authors conducted open coding (Karlsen & Stavelin, 2014; Utesheva et al., 2012). After the initial open coding stage, axial coding was applied to fit identified concepts into categories. We then compared the categories based on which we were able to derive final themes, which were observed by both authors.

Findings

1.1 Social media – a strategic digital platform for news companies

The informants are observing a trend where online news media companies are transitioning to the other side of the market from users. Digital platforms leverage their members by turning individual users into captive audience. In this setting users do not leave a platform in order to receive third-party media content. Instead users consume all content within a digital platform. A current understanding of social media implies user-generated content as a driving force for attracting an audience. However, our interviews reveal that social media platforms now look for professionally produced media content to attract further users. News media companies are being increasingly prioritized, on the expense of them becoming revenue drivers for digital platforms.

*"One of the things that people talk about a lot is how Facebook works for publishers [news media companies]. […] They're **interested in people hosting content on their platform within Facebook rather than on a separate, external website**. So whatever moves Facebook makes make people pay attention to because of their referral power".* - Informant 3.

Our informants observe positive effects in terms of building and retaining audiences on social media platforms. Looking into the future, some media companies predict a completely distributed model without a website of the publication being the hub of all operations. Instead, informants envision a scenario where their content is present only on native applications within social platforms.

*"you focus on building a Facebook audience and if you were a reporter covering a local neighborhood you probably wouldn't want to build a website at all you would probably just want to start a Facebook page and cover the neighborhood on the Facebook page. **Once you would reach a certain size, figure out some advertising and you could probably do it all from the platform**."* - Informant 3.

Further our informants observe negative network externalities, such as lock-in and high dependence on digital platform provider regulations. Social media platforms increasingly introduce new boundary resources in the form of rules to the news media companies and establish control over content and user data. This development has a dual meaning for operating on these platforms. Platforms promise to improve audience targeting, increase efficiency of social media efforts, and offer tools to acquire new audiences, which have definite benefits for news media companies. Despite that, media companies are losing control over their audience and content, which is disrupting the news media companies' business models.

"*But the bigger broader question that people are worried about is in terms of whether media companies are seeding too much control to Facebook or whether this is going to have a long term impact –whether all business is going to end up there. We are still at a point where companies can still pull out of it and say – we don't need to do this anymore"* - Informant 9.

An increasing power of digital platforms is to create challenges to an established mode of business for news media companies. The more conventional business model for news companies is to attract an audience to their website and generate income through subscriptions or advertisements present on the website. In this model, news media companies fully control their audience as well as revenue streams, and typically the income are not shared with third parties. In the new setting however, social media platforms offer a significantly bigger audience for news media companies, with the trade-off of losing control over the audience and the revenue streams.

*"If we can create a really compelling video, say its an animation project, and we can reach 3 million people with that project in a relatively short time, reaching them **through other platforms,** versus 500 000 people watching that content specifically and only on [our website] – it is I think something **that we really have to embrace if we want to get our brand out there**."* - Informant 2.

While concrete revenue models between content creating news media companies and social media platforms are not obvious, our informants expect some type of profit sharing between the two parties. It is also notable to point out that despite the uncertainties related to and impacts of a mode of co-operation on the companies' bottom-line, the informants were eager to experiment with the new model, even if sometimes mainly due to the competitive pressure.

"Facebook will start natively hosting news stories on Facebook. So ***you will read a story from lets say the New York Times on Facebook without ever visiting the New York Times.*** *And then the New York Times will probably get some cut of that revenue. If Facebook does that, I imagine we will at least explore the possibility of doing that as well"* - Informant 4.

1.2 A competition within and between digital platforms

The transition to be a part of a digital platform, rather than creating content on a news media's own website is changing the competitive landscape for news media companies. When discussing competition, most of the informants mentioned the variety of e-services and sources of entertainment, such as mobile games and mobile applications (e.g. Snapchat, Facebook, Instagram). Informants did not limit their competitors to what one could traditionally perceive as direct competitors in the news media industry. Moreover, news media companies find that in essence, they are competing for people's time on all digital platforms.

*"…When it comes to platforms its not so much that you are competing for brand recognition or audience –**you're competing for just time that people have during the day**. […] We are just trying to fight to move up the prioritization scale when they wake up every morning or they are waiting for a bus or they're bored at work. What [content] are they going to look at their phone?"* – Informant 2.

The informants expressed a clear understanding of their audience's limited attention and time to spend on any media, whether it is news or entertainment, giving examples of competition such as online games and blogs. Moreover, news companies tend to also see social networks and mobile applications as their competitors, as these have content, which diverts the audience from their media's websites.

"We compete against Facebook, we compete against Twitter, we compete against Candy Crush. We compete against any other thing anybody could be doing with their smartphone at any time. […] But more broadly speaking, ***any social network and almost any app on your phone in some way could be considered as competitor to a news publication****. Because people have limited time."* - Informant 4.

Users are not so much exposed to the Internet as they are to social, mobile applications. The shift of audience to smartphones for content consumption intensifies the competition for attention. Media companies strive to find a place within a social media platform with a mobile application in addition to which, informants felt that the prevalence of mobile applications also required customizing content for these social media platforms' mobile applications.

*"**The stuff that people spend time on**, particularly **on their phones.** That could be media, but, I think it is games, or other forms of entertainment, blogs and that sort."* – Informant 5.

*"Journalism companies are going to increasingly look to tools, technology, because they can't be everywhere at once but their **audience can be everywhere at once on their phones** or wherever they have the technology to interact with and shape the media that they have."* - Informant 8.

News media companies face a challenge when trying to reach a mobile audience.

*"There's **a very large audience on Facebook that is specifically on mobile**. That's an area where publishers have had a lot of trouble reaching people and not just reaching people but actually reaching people in the same size and scope as Facebook."* Informant 9.

News companies are concerned with capturing an audience's attention and delivering it in a suitable form to audiences across a variety of devices and digital platforms. Informants are increasingly concerned about the way digital platforms distribute news media content within and across digital platforms. In particular, informants highlighted a loss of control over the process.

*"There is part of me, which is protective over "our children" [content produced by the company], but after they grow up, they go on their own**, so we will let our stories go. And you always have to test an environment.**"* - Informant 6.

The way content is distributed to the readers online is changing. Before digital platforms would be used to deliver news from the providers to the users (Águila-Obra et al., 2007), leading the latter back to the original source, now content can have a life of its own on various digital platforms. Informant 6 above shares a concern about its "children leaving home", referring to the content produced by the media company being designed for various social media platforms as opposed to their own website. Platforms are becoming a destination for users, instead of being a gateway to the Internet.

*"Facebook especially is playing around with content experiences that are native to Facebook from other publishers. Whether that's video that's played in the Facebook feed or the full article or content experience that takes place within Facebook newsfeed. **That's not going to lead back [to our website] necessarily**."* - Informant 2.

Today it is more important to ensure that news appear on readers' Facebook News Feed for news to be consumed there, than using digital platforms as a simple news distribution engine funneling readers to the website.

*"We set out to do and provide a real substitute news but in today's distribution environment. […] **With the change in medium you also have a big change in how distribution occurs.** You also have a big change in how stories are produced, how resources are going to them. […] but there's much fewer companies that are producing something that you want to click on your Facebook feed and that is also substantive and informative […] that's our mission - what we're going for."* - Informant 3.

*"**We have to stay open to all the platforms** and we should have this mindset, because you do not know unless you try it. So we are open to try it. I came from the meeting this morning with **another major platform who wants to take our content and put it into their platform** and so we will try, because you can't stay stuck to old models."* - Informant 6.

As a response to this new distribution environment some of our informants are experimenting with posting tailored content to various platforms, trying to appeal to the demographics of the platform. Simultaneously they try to bring this tailored experience to other parts of their publishing activities. Instead of having a conversion with a reader on the website and getting direct feedback to the news media company, the companies now rely on the feedback spread across different platforms, to learn about particular demographics.

*"When you take something like Instagram, we look at the number of likes, we look at the number of comments and we see how our followings gro. It's more about a hub to just experiment with new types of content that are aimed to the young audience. And for things that might resonate on Instagram – **we think how we can replicate this same mentality directly on [our website] where the audience is young as well.** Its an enormous testing ground and a great opportunity for us to just try new things"* - Informant 2.

1.3 Coping with the change initiated by digital platforms

Increasing the role of digital platforms, especially social media platforms, in news publishing business causes changes in how news media companies are building their business. According to our informants there is a shift in the measurements of success, from traffic on their webpages to the level of brand awareness.

*"…it's not so much about traffic anymore – audience doesn't always mean visitors or unique visitors**.** **Audience means brand awareness essentially.** […] [Our website] doesn't see direct traffic from them [digital platforms] but we see them as good investments because it is an opportunity to reach an audience for our content, even if that doesn't bring them back to [the company's website]."* –Informant 2.

On the other hand Facebook can also be used as a platform to build a community. This view is more in line with prior research (see e.g. (Kaplan & Haenlein, 2010)).

*"**Shares are what allow us to reach a larger platform** – particularly on Facebook. It is very important to us, it's a metric that I look at really closely."* –Informant 4.

*"Our focus has been Facebook. You know I think now we're to almost a million followers on Facebook which is great and we're always looking to **reach for the audience we're looking to reach- which is the 40 million, American millennials**. So when we're creating demand – its really more creating the kind of stuff that people love and that will give them a great perspective on the world."* –Informant 3.

A digital platform can even be seen as a partner with whom the news media company has a relationship with as the platform drives traffic to the media's website.

*"In the particular case of Facebook, we could publish our stories to Facebook and they'll be seen by a large number of readers there. And **Facebook actually drives a lot of traffic our way.**"* -Informant 4.

One of the mechanisms to cope with the diminishing direct website traffic and lower click-through rate on advertisements is native advertising. Increasingly, news media companies are offering specially created content to advertisers, which is integrated into the regular content stream. Such an approach allows companies to sell the content, regardless of its location, as opposed to the traffic on one particular page.

*"**We basically sell what you might call native advertising**, which is where most of the money comes from. The studies show that most of the millennial generation, want to see its purchasing decision as a moral decision. They care that company they buy from*

should have the same values that they do, and because [our company] has got very strong set of values that people associate it with, if brands want to sell products to people who care about values of the company" - Informant 5.

1.4 Summary and interpretation

News media companies reshape their content creation and distribution strategy to accommodate digital platforms, specifically social media platforms. Companies are moving from a centralized to a distributed content creation model (see Figure 1). While content is created on and for a digital platform, it is still created by the news media companies. Unlike web-content aggregators, digital platforms still brand the content by the news media producing it. The emergence of the new model has an implication on how news media companies build their business on digital platforms.

In order to be successful and relevant on each platform separately, a news media company has to have a strategy designed specifically for each platform. In this model, the content may exclusively reside on a digital platform and does not lead to the native content developed on and for a news media's website, which is the case in a distributor model. Such a setting creates a captive audience based on the digital platform, which is not easily transferrable to the news media company's own platform, e.g. website.

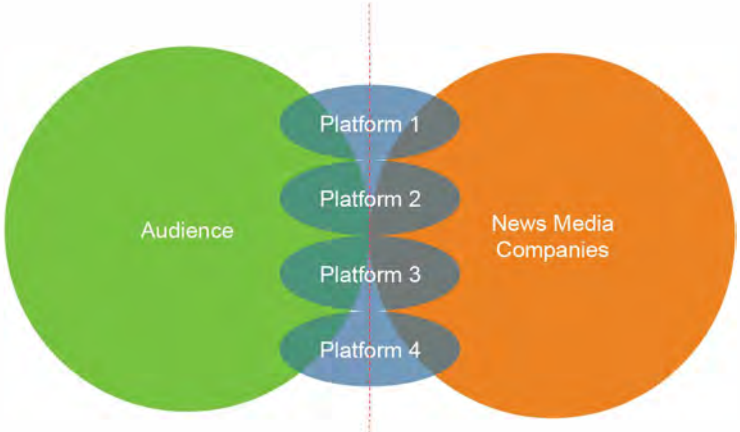


Figure 1: Content creation and distribution on digital platforms

The ecosystem of digital platforms is now seen as a market place for content as opposed to the traditional notion of using social media platforms as mere marketing channels (Leeflang, Verhoef, Dahlström, & Freundt, 2014). We propose that media companies are becoming a sponsoring side in the two-sided marketplace, in which they act as contributors of content on digital platforms. This leads the platforms having a distributed contribution of content sourced from a wide array of contributors. In order to accommodate the new distributed content creation model, we put forward two propositions.

Proposition 1: News media companies will need to re-organize their business to accommodate the boundary resources of digital platforms before creating and distributing content on the digital platforms.

Our first proposition stems from the differences in the power roles between the digital platforms and the news media (Eaton, 2015). The publishing and distribution model is changing from the news media website being the primary publishing and distribution platform to a multi-platform distribution model. As content contributors, news media need to recognize the boundary resources of digital platforms and the consequent change in the power structure (Ghazawneh & Henfridsson, 2013). News media companies want to be on digital platforms for the positive network externalities. However, as the publishers rely heavily on platforms for publishing and sharing their content they will also encounter negative network externalities, such as lock-in and high platform provider dependency. Platforms such as Facebook have a high level of authority and leverage due to the tremendously large user base. Therefore they are able to impose their boundary resources to news publishers interested in publishing on the platforms.

When a news media distributes content to a platform that is not owned by the news media company, it has to assess the implications of not having access to or ownership of the platform’s user database (Eaton, Elaluf-Calderwood, Sørensen, & Yoo, 2015). However, the relationship between news media and digital platforms is still at the beginning. The interviewed media companies were mainly trying to frame and understand the actions of digital platforms. It is only during and after the process of active framing of each other’s actions that the boundary resources, rules and capabilities are established (Eaton, 2015).

Proposition 2 In order to remain competitive on digital platforms, news media companies need to put greater emphasis on the hedonic component of news

News media companies want to provide more than news and information. They want to be the online users’ service of choice. With increasing availability of smartphones and fast Internet connection, media companies compete with a wide range of media content (e.g games, social media) available to a user at any given moment. Therefore there is a shift from mere utilitarian, informative news delivery to providing a hedonic experience. When developing news, media companies should include hedonic elements such as animated images, sounds and a user-friendly layout (Heijden, 2004). The main goal of designing such content is to maximize the time a user spends with it (Heijden, 2004). Platforms often have the upper hand when negotiating with contributors and therefore when wanting to be successful, contributors need to continuously be able to provide added value to the digital platform (Cusumano & Gawer, 2002).

The basic premise of social media is a prevalence of user-generated content created outside of professional routines and provision of democratized access to all participants (Kaplan & Haenlein, 2010). Literature on social media has emphasized using social media platforms for analytics, brand building, and customer acquisition (Hoffman & Fodor, 2010). With social media platforms gaining significant power over the value chain of content creation and distribution of news media, these principles may be jeopardized. As digital platforms are striving for higher quality media content in order to lock-in audience, they set up closer partnerships with professional news media companies. In exchange, digital platforms enable disproportionate reach to news media companies and hence disproportionate influence, undermining the contribution from users, which has a priori been the core of the business model of social media platforms (Grossman, 2014).

Conclusion

In the future, news media companies will need to focus on cross-platform brand building. For practitioners, this change means that they will need to invest resources in not only publishing on multiple digital platforms, but also creating content that is specific to any individual platform. Further, the content needs to resonate with the platform's user otherwise the content will be shortly abandoned. Creating content for other platforms, especially social media platforms, also requires accepting that not all content published or shared outside a news media's website will direct the traffic back to a media's own platform. To support a native advertising business model, news media companies will need skilled employees who are able to work explicitly with advertisers to create native content.

Whilst this conceptual research provides an explanation for the way social media platforms are used for professional content distribution, we acknowledge some limitations. One limitation is our sample. When selecting the interviewees for the study, our main criterion was to learn about online news media companies. Hence there is variation between the interviewed employees' positions in their company. Future studies could take the users' perspective and test the extent to which they require hedonic experiences when consuming news on digital platforms.

Acknowledgement

The authors wish to acknowledge the *Media Industry Research Foundation of Finland* for supporting this research.

References

- **Journal Articles**

Águila-Obra, A. R. Del, Padilla-Meléndez, A., & Serarols-Tarrés, C. (2007). Value creation and new intermediaries on Internet. An exploratory analysis of the online news industry and the web content aggregators. *International Journal of Information Management*, *27*, 187–199.

Armstrong, M. (2006). Competition in two-sided markets. *The RAND Journal of Economics*, *37*(3), 668–691.

Bakker, P. (2012). Aggregation, Content Farms and Huffinization. *Journalism Practice*, *6*(5-6), 627–637.

Berman, S. J., Battino, B., & Feldman, K. (2011). New business models for emerging media and entertainment revenue opportunities. *Strategy & Leadership*, *39*(3), 44–53.

Bernoff, J., & Li, C. (2010). Harnessing the power of the oh-so-social web. *MIT Sloan Management Review*, *38*(3), 8.

Bivens, R. K. (2008). The Internet, Mobile Phones and Blogging. How New Media are

Transforming Traditional Journalism. *Journalism Practice*, *2*(1), 113–129.

Cusumano, M. A., & Gawer, A. (2002). The elements of platform leadership. *MIT Sloan Management Review*, *43*(3), 51–58.

Eaton, B. (2015). Distributed Tuning of Boundary Resources : the Case of Apple's iOS Service System. *MIS Quarterly*, *39*(1), 217–243.

Eaton, B., Elaluf-Calderwood, S., Sørensen, C., & Yoo, Y. (2015). Distributed Tuning of Boundary Resources: the Case of Apple's iOS Service System. *MIS Quarterly*, *39*(1), 217–243.

Ghazawneh, A., & Henfridsson, O. (2013). Balancing platform control and external contribution in third-party development: The boundary resources model. *Information Systems Journal*, *23*(2), 173–192.

Glaser, B., & Strauss, A. (1967). The discovery grounded theory: strategies for qualitative inquiry. *Aldin, Chicago*.

Godes, D. (2013). Business Transformation: A Framework for Research Social Media and Business Transformation: A Framework for Research. *Information Systems Research*, *24*(June 2014), 3–13.

Grossman, L. (2014). Inside Facebook's plan to wire the world.

Haucap, J., & Heimeshoff, U. (2014). Google, Facebook, Amazon, eBay: Is the Internet driving competition or market monopolization? *International Economics and Economic Policy*, *11*(1-2), 49–61.

Heijden, H. Van Der. (2004). User acceptance of hedonic information systems^. *MIS Quarterly*, *28*(4), 695–704.

Hoffman, D. D. L. D. L., & Fodor, M. (2010). Can You Measure the ROI of Your Social Media Marketing? *MIT Sloan Management Review*, *52*(1), 41–49.

Holm, A. B., Günzel, F., & Ulhøi, J. P. (2013). Openness in innovation and business models : lessons from the newspaper industry. *International Journal of Technology Management*, *61*(2007), 324–348.

Ju, A., Jeong, S. H., & Chyi, H. I. (2014). Will Social Media Save Newspapers? *Journalism Practice*, *8*(1), 1–17.

Kaplan, A., & Haenlein, M. (2010). Users of the world, unite! The challenges and opportunities of Social Media. *Business Horizons*, *53*(1), 59–68.

Karlsen, J., & Stavelin, E. (2014). Computational Journalism in Norwegian Newsrooms. *Journalism Practice*, *8*(March 2015), 34–48.

Leeflang, P. S. H., Verhoef, P. C., Dahlström, P., & Freundt, T. (2014). Challenges and solutions for marketing in a digital era. *European Management Journal*, *32*(1), 1–12.

Lublin, J., Efrati, A., & Ante, S. (2013). Yahoo Deal Shows Power Shift.

Luo, X., Zhang, J., & Duan, W. (2013). Social Media and Firm Equity Value. *Information Systems Research*, *24*(March 2013), 146–163.

Meraz, S. (2009). Is There an Elite Hold? Traditional Media to Social Media Agenda Setting Influence in Blog Networks. *Journal of Computer-Mediated Communication*, *14*(3), 682–707.

Mitchell, A., & Page, D. (2014). State of the News Media 2014: The Growth in Digital Reporting: What it means for Journalism and News Consumers. *Pew Research Center*.

Mitchell, A., & Page, D. (2015). *Millenials & Political News*.

Rochet, J.-C., & Tirole, J. (2003). Platform Competition in Two-Sided Markets. *Journal of the European Economic Association*, *1*(4), 990–1029.

Smyrnaios, N. (2012). How does news infomediation operate online? The examples of Google and Facebook. In *World Media Economics & Management Conference 2012* (pp. 1–17).

Tandoc, E. C. (2014a). Journalism is twerking? How web analytics is changing the process of gatekeeping. *New Media & Society*, *16*, 559–575.

Tandoc, E. C. (2014b). Why Web Analytics Click. *Journalism Studies*, (March 2015), 1–18.

Utesheva, A., Cecez-Kecmanovic, D., & Schlagwein, D. (2012). Understanding The Digital Newspaper Genre: Medium vs. Message. *Proceedings of the 20th European Conference on Information Systems*.

Veglis, A. (2008). Comparison of alternative channels in cross media publishing. *Publishing Research Quarterly*, *24*(2), 111–123.

Walsham, G. (2006). Doing interpretive research. *European Journal of Information Systems*, *15*(3), 320–330.

Weinberg, B. D., & Pehlivan, E. (2011). Social spending: Managing the social media mix. *Business Horizons*, *54*(3), 275–282.

Wikström, P., & Ellonen, H.-K. (2012). the Impact of Social Media Features on Print Media Firms' Online Business Models. *Journal of Media Business Studies*, *9*(3), 63–80.

29th Bled eConference

Digital Economy

June 19 - 22, 2016; Bled, Slovenia

Social Media Analytics in Social CRM – Towards a Research Agenda

Matthias Wittwer

Leipzig University, Germany

wittwer@wifa.uni-leipzig.de

Olaf Reinhold

Leipzig University, Germany

reinhold@wifa.uni-leipzig.de

Rainer Alt

Leipzig University, Germany

rainer.alt@uni-leipzig.de

Abstract

Social Media have emerged as an additional source of information for companies. Regarding an analysis of the huge data volumes within the Social Web, other approaches than manually analyzing social content are needed. Thus, Social Media Analytics (SMA) applications have emerged in recent years and have become inevitable for automatically generating valuable insights. However, these tools still suffer different shortcomings, which inhibit a deeper analysis and understanding of data. This research investigates and categorizes currently available analytics methods by outlining literature and analyzing practical applications. Furthermore, it draws a line between descriptive, predictive, and prescriptive analytics in the field of Social Media Analytics. As a result, this research complements existing research with strategic questions, possible outcomes of SMA applications, and enabling methods to compute these outcomes, and finally defines a research agenda.

Keywords: Social Media, Social Media Analytics, Business Analytics, Social CRM

1 Introduction

Within the last years, the use of Social Media has increased considerably. Social platforms, such as Facebook and Twitter, report more than one billion respectively 284 million monthly active users (Facebook 2015; Twitter 2015) and are thus connecting millions of consumers with their opinions worldwide. For example, every day there are more than 430,000 hours of new video material uploaded on the video platform Youtube (Youtube 2015), whereas in the same time Facebook counts more than 55 million status updates (KISSmetrics 2015) and Twitter reports over 500 million tweets (Twitter 2014). Companies are thus increasingly confronted with a growing participation of internet users–and thereby potential consumers–within social networks. Regarding the customer lifecycle, a shift can be observed in the information and evaluation phases: consumers are no longer focusing on information given by a provider, but rather opinions on products or services shared by other consumers within social media. Therefore, social content is of high relevance for companies (Kaplan & Haenlein 2010; Heller Baird & Parasnis 2011; Woodcock et al. 2011; Mikalef et al. 2012) as they are able to gather additional insights into markets and consumer behavior. Those large volumes of social data match with the characteristic “3V” of Big Data–namely variety, velocity, and volume as summarized by Sagiroglu & Sinanc (2013)–and require automated analysis functionalities which are delivered through so called Social Media Analytics (SMA) applications. SMA applications are an integral part of a Social Customer Relationship Management (Social CRM) system as described in current literature (Sarner et al. 2010; Woodcock et al. 2011; Alt & Reinhold 2012). This has led to numerous SMA platform providers, while many of these tools are often easy to use and present qualitative results to obtain first insights into the market or the consumer base.

With respect to recent scientific literature on Social CRM and SMA software, there is no comprehensive understanding about analysis methods, analysis outcomes, and the enabling methods to compute certain outcomes. Therefore, this research aims at outlining literature and analyzing SMA applications in order to define the capabilities of SMA software for the analysis of unstructured content. The overall aim is to deepen insights generated through these applications and thereby to support decision making processes. In this context, this article formulates the following two research questions: First, are retrospective and prospective analytics supported by currently available SMA applications and are suggestions for the best possible actions provided based on these analytics in order to guide decision making? Second, which basic points can be derived from a tool analysis with regard to further research? A basic understanding based on business analytics is developed and, finally, a research agenda covering questions, enablers, outcomes, and a maturity level of SMA applications is defined. Finally, this article calls for further research, which helps driving analytics and decision making in an increasingly social environment.

2 Foundations

The following section clarifies the necessary foundations in the areas Social CRM and SMA, a general classification of SMA technologies as well as the SMA Process (also termed pipeline). Social CRM is regarded as the focused field of application of SMA, while SMA includes different technologies for analyzing unstructured data, such as user-generated content, in the frame of the SMA pipeline. A general classification of SMA technologies is used to identify the technological state-of-the-art and research gaps.

2.1 Social CRM and SMA

Although researchers may have a rough idea of what is meant by the term Social CRM, it is necessary to draw a line to the two related concepts it consists of: Social Media and Social CRM. Following (Greenberg 2010), Social Media is defined as web-based internet applications that allow the creation, access, and exchange of user-generated content. Besides the well-known social networking sites, such as Facebook, there is a multitude of applications which can be classified according to (Kaplan & Haenlein 2010) into at least the following categories: social networking sites (e.g. Facebook), blogs and micro blogs (e.g. Wordpress, Twitter), collaborative projects (e.g. Wikipedia), and content communities (e.g. Youtube). With regard to a CRM system, these channels can be associated with a business's operational communication channels.

The term Social CRM is building upon these applications and describes a concept (Greenberg 2009). A broad base of research that covers various strategic and tactical elements in the application of social media to business purposes has developed. However, research focusing the integration of social media and CRM on the system and process level is still scarce (Lehmkuhl & Jung 2013; Alt & Reinhold 2012; Askool & Nakata 2011). This integration requires three additional components: an analysis layer for the identification of relevant content, an integration layer for interlinking CRM functionalities and processes with information from the social web, and an interaction layer for supporting the dialogue with the community (Alt & Reinhold 2012) to reduce the isolation of social media activities from the existing customer oriented business processes.

A key element of Social CRM is the integration of data from the social web. While traditional CRM systems are based on structured data in internal databases, the integration of social media introduces unstructured data and requires new techniques of data analysis. One potential pitfall is that unstructured data is not compatible with existing analytics software, such as Business Intelligence or SMA applications. Therefore, semantic mining methods (e.g. text or web mining) are applied in order to transform unstructured data into structured formats by adding missing meta-data or context, extracting meanings, and classifying postings (Reinhold & Alt 2011). In terms of Big Data and with regard to an integration of social media with CRM applications, social content has a high variety as it includes both structured data and unstructured elements, which may respectively may not conform to existing data fields in a CRM application. Data volumes are a further aspect which needs to be considered when analysing social content. Therefore, both analytical functionalities and data storage capabilities need to be adapted to the respective intent. Finally, the velocity of incoming data needs to be considered as SMA applications ultimately form an information base on which CRM processes should build upon.

However, referring to (Stieglitz et al. 2014), SMA aims at "*developing and evaluating scientific methods, technical frameworks, and software tools for tracking, modelling, analysing, and mining large-scale social media data*" and therefore bridges the gap between unstructured social media data on the one and structured CRM data on the other hand. This challenge was answered in the past by the development of new software applications such as Sysomos, Brandwatch, or Synthesio for assessing, analyzing and transforming such information (Rappaport 2010).

2.2 Classification of SMA technologies

As mentioned before, SMA is an integral part of Social CRM systems, which in turn may be regarded as a specialization of the more general research area business analytics (for a description of analytics see Davenport & Harris 2007), which makes use of all forms of analytics to realize business outcomes. It emphasizes on actionable insights (Stubbs 2011) and thereby extends the existing understanding of analytics. As proposed by Davenport and Harris (2007) and refined by Lustig et al. (2010), three categories of analytics may be defined within business analytics: descriptive, predictive, and prescriptive analytics (Lustig et al. 2010). These categories can be adapted to the field of SMA to assess the necessity and potential of analysis methods. Figure 1 presents these categories, their enablers and outcomes according to Delen and Demirkan (2013).

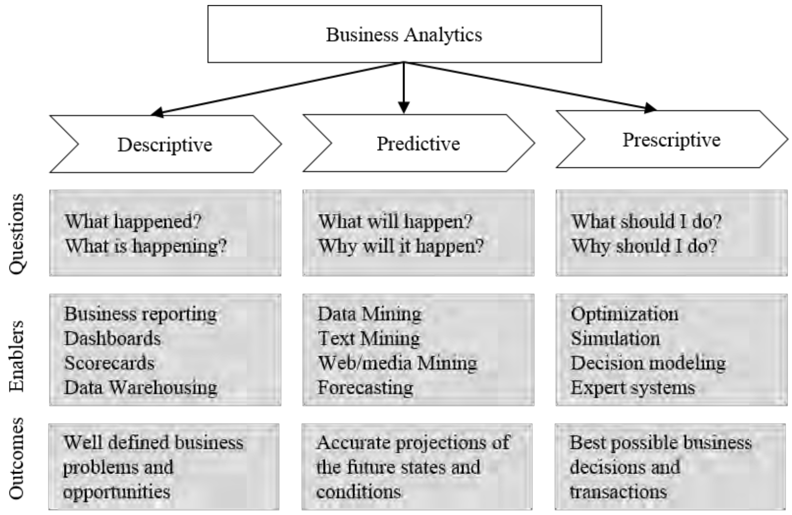


Figure 1: Basic theoretical understanding (according to Delen & Demirkan 2013)

Descriptive analytics thereby comprise a set of data processing technologies to understand and analyze business performance. Characteristic questions within this perspective are “What happened?” and/or “What is happening?”, which in turn describes a predominantly retrospective view. Within SMA applications these questions are answered through simple standard and on-demand reporting, dashboards, and scorecards delivering insights like the number or fans, postings, and a distribution of conversations within different social media channels. The main outcome is the current business situation in terms of possible problems and opportunities. In contrast, predictive analytics use mathematical techniques to identify patterns (e.g. conversation volume per channel, the development of trending topics or user sentiments) and therefore answer questions like “What will happen?” and/or “Why will it happen?”. Data, web, and text mining, as well as statistical time-series forecasting are the enablers of this view. The main outcome are future events and a reasoning why they may happen. Finally, prescriptive analytics include a set of mathematical techniques for determining a set of alternative activities (e.g. launching or re-adjusting a social marketing campaign) to improve decision making. This view focusses mainly on questions like “What should I do?” and/or “Why should I do?”. Enablers of prescriptive analytics are among others optimization modelling, simulation modelling, and decision modelling, finally driving expert systems. The best course of action for a specific Social CRM scenario or a rich set of information leading to the best course of action are the main outcomes.

As business analytics may be regarded as a more general term of SMA, the given basic model will be applied to the conducted tool analysis. The functionalities of each SMA application will be clustered using the model. As a result, the state-of-the-art in analytics technologies and related deficits will be emphasized and points for a research agenda will be formulated.

2.3 SMA Pipeline

In the scientific literature, the analytics process, which may also be termed as analytics pipeline, consists of different phases and originates from the analysis of news media (Tenney 1912; Woodward 1934; Lasswell 1941). Current research presents several approaches with partially differing process steps. Below, a view on recent literature which describes automatable approaches is given. However, all processes require manual activities either by defining relevant source, configuring the search query, or by integrating results with third-party applications.

Following (Bengston et al. 2009) for the analysis of modern social media, the monitoring process encompasses the following five phases: the definition of the problem, the identification of online news sources that will be used to collect content, the development of search terms with respect to several strategies and the storage of search results, the analysis of textual content as the core phase of the analytics process, and finally the presentation of gained results. This analytics process approach is extensive as it includes strategic considerations with its first step and gives some relevant details. With regard to a Social CRM system, Reinhold & Alt (2011) propose seven "activities in an analytical Social CRM process", including monitoring, extraction, transformation, load, use, integration, and finally interaction regarding the subsequent interaction opportunities with a social community (Reinhold & Alt 2011, p.231). Another approach is proposed by (Bruns & Liang 2012) for the analysis of Twitter data. The authors suggest a three-step approach including data collection and storage in a first, data analysis in a second, and finally the publication of results in a third step. Stavrakantonakis et al. mention four relevant steps starting also with the collection of data, the establishment of a "listening grid" to store gathered data, followed by the actual analysis, and finally the generation of "actionable reports" in order to support decision-making (Stavrakantonakis et al. 2012, p.54). Finally, Ruggiero and Vos (2014) present a four-step approach. The following table summarizes relevant literature and gives a brief overview of considered process steps.

Author	Considered process steps
(Bengston et al. 2009)	• Define the problem • Identify online news sources • Develop search terms and download stories • Analysis • Presentation
(Reinhold & Alt 2011)	• Monitoring • Extraction • Transformation • Load • Use • Integrate • Interaction
(Bruns & Liang 2012)	• Data collection • Data analysis • Results publication
(Stavrakantonakis et al. 2012)	• Gather data • Establishing a listening grid • Analysis • Reporting • Insights
(Ruggiero & Vos 2014)	• Preparation • Data collection • Data analysis • Reporting

Table 1: Approaches to the definition of the SMA pipeline

Summarizing the existing approaches of an analytics pipeline, four main steps are suggested as displayed in Figure 2. First, the definition of media sources and appropriate search terms. Second, the pre-processing of data for integrating and aligning the heterogeneous data from different sources as well as the application of various analysis techniques. This paper focuses mainly on this step. Third, the presentation and interaction of users with the results. Fourth, the use of results, which is the only manual task. Each steps yields requirements for and influences the outcome of the other steps.

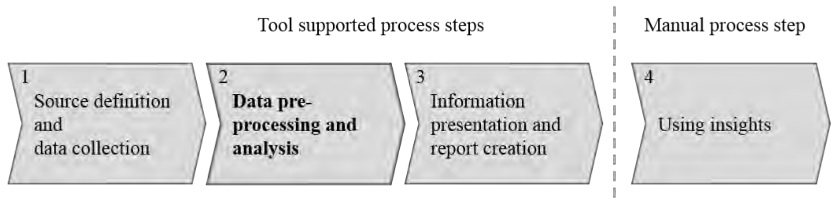


Figure 2: Social Media Analytics Pipeline

The definition of media sources that are used to extract the social web content will influence all future outcomes as well as the configuration of the pipeline. It is essential to choose relevant channels carefully, because this step defines the ability to use historic data.

Each SMA application also covers different social media channels and those even in different degrees, which may require the use and integration of different applications. Furthermore, it is a crucial step to select the search terms that are relevant for the analytics scenario. Those terms generally define the dataset from which results can be obtained in the next steps. If the search phrase is too narrow, methods can produce only results within this scope. If the search phrase is too broad, the volume may be overwhelming and noise will influence the applied methods.

The step of analysis itself builds up on the data basis, requires a pre-processing, applies the analyzing methods (e.g. web, text, and data mining) and aims at generating domain insights. Data analysis is thereby a core element of the analytics pipeline and influences the necessary pre-processing (e.g. data aggregation, data fusion). The main task within this process step is to calculate information based on unstructured data, such as social media content and the quality of data as well as the algorithms define the outcome (e.g. sentiment, precision). The last step presents the results in the form of interactive visualizations, input into other systems or reports. Usually, SMA applications provide several presentations in the form of e.g. dashboards, diagrams, and charts, or support export functionalities, but the ability to refine search terms or to drill down depends on the applied methods and the user interface. Exemplary results that are displayed are the volume of postings per channel over time, demographic aspects of the posting writer, the overall tone of the postings based on their content, and the relevance of a media channel based on the volume posted on it. Because of its central role within the SMA pipeline, the step of data analysis and the available methods are the focus of the following sections.

3 Analysis methods and basic outcomes

Several approaches for the extraction of information from social media have evolved yet. Stieglitz et al. (2014) summarize these methods as “Social Media Analytics”, a term which encompasses the extraction of raw data from social media and their transformation into insightful and useful information. Following (Zeng et al. 2010) SMA “is concerned with developing and evaluating informatics tools and frameworks to collect, monitor, analyze, summarize, and visualize social media data (…) to facilitate conversations and interactions (…) to extract useful patterns and intelligence”. Hereby, methods like text mining are subjected to an often complicated task. Major challenges are (1) the automated analysis of contained information within unstructured texts, (2) the automated recognition of patterns within texts, and (3) the aggregated presentation of gained information. Following Stieglitz et al. (2014), in the context of SMA three main analysis methods have evolved: text analysis/mining, social network analysis, and trend analysis (Stieglitz et al. 2014). For descriptive analytics the first methods commonly comprise tasks of data gathering and extraction, text categorization and clustering, as well as summarization and visualization methods (Zanasi 2007). Methods of data mining are partially overlapping with those from text mining as they comprise classification and clustering of texts, as well as affinity grouping and profiling (Berry & Linoff 2004). As a second method, social network analysis includes data aggregation and mining, network modeling, user attribute and behavior analysis, interaction analysis, recommender system development, and finally link prediction and entity resolution (Golbeck 2013).

Patterns extraction and trend analysis as mentioned by Zeng et al. (2010) and Stieglitz et al. (2014) indicate the necessity of predictive methods. Predictive analytics are considered as a further necessary view (Sussin et al. 2015) and comprise a collection of computer-based methods from the research fields text mining (Weiss 2005), data mining and statistical methods. Text Mining may contribute to this task through categorization and clustering techniques whereas data mining contributes to predictions in the same way and adds specific methods as for example estimation based on regression models and prediction. Computational intelligence may also contribute to predictions as its specific methods like artificial neural networks have been applied to classification, pattern completion, and times-series modelling tasks (Engelbrecht 2007). Currently under development are for example methods of sentiment analysis based on machine learning (Stieglitz et al. 2014) and–following the practical example of Brandwatch–based on complex rules instead of simple word lists (Brandwatch 2012). Budak et al. propose coordinated and uncoordinated trend detection as a means to detect emerging topics among highly clustered and distributed users (Budak et al. 2011) and Kasiviswanathanet al. (2011) propose a dictionary learning-based framework for the detection of emerging topics (Kasiviswanathan et al. 2011). Finally, Mathioudakis et al. (2010) define a method for the early identification of items with high attention in social media (Mathioudakis et al. 2010). From a research perspective, a basic set of methods for predictive analytics is given, but no prescriptive methods in the field of social media analytics were found in the related literature.

Using scientific literature on social media analytics and monitoring, a set of basic outcomes–merely in the field of descriptive analytics–can be defined. These outcomes represent exemplary insights, which are generated by applying e.g. text and data mining methods to social content. Reinhold and Alt (2012) instance the definition of relevant content, the identification of opinion leaders, and the presentation of relationships between actors as basic outcomes (Alt & Reinhold 2012). Stieglitz et al. (2014) extend this view and further instance the analysis of posting sentiments, trending topics, as well as relevant communities. Zhang et al. (2014) contribute to these examples with the analysis of spread patterns (Zhang & Vos 2014). The following table summarizes recurring analysis results within literature. The results will further structure the analysis and represent outcomes to be observed.

Author	Examples for analysis outcomes
(Alt & Reinhold 2012)	• Relevant content • Opinion leaders • Relations between actors
(Stieglitz et al. 2014)	• Posting sentiments • Trending topics • Relations between actors • Opinion leaders • Relevant communities
(Zhang & Vos 2014)	• Posting sentiments • Spread patterns

Table 2: Example results of social media analytics

4 Analysis of current SMA applications

The following chapter builds up on the proposed classification of SMA technologies (Figure 1) and the analytics pipeline with its respective analytics outcomes (Table 2) and aims at structuring the associated analysis of SMA applications. While literature defines a myriad of SMA technologies for at least descriptive and predictive analytics, it is supposed that currently available SMA applications lack rich functionality in the field of predictions and prescriptions. Therefore, the following research questions are formulated: Are descriptive, predictive, and prescriptive analytics offered by current SMA applications? Which basic points can be derived for a research agenda? The analysis aims at answering these research questions. Following on this, a technological gap is explained in more detail and a research agenda for SMA applications is defined.

4.1 Structure of the analysis

To conduct the analysis it is first necessary to create the analysis structure referring to an analysis concept. This concept is deduced from the introduced analytics categories and the exemplary outcomes as mentioned above.

Based on this simple structure the tools are assessed with respect to the delivery of the given result within each analytics category. This articles goal is not the determination of the best application available as this depends strongly on the respective underlying business scenario and other influencing variables. Instead, the contribution of the analysis lies in a formative evaluation of the tools functionalities. The resources of this analysis were trial and full versions of the tools. All tools were configured with the same input and used in practice in order to verify the availability of relevant features within the analytics process. In addition, white paper and provider information were used if provided. However, it seems obvious that marketing material of providers is biased and needs to be considered critically.

4.2 Selection of applications

In the present paper, a list of seven social media analytics applications forms the basis of the analysis: Sysomos, Brandwatch, Viralheat, Social Mention, Talkwalker, Synthesio, and Trackur. Although this list does not claim to be exhaustive, it represents a selection that was based on the following criteria (Stavrakantonakis et al. 2012):

1. Applications need to cover multiple business functions, e.g. market research, customer support, marketing, and trend identification;
2. Applications need to offer a rich set of functionalities, e.g. dashboards, crawlers, and sentiment analysis;
3. Applications need to have a considerable presence in the market, i.e. they are amongst the most relevant tools on the market;
4. Applications need to have technical information and trial accounts available.

Considering the information offered by the software vendors, tools were selected that correspond to the first two criteria. Covering the third criterion, tools were selected that are mentioned by market research companies, such as Forrester Research and Gartner (Smith 2014; Hopkins et al. 2014). Regarding the third criterion, only tools which offer a trial version to practically analyze the functionalities were chosen, in order to enrich information given in vendor's marketing material.

5 Findings

According to the above mentioned approach and by applying the constructed model, the analysis was conducted. Appendix A gives a complete overview of the results table and shows that descriptive analytics are mostly covered through the considered outcomes (Table 2), whereas predictive analytics are only partially covered within SMA applications. This result is even emphasized with regard to prescriptive analysis methods implemented in recent applications as there were no related functionalities found within the applications. These results are staying in contrast to the introduced literature and answer the first research question: descriptive, predictive, and prescriptive analytics are not evenly distributed in the investigated SMA applications.

Looking back at the basic model (Figure 1), the conducted tool analysis and scientific literature lack sufficient evidence of enablers in the three discussed categories. Consequently, based on research from IBM in the field of descriptive, predictive, and prescriptive analytics, the following enablers may be defined for each category and are proposed for the adaption to SMA applications (IBM Corporation 2013):

- Descriptive analytics: reports, dashboards, business intelligence
- Predictive analytics: alerts, predictive models, forecasts, scorings
- Prescriptive analytics: business rules, organization models, comparisons, optimizations.

Descriptive analytics are included in all of the analyzed applications and therefore form the methodological basis of the performed analytics. Methods of Business Intelligence are the enablers of a retrospective analysis of social content, presenting results mainly in dashboards and reports. These results are suitable for describing the current business situation and possible problems.

Regarding predictive features, only few outcomes are delivered. In the case of conversation volume and sentiments this is mainly because of alerts, which can be defined by a user and help identifying an ongoing development. With regard to trending topics, alerts and simple forecasts are offered, but are less distributed among the applications. Opinions leaders are predicted only by one application, whereas this result is computed through an alert, too. In summary and in addition to the use of analysis methods as mentioned before, it is observed that the proposed enablers are not used to their fully extend. Outcomes hereby aim at predicting future events and developments.

Finally, prescriptive features were not identified within the chosen applications, although providers of specialized tools are already providing optimization features. In this context, RiteTag helps a twitter user to complement a tweet with the most appropriate hashtags, for example. However, this tool does not belong to the class of SMA applications and requires the user to switch between multiple applications. Taking this into account, it offers a simple optimization feature and thereby contributes to answering the question of the best possible actions. Prescriptive analytics are expected to indicate the best possible activities and decisions within a Social CRM environment. In summary, the assessed maturity level of the three analytics categories may be divided into high for descriptive, middle for predictive, and low for prescriptive analytics.

With regard to a Social CRM system, prescriptive analytics generally represent a high level of marketing optimization as they answer the above mentioned question "Which actions are appropriate?". It allows marketers to go even further than predicting user sentiments or campaign developments by considering predictions and highlighting fields of action. Given this tool set, marketers may be able to drive customer engagement and increase revenue. The current analytics pipeline encompasses the process steps as shown in Figure 2, but, however, needs to be enhanced. Recent analysis technologies (e.g. computational intelligence, graph analysis, and graph mining) may facilitate higher quality of outcomes and provide additional insights. As the analysis step is influencing the entire pipeline and the named potentials need to be leveraged, research in the following areas is necessary (Table 3). The listed points are sorted by the affected pipeline steps, beginning with the first step.

Research area	Examples	Affected pipeline steps			
		1	2	3	4
Adaption of the analytics pipeline	An adaption of the analytics pipeline may lead to better analysis results. Therefore, the following adaptions are proposed: • Dictionaries such as taxonomies or ontologies can be derived from enterprise databases and may simplify the source definition as explained above and may even provide query suggestions (Alt & Wittwer 2014) • Construction of hypotheses within the analysis step of the pipeline may lead to new insights • Rule engines offer the ability to define business rules for alerts and therefore enable better predictions • The users' opportunity of influencing the presentation of results (e.g. the manual editing of incorrect computed sentiments or the adoption of dashboards) need to be increased User-friendly and simple description languages may improve both querying social data (e.g. XML-based formats) and defining rules for decision making (e.g. decision modeling languages)	●	●	●	(●)
Implementation of advanced analysis methods	Regarding the enablers of descriptive, predictive and prescriptive analytics, it is necessary to determine, which *underlying analysis techniques* are relevant. Therefore, research on recent analysis techniques is necessary. Following		●	(●)	(●)

Table 3: Research agenda

Research area	**Examples**	**Affected pipeline steps**			
		1	**2**	**3**	**4**
Interactive visualization	The improvement of visualizations leads to a better usability of applications and improved understanding of present data. Therefore the following is proposed: • *Improved presentations* of results with recent approaches (e.g. hyperbolic search tree, graphs and interactive dashboards) may even raise intelligibility of data • *Time lines* order data by publication time and deepen understanding of developments • The application of *predictions variants* (e.g. linear and non-linear regression models) • *Responsive visualizations* as known from Business Intelligence applications (e.g. drill down) need to be adopted to the field of SMA User-defined *combination of results* (e.g. the combination of sentiments and channels, cf. Sussin et al. 2015) as possible through Online Analytical Processing (OLAP) techniques may also raise intelligibility and lead to new, case-specific insights		(●)	●	
Domain of application	The following functionalities would improve predictive (e.g. alerts) and prescriptive analytics: • *Recommendations* are a means to improve decision making and successful activities (e.g. rule-based actions, alerts, and the suggestion of similar successful marketing activities) • *Time planning* (e.g. the best point of time to release a posting on social media) • *Suggestions* (e.g. posting, text, tweet, next best action) *Simulation* (e.g. influencer fit, channel strategy, inquiry prediction)		●	(●)	
Systems integration	Research is needed in the field of systems integration as companies need to decide between a *best-of-breed approach* (using isolated, specialized applications) and an *integrated systems approach* (e.g. integrated Social CRM systems). Regarding the use of analyzed data research is needed in the following areas: • Integrated systems may provide *automated interactions* with consumers (e.g. automated answers after a complaint was detected) Research on *decision support* based on social content needs improvement regarding reliable and robust methods			(●)	●
●	Directly affected pipeline step				
(●)	Indirectly affected pipeline step				

Table 3 (continued): Research agenda

The adapted model (Figure 3) summarizes the proposed enablers for the realization of descriptive, predictive and prescriptive analytics in the context of SMA as well as an assessment of the maturity level of these analytics. Based on these results, a basic set of research areas is formulated and thereby answers research the second question.

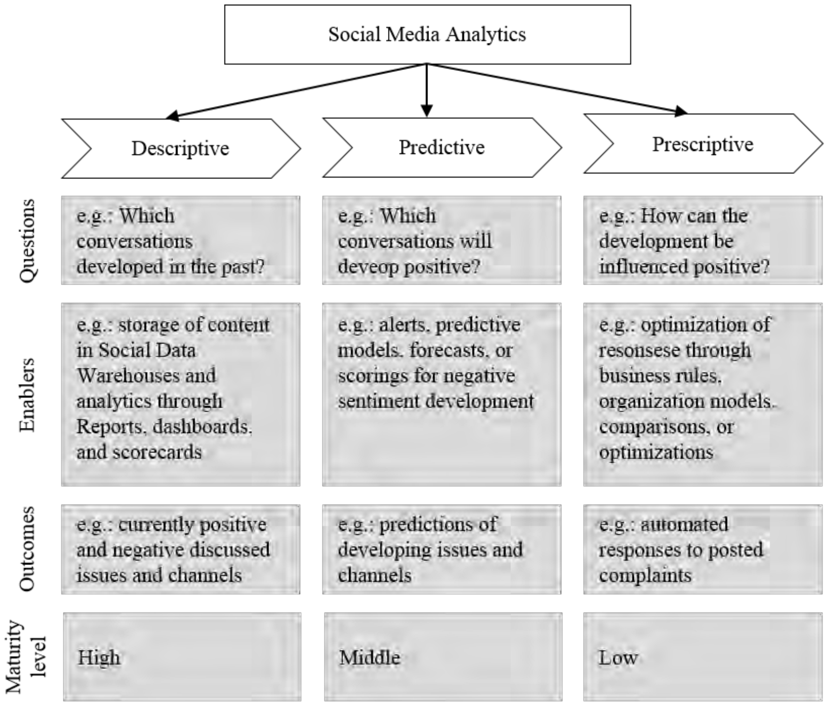


Figure 3: Adapted theoretical model

6 Conclusion and outlook

This research presents an analysis of currently available methods for SMA. It illustrates that SMA may be clustered into three categories, namely descriptive, predictive, and prescriptive. Based on business analytics, a model is provided and adapted for the research field of SMA. For each analytics category it shows basic questions and outcomes, and reveals necessary methods to compute those outcomes. Each part of the model is explained by simple examples. Based on an analysis of SMA applications, a maturity level in practice is deduced and, finally, points for a research agenda within the field of SMA are defined. These results are based on scientific literature and on a tool survey.

In detail the findings show that the maturity level of descriptive analytics is rather high, which is supported by current literature. Compared to predictive analytics features in practice, where maturity level is rather medium, literature shows first approaches for each analytics category. A low maturity level is observed for prescriptive analytics features, which are the least covered–in literature and practice. Following this idea, this requires an adaption of the proposed analytics pipeline, which is differently defined by current scientific literature. The formulated points for a research agenda reflect this adaption, providing more detail for concrete research activities (see Table 3Table). The suggestions for the adaption of the pipeline are a first approach that needs more elaboration. However, this framework reveals an approach for the first time.

Limitations arise considering the number of analyzed SMA applications. The study examined seven applications, but, of course, there are numerous applications in the market.

Although the study cannot be regarded as representative, tools were chosen, which are recommended by Gartner and Forrester. Furthermore, some potentially relevant applications could not be considered as there were no trial versions available. Lastly, this article focuses on SMA applications, but with regard to a Social CRM system there are more classes of applications identified, e.g. in the field of social media management. These tools aim at planning and publishing postings across multiple social media channels (e.g. Twitter, Facebook) based on the division of labor. Following this idea, possible prescriptive technologies, such as suggestions for the most appropriate hashtags or keyword within a social media posting, may be spread wider.

Acknowledgements

The authors gratefully acknowledge the support of Richard Stüber for his valuable inputs and time in numerous discussions.

Appendix A

Application outcomes	Sysomos			Brandwatch			Viralheat			Social Mention			Talkwalker			Synthesio			Trackur		
	Descriptive	Predictive	Prescriptive	Descriptive	Predictive	Prescriptive	Descriptive	Predictive	Prescriptive	Descriptive	Predictive	Prescriptive	Descriptive	Predictive	Prescriptive	Descriptive	Predictive	Prescriptive	Descriptive	Predictive	Prescriptive
Relationsips between actors	◐	○	○	◐	○	○	○	○	○	○	○	○	●	○	○	○	○	○	○	○	○
Relevant communities	●	○	○	●	○	○	●	○	○	●	○	○	●	○	○	●	○	○	●	○	○
Conversation volume	●	●	○	●	◐	○	●	○	○	○	○	○	●	◐	○	●	◐	○	○	◐	○
Sentiment	●	○	○	●	◐	○	●	●	○	●	○	○	●	○	○	●	◐	○	●	◐	○
Trending topics	○	◐	○	◐	◐	○	◐	○	○	○	○	○	○	○	○	●	○	○	○	○	○
Opinion leaders	●	○	○	●	◐	○	●	○	○	●	○	○	●	○	○	●	○	○	○	○	○

●	Feature is available
◐	Feature is partially available
○	Feature is not available

Table 4: Results of the analysis of SMA applications

References

Alt, R. & Reinhold, O., 2012. Social Customer Relationship Management (Social CRM). *Business & Information Systems Engineering*, 4(5), pp.287–291.

Alt, R. & Wittwer, M., 2014. Towards an Ontology-based Approach for Social Media Analysis. In *Proceedings 22nd European Conference on Information Systems*. pp. 1–10.

Askool, S. & Nakata, K., 2011. A conceptual model for acceptance of social CRM systems based on a scoping study. *Ai & Society*, 26(3), pp.205–220.

Bengston, D.N. et al., 2009. Rapid Issue Tracking: A Method for Taking the Pulse of the Public Discussion of Environmental Policy. *Environmental Communication: A Journal of Nature and Culture*, 3(3), pp.367–385.

Berry, M.J. a & Linoff, G.S., 2004. *Data Mining Techniques. For Marketing, Sales, and Customer Relationship Management* 2nd ed., Indianapolis: Wiley Publishing Inc.

Brandwatch, 2012. *Brandwatch. How our sentiment analysis works*, Available at: https://www.brandwatch.com/wp-content/uploads/2012/11/Sentiment-Analysis.pdf.

Bruns, A. & Liang, Y., 2012. Tools and Methods for Capturing Twitter Data During Natural Disasters. *First Monday*, 17(4-2).

Budak, C., Agrawal, D. & Abbadi, A. El, 2011. *Structural trend analysis for online social networks*,

Davenport, T.H. & Harris, J.G., 2007. *Competing on Analytics: the New Science of Winning*, Boston, Mass.: Harvard Business School.

Delen, D. & Demirkan, H., 2013. Data, information and analytics as services. *Decision Support Systems*, 55(1), pp.359–363.

Engelbrecht, A., 2007. *Computational Intelligence, in Introduction*, Chichester: Wiley.

Facebook, 2015. *Facebook Q2 2015 Earnings*, Available at: http://files.shareholder.com/downloads/AMDA-NJ5DZ/751446228x0x842064/619A417E-5E3E-496C-B125-987FA25A0570/FB_Q215EarningsSlides.pdf.

Golbeck, J., 2013. *Analyzing the Social Web*, Waltham (USA): Morgan Kaufmann.

Greenberg, P., 2010. *CRM at the speed of light: social CRM strategies, tools and techniques for engaging your customers* 4th ed., New York et al.: McGraw-Hill.

Greenberg, P., 2009. Time to Put a Stake in the Ground on Social CRM. *PGreenBlog*. Available at: http://the56group.typepad.com/pgreenblog/2009/07/time-to-put-a-stake-in-the-ground-on-social-crm.html.

Heller Baird, C. & Parasnis, G., 2011. From social media to social customer relationship management. *Strategy & Leadership*, 39(5), pp.30–37.

Hopkins, J., Kihn, M. & Rozwell, C., 2014. *Market Guide: Social Analytics for Marketing Leaders*,

IBM Corporation, 2013. *Descriptive, predictive, prescriptive: Transforming asset and facilities management with analytics*,

Kaplan, A.M. & Haenlein, M., 2010. Users of the world, unite! The challenges and opportunities of Social Media. *Business Horizons*, 53(1), pp.59–68.

Kasiviswanathan, S.P. et al., 2011. Emerging topic detection using dictionary learning. In *Proceedings of the 20th ACM international conference on Information and knowledge management*. pp. 745–754.

KISSmetrics, 2015. Facebook Statistics. Available at: https://blog.kissmetrics.com/facebook-statistics/ [Accessed June 14, 2015].

Lasswell, H., 1941. The world attention survey. *Public Opinion Quarterly*, 5(3), pp.456–462.

Lehmkuhl, T. & Jung, R., 2013. Towards Social CRM – Scoping the Concept and Guiding Research. In *BLED 2013 Proceedings*. Bled, pp. 190–205.

Lustig, I. et al., 2010. The Analytics Journey. , pp.11–18.

Mathioudakis, M., Koudas, N. & Marbach, P., 2010. Early online identification of attention gathering items in social media. In *Proceedings of the 3rd ACM international conference on web search and data mining*. New York.

Mikalef, P., Giannakos, M. & Pateli, A., 2012. Exploring the Business Potential of Social Media : An Utilitarian and Hedonic Motivation Approach. In *Bled eConference eDependability: Reliable and Trustworthy eStructures, eProcesses, eOperations and eServices for the Future*. Bled, pp. 1–14.

Rappaport, S.D., 2010. Putting Listening to Work - The Essentials of Listening. *Journal of Advertising Research*, 20(1), pp.30–41.

Reinhold, O. & Alt, R., 2011. Analytical Social CRM: Concept and Tool Support. In *24th Bled eConference eFuture: Creating Solutions for the Individual, Organisations and Society*. pp. 226–241.

Ruggiero, A. & Vos, M., 2014. Social Media Monitoring for Crisis Communication: Process, Methods and Trends in the Scientific Literature. *Online Journal of Communication and Media Technologies*, 4(1), pp.105–130.

Sagiroglu, S. & Sinanc, D., 2013. Big data : A review. In *International Conference on Collaboration Technologies and Systems*. pp. 42–47.

Sarner, A. et al., 2010. *Magic Quadrant for Social CRM*,

Smith, A., 2014. *The Forrester Wave: Enterprise Listening Platforms , Q1 2014*,

Stavrakantonakis, I. et al., 2012. An approach for evaluation of social media monitoring tools. In *1st International Workshop on Common Value Management*. pp. 52–64.

Stieglitz, S. et al., 2014. Social Media Analytics. *Business & Information Systems Engineering*, 6(2), pp.89–96. Available at: http://link.springer.com/10.1007/s12599-014-0315-7 [Accessed October 21, 2014].

Stubbs, E., 2011. The importance of business ethics. In *The Value of Business Analytics: Identifying the Path to Profitability*. Wiley, pp. 9–51.

Sussin, J., Rozwell, C. & Sallam, R., 2015. *Technology Overview for Social Analytics Applications*,

Tenney, A., 1912. The scientific analysis of the press. *73*, pp.895–898.

Twitter, 2014. About Twitter. Available at: https://about.twitter.com/company.

Twitter, 2015. *Twitter Second Quarter 2015 Results*, Available at: http://files.shareholder.com/downloads/AMDA-2F526X/751374626x0x841608/0DC29153-1788-4E20-B3A2-274058770AD8/2015_Q2_Earnings_Slides.pdf.

Weiss, S., 2005. *Text mining : predictive methods for analyzing unstructured information*, New York: Springer.

Woodcock, N., Green, A. & Starkey, M., 2011. Social CRM as a business strategy. *Journal of Database Marketing & Customer Strategy Management*, 18(1), pp.50–64. Available at: http://www.palgrave-journals.com/doifinder/10.1057/dbm.2011.7 [Accessed November 18, 2013].

Woodward, J., 1934. Quantitative newspaper analysis as a technique of opinion research. *Social Forces*, 12(4), pp.526–537.

Youtube, 2015. Youtube - Statistiken. Available at: https://www.youtube.com/yt/press/de/statistics.html [Accessed June 14, 2015].

Zanasi, A., 2007. *Text mining and its applications to intelligence, CRM and knowledge management*, Southampton: WIT Press.

Zeng, D. et al., 2010. Social Media Analytics and Intelligence. *Intelligent Systems, IEEE*, 25(6), pp.13–16.

Zhang, B. & Vos, M., 2014. Social media monitoring: aims, methods, and challenges for international companies. *Corporate Communications: An International Journal*, 19(4), pp.371–383.

29th Bled eConference

Digital Economy

June 19 - 22, 2016; Bled, Slovenia

On Firehoses, Windows, and Business Rules:
Towards a Successful Fast Data Organisation

Chris L.V. Bartels

Vrije Universiteit Amsterdam, The Netherlands

c.l.v.bartels@student.vu.nl

Marijn G.A. Plomp

Vrije Universiteit Amsterdam, The Netherlands

m.g.a.plomp@vu.nl

Abstract

Due to the enormous growth of data and the increasing speed at which organisations are required to respond to it, Fast data is the latest trend in data science. In this study, we set out to answer the question what Fast data is and how organisations can deal with it in a successful way. We define Fast data as: the ability to gain insights from (near) real-time data streams and derive value from these insights. We argue that successful Fast data organisations are built on four pillars: (i) technology, (ii) strategy, (iii) culture, and (iv) skills & experience. We conclude with a critical discussion of our results, for instance touching upon whether Fast data is really 'new'.

Keywords: Analytics, Big data, Conceptual paper, Competitive advantage, Organisational change

1 Introduction

Finding information on the internet is like taking a sip from a firehose.

– Mitchell Kapor

The above quote highlights the enormous and growing availability of data in today's world. While the quote only refers to the internet, much more data is available nowadays, increasing the 'firehose effect'. As a striking example, 90% of all data available in the world has been created in the last two years (Sherman, 2015). Organisations are trying to make sense of and find useful information in this vast amount of data. This has led to an increased level of organisations adopting 'Big data' technologies (Press, 2013).

In the past few years, Big data has offered many organisations some form of competitive advantage (Lavalle et al., 2011). The patterns found helped organisations in finding flaws or trends and act on them. However, due to the enormous amount of data it is difficult for organisations to directly find the data they need to discover these patterns. Therefore, some people argue that Big data only offers a 'rear-mirror view'.

Technologies have evolved over time and become better at dealing with huge amounts of data. However, even advanced technologies such as Hadoop take some time to analyse all this data (Mishne et al., 2013). The desire to prevent the rear-mirror view and analyse data 'as it happens', leads to the rise of a new phenomenon: Fast data. Organisations are increasingly on the lookout for technology that can deal with Fast data.

The use of real-time data in order to obtain new insights is increasingly seen as a 'game changer' (Porter & Heppelmann, 2015). Unfortunately, many organisations have no idea what Fast data entails and how to deal with it. In this conceptual paper, we try to fill this gap by addressing the research question: *What is Fast data and how can organisations deal with it in a successful way?*

In line with the audience of the Bled conference and taking a managerial perspective, we will not cover the technical aspects of Fast data in depth in this paper. Describing only the high-level technological data processing changes and challenges may actually be beneficial, as currently many technologies for working with Fast data are still under development.

The literature used in this paper was retrieved via a search using Google Scholar and library of the Vrije Universiteit Amsterdam. As the term Fast data is not widely used in existing academic literature, synonyms and related topics such as 'Real-time data streams', 'Big data' and 'Real-time data management' were used as search terms as well. A snowball approach was used to find additional literature, *i.e.*, from relevant papers the references where scanned in order to find more possibly relevant articles. After we identified the four most named factors in the literature (*i.e.*, the four pillars; see §3), a more focused approach was used to search for additional literature, *e.g.*, by adding one of the four factors to the original search terms. Because this topic is quite new and because of our managerial focus, we also searched the 'grey'/business literature.

After performing our literature review, we conducted two semi-structured interviews with technical domain experts (*i.e.*, computer scientists) to validate our findings from the literature. These validation interviews were held with Henri Bal & Frank van Harmelen, full professors at the Computer Science department of the Vrije Universiteit Amsterdam. They provided us with their insights on what Fast data is and what its technological requirements and possibilities are. The main part of the interview consisted of letting the interviewee tell about the key technological aspects of Fast data. The second part of the interview consisted of discussing examples of real-life cases and testing the earlier literature findings against the knowledge and experience of the interviewees. These interviews led to a deeper understanding of the aspects that should be taken into account when implementing Fast data.

The remainder of this paper is structured as follows. In the next section, we delineate the concept of Fast data, based on its ancestor Big data. Following that, we come to the core of our paper: a description of the four 'pillars' of a successful Fast data organisation, based on our review of the literature and the validation interviews. Finally, we present and discuss our main conclusions.

2 Defining Fast Data

Although many organisations are still busy dealing with the trend of Big data, a second trend arises: Fast data. Fast data is not exactly the same as Big data, but an extension or expansion of the concept of Big data. Fast data, opposed to Big data, is data that should be analysed directly in order to gain value from it (Lam et al., 2012). Fast data loses its value when stored for a while before being used. Lam et al. (2012) define Fast data as “high-speed real-time and near-real-time data streams” (p. 1814). Focusing on the real-time aspect, this definition lacks the aspect of the impact or possibilities of Fast data. Just like Big data, Fast data has certain goals or added value for organisations that makes it important (Mishne et al., 2013). As Fast data is an extension of Big data, the aim of Big data seems relevant here as well. The goal of Big data is to gain insights in the data gathered and base valuable decisions on these insights (Chen, Chiang, & Storey, 2012). Fast data could thus be seen as a new possibility for being able to act in real-time on your incoming data. Therefore, we propose to define Fast data as follows: *Fast data is the ability to gain insights from (near) real-time data streams and derive value from these insights.*

3 The Four Pillars of a Successful Fast Data Organisation

As our definition of Fast data shows, organisations have to act quickly in order to gain value from Fast data (Mishne et al., 2013). However, in order for organisations to be able to do so, it seems likely that a certain amount of organizational change is required first. Literature suggests that in order to successfully adopt Big data certain changes have to be made in an organisation (Davenport et al., 2001; Davenport, 2006; Lavalle et al., 2011; McAfee, 2012; Porter & Heppelmann, 2015). As Fast data is closely related to Big data, it is important to view how factors that are affected by the adoption of Big data play a part in the rise of Fast data. In order to be able to analyse the impact of Fast data on organisations adopting it, we use the aspects defined in the Big data literature as an organising principle. These aspects – or pillars – are the following:

- Technology
- Strategy
- Culture
- Skills & Experience

The remainder of this paper will focus on explaining how these four pillars are influenced by or should be adjusted for dealing with Fast data.

3.1 Technology

The first pillar of a successful Fast data organisation is *technology*, which enables an organisation to process its data in real-time. Getting the right technology in place is the first step that should be taken in order to successfully use Fast data, and it is a *conditio sine qua non*: the remaining three pillars can be partially present and/or adjusted at a later moment, but when an organisation’s technology is not ready for real-time data processing, no value will be gained from Fast data.

Big data and speed

The current Big data IT-architecture is focused on gathering all data in a single data warehouse and making this data available for employees through insights (Lavalle et al., 2011; McAfee, 2012). However, gathering all this data also has a negative effect: the continuously growing amount of data in these systems makes that processing it takes longer (Kaisler et al., 2013). Thus, the more data organisations gather, the longer their analysis of this data takes, and the slower they are in responding. As Fast data becomes increasingly important this is not something organisations can ignore.

The challenge of volume versus speed

Currently, the best-known product to rapidly deal with massive amounts of data is Hadoop. Hadoop is open source software aimed at speeding up the analysis of Big data. Hadoop uses the 'MapReduce' technology. This technology allows an organisation to store the data that needs to be analysed over multiple data warehouses and bring the analysis software to the data instead of sending the data to the analysis tool (Dean & Ghemawat, 2004). As the Hadoop software is able to divide the data over several smaller databases, it is able to complete analyses more quickly.

Although the solution of Hadoop is relatively new and much faster than older business intelligence technologies, it is already becoming too slow for the current data processing needs (Mone, 2013). The reason for this is that Hadoop analyses data in batches. These batches analyse data at predefined intervals instead of real-time. This makes that between the analysing intervals data simply 'sits' in the database (Stonebraker, Çetintemel, & Zdonik, 2005). If an organisation wants to gain real-time insights in what is happening, this is impermissible (Mone, 2013). Dealing with Fast data through Hadoop makes that the data loses most of its value when it is eventually analysed (Mishne et al., 2013). The solution for this problem lies in the technology of stream processing. Stream processing analyses all data directly when it enters the system. However, before an organisation can successfully apply stream processing, it first has to reduce the amount of data that actually enters the system.

Dealing with data volume and variety

As indicated above, a huge amount of data is flowing into the organisation's systems. These systems can try to handle all this data, but with a speed trade-off. With Fast data there is no question whether this is a permissible trade-off, as speed should always be of very high importance. The way to deal with this volume problem is to implement (the right) filters. Filters should be used in such a way that no longer all data passes to the system, but only the data that fits the organisation's strategy (Barton & Court, 2012). In the case of Fast data, it is extremely important to filter as early as possible, as reducing the volume of the data increases the speed of analysis (Kaisler et al., 2013). What this 'earliest possible' moment is, depends strongly on what data you need as organisation.

Stream processing

After the amount of data to be processed is reduced, it is time to send the data through the stream processing engine. This technology does not find patterns in the data itself, but matches all incoming data with earlier found patterns to see if these patterns reoccur (Bifet, 2013;

Stonebraker et al., 2005). It is important to fill the stream processing engine with predefined *business rules* or *queries* as these are the rules to which the incoming data is compared. When the incoming data matches the predefined pattern or business rule, a signal will be send to a machine or employee to set an action into motion.

Stream processing makes use of a 'window' in which the data is viewable and usable. This window is the length through which the data is temporarily saved to recognise patterns or deviations. After the data has passed through this window, it cannot be analysed again until it is later stored in the historical data warehouse (Ari, Olmezogullari, & Celebi, 2012). Figure 1 depicts the process described so far.

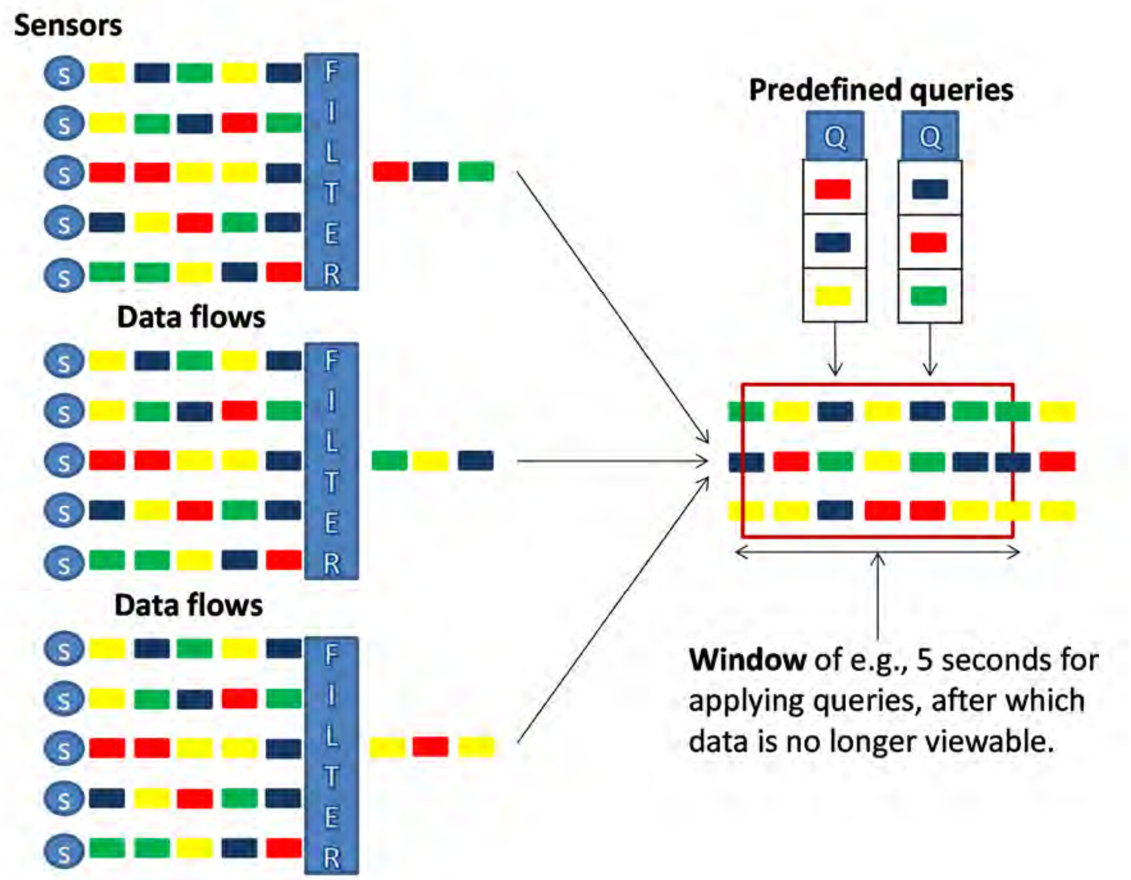


Figure 1: Sensors produce to data flows, which are filtered and next (in a predefined window) continuously checked against predefined queries.

In order to make this type of processing possible, data should be stored in a different way than most organisations do with Big data. Big data is often saved in the form of a long list of data without direct correlation. This makes that the analysis tools have to go through every single entry in order to find a pattern or deviation, which takes up a lot of time. The solution to this problem can be found in saving data in the form of *events* (Roth et al., 2010; Tsividis, 2010). This means that data of the same nature or entity are saved under a common key or location. This listing of all information about the same topic under one database key allows for faster analyses (Luckham, 2011).

An example of saving data in the form of events can be found in the processing of cash withdrawals of a bank. When someone normally withdraws money in Europe and suddenly money is withdrawn in Asia, an immediate notification can be created as this is a deviation of the person's normal pattern. In an old and traditional database these withdrawals would have been stored separately and only brought together at the end of the day. When all data of a single user's cash withdrawal is saved under one key, the system could directly stream the data of the location of the withdrawal with the predefined pattern of earlier withdrawals and immediately detect that the request in Asia is a deviation. A deeper understanding of how such stream reasoning works and what its technological needs are can be found in the article of Margara et al (2014).

The importance of historical data

Although the above seems to deprecate older data processing software, this remains very important in the context of Fast data analysis. As mentioned before, the predefined patterns are of major importance in order to be able to see if a pattern occurs or not. Without having a large historical database, stream processing is hardly possible (Mishne et al., 2013; Suntinger et al., 2008). The historical database is also important for developing potential outcomes of detected events. When an event is recognised by the stream processing engine, the knowledge found in the historical database can be used to predict how this event will develop (Gottumukkala et al., 2012). Therefore, historical databases should still be updated with new data.

3.2 Strategy

The way an organisation should respond to events found in the gathered data should depend on the organisation's *strategy* (Baets, 1992). It is important that this strategy is used as guidance for the data and IT strategy (Baets, 1992). For Big data and Fast data, this is not different (Lavalle et al., 2011).

The 'right' data

As already mentioned when discussing filters, it is important to delineate what data is relevant for an organisation and what not. Where Big data can lure organisations into gathering all data because it 'may have value', this is simply impossible for Fast data due to the volume and speed trade-off. Therefore, data an organisation gathers should be of high quality, which means supportive of the organisation's goals (Wang & Strong, 1996). This is where the earlier mentioned filters come into play: how to set these? A (fictional) example can be found in tracking a city's inhabitants. A municipality could monitor every movement an inhabitant makes, or monitor predefined areas and only collect data when an inhabitant leaves a certain area. Clearly, the first approach creates much more data than the second one. What is the best approach depends on the goals of the municipality. When monitoring the way people navigate through the city, the first approach would probably fit better. However, when studying from which areas most people travel to the city centre, a high level area overview should be sufficient.

What is real-time?

As goals and the right filter settings differ between organisations, so does the notion of what is real-time. Intuitively, this concept refers to *directly* (*i.e.*, as it happens) seeing, responding to, etc. events. However, what is 'directly' differs for each organisation/context, again depending on the goal you have. *E.g.*, monitoring traffic jams happens at a different pace than high-frequency trading on Wall Street. Before organisations can effectively use Fast data in the decision making process, it is important to define what the speed is at which they need to react (Stonebraker et al., 2005). This reaction speed namely influences the length of the window in which the data is viewed and temporarily usable. The length of the window influences the computing power you need and is an important aspect for organisations to consider (Abadi et al., 2005).

Translating strategy to event recognition and actions

When a deviation or problem is detected in the incoming data, action should be taken as soon as possible. The way to do this is by formulating *business rules* (Stonebraker et al., 2005; see also Technology pillar above). Clear business rules allow the stream processing engine to do its work properly; otherwise it is uncertain what to do when a pattern is found (Stonebraker et al., 2005).

Next to the recognition of patterns, business rules should be defined on how to react on a certain event. As these rules are key to responding to events in the right way, they have to be based on the organisation strategy (Paschke & Kozlenkov, 2009; Yang, Yang, & Lou, 2011). These rules, e.g, sending an automated discount offer, make sure that there is a prompt and correct response to the incoming data.

Managing business rules in a Fast data organisation

Business rules have been around for quite some time and have become more important since the rise of Big data (Yang et al., 2011). The difference for business rules for Fast data compared to (Big) data lies in how to manage them. In this rapidly changing world it is important that these rules always stay up-to-date (Boyer & Mili, 2011; Smaizys & Vasilecas, 2009), as the value of Fast data lies in directly recognising patterns and acting upon them. Therefore, the successful implementation of Fast data requires the organisation to revise its business rules more often than before.

3.3 Culture

The third pillar is concerned with what *culture* fits best with organisations that are adopting Fast data: a data-driven, agile one.

A data-driven culture

The first step important for being able to react fast on data is trusting your data. Collecting data but without trusting it could mean you do not gather the right data in the first place. A culture where data is trusted and people are willing to set aside their intuitions to base their actions on data is also known as a data-driven culture (McAfee & Brynjolfsson, 2012). Such a culture is of great importance in dealing with Fast data. With the perishable nature of Fast data, data usually cannot first be crosschecked or scanned by multiple rule engines before an action is taken. Whereas with Big data one could *e.g.*, discuss with colleagues before taking an action this becomes impossible for organisations that need to respond in real-time. Therefore, throughout the organisation it should be clear to trust and deal with data in the decision-making process.

A culture focused on change

Being data-driven alone is not enough for an organisation to successfully deal with Fast data. Actively improving (the quality of) your data and using it to base decisions on is already a big step forward in speeding up the response to events recognized in the data, but there is more. As Fast data requires an imminent response in order to gain value, it is important that the organisation is equipped for this level of speed. Organisations will have to adjust resolutely when new patterns are found (Porter & Heppelmann, 2015). Aiming to adjust and respond to every event as soon as possible requires flexibility and change readiness in an organisation. These changes can be as simple as having the ability to put all other work on hold to respond to an urgent event or as complex as changing the shipping location of your goods on-the-fly when demand is predicted to be higher somewhere else. A culture able to deal with these rapid changes in the environment is called an agile culture (Sherehiy, Karwowski, & Layer, 2007). For production companies, a good way to do this is speeding up the new product development cycle, which should in turn lead to being able to respond faster to changing customer demands than competitors (Porter & Heppelmann, 2015). Porter & Heppelmann (2015) suggest a unified data department that manages all data and that business departments have different knowledge and respond differently to market trends.

Achieving an agile culture for Fast data translates into speeding up the response on data (or events). In order to realize this an organisation could increase the autonomy of employees responding to data or place decision rights lower in the organisation (Lee & Xia, 2010). Next to this, support from top management, clear benefits for employees and the organisation, and guidance on how to deal with changes are all elements that should be present (Chan & Thong, 2009).

3.4 Skills & experience

Having the right technology, strategy, and culture in place are already big steps for an organisation towards being able to reap the benefits of Fast data. However, creating or working in such an organisation also requires the fourth and final pillar: the presence of certain *skills and experience*. Without these, the chance of getting value out of your data is greatly decreased (Davenport et al., 2001; Davenport, 2006; Porter & Heppelmann, 2015).

First, sufficient knowledge about the technology should be present within the organisation: knowing how the data should be stored, processed, analysed, and visualised (Davenport et al., 2001). Big software vendors such as Oracle or Microsoft supply stream processing engines, but as Fast data requires constant changes, knowledge about how to alter the systems becomes an important skill in the organisation as well.

Second, knowledge should be available about what the 'right' algorithm is and how to develop it. While this already is of high importance to Big data (Bell, 2015), successful Fast data organisations will most likely put even more emphasis on this. Organisations deploying Big data analytics have time to carefully develop algorithms and adjust them overtime when needed; even outsourcing this activity may be possible. However, when aiming for a fast response, it is important to act quickly to changes. Therefore, development and control of algorithms should be done with great care and more frequently than for Big data. This makes having in-house knowledge about algorithms important.

Finally, sufficient knowledge should be present on the organisation's data and strategy. This appears trivial but is key to obtaining value from data. This knowledge allows an organisation to understand whether they gather the right data for their goals and what actions can (should) be taken based on the data. As mentioned before, the data an organisation gathers should fit its strategic goals (Lavalle et al., 2011; Wang & Strong, 1996). Hence it is important that knowledge about strategy and the available data are combined and made known throughout the organisation (Davenport et al., 2001). Without combining this knowledge, organisations take the risk of missing out on events that should be reacted upon immediately.

4 Conclusion & Discussion

Due to the enormous growth of data and the increasing speed at which organisations are required to respond to it, Fast data is the latest trend in the field of data science. In this study, we set out to answer the question what Fast data is and how organisations can deal with it in a successful way. We defined Fast data as: *the ability to gain insights from (near) real-time data streams and derive value from these insights*. We argue that successful Fast data organisations are built on four pillars: (i) technology, (ii) strategy, (iii) culture, and (iv) skills & experience.

It is our impression that much of the research on Fast data focuses on the technology behind Fast data. However, learning from the Big data trend, changes in the way data is used by an organisation will have a much broader impact. This paper suggests some changes organisations will have to make beyond technology in order to be able to reap the full benefits Fast data promises.

Many of the proposed changes in this paper are in line with the changes needed for adopting Big data. However, there are prominent differences in the areas of technology and culture. In order to process these huge amounts of data in (near) real-time, new technologies are needed that are 'smart' enough to filter large amounts of data close to the source and direct the remaining data past predefined queries. In terms of culture, especially agility is important in dealing with Fast data. Flexibility in the organisation seems key to being able to respond quickly to events detected in the data.

The relation between Fast and Big data makes that for organisations already (in the process of) deploying Big data solutions, only some of the proposed changes will be required to reach successful Fast data usage. However, although the amount of changes may be small, Fast data places a greater importance on having these factors in place. In conclusion, it can be said that Fast data is an extreme form of Big data, requiring organisations to work with their data in real-time. This places much greater pressure on organisations, while at the same time enabling competitive advantage.

In terms of the limitations of our work, it is relevant to note there is currently not much scholarly work available that is strictly concerned with Fast data. Hence, some of the findings in this paper are extrapolations of Big data studies, are derived from practitioner papers, or are based on discussions with researchers who study Fast data from a more technical point of view (*i.e.*, computer scientists). In the same vein, a valid point of critique is whether Fast data is really 'new' and not just the next hype. Time will tell, but we strongly believe Fast data is a concept that adequately illustrates the undeniable trend towards a growing amount of data available to organisations, to which an increasingly fast response is required from them.

For future work, it seems fruitful to empirically study Fast data and how it is adopted by organisations. These studies could also look into the contingencies of Fast data for organisations, *i.e.*, when is an organisation 'truly prepared' and are there perhaps organisations for which Fast data turns out to not be so relevant? Fast data may be applicable to commercial parties that ship goods around the globe as discussed earlier in this paper. Also in the context of Smart cities Fast data may prove relevant, *e.g.*, in the deployment of a so-called 'cockpit' that continuously monitors and reacts to incoming data (Kitchin, 2014). In studying this, the link with work on organisational agility & IS (*e.g.*, Sambamurthy, Bharadwaj, & Grover, 2003) seems relevant to take into account.

Acknowledgements

The authors cordially thank Henri Bal & Frank van Harmelen from the Department of Computer Science at the Faculty of Sciences of the Vrije Universiteit Amsterdam for their relevant input for this paper.

This work was funded in part through the joint innovation project 'DigitalWe': http://www.digitalwe.nl.

References

Abadi, D. J., Ahmad, Y., Balazinska, M., Çetintemel, U., Cherniack, M., Hwang, J., Lindner, W., Maskey, A. S., Rasin, A., Ryvkina, E., Tatbul, N., Xing, Y., & Zdonik, S. (2005). The Design of the Borealis Stream Processing Engine. *Proceedings of the CIDR Conference*, 277-289.

Ari, I., Olmezogullari, E., & Celebi, O. F. (2012). Data stream analytics and mining in the cloud. *CloudCom 2012 - Proceedings: 4th IEEE International Conference on Cloud Computing Technology and Science*, 857-862.

Baets, W. (1992). Aligning information systems with business strategy. *The Journal of Strategic Information Systems*, *1*(4), 205-213.

Barton, D., & Court, D. (2012). Spotlight on big data. *Harvard Business Review*, *90*(10), 78-83.

Bell, P. C. (2015). Sustaining an Analytics Advantage. *MIT Sloan Management Review*, *56*(3), 21.

Bifet, A. (2013). Mining big data in real time. *Informatica*, *37*(1), 15-20.

Boyer, M. J., & Mili, H. (2011). *Agile business rule development* (pp. 49-71). Springer: Berlin Heidelberg.

Chan, F. K. Y., & Thong, J. Y. L. (2009). Acceptance of agile methodologies: A critical review and conceptual framework. *Decision Support Systems*, *46*(4), 803-814.

Chen, H., Chiang, R. H. L., & Storey, V. C. (2012). Business Intelligence and Analytics: From Big Data to Big Impact. *MIS Quarterly*, *36*(4), 1165-1188.

Davenport, T. H. (2006). Competing on Analytics. *Harvard Business Review*, *84*(1), 98-107.

Davenport, T. H., Harris, J. G., De Long, D. W., & Jacobson, A. L. (2001). Data to Knowledge to Results: Building an Analytic Capability. *California Management Review*, *43*(2), 117-138.

Dean, J., & Ghemawat, S. (2004). MapReduce: Simplified Data Processing on Large Clusters. *Proceedings of 6th Symposium on Operating Systems Design and Implementation*, 137-149.

Gottumukkala, R., Zachary, J., Kearfott, B., & Kolluru, R. (2012). Real-time information driven decision support system for evacuation planning. *IEEE International Multi-Disciplinary Conference on Cognitive Methods in Situation Awareness and Decision Support*, 206-209.

Kaisler, S., Armour, F., Espinosa, J., & Money, W. (2013). Big Data: Issues and Challenges Moving Forward. *46th Hawaii International Conference on System Sciences (HICSS)*, 995-1004.

Kitchin, R. (2014). The real-time city? Big data and smart urbanism. *GeoJournal, 79*(1), 1-14.

Lam, W., Liu, L., Prasad, S. T. S., Rajaraman, A., Vacheri, Z., & Doan, A. (2012). Muppet: MapReduce-style processing of fast data. Proceedings of the VLDB Endowment, 5(12), 1814-1825.

Lavalle, S., Lesser, E., Shockley, R., Hopkins, M. S., & Kruschwitz, N. (2011). Big Data, Analytics and the Path From Insights to Value. *MIT Sloan Management Review*, *52*(2), 21-32.

Lee, G., & Xia, W. (2010). Toward agile: An integrated analysis of quantitative and qualitative field data on software development agility. *MIS Quarterly*, *34*(1), 87-114.

Luckham, D. C. (2011). *Event processing for business: organizing the real-time enterprise*. John Wiley & Sons.

Margara, A., Urbani, J., Van Harmelen, F., & Bal, H. (2014). Streaming the Web: Reasoning over dynamic data. *Web Semantics: Science, Services and Agents on the World Wide Web, 25*, 24-44.

McAfee, A., & Brynjolfsson, E. (2012). Big data: the management revolution. *Harvard Business Review*, *90*(10), 61-67.

Mishne, G., Dalton, J., Li, Z., Sharma, A., & Lin, J. (2013). Fast data in the era of big data: Twitter's real-time related query suggestion architecture. *Proceedings of the ACM SIGMOD International Conference on Management of Data*, 1147-1158.

Mone, G. (2013). Beyond Hadoop. *Communications of the ACM*, *56*(1), 1-3.

Paschke, A., & Kozlenkov, A. (2009). Rule-based event processing and reaction rules. *Rule Interchange and Applications, LNCS 5858*, 53-66.

Porter, M. E., & Heppelmann, J. E. (2015). How Smart, Connected Products Are Transforming Companies. *Harvard Business Review, 93*(10), 96-114.

Press, G. (2013). *Surveys find rising adoption of big data*. Retrieved from http://www.forbes.com/sites/gilpress/2013/09/12/surveys-find-rising-adoption-of-big-data/#39785d30afdb.

Roth, H., Schiefer, J., Obweger, H., & Rozsnyai, S. (2010). Event data warehousing for Complex Event Processing. *Fourth International Conference on Research Challenges in Information Science*, 203-212.

Sambamurthy, V., Bharadwaj, A., & Grover, V. (2003). Shaping agility through digital options: Reconceptualizing the role of information technology in contemporary firms. *MIS Quarterly, 27*(2), 237-263.

Sherehiy, B., Karwowski, W., & Layer, J. K. (2007). A review of enterprise agility: Concepts, frameworks, and attributes. *International Journal of Industrial Ergonomics*, *37*(5), 445-460.

Sherman, R. (2015). *The Business intelligence guidebook: From data integration to analytics*. Amsterdam: Elsevier.

Smaizys, A., & Vasilecas, O. (2009). Business Rules Based Agile ERP Systems Development. *Informatica*, *20*(3), 439-460.

Stonebraker, M., Çetintemel, U., & Zdonik, S. (2005). The 8 requirements of real-time stream processing. *ACM SIGMOD Record*, *34*(4), 42-47.

Suntinger, M., Schiefer, J., Obweger, H., & Gröller, M.E. (2008). The event tunnel: Interactive visualization of complex event streams for business process pattern analysis. *IEEE Pacific Visualisation Symposium*, 111-118.

Tsividis, Y. (2010). Event-Driven Data Acquisition and Digital Signal Processing — A Tutorial. *Techniques*, *57*(8), 577-581.

Wang, R. W., & Strong, D. M. (1996). Beyond Accuracy: What Data Quality Means to Data Consumers. *Journal of Management Information Systems*, *12*(4), 5.

Yang, P., Yang, Y., & Lou, Y. (2011). A Business Activity Real-Time Monitoring Platform Based on Rule Engine. *Procedia Engineering*, *15*, 3744-3748.

29th Bled eConference

Digital Economy

June 19 - 22, 2016; Bled, Slovenia

The Role of Social Media for Stakeholder Involvement: *A Literature Review*

Barbara Krumay

WU Vienna University of Economics and Business, Austria

bkrumay@wu.ac.at

Sylvia Geyer

University of Applied Sciences Technikum Wien, Austria

geyers@technikum-wien.at

Abstract

Social media has found its place in the digital economy. Social media tools offer easy, interactive and cost-efficient possibilities to interact with various stakeholders. Not only the mere availability of social media tools but also their implementation renders benefits to an organization. Consequently, evidence from practice indicates that social media is an appropriate way to establish stakeholder involvement; however, current research is ambiguous, lacking a comprehensive approach to social media stakeholder involvement. Thus, the question addressed targets the underlying concepts in research on social media for stakeholder involvement. Conducting a literature review based on a final sample size of 70 peer-reviewed papers, our findings deliver insight into three main research directions and nine different concepts addressed by the literature. The results may function as a starting point for further research into the field of structured stakeholder involvement.

Keywords: Social media, Stakeholder involvement, Stakeholder theory

1 Introduction

Various information systems (IS) support companies in their efforts to establish communication and manage stakeholder involvement (SI) (Krumay & Brandtweiner, 2014). Stakeholder involvement requires structured, interactive and bi-directional communication (Unerman, 2007). Thus, social media tools seem to be a perfect fit. Although there is some evidence in literature and practice (Krick et al., 2005), a solid grounding for understanding how social media is used for stakeholder involvement is missing. We want to establish this sound background and contribute to a better understanding of this topic by reviewing literature from different scientific communities. Hence, this study provides a summary of theoretical concepts, social media tools and stakeholders that have been investigated so far in this context. Furthermore, we identify concepts to better understand the research area. The results may serve in particular the interests of scholars by establishing a starting point for more in-depth investigation on social media and stakeholder involvement. The paper proceeds as follows: First, we provide a brief description of the theoretical background. Second, we describe our methodological approach. Third, we present results and discuss possible implications for academia and business. Finally, we offer conclusions, limitations and future research directions.

2 Background Information

Although business and research were doubtful, social media (SM) will survive (Qualman, 2010). Furthermore, companies are forced to use SM to remain competitive and demonstrate their “nearness” to customers (Parveen, 2012). Social media is ‘social’ through the activities of users, who actively participate without having profound technological knowledge (Kaplan & Haenlein, 2010). This social integration of users, based on Internet technology, is also subsumed under the term Web 2.0 (Margraf, 2011), represented by a huge variety of tools (Mangold & Faulds, 2009; Meske & Stieglitz, 2013). Various factors make social media tools attractive for companies, such as expected decrease in transaction and coordination costs (Nie et al., 2010). In addition, the chance to gain additional information from and about their customers (Mustonen, 2009) and the possibility to involve customers to become prosumers, supporting companies in product development are promising (Chaney, 2012). Finally, by using SM appropriately, an organization can establish a dialogue and therefore a high degree of interaction with relevant target groups (Mangold & Faulds, 2009; Mustonen, 2009). Of course, social media tools also allow companies to fragment their audience into different target groups, serving them with relevant and interesting information (Mustonen, 2009). Various communication activities combined in Web 2.0 tools are making it a “hybrid element of the promotion mix” (Mangold & Faulds, 2009). However, the possibilities of social media tools extend far beyond a marketing instrument. They can be used as knowledge-management tools (Chua & Banerjee, 2013) or for training and idea exchange (Mustonen, 2009). Besides these opportunities, SM poses some threats for companies (Hastings, Stead, & Webb, 2004). First, SM platforms are not controlled by the companies using them, so the diffusion of information is hard to steer (Mangold & Faulds, 2009). Second, creating value through the application of SM requires a structured and well-managed approach (Spaulding, 2010). Thus, companies have to acquire specific knowledge to avoid cannibalization effects between different marketing channels and to identify the right target groups in the new channels (Berthon et al., 2012; Michaelidou, Siamagka, & Christodoulides, 2011).

However, companies need these direct, fast, low-cost and interactive tools (Meske & Stieglitz, 2013) to communicate with their stakeholders. Stakeholders are those having a stake’ in a subject, characterized by their relationship with the subject. Formal and easy-to-assess relationships exist for primary stakeholder, namely internal (i.e., employees) and some external stakeholders, including customers, partners or shareholders (Freeman et al., 2010). However, the definition extends the relationships beyond the primary stakeholders and includes all actors or secondary stakeholders influenced by the projects and activities of an organization (Freeman et al., 2010). Communication with stakeholders and their involvement in decisions originates from citizen participation (Rowley, 2011). Because it has been shown to be beneficial for business (Ulmer, 2001), companies have adopted stakeholder involvement, mainly as an integrative part of their corporate social responsibility (CSR) approach (Etter, 2014). Whereas classic stakeholder theory identifies a set of relevant stakeholders, literature shows that companies mainly focus on customers (Hoffmann & Lutz, 2015). The basis for stable and successful stakeholder involvement is target-group-oriented, pro-active, bi-directional communication (Carroll & Buchholtz, 2014). This has to be considered especially for relationships with external stakeholders, which are heterogeneous, hard to steer and without access to internal communication (Peters & Golden, 2013). Thus, stakeholder involvement requires a structured approach based on the stakeholders' needs, influenced by their relationship with the organization (Clarkson, 1995). Beyond this established relationship, different factors influence the success of stakeholder involvement, for example, the level of communication (Carroll & Buchholtz, 2014), the company's willingness to integrate stakeholders into decision-making (Man Hang, Phaal, & Probert, 2014) and the needs of the specific stakeholder group (Poister, Thomas, & Berryman, 2013).

Consequently, SM tools seem to be the perfect approach for successful stakeholder involvement. Because social media allow stakeholders to communicate on a level playing field with an organization, they have the same control over the communication and hence feel truly involved (Vernuccio, 2014). However, organizations on the verge of establishing ties to their stakeholders (via SM) need to decide which stakeholder target groups are relevant and which level of attention is appropriate (Freeman et al., 2010).

In this study, we ask how research has investigated organizations' approaches to stakeholder involvement and application of the rather new technology of social media in these approaches. Consequently, this paper provides an overview of the current state of the field addressing the role of SM for SI and revealing general concepts evolving in the literature. For this research, we define stakeholder involvement as structured communication with identified stakeholders based on their needs and aimed at fulfilling responsibilities for society's well-being.

3 Methodological Approach

We applied a structured literature review based on search terms, developed from literature (Kaplan & Haenlein, 2010), SM guidelines (Ceres, 2007; Krick et al., 2005; Michigan Department of Information, 2009) and three interviews with SM experts. This lead to 18 search terms (Social media, Google+, Blog, Facebook, Twitter, Web 2.0, YouTube, Wiki, LinkedIn, Flickr, MySpace, Tumblr, Instagram, Reddit, Pinterest, WhatsApp, app.net, XING). We combined them with stakeholder involvement terms (involvement, engagement, dialogue, communication, and management, respectively) for identifying research that could answer the research question. We, on purpose, excluded the search term 'social networks' since it is used in various ways (e.g., for social network analysis). Based on the search terms, we iteratively searched various academic databases exclusively focusing on scholarly journals. We started the search with a randomly selected database (ABI/Inform Global | T&I ProQuest) and extended the search to others (e.g., EBSCO Business Source Premier, Google Scholar, Web of Knowledge). We stopped after having reached a certain saturation. The whole data collection process took place in September 2015. After excluding overlaps, we obtained a sample of 613 academic publications. We eliminated papers not investigating companies (82), having social media search terms only in references (44), with language issues (3), unavailable (5) and those that did not investigate the involvement of stakeholders via SM (372). In the in-depth analysis of the remaining 109 papers, we further eliminated 39 papers due to their lack of content that fit our research goal. Based on the final set of 70 papers and with the help of another independent researcher, we analyzed the sample papers.

4 Results

Results of the analysis of 70 papers indicate that different research directions exist for SM application in SI. First, we show some descriptive aspects, giving an overview of chronology, quality and research domains. Second, we describe the methods used in the paper and the current direction of academia. Third, the relevant stakeholders are identified. Lastly, we develop research directions and concepts based on the literature review.

4.1 Sample Description

The majority of the papers were published in 2012 (13), 2013 (21), 2014 (14) and 2015 (11). The 41 different journals in the sample are mainly represented by one paper (33). Multiple occurrences were found in *Journal of Business Ethics* (8), *Journal of Communication Management* (7), *Corporate Communications: An International Journal* (7), *Public Relations Review* (5), *Online Information Review* (4), *Journal of Business & Economics Research* (2), *International Journal of Marketing Studies* (2) *and International Journal of Nonprofit and Voluntary Sector Marketing* (2). The impact factors of these journals range from 0.060 to 3.117 (*Journal of Computer-Mediated Communication*). Only one paper in our sample has been published in this highly ranked journal. In accordance with journal categories developed by SJR (http://www.scimagojr.com), most of the journals report on business, management and accounting (10), communications (9), information systems (5), marketing (4) or computer science (3).

4.2 Theoretical Concepts, Methods and Topics

Concerning theoretical concepts, stakeholder theory has been used (6) and is mentioned (8) relatively often. Other theoretical concepts such as institutional approach, communication and media theories, or agenda setting and building have been found. However, 27 of the papers did not use or mention a theory. Considering methodological approaches, we found a huge variety of empirical (47) and conceptual (18) papers as well as literature reviews (11). Compared to our own study, they mainly investigated a specific tool or from very different angles, such as marketing or PR. In addition, two conceptual papers were evaluated empirically. Qualitative (26) and quantitative (36) methods applied include data gathering via interviews, from case studies or from surveys. On the analysis level, the bandwidth spans from qualitative and quantitative analysis to ANOVA and multiple-regression approaches. Interestingly, exploratory research (30) was slightly dominant compared to explanatory research (20) in our sample. Concerning the topics covered, we found a slight dominance of Twitter and Facebook as sources for investigation. Moreover, the umbrella terms 'social media' and 'Web 2.0' predominate the sample papers. Most papers focused on the dialogic concept of SM. In terms of stakeholders, a clear dominance of customers as external stakeholders over internal stakeholders and other stakeholders (NGOs, distributors, partners and experts) was discovered.

4.3 Concepts

To allow for categorization, we identified three main research directions: actual use, possible use, and impact of use on the organization. Whereas actual use includes questions like, 'How?', 'What for?', 'What?', 'For Whom?', and 'Why?', possible use targets towards 'How to?' and comparisons of usage. The third direction refers to papers that clearly discuss the impact of using SM for SI on the organization. Table 1 provides an overview of the research directions identified. Furthermore, the table shows how many papers fall into the research directions. To increase clarity and avoid double attribution, we assigned the papers based on their main research ideas.

Direction	No.	Sources
Actual use How? What for? What?	46	Alikilic & Atabek, 2012; Argyris & Monu, 2015; Austin, 2015; Bonsón & Bednárová, 2013; Bonsón & Ratkai, 2013; Bonsón, Bednarova, & Escobar-Rodríguez, 2014; Bonsón, Carvajal-Trujillo, & Escobar-Rodríguez, 2015; Byrd, 2012; Carboni & Maxwell, 2015; Chae, 2015; Colleoni, 2013;

For whom? Why?		Coombs & Holladay, 2012; Etter, 2014; Fieseler & Fleck, 2013; Gálvez-Rodriguez, Caba-Perez, & López-Godoy, 2014; Georges, Sachs, & Millett, 2010; Guo & Saxton, 2014; Haigh, Brubaker, & Whiteside, 2013; Hoffmann & Lutz, 2015; Johansen & Nielsen, 2011; Kim, Kim, & Hoon Sung, 2014; Krishnamurthy, Rivera-Sánchez, & Soriano, 2013; Lauritsen & Perks, 2015; Lee, Oh, & Kim, 2013; Lovejoy & Saxton, 2012; Lovejoy, Waters, & Saxton, 2012; Luarn, Lin, & Chiu, 2015; Luo & Jiang, 2012; Martyn & Gallant, 2012; Maxwell & Carboni, 2014; Mishra & Li, 2008; Nah & Saxton, 2013; O'Sullivan, 2013; Paolocci, 2014; Perrigot et al., 2012 Porter, Anderson, & Nhotsavang, 2015; Romenti, Murtarelli, & Valentini, 2014; Rybalko & Seltzer, 2010; Saxton & Guo, 2014; Saxton & Waters, 2014; Schmeltz, 2014; Tao & Wilson, 2015; Ubeda et al., 2013; Vernuccio, 2014; Waters et al., 2009; Wattanacharoensil & Schuckert, 2015
Possible use How should/could it be used?	18	Baue & Murninghan, 2011; Beelitz & Merkl-Davies, 2012; Castelló, Morsing, & Schultz, 2013; Decker et al., 2007; Deschamps & McNutt, 2014; Driessen, Kok, & Hillebrand, 2013; Fieseler, Fleck, & Meckel, 2010; Haegeman et al., 2012; Leonardo & Harrill, 2011; Lyon & Montgomery, 2013; Mount & Garcia Martinez, 2014; Nwagbara & Reid, 2013; Panagiotopoulos et al., 2015; Pronschinske, Groza, & Walker, 2012; Schoeneborn & Trittin, 2013; Schultz, Castelló, & Morsing, 2013; Vaccaro & Madsen, 2009; Vos, Schoemaker, & Luoma-aho, 2014
Impact of use on the organization	6	Besiou, Hunter, & Van Wassenhove, 2013; Chien Hsing, Shu-Chen, & Hsin-Hui, 2013; Gilfoil & Jobs, 2012; Lee, Dolen, & Kolk, 2013; Schniederjans, Cao, & Schniederjans, 2013; Swerling, Thorson, & Zerfass, 2014
Total	70	

Table 1: Identified research directions (full list of references: https://www.wu.ac.at/fileadmin/wu/d/i/imc/Staff/eBled2016_ReferencesLiteratureReview.pdf)

In addition to the three research directions, we identified nine concepts. Table 2 presents the concepts and their occurrence within the three research directions. Since one paper may include different concepts, the overall number of occurrences of concepts exceeds the number of papers.

	Activity design	Factual involvement	Strategic aspects	CSR / TBL	PR & Marketing	Cooperation	Effect of SM	Measurement	Shift of Power	
Actual use	47	22	12	8	11	8	9	6	1	124
Possible use	5	17	6	6	0	5	2	0	4	45
Impact	0	1	1	1	3	0	1	2	3	12
Sum	52	40	19	15	14	13	12	8	8	

Table 2: Occurrence of concepts per research direction

The concept named ‘activity design’ subsumes articles focusing on the choice of tools, content or target group and design requirements. Argyris & Monu (2015), for example, describe the affordances of SM for communicating with external stakeholders. The concept of ‘factual involvement’ is concerned with stakeholder involvement and stakeholder dialogue. Colleoni (2013), for example, explores how companies in fact handle “the complexity of stakeholders’ view and their high ethical expectations towards CSR”. The next concept deals with ‘strategic aspects’ of SM use for SI (e.g., Etter, 2014). Internal strategic aspects mainly describe communication strategies (Etter, 2014), external strategic aspects, by contrast, include strategies concerning positioning of companies towards stakeholders (e.g., Johansen & Nielsen, 2011). The concept of ‘CSR/TBL’ deals with articles spreading information on CSR and triple bottom line (TBL—environmental, economic and social) related topics effectively, such as using blogs for CSR communication to address “those who actively look for conversation and engage in online discussions” (Fieseler & Fleck, 2013). Another concept subsumes SM being the vehicle for ‘PR and marketing’ activities to attract stakeholders, for example, in terms of conceptualizing PR as part of external communication activities for identifying SM affordances (Argyris & Monu, 2015). The concept named ‘cooperation’ encompasses the collective work on a specific field of interest or topic, e.g., in terms of supply chain management (Chae, 2015). The ‘effect of social media’, covers aspects such as trust, stronger relationships, and improved attitudes of the stakeholder towards the company. Etter (2014), for example, analyzed Twitter posts, revealing that the rare cases of real engagement lead to better relationship. ‘Measurement’ deals with the measurement of SM actions for SI, e.g., ROI, stakeholder engagement, reactivity, and mood, such as measuring the extent of LinkedIn usage based on an index (Bonsón & Ratkai, 2013). Some articles focus on the ‘shift of power’, which means directing the agenda away from companies to the stakeholders, loss of control over communication and increased stakeholder activism—for example, the role of SM for corporate governance to tackle the shift of power (Hoffmann & Lutz, 2015).

5 Discussion

By synthesizing prior research (Rowe, 2014), we revealed how research has so far investigated organizations’ application of the rather new technology for stakeholder involvement. On the one hand, the research directions show that the actual use of SM for SI is the primary interest of research. In particular, concepts like design of the SM activities or factual involvement attract a lot of attention. However, only a few papers investigate impacts of SM for SI or the shift of power.

In general, the literature review unveiled that companies and research have slowly adopted social media for stakeholder involvement (Ellison, 2007). From the rather high number of exploratory papers, we conclude that research in this field is still in its infancy. Clearly, the topic has attracted attention in some disciplines, such as business, management and accounting, communications and marketing, and CSR. This may be because stakeholder involvement ever since has been discussed by strategic management (Freeman, 2010) and CSR (Carroll & Buchholtz, 2014; Ingenhoff & Sommer, 2011). Marketing and public relations, on the other hand, were early adopters of SM (Berthon et al., 2012). The dominance of umbrella terms such as ‘social media’ and ‘Web 2.0’ in the conceptual papers (Johansen & Nielsen, 2011) refers to their investigation of the topic on a general level. By contrast, application of tools like Twitter and Facebook were in the focus of empirical papers or even the basis for analysis (Colleoni, 2013; Lovejoy, Waters, & Saxton, 2012). This dominance of Twitter and Facebook is also consistent with practical guidelines (Krick et al., 2005) and the literature (Kaplan & Haenlein, 2010). Likewise, the dominance of research focusing on external stakeholders, especially customers, is in accordance with prior findings (Argyris & Monu, 2015).

Interestingly, the three research directions identified (actual use, possible use, impact) reveal different qualities. Whereas 'actual use' is rather descriptive (answering questions concerning 'How is it used?'), the concept 'possible use' aims towards a more normative direction. The direction 'impacts', by contrast, seems to have instrumental character by integrating consequences of activities. Donaldson & Preston (1995) already identified similar aspects of stakeholder theory—descriptive, instrumental, and normative—that "are nested within each other" (Donaldson & Preston, 1995). In general, 'activity design' dominates in all papers but also 'actual use'. We argue that this dominance is a consequence of the youth of the field. Research can focus on normative or instrumental aspects after having explored 'How?'. In addition, 'activity design' is strongly connected to the concept 'PR & marketing' and influenced by well-established research areas (e.g., e-commerce and marketing) discussing the same topics, like channel (Devaraj, Fan, & Kohli, 2002) or content (Byrd, 2012) decisions. Surprisingly, papers investigating strategic aspects mainly fall into the 'actual use' direction. This is interesting, because strategy as the core of stakeholder theory (Freeman, 2010) often considers instrumental aspects (Donaldson & Preston, 1995). Research into what concerns 'possible use' or normative aspects is less developed. The ongoing discussion concerning norms of how companies involve stakeholders in decision-making (Rowley, 2011) nicely fits the importance of 'factual involvement' in this normative aspect. Interestingly, the 'shift of power', reflecting that SM is not under the control of the organizations using it (Mangold & Faulds, 2009) has been investigated from a normative direction. This has already been discussed in the strategic management literature (Porter & Kramer, 2006) in a merely descriptive way. However, we would have expected more research of handling the 'effects of SM'. Instead, we find papers addressing negative effects of 'CSR/TBL' communication, like greenwashing (Athanasiou, 1996) or mismatch between stakeholders' expectations and companies' communication. Colleoni (2013), for example, shows that stakeholders expect to receive specific information (e.g., renewable energy) via SM, but companies discuss CSR on a general level. We conclude that normative aspects in research so far have mainly covered the risks evolving from SI via SM and approaches to tackle them. There are even fewer papers investigating the instrumental aspects or impact direction. We believe there are two reasons for this. First, instrumental aspects require a solid empirical descriptive basis "to identify the connections, or lack of connections, between stakeholder management and the achievement of traditional corporate objectives" (Donaldson & Preston, 1995). Second, due to the rather new technology and ongoing technological progress (Aakhus et al., 2012), impacts from SM are hard to measure. More research is needed in this area to establish a solid knowledge base. Figure 1 shows the occurrences of concepts in the three directions in form of a 'tag cloud', where the size of the terms indicates their importance.

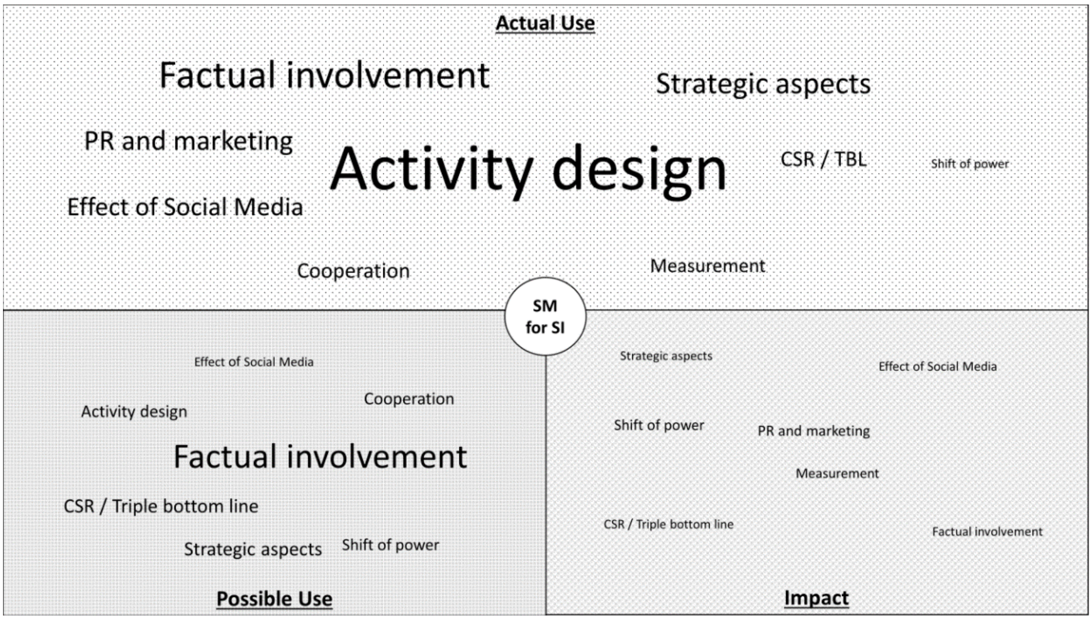


Figure 1: Identified concepts embedded in main research directions.

As Figure 1 shows, most of the papers examine the actual use of SM for SI and describe the current situation. The often-claimed perfect fit between SM and SI has mainly been investigated in terms of how it is used, but normative and instrumental aspects are rarely found in the literature. Therefore, research currently is not able to assess the impacts of SM for SI. The possible use (normative) and the impacts (instrumental) have not attracted that much attention. This is surprising, since research on how to use SM in companies—for example, maturity models (Geyer & Krumay, 2015)—and guidelines in practice concerning SM for SI (e.g., Ceres, 2007) exist. Our goal was to provide a condensed view of the past and lay a solid foundation for more in-depth investigation in these areas. Consequently, the results mainly serve the interests of scholars. It allows identifying research gaps and start more in-depth investigation in this area, based on the research directions and newly explored concepts. In general, describing how SM is used to support SI adds to the ongoing discussion and enriches it in terms describing the possibilities of SM to establish the direct, bi-directional communication that is required for true stakeholder involvement (Unerman, 2007). It also aims towards more conceptual work and guidelines for research and practice alike.

6 Conclusions, Limitations and Further Research

Summarizing this, the discussion on this topic is quite diverse. Social media tools, as interactive, bi-directional and relatively cheap options, have attracted attention in research and practice. However, more research is required to provide insights into how to use SM for SI successfully and how influences of this use can be assessed. Limitations of this research evolve from the method, since a literature review often requires further empirical research. A certain saturation of papers has been found after applying the search terms in two databases. Hence, restricted result validity is given. Moreover, the selection of search terms influenced the search result and may have led to a restricted viewpoint on the topic. Further research could include a repeat of the analysis in one year's time, highlighting the changes in research directions and concepts. As a next step, we will target towards the shift of power, which has been identified as a rather blind spot, although it has already been investigated in other areas.

References

Aakhus, Mark, Agerfalk, P, Lyytinen, Kalle, & Te'eni, Dov. (2012). Information systems for symbolic action: Social Media and Beyond. *Call for papers MISQ Special Issue*

Argyris, Young Anna, & Monu, Kafui. (2015). Corporate Use of Social Media: Technology Affordance and External Stakeholder Relations. *Journal of Organizational Computing and Electronic Commerce, 25*(2), 140-168.

Athanasiou, Tom. (1996). The age of greenwashing. *Capitalism Nature Socialism, 7*(1), 1-36.

Berthon, Pierre R, Pitt, Leyland F, Plangger, Kirk, & Shapiro, Daniel. (2012). Marketing meets Web 2.0, social media, and creative consumers: Implications for international marketing strategy. *Business Horizons, 55*(3), 261-271.

Bonsón, Enrique, & Ratkai, Melinda. (2013). A set of metrics to assess stakeholder engagement and social legitimacy on a corporate Facebook page. *Online Information Review, 37*(5), 787-803.

Byrd, Simone. (2012). Hi fans! Tell us your story!: Incorporating a stewardship-based social media strategy to maintain brand reputation during a crisis. *Corporate Communications: An International Journal, 17*(3), 241-254.

Carroll, Archie B., & Buchholtz, Ann. (2014). *Business and society: Ethics, sustainability, and stakeholder management*. Stamford (US): Cengage Learning.

Ceres. (2007). FRP Stakeholder Engagement Guide. Retrieved 2015-08-09, from http://www.ceres.org.

Chae, Bongsug. (2015). Insights from hashtag #supplychain and Twitter Analytics: Considering Twitter and Twitter data for supply chain practice and research. *International Journal of Production Economics, 165*, 247-259.

Chaney, Damien. (2012). The music industry in the digital age : consumer participation in value creation. *International journal of arts management, 15*(1), 42-52.

Chua, Alton Y.K, & Banerjee, Snehasish. (2013). Customer knowledge management via social media: the case of Starbucks. *Journal of Knowledge Management, 17*(2), 237-249.

Clarkson, Max E. (1995). A stakeholder framework for analyzing and evaluating corporate social performance. *Academy of management review, 20*(1), 92-117.

Colleoni, Elanor. (2013). CSR communication strategies for organizational legitimacy in social media. *Corporate Communications: An International Journal, 18*(2), 228-248.

Devaraj, Sarv, Fan, Ming, & Kohli, Rajiv. (2002). Antecedents of B2C channel satisfaction and preference: validating e-commerce metrics. *Information systems research, 13*(3), 316-333.

Donaldson, Thomas, & Preston, Lee E. (1995). The stakeholder theory of the corporation: Concepts, evidence, and implications. *Academy of management review, 20*(1), 65-91.

Ellison, Nicole B. (2007). Social network sites: Definition, history, and scholarship. *Journal of Computer-Mediated Communication, 13*(1), 210-230.

Etter, Michael. (2014). Broadcasting, reacting, engaging–three strategies for CSR communication in Twitter. *Journal of Communication Management, 18*(4), 322-342.

Fieseler, Christian, & Fleck, Matthes. (2013). The Pursuit of Empowerment through Social Media: Structural Social Capital Dynamics in CSR-Blogging. *Journal of Business Ethics, 118*(4), 759-775.

Freeman, R Edward, Harrison, Jeffrey S, Wicks, Andrew C, Parmar, Bidhan L, & De Colle, Simone. (2010). *Stakeholder theory: The state of the art*. Cambridge: Cambridge University Press.

Freeman, R.E. (2010). *Strategic management: A stakeholder approach*. Cambridge: Cambridge University Press.

Geyer, Sylvia, & Krumay, Barbara. (2015, 5-8 Jan. 2015). *Development of a Social Media Maturity Model -- A Grounded Theory Approach.* Paper presented at the HICSS, 2015 48th Hawaii International Conference on System Sciences.

Hastings, Gerard, Stead, Martine, & Webb, John. (2004). Fear appeals in social marketing: Strategic and ethical reasons for concern. *Psychology & marketing, 21*(11), 961-986.

Hoffmann, Christian Pieter, & Lutz, Christoph. (2015). The impact of online media on stakeholder engagement and the governance of corporations. *Journal of Public Affairs (14723891), 15*(2), 163-174.

Ingenhoff, Diana, & Sommer, Katharina. (2011). Corporate Social Responsibility Communication. *Journal of Corporate Citizenship, 42*(1), 73-91.

Johansen, Trine Susanne, & Nielsen, Anne Ellerup. (2011). Strategic stakeholder dialogues: a discursive perspective on relationship building. *Corporate Communications: An International Journal, 16*(3), 204-217.

Kaplan, Andreas M., & Haenlein, Michael. (2010). Users of the world, unite! The challenges and opportunities of Social Media. *Business Horizons, 53*(1), 59-68.

Krick, Thomas, Forstater, Maya, Monaghan, Philip, & Sillanpää, Maria. (2005). The Stakeholder Engagement Manual, Volume 2: The Practitioner's Handbook on Stakeholder Engagement. Retrieved 2015-08-09, from http://www.accountability.org/images/content/2/0/208.pdf.

Krumay, Barbara, & Brandtweiner, Roman. (2014). *Information Systems and Stakeholder Engagement. First Results from Content Analysis*. Paper presented at the MCSI 2014, Verona, Italien.

Lovejoy, Kristen, Waters, Richard D., & Saxton, Gregory D. (2012). Engaging stakeholders through Twitter: How nonprofit organizations are getting more out of 140 characters or less. *Public Relations Review, 38*(2), 313-318.

Man Hang, Yip, Phaal, Robert, & Probert, David R. (2014). Stakeholder Engagement in Early Stage Product-Service System Development for Healthcare Informatics. *Engineering Management Journal, 26*(3), 52-62.

Mangold, W. Glynn, & Faulds, David J. (2009). Social media: The new hybrid element of the promotion mix. *Business Horizons, 52*(4), 357-365.

Margraf, Sandra. (2011). *Strategisches Multi Channel Management & Social Media im CRM*. München: Martin Meidenbauer Verlagsbuchhandlung.

Meske, Christian, & Stieglitz, Stefan. (2013). Adoption and Use of Social Media in Small and Medium-Sized Enterprises. In Frank Harmsen & HenderikA Proper (Eds.), *Practice-Driven Research on Enterprise Transformation* (Vol. 151, pp. 61-75): Springer Berlin Heidelberg.

Michaelidou, Nina, Siamagka, Nikoletta Theofania, & Christodoulides, George. (2011). Usage, barriers and measurement of social media marketing: An exploratory investigation of small and medium B2B brands. *Industrial marketing management, 40*(7), 1153-1159.

Michigan Department of Information. (2009). Gudelines for Stakeholder Engagement.

Mustonen, Piia. (2009). *Social media: a new way to success?* (Vol. 1): Turku School of Economics.

Nie, Norman H., Miller, III. Darwin W., Golde, Saar, Butler, Daniel M., & Winneg, Kenneth. (2010). The World Wide Web and the U.S. Political News Market. *American Journal of Political Science, 54*(2), 428-439.

Parveen, Farzana. (2012). *Impact Of Social Media Usage On Organizations.* Paper presented at the Pacific Asia Conference on Information Systems.

Peters, Richard, & Golden, Peggy. (2013). Stakeholder Networks and Strategy: The Influence of Network Consistency and Network Diversity on Firm Performance. *Journal of Business Strategies, 30*(2), 120-144.

Poister, Theodore H., Thomas, John Clayton, & Berryman, Anita Faust. (2013). Reaching Out to Stakeholders. *Public Performance & Management Review, 37*(2), 302-328.

Porter, Michael E., & Kramer, Mark R. (2006). Strategy and Society: The Link Between Competitive Advantage and Corporate Social Responsibility. *Harvard Business Review, 84*(12), 78-92.

Qualman, Erik. (2010). *Socialnomics: How social media transforms the way we live and do business*: John Wiley & Sons.

Rowe, Frantz. (2014). What literature review is not: diversity, boundaries and recommendations. *European Journal of Information Systems, 23*(3), 15.

Rowley, Jennifer. (2011). e-Government stakeholders—Who are they and what do they want? *International journal of Information management, 31*(1), 53-62.

Spaulding, Trent J. (2010). How can virtual communities create value for business? *Electronic Commerce Research and Applications, 9*(1), 38-49.

Ulmer, Robert R. (2001). Effective crisis management through established stakeholder relationships Malden Mills as a case study. *Management Communication Quarterly, 14*(4), 590-615.

Unerman, Jeffery. (2007). Stakeholder engagement and dialogue. In Jeffery Unerman, Jan Bebbington, & Brendan O'Dwyer (Eds.), *Sustainability accounting and accountability*: Routledge.

Vernuccio, Maria. (2014). Communicating Corporate Brands Through Social Media An Exploratory Study. *International Journal of Business Communication, 51*(3), 211-233.

29th Bled eConference

Digital Economy

June 19 - 22, 2016; Bled, Slovenia

Do Gender and Personality Traits Influence Frequency of Use of Deal Sites?

Frantisek Sudzina

Aalborg University, Denmark

sudzina@business.aau.dk

Abstract

Although deal sites cannot be considered a new technology anymore, there is still only a limited amount of quantitative research on the topic. The paper aims to expand the body of knowledge. The study investigates impact of gender and personality traits on frequency of use of deal sites. Big Five Inventory-10 is used to measure personality traits. Three models are tested. First, all respondents are taken into account, i.e. also ones not aware of deal sites. In the first model, only gender is significant. Second, only respondents aware of deal sites are taken into account. In the second model, neuroticism, openness to experience, gender (and possibly agreeableness) are significant. Third, only respondents who use deal sites are taken into account. In the third model, openness to experience (and possibly extraversion) are significant.

Keywords: Deal Sites, Use, Personality Traits, Empirical Research

1 Introduction

By its nature, daily deal sites can be defined as social promotion sites or social media sites partners just like the well-known Groupon or LivingSocial, which usually offer vouchers or coupons for a local businesses at a deeply discounted price. As Gros and Grosova (2006) put it, price of goods or services is just one of the selection criteria, though still very important.

There are three main set of participants in a daily deal: subscriber, deal website, and merchant (Kim, Lee, & Park, 2013), where the revenue from it is divided between the daily deal site and the business (Schiller, 2011). As a consequence, it can be naturally stated that on the one hand, daily deals are involved in the action of representing the merchant, which offers discounted products, and on the other hand, they are appointed to present the customers, who are interested in purchasing them.

Interestingly, the daily deal's consumers are usually described as sporadic bargain hunters (Lacerda, Santos, Veloso, & Ziviani, 2015), but also can be defined as compulsive buyers. According to Kukar-Kinney, Scheinbaum and Schaefers (2016), the daily deal promotions can be closely associated with the compulsive buying, which explains the consumer's purchasing willingness as uncontrollable obsession. Moreover, Dholakia and Kimes (2011) reveal the statement that daily deal shoppers seem less sensitive to the so-called discount intensity, and they indicate more interest in the opportunity to experience some new products. Last but not least, Zhao, Wang and Gan (2016) argue that the deep discount can be considered as a main reason for a purchase, but only if the quality of the product is not considered as low.

Additionally, it seems that most of the academic studies related to different aspects over daily deals as a matter, use data obtained from the above mentioned two biggest players. Therefore, it can be assumed that to some extend most of the daily deal sites use also their models as a base for their own. For example, Ye, Sandholm, Wang, Aperjis, and Huberman (2012) make a comparison between Groupon and LivingSocial in relation to the dynamics of purchasing times. Byers, Mitzenmacher and Zervas (2012) utilize their data collection on a similar way, and analyze the relationship between deal sales and deal features.

In general, it was observed that there are almost no analyses concerned with the consumer's behavior in a daily deal, which probably can give more openings towards the knowledge about the rate at which daily deals occur. For example, there are studies, which focus is mainly on detailed examination of the businesses and the value of the use of deal sites as a reason that can bring profit or vice versa (Kumar & Rajan, 2011, Edelman, Jaffe, & Kominers, 2011).

Additionally, it was identified only one empirical research in relation to that issue, which classifies the daily deal site's consumers into two main groups: experienced customers and typical customers. According to Song, Park, Yoo and Jeon (2016), when the deal starts, the experienced consumers are more favorably disposed towards it, while the second group of shoppers tend to wait longer.

The aim of the paper is to investigate if gender and personality traits influence frequency of use of deal sites. Big Five Inventory framework is used because it is a prevalent framework for personality traits in information systems literature. Gender is considered because in many (probably in most) technology studies, men are higher and/or faster in adopting technology.

With regards to the rationale for impact of personality traits - deal sites are meant to promote business by encouraging preferably people, who never tried the product or the service, to try it due to a lower price while expecting that if they discover that they like the product or the service, they will keep buying it - people high in openness to experience are more interested in new things intrinsically, they do not need a monetary incentive, so it will be people low in openness to experience who would be likely influenced by deal site offers to try new products or services.

According to John, Naumann and Soto (2008) people high in extraversion enjoy being with others and according to Booth and Babchuk (1972), they report more leisure activities. So extraversion may be reflected by higher interested in deals for restaurants, sport activities (such as bowling) and services alike that allow them to spend time with other people. It is worth noting that the effect of extraversion is more narrow compared to openness to experience that applied equally to any type of service (including ones not allowing people to spend time with friends) and product.

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. Due to homogeneity of respondents, control variables such as age, income or education level were not collected.

Frequency of use of deal sites was measured using the question - *How frequently do you use deal sites?* Possible answers were

- Never
- Once a year
- Every 6 months
- Every 3 months
- Once a month
- 2-4 times a month
- Many times per week

They were coded from 1 to 7. There was no additional indication provided in the questionnaire whether it means checking available deals, buying vouchers, or both.

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 versus non-awareness of deal sites is provided in (Sudzina, 2015a). Of

237 respondents aware of deal sites, 106 never used them and 131 did. The analysis of use versus non-use of deal sites is provided in (Sudzina, 2015b).

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 disagree 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.

Ordinal logisitic regression was used to analyze impact of gender and five personality traits (extraversion, agreeableness, conscientiousness, neuroticism, openness to experience) on frequency of use of deal sites. A multivariate approach was used. SPSS software was used for the analysis.

Three models are presented. In the first model, raw data are used, i.e. included are also non-users (153 respondents) who never used deal sites regardless whether they were aware of them or not. In the second model, included are non-users (106 respondents), who were aware of deal sites but never used them. In both models, frequency of use for non-users is coded as 1, i.e. never. In the third model, only respondents, who use deal sites, were taken into consideration. Therefore, there is no estimate for [frequency = 1] in the third model. In other words, the models are meant for different scenarios depending on the amount of information, i.e. no other information than gender and personality traits for the first model, an additional information that the person is aware of deal sites for the second, and an additional information that the person uses deal sites for the third model.

3 Results

In the first model, all respondents, who never used deal sites (regardless whether they were aware of them), were considered as non-users. The research question is if gender, extraversion, agreeableness, conscientiousness, neuroticism, and openness to experience influence use of deal sites. Ordinal logisitic regression results for the full model are provided in Table 1. Cox&Snell R^2 is 0.056, Nagelkerke R^2 is 0.060, and McFadden R^2 is 0.020.

	Estimate	Std. Error	Wald	df	Sig.
[frequency = 1]	.385	1.161	.110	1	.740
[frequency = 2]	1.169	1.163	1.011	1	.315
[frequency = 3]	1.788	1.166	2.352	1	.125
[frequency = 4]	2.525	1.173	4.631	1	.031
[frequency = 5]	3.140	1.185	7.024	1	.008
[frequency = 6]	3.871	1.211	10.216	1	.001
extraversion	.039	.110	.125	1	.724
agreeableness	.179	.124	2.077	1	.150
conscientiousness	-.037	.113	.111	1	.739
neuroticism	.113	.099	1.289	1	.256
openness	-.145	.117	1.550	1	.213
[gender=male]	-.662	.244	7.359	1	.007

Table 1: Ordinal logistic regression with all respondents

Only gender is significant in the first model. Being male is associate with a negative estimator of frequency of use of deal sites. The reason for not even one personality trait being significant could be inclusion of respondents who were not aware of deal sites.

So, in the second 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 same independent variables were used. Ordinal logisitic regression results for the full model are provided in Table 2. Cox&Snell R^2 is 0.108, Nagelkerke R^2 is 0.113, and McFadden R^2 is 0.036.

	Estimate	Std. Error	Wald	df	Sig.
[frequency = 1]	.315	1.206	.068	1	.794
[frequency = 2]	1.248	1.209	1.066	1	.302
[frequency = 3]	1.931	1.213	2.534	1	.111
[frequency = 4]	2.713	1.221	4.934	1	.026
[frequency = 5]	3.351	1.233	7.384	1	.007
[frequency = 6]	4.098	1.259	10.591	1	.001
extraversion	.076	.115	.437	1	.508
agreeableness	.240	.132	3.297	1	.069
conscientiousness	-.032	.116	.078	1	.781
neuroticism	.220	.106	4.337	1	.037
openness	-.247	.124	3.978	1	.046
[gender=male]	-.782	.257	9.220	1	.002

Table 2: Ordinal logistic regression with respondents aware of deal sites

Neuroticism, openness to experience and gender are significant in the second model. In case of a larger sample, possibly agreeableness may prove to be significant as well. The influence on neuroticism (and agreeableness) on frequency of use of deal sites is positive, while the impact of openness to experience and gender is negative (the effect of being male was negative also in the first model).

Openness to experience is significant and in the direction hypothesized in the introduction. The hypothesized impact of extraversion was discovered.

The reason for neuroticism being significant is not completely clear. Neuroticism may imply more compulsive behavior that likely means usage. But most probably in only turns a non-user into a user, since neuroticism is not significant in the third model analyzing only users.

The reason for agreeableness being possibly significant is not clear. It may mean that a person agrees that the deal is worth trying or valuable as advertized.

In the third model, only respondents, who used deal sites, were considered. Respondents, who never used deal sites, were excluded from the analysis, therefore there is no estimate for [frequency = 1] in Table 3. The same independent variables as before were used. Ordinal logisitic regression results for the full model are provided in Table 3. Cox&Snell R^2 is 0.078, Nagelkerke R^2 is 0.081, and McFadden R^2 is 0.026.

	Estimate Std.	Error	Wald	df	Sig.
[frequency = 2]	-.274	1.602	.029	1	.864
[frequency = 3]	.722	1.603	.203	1	.652
[frequency = 4]	1.657	1.608	1.062	1	.303
[frequency = 5]	2.349	1.617	2.109	1	.146
[frequency = 6]	3.125	1.637	3.646	1	.056
extraversion	.286	.157	3.331	1	.068
agreeableness	-.072	.164	.193	1	.661
conscientiousness	.123	.151	.661	1	.416
neuroticism	.099	.137	.522	1	.470
openness	-.344	.167	4.235	1	.040
[gender=male]	-.409	.335	1.491	1	.222

Table 3: Ordinal logistic regression with respondents who use deal sites

Openness to experience is significant in the third model. In case of a larger sample, significance of extraversion may decrease bellow .05. Compared to the second model, neuroticism does not appear to be significant. The influence of openness to experience on frequency of use of deal sites is negative, while the impact of extraversion is positive.

4 Conclusion

In spite of fact that 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. 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 frequency of use of deal sites.

Three models were used to estimate their influence on frequency of use of deal sites. When all respondents were taken into consideration, only gender was significant. When information on whether a respondent is aware of deal sites is available, and only such respondents were taken into consideration, neuroticism, openness to experience, gender (and possibly agreeableness) were significant. When information on whether a respondent uses deal sites is available, and only such respondents were taken into consideration, openness to experience (and possibly extraversion) were significant.

So, depending on the background information is available about respondents, it would be appropriate for future studies focused on frequency of use of deal sites to include abovementioned variables as control variables. From a different point of view, if Big Five Inventory is to be used in a future study focused on frequency of use of deal sites and there is a need to cut down on questions, statements for conscientiousness can be dropped as it is unlikely to be significant considering its significance was between 0.416 and 0.781 in the presented analysis.

To conclude, women are more likely to use deal sites but considering only users, there is no significant difference between frequency of use between genders. It is people low in openness to experience who need the extrinsic motivation provided by deal sites in order to try new products and services. Further research using a probability sampling is necessary. Such research should then include additional control variables, such as age, education and income levels. It should also aim to test whether high extraversion leads to high interest only in deals which allow to spend time with others, such as restaurants, sporting and other leisure offers, or in all kinds of deals equally.

References

Booth, A. & Babchuk, N. (1972). Informal medical opinion leadership among the middle aged and elderly. Public Opinion Quarterly, 36(1), 87-94.

Byers, J.W., Mitzenmacher, M. & Zervas, G. (2012). Daily deals: prediction, social diffusion, and reputational remifications. Proceedings of the fifth ACM international conference on Web search and data mining, 543-552.

Dholakia, U. M. & Kimes, Sh. E. (2011). Daily Deal Fatigue or Unabated Enthusiasm? A Study of Consumer Perceptions of Daily Deal Promotions. SSRN. Retrieved on 11 February 2016 from http://ssrn.com/abstract=1925865

Edelman, B., Jaffe, S. & Kominers, S.D. (2011). To Groupon or Not to Groupon: The Profitability of Deep Discounts. Harvard Business School, Working Paper, 1-15.

Gros I., & Grosova S. (2006). Tajemstvi moderniho nakupu. Praha: Vysoka skola chemickotechnologicka v Praze.

John, O. P., Naumann, L. P. & Soto, C. J. (2008). Paradigm shift to the integrative Big Five trait taxonomy: History, measurement, and conceptual issues. In O. P. John, R. W. Robins, & L. A. Pervin (Eds.), Handbook of personality: Theory and research, 3rd edition (pp. 114-158). New York, NY: Guilford Press.

Kim, B., Lee, J. & Park, H. (2013). Platform Entry Strategy in Two-Sided Markets: Evidence from the Online Daily Deals Industry. Paper presented at the 11th Annual International Industrial Organization, Boston.

Kukar-Kinney, M., Scheinbaum, A. & Schaefers, T. (2016). Compulsive buying in online daily deal settings: An investigation of motivations and contextual elements. Journal of Business Research. 69(2), 691-699.

Kumar, V. & Rajan, B. (2011). Social coupons as a marketing strategy: a multifaceted perspective. Journal of the Academy of Marketing Science. 40(1), 120-136.

Lacerda, A., Santos, R., Veloso, A. & Ziviani, N. (2015). Improving daily deals recommendation using explore-then-exploit strategies. Information Retrieval Journal. 18(2), 95-122.

Rammstedt, B. & John, O. P. (2007). Measuring Personality in One Minute or Less: A 10-Item Short Version of the Big Five Inventory in English and German. Journal of Research in Personality. 41(1), 203-212.

Schiller, K. (2011). The rise of the daily deal: bargains drive revenue of publishers. EContent. 34(8), 16-20.

Song, M., Park, E., Yoo, B. & Jeon, S. (2016). Is the Daily Deal Social Shopping?: An Empirical Analysis of Customer Panel Data. Journal of Interactive Marketing. 33(1), 57-76.

Sudzina, F. (2015a). Do gender and personality traits influence awareness of deal sites? In The 11th International Conference on Strategic Management and its Support by Information Systems, 20-22 May 2015. Uherské Hradiště: VŠB-TU Ostrava, 304-308.

Sudzina, F. (2015b). Do gender and personality traits influence use of deal sites? In IDIMT-2015, Information Technology and Society, 9-11 September 2015. Poděbrady: Trauner Verlag, 133-138.

Ye, M., Sandholm, T., Wang, C., Aperjis, C. & Huberman, B. (2012). Collective attention and the dynamics of group deals. Proceedings of the 21st International Conference on World Wide Web, 1205-1212.

Zhao, M., Wang, Y. & Gan, X. (2016). Signalling effect of daily deal promotion for. Journal of the Operational Research Society. 67(2), 280-293.

29th Bled eConference

Digital Economy

June 19 - 22, 2016; Bled, Slovenia

Overcoming the interruptible nature of allergy treatment through applying knowledge management principles:

A Trip from raw knowledge to transferable wisdom

Peter Haddad

Deakin University and Epworth HealthCare, Australia

peter.e.haddad@gmail.com

Nilmini Wickramasinghe

Deakin University and Epworth HealthCare, Australia

nilmini.work@gmail.com

Abstract

Rates of food allergy diagnosis in children are increasing exponentially in developed countries; in Melbourne for example, 20% sensitisation and a 10% challenge in 12 month old infants were confirmed (Osborne et al., 2011).

As allergy services are stretched, patients are seen by different allergy practitioners, thus significantly challenging uninterruptible allergy care. Specific problems include prolonged waiting times for food allergy reviews; and the lack of a clear and comprehensive documentation of serial allergy test results over time in a consistent format. To address these issues this study will develop an electronic solution for use by both allergists and their patients to ensure prospective accurate and secure collection of skin prick test [SPT] or serum specific IgE [ssIgE] test data for long term follow-up of patients with food allergy, and applying intelligent tools and techniques to the developed database to enhance the ongoing care of children with allergies including developing tailored preventative strategies.

Keywords: Allergy, Intelligent tools and techniques, skin prick test, serum specific IgE test, database, knowledge management

1. Introduction

Rates of food allergy diagnosis have increased exponentially in recent decades in developed countries (Wang & Sampson, 2011). Recent data generated from the local Healthnuts study has identified an increase of 20% sensitisation and a 10% challenge confirmed food allergy rate in 12 month old Melbourne infants (Osborne et al., 2011), the picture of allergy in Australia in general looks even more worrying (Abels, Cogdill, & Zach, 2004). According to a report made for the Australasian Society of Clinical Immunology and Allergy (ASCIA) in 2007, there were 4.1 million Australians (19.6%) having at least one allergy, and the average Australian allergic person with 1.74 allergies, forecasting of 70% in the number of Australians with allergies affected from 4.1 million now to 7.7 million by 2050, and an increased proportion affected from 19.6% to 26.1% if the trends back then continued (Access Economics Pty Limited, 2007).

The financial impact of allergy treatment is high as well. 7.8 billion Australian dollar was the calculated cost of allergies in Australia in 2007. This is due to different interrelated factors like lower productivity ("presenteeism" $4.2 billion), direct medical costs ($1.2 billion), lower employment rates ($1.1 billion), absenteeism and lost household productivity ($0.2 billion) and premature death ($83 million)(Access Economics Pty Limited, 2007; Sampson, 2002).

Food allergy diagnosis is confirmed by a positive allergy test (Skin Prick Test [SPT] or serum specific IgE [ssIgE] blood test) in conjunction with a history of an immediate allergic reaction to that food. However, screening allergy testing is frequently performed in the community prior to a patient having known exposure to a food allergen, particularly in at risk patient groups eg. patients' with Atopic Dermatitis (AD). The size of the SPT or level of ssIgE are used as guides as to the likelihood or otherwise of clinical food allergy (Hill, Heine, & Hosking, 2004).

The gold standard for food allergy diagnosis in this setting is by a physician supervised food challenge.

Most food allergy in childhood resolves with time (eg. egg, milk, wheat, soy), however allergies to peanut, tree nut, fish and shellfish tend to be ongoing into adult life in up to 80-90% of patients. To follow up for the development of potential clinical tolerance patients are re-evaluated every few years with repeat allergy testing (either SPT or ssIgE) (Peters, Gurrin, Dharmage, Koplin, & Allen, 2013). The size of the SPT or level of ssIgE are used as guides as to the likelihood or otherwise of the development of clinical tolerance. Serial allergy testing over several years is common before the allergy test (SPT or ssIgE) is at a level where it may be considered appropriate to proceed with an oral food challenge (Sampson, 2002).

It is not an unusual clinical practice for clinicians to provide patients with a copy of their SPT results each time the test is performed as well as keep a record of the test in either written or electronic form in their patient database. As allergy services are currently stretched, there are frequently prolonged waiting times for food allergy review, particularly in the public sector. It is not uncommon for patients to be seen by different Allergy Practitioners for follow up testing in the longer term. In the interim patients are frequently encouraged to attend their general practitioner for food allergy follow up that may include intermittent evaluation of yearly or second yearly ssIgE to the food allergen(s) in question. In the event that these levels are low or approaching negative re-referral for follow up and consideration of formal inpatient challenge may be appropriate. In this situation it is not uncommon that previous test results are not readily available for comparison (Chan et al., 2015). There is some evidence to suggest that the rate of change in SPT size or ssIgE levels over time may help in predicting the development of tolerance.

Provisioning allergy care seems to lack accurate and reliable data within and between different allergy care providers. According to Prescott et al. (2013), more than 57% of 89 countries around the world had no food allergy prevalence data of any kind, and just 10% of these countries had this sort of data.

Thus, analysing the current approaches to treat allergy (Nieuwenhuizen & Lopata, 2005) shows a clear gap in this area. This mainly relates to the lack of documenting serial allergy test results (both SPT size and ssIgE levels) over time in a readily available and consistent dataset by both allergists and their patients. Offering this possibility would be an invaluable tool in the long term management of these patients. Thus, this study aims at developing an electronic solution for use by both allergists and their patients to ensure prospective accurate and secure collection of SPT and ssIgE data for long term follow-up of patients with food allergy.

Allergy Specialists (EAS) at the study site was established in 2010 to provide a comprehensive service for children, adolescents and adults with allergic and immune disorders including the long term follow up and management of patients with food allergy. EAS is the first such service to provide safe inpatient food challenges in the private sector in Australia. To date EAS has performed over 2000 food challenges to confirm or refute the development of tolerance to previously identified food allergens with a positive challenge rate of 20%. These challenges are not without risk with anaphylaxis occurring in 2% of all challenges currently performed at the study site, highlighting the importance of a service with expert staff equipped to deal with potentially life threatening anaphylaxis (Metcalfe, Sampson, & Simon, 2009; Prescott et al., 2013).

2. The Theory of Knowledge Management

To solve the dilemma of increasing rates of allergy, and its financial burdens, this research adopts the approach of Knowledge Management (KM). This theory deems appropriate to back this type of researches, as it aims at solving current business challenges by increasing the efficiency and efficacy of core business processes, while simultaneously incorporating continuous innovation (Wickramasinghe, Bali, Lehaney, Schaffer, & Gibbons, 2009).

Knowledge management is an emerging management approach that aimed at responding to the increasing need to better management of the ever increasing data stored in databases or even information that is being exchanged throughout different and complex networks (Geisler & Wickramasinghe, 2009). Primary drivers for KM include: 1) the global trend to invest in information and communication technology since late 1980s, and 2) the dilemma of lack of tools that domesticate the expertise within the organizations when senior executives leave their organizations (Wickramasinghe et al., 2009).

Knowledge management deals with distinct, but related, concepts, starting from data (raw knowledge), to information (data arranged into a meaningful pattern, to knowledge (contextualized information, and wisdom, upon its existence beyond knowledge there is a wide agreement (Wickramasinghe et al., 2009; Wickramasinghe & Von Lubitz, 2007).

2.1 Knowledge Management for Healthcare

With the ever increasing volume of data being produced daily in the electronic medical records (EMR) and clinical databases, knowledge management approaches provide a tools-rich platform to perform pattern-identification tasks, such as detecting associations between certain risk factors and outcomes, ascertaining trends in healthcare utilization, or discovering new models of disease in populations (Holmes et al., 2002).

In their comprehensive assessment of applying knowledge management in the healthcare industry, Wickramasinghe et al. (2009) noted that the gap between data collection and data comprehension and analysis is becoming more problematic, given the increased volume and complexity of clinical data, which, in on one or other, reflects the complexity of the healthcare itself (Wickramasinghe et al., 2009).

2.2 The Application of Knowledge Management on this Study

Utilizing the tools, tactics, and techniques that knowledge management offers is deemed appropriate for this research for the following reasons: First, the designed data base is expected to produce high volumes of data on different types of allergy in different age groups. Not only is the volume demanding, but also the complexity of the produced data is an issue. Those two factors combined, make the use of knowledge management prudent to maximize the benefit of using the designed database. Second, knowledge management will help bridge the gap between data collection as a routine procedure and data comprehension and analysis as an innovative and iterative process. This is highly important based on the explanation aforementioned.

Third, it will help clinicians to better understand their patients' data with less effort and time, which, in turn, increases the efficiency and efficacy of their daily operations.

Fourth, the aim of this study is to create a reliable and exchangeable knowledge among different allergy treatment providers, rather than merely creating the database. This is the core interest of knowledge management approach, by moving from raw knowledge (data), which is much context-dependent, to knowledge and then wisdom, which are much more context-independent (Wickramasinghe et al., 2009).

3. The Solution

Such an electronic database will ensure prospective accurate collection of allergy test results over time. In doing so, this will enable ready access to these results by both patients and clinicians at each point of contact with health service providers to aide in the long term follow-up and management of these patients with food allergies. The database will be designed to alert patients to appropriate timing for re-evaluation and potential consideration for food challenge; thereby, allowing timelier introduction of food to which they had previously reacted or had allergy test results predictive of likely true clinical allergy.

The longer term plan is to develop the database into a usable application for smartphone/ hand held devices increasing portability/usability and autonomy of patient groups with allergic disease.

4. Study Design Methodology

This research is exploratory, and aims at developing a tool to facilitate better allergy care. To operationalise this endeavour, a single case study methodology will be adopted. The case study is the paediatric allergy clinic at one of the largest private hospitals in Melbourne Australia. A number of data collection and analysis techniques will be used during this study. As noted by (Yin, 2009), case study methodology is appropriate when embarking upon exploratory research. Further, we will subscribe to established qualitative data analysis techniques such as thematic analysis to analyse the qualitative data (Boyatzis, 1998; Vaismoradi, Turunen, & Bondas, 2013) while descriptive statistics (Bower, 2013; Woolson & Clarke, 2011) will be used to analyse the survey data.

The study has two distinct phases:

1) Designing the technology solution; the database,

2) Testing the fidelity and usability of the designed database. Key activities will include:

- Storyboarding with head of clinic to clearly understand needs and requirements.
- Investigating the possibility to securely store photos of results of skin prick tests with data.
- Creating an App that the clinicians can use to enter skin prick test data.
- Creating a secure encrypted database.
- Ensuring data is backed up automatically.
- Calculating the "mean" for each allergen.
- Generating a trend analysis for each patient.
- Creating a printout results to replicate the existing Skin Prick Test.
- Printing out an informative results sheet for parents/patients.
- Testing and validation of the product.
- Testing the fidelity and validity of the database will be done over a 3 month period through a two-armed study, during which patients who agree to participate will be randomly selected into the technology arm (database plus standard care protocols) or standard care arm (current practice method) respectively. Clinicians will then perform the required allergy testing and consult using respectively the technology solution or standard care approach. We note that for the technology arm the research assistant will still complete the paper work as directed by the clinician so at all times all patients will at a minimum receive the same standard care. On the completion of the trial a focus group with the clinicians will be conducted to capture their insights on the usability of the proposed system, as well as their comments, recommendations and other feedback. Fidelity of the system will also be assessed by comparing standard care results with the technology arm results.

- To ensure the validity of the data collected through the focus group, an online survey will be administered at the conclusion of the focus group to ensure data triangulation.

5. Setting and Participants

This is an exploratory research study with a single case study in one of the largest private hospitals in Melbourne Australia.

During which both qualitative and quantitative data will be collected from three different sources:

1. Initial discussions with the head of a Melbournian allergy clinic to specify the initial design requirements based on the standard allergy care protocol.
2. Randomly selected de-identified existing patients' records from this clinic to help establish the main structure of the proposed system.
3. A focus group with up to 5 clinicians from this clinic to have their insights on the use of the proposed system, recommendations, and comments on and about the prototype once it is developed.

For data triangulation, an online survey to these clinicians will follow analysis of the collected data through the focus group. This survey will be designed and administrated using SurveyGizmo.

Participants will be invited via email and/or phone to join the focus group. They will be given a Plain Language Statement describing the research using simple English language and a consent form to guarantee anonymity while participating in the focus group.

6. Data Collection Plan and Techniques

Initial discussions have been conducted with the head of the allergy clinic. Through these discussions we have established that the need for an electronic database with intelligent analysis tools and techniques plus the mobile App is greatly needed. Patients' records will be randomly selected with full compliance with ethical requirements. This data will then be used to populate the developed database. The focus group will target up to 5 clinicians who work for the selected clinic. They are recruited based on their daily interaction with patients and their records. Those who participate in the focus group will be requested to complete a follow up survey for data triangulation. Patients who visit the clinic during the 3 month trial period will be asked if they wish to participate in the study (again subscribing to all ethical requirements) and if so will then be randomly selected into the respective arms of the two arm trial (as described above). All patients will receive equal care and attention irrespective of their participation or not in the study.

Data will be collected using the methods of 1) De-identified patient records, 2) focus groups, and 3) an online survey (using SurveyGizmo). All patient data will be handled using standard Australian Privacy Principles; including using double de-identified data to ensure confidentiality and anonymity. In addition, all patient data collected will be disclosed only with participants' permission, except as required by law. All information will be stored securely at the study site in a locked office in a filing cabinet and /or password protected computer. Table 1 summarises data collection plan and techniques:

Table1. A Summary of Data Collection Plan and Techniques

Key Participants/Key Milestones	Participants/Records	participant numbers
Initial Discussions	Specialist doctor (allergist)	• 1
Patients' records	De-identified Patients' records (historical records) randomly selected.	• Patients' records: <= 50 records
Focus Group	Clinicians work in allergy care. This will be conducted after the solution is trialled	• An expert group: ~= 5
On-line Survey	Clinicians work in allergy care. This will be conducted after the completion of the focus group.	• An expert group: ~= 5

7. Data Analysis

This study is predominantly qualitative. Thus, we will employ standard thematic analysis techniques to analyse the data collected through the focus group. This can be done effectively using NVivo 10 qualitative analysis software (Bazeley & Jackson, 2013), which will also be used to identify design requirements from the discussions with the recruited allergist. For the survey, we will use Nvivo as well as some basic quantitative analysis such as frequency analysis. The online survey will be administered using SurveyGizmo.

8. The Study Initial Outcomes

Currently the initial project prototype has been developed using: HTML, CSS, PHP, JavaScript, MySQL, PHP My Admin. A local WAMP server is installed on the study site.

A temporary database is created with dummy data for this initial development and testing.

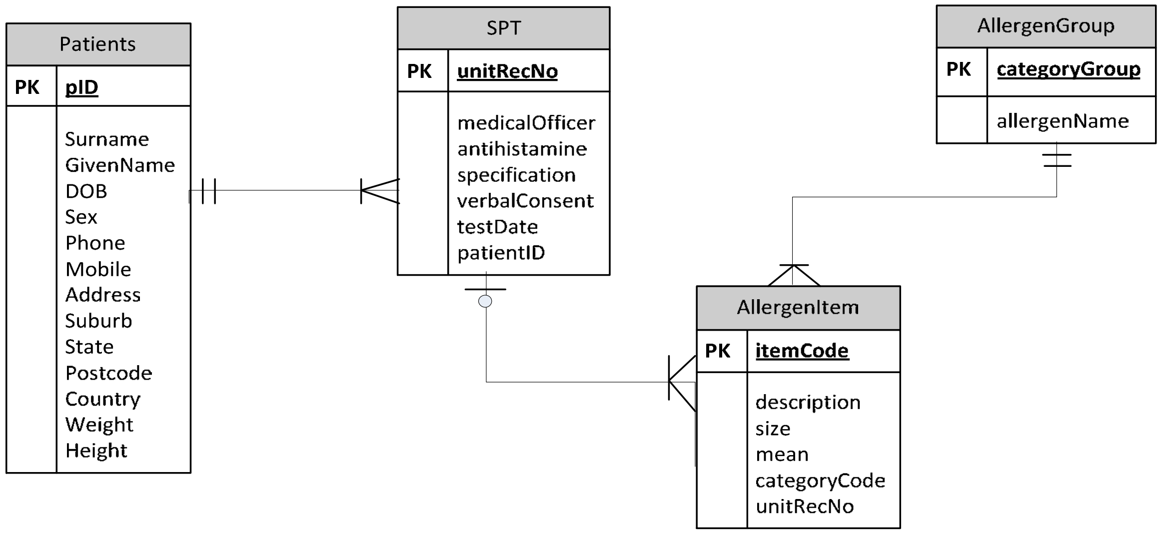


Figure 1. Allergy Database ERD

A proper database with real patient records/information must be imported and/or created for the next stages of the project development. The project progress is summarized as follows:

- **Requirements gathering**

Requirements gathering has already started. Project description, scope, and expectations are discussed in these meetings. Existing SPT forms and materials are gathered and stored in the research office.

- **Database**

A temporary database is created as the back-bone supporting system. The "allergyProject" database is stored on the standalone computer at the Research Institute and has the following details:

- users (<u>userID</u>, name, password)
- Patients (<u>patientID</u>, surname, givenName, DOB, sex, phone, mobile, address, suburb, state, postcode, country, weight, height)
- SPT (<u>unitRecNo</u>, medicalOfficer, antihistamine, specification, verbalConsent testDate, patientID)
- allergyGroup (<u>categoryCode</u>, allergenName)

- allergenItem (itemCode, description, size , mean, categoryCode, unitRecNo)

  - **SPT – website**

SPT-website is designed as demonstrated in Figure 2. The following are the major categories of the SPT and/or sslgE allergy testings.

- Food
- Plants
- Nuts
- Grain
- Inhalants / Aeroallergens
- Pollens
- Latex Panel
- Insects
- Animals
- Controls

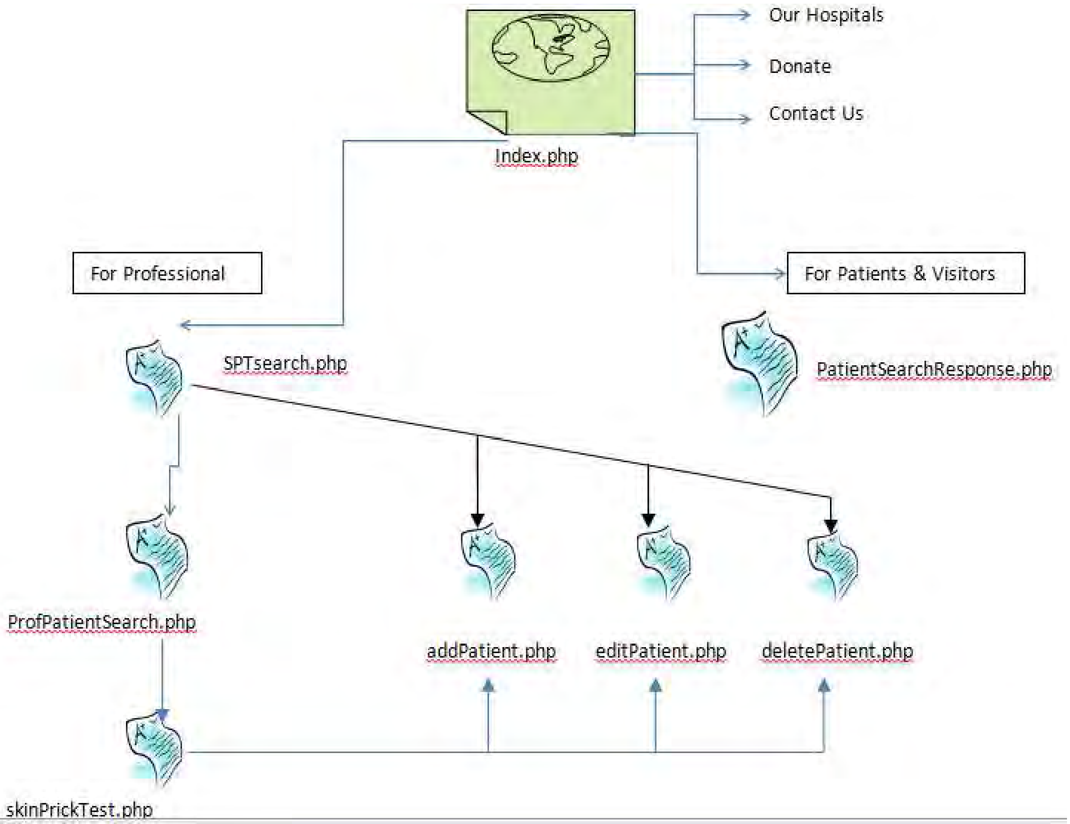


Figure 2. SPT – website

9. Discussion and Conclusion

This research has a number of implications for both theory and practice on achieving values, research and care quality. From a theoretical perspective it serves to extend many aspects of KM theory into the healthcare domain, which is a rich environment with data, information and knowledge. It is particularly useful for addressing the gap between data collection and data comprehension and analysis, which is becoming more problematic, given the increased volume and complexity of clinical data as pointed out by Wickramasinghe et al. (2009). This is expanded upon in our future work.

From the perspective of practice we highlight several key aspects as follows:

First, the product of this study can play a key role in keeping with the values this solution will enable patients to receive a better care experience. Furthermore, a solution like the proposed solution to provide superior allergy treatment and follow up for children will certainly enable healthcare providers to differentiate itself in this regard specially given that to the best of our knowledge this is a solution that has yet to be developed in other hospitals in Australia.

Second, this database has the potential to enhance the long term follow up of patients attending for comprehensive food allergy management at healthcare contexts. For example, this tool can generate much needed updated long term data on the natural history of food allergy from infancy, through to adolescence and adulthood.

Third, this project has great potential to be patented and commercialised again bringing kudos and financial benefits to healthcare contexts.

Fourth, this project will have benefits for pioneering both teaching and allergy areas at healthcare, as this is one of the first systems of its type in the Australian context, if any, to facilitate superior allergy care.

Further advancing outcomes are include developing the database according to agreed standards and through details discussions between clinicians, IT developers, and researchers will also help to develop rubrics for all such projects which are of importance in healthcare.

Most importantly, there will be instant and long-term clinical benefits by facilitating proactive and protective allergy care and management practices.

The next steps of this research will include empirical testing and also further focus on other aspects of KM including tacit knowledge and implicit knowledge capture.

10. Acknowledgement

We would like to thank Dr Joanne Smart for her help in this study. Her efforts and insights are highly appreciated.

References

Abels, E. G., Cogdill, K. W., & Zach, L. (2004). Identifying and communicating the contributions of library and information services in hospitals and academic health sciences centers. *Journal of the Medical Library Association, 90*(3), 46-55.

Access Economics Pty Limited. (2007). The economic impact of allergic disease in Australia: not to be sneezed at. Australia: Australasian Society of Clinical Immunology and Allergy (ASCIA).

Bazeley, P. a., & Jackson, K. (2013). *Qualitative data analysis with NVivo* (Second Edition. ed.): SAGE.

Bower, J. A. (2013). *Descriptive Statistics*. Oxford, UK: Oxford, UK: John Wiley & Sons Ltd.

Boyatzis, R. E. (1998). *Transforming qualitative information : thematic analysis and code development*. Thousand Oaks, CA: Sage Publications.

Chan, Y., Ho, H., Lai, C. K., Lau, C., Lau, Y., Lee, T., . . . Wu, Y. (2015). Allergy in Hong Kong: an unmet need in service provision and training. *Hong Kong Med J, 21*(1), 52-60.

Geisler, E., & Wickramasinghe, N. (2009). *Principles of knowledge management : theory, practices, and cases*. Armonk, N.Y.: M.E. Sharpe.

Hill, D. J., Heine, R. G., & Hosking, C. S. (2004). The diagnostic value of skin prick testing in children with food allergy. *Pediatric Allergy and Immunology, 15*(5), 435-441. doi: 10.1111/j.1399-3038.2004.00188.x

Holmes, J. P., Abbott, P., Cullen, R. N., Moody, L., Philips, K., & Zupan, B. (2002). *Clinical Data Mining: Who Does It, and What Do They Do?* Paper presented at the AMIA 2002 Symposium.

Metcalfe, D. D., Sampson, H. A., & Simon, R. A. (2009). *Food Allergy Adverse Reactions to Foods and Food Additives* (4th ed. ed.). Hoboken: Wiley.

Nieuwenhuizen, N., & Lopata, A. (2005). Fighting food allergy: current approaches.

Osborne, N. J., Koplin, J. J., Martin, P. E., Gurrin, L. C., Lowe, A. J., Matheson, M. C., . . . Allen, K. J. (2011). Prevalence of challenge-proven IgE-mediated food allergy using population-based sampling and predetermined challenge criteria in infants. *The Journal of Allergy and Clinical Immunology, 127*(3), 668-676.e662. doi: 10.1016/j.jaci.2011.01.039

Peters, R. L., Gurrin, L. C., Dharmage, S. C., Koplin, J. J., & Allen, K. J. (2013). The Natural History of IgE-Mediated Food Allergy: Can Skin Prick Tests and Serum-Specific IgE Predict the Resolution of Food Allergy? *International Journal of Environmental Research and Public Health, 10*(10), 5039-5061. doi: 10.3390/ijerph10105039

Prescott, S. L., Pawankar, R., Allen, K. J., Campbell, D. E., Sinn, J. K., Fiocchi, A., . . . Lee, B.-W. (2013). A global survey of changing patterns of food allergy burden in children. *The World Allergy Organization journal, 6*(1), 21. doi: 10.1186/1939-4551-6-21

Sampson, H. A. (2002). Improving in-vitro tests for the diagnosis of food hypersensitivity. *Curr Opin Allergy Clin Immunol, 2*(3), 257-261.

Vaismoradi, M., Turunen, H., & Bondas, T. (2013). Content analysis and thematic analysis: Implications for conducting a qualitative descriptive study (Vol. 15, pp. 398-405).

Wang, J., & Sampson, H. A. (2011). Food allergy.(Science in medicine)(Disease/Disorder overview). *Journal of Clinical Investigation, 121*(3), 827.

Wickramasinghe, N., Bali, R. K., Lehaney, B., Schaffer, J., & Gibbons, M. C. (2009). *Healthcare Knowledge Management Primer*. Hoboken: Taylor and Francis.

Wickramasinghe, N., & Von Lubitz, D. (2007). *Knowledge-based enterprise: Theories and fundamentals*: IGI (Hershey, PA, USA).

Woolson, R. F., & Clarke, W. R. (2011). *Descriptive Statistics*. Hoboken, NJ, USA: Hoboken, NJ, USA: John Wiley & Sons, Inc.

Yin, R. K. (2009). *Case Study Research: Design and Methods*. Beverley Hills: Sage Publications.

29th Bled eConference

Digital Economy

June 19 - 22, 2016; Bled, Slovenia

An Investigation on Integrating Eastern and Western Medicine with Informatics

Catherine Han Lin

Deakin University, Australia

lcatheri@deakin.edu.au

Angela Wei Hong Yang

RMIT University, Australia

angela.yang@rmit.edu.au

David Phillips

Deakin University, Epworth Healthcare, Australia

david.phillips@epworth.org.au

Nilmini Wickramasinghe

Deakin University, Epworth Healthcare, Australia

n.wickramasinghe@deakin.edu.au

Abstract

Today, in many western countries, acceptance of alternate forms of healthcare such as Chinese medicine (CM) is increasing. In fact, countries such as Australia, Canada, and England are going so far as to set regulations, education, and standards regarding the practice of CM in these respective countries. Further, we can see the integration between western and Chinese medicine delivery of care and treatments in many instances. Information Systems and Information Technology (IS/IT) can be a key enabler in assisting this integration. The following study examines aspects of such integrations using IS/IT and identifies that CM IS/IT is more likely to succeed when there is synthesis between key aspects of the unique environment and user requirements. This perspective is supported theoretically by adapting Churchman's Inquiring Systems to frame CM as a combination of Hegelian and Kantian inquiring systems with the support of Singerian, Lockean, and Leibnizian inquiring systems and Knowledge Management (KM) features. Based on this, the study then proposes a new design for a patient management system in clinics and hospitals.

Keywords: Healthcare Informatics, Clinic Management System, Inquiring Systems, Knowledge Management Systems, Information Systems, Information Technology

1. Introduction

Integrating western medicine (WM) with Chinese medicine (CM) has been a feature in China since WM was introduced to the country in the mid-19th century of Qing dynasty (Lin, Yang, Pittayachawan, & Wickramasinghe, 2015b). Today, it is common that patients are treated with both types of medicine (E. Chan, Tan, Xin, Sudarsanam, & Johnson, 2010). Although this integration has been very popular in China, it is relatively new to western countries. WM uses disease diagnosis with the foundation of pathological examination of individual organ functions or malfunctions (E. Chan et al., 2010). CM, on the other hand, is largely a philosophy, although it has been in practice for thousands of years based on its incredible values in healing and well-being. The lack of scientific and medical evidence is one of the major reasons that CM has not been fully accepted and integrated into the western healthcare system (Lin et al., 2015b). The situation, however, has altered in recent times. Studies have shown that CM is used in treatment plans either as ingredients (E. Chan et al., 2010; A. C. Chau, Cheung, Jiang, Au-Yeung, & Li, 2009; Xijun Wang et al., 2011) or to improve physical and emotional well-being (Molassiotis et al., 2005). World Health Organization's (WHO) traditional and complementary medicine (T&CM) strategy 2014 – 2023 urge its member counties to promote integrating "T&CM services and self-health care into national health systems" said general director Margaret Chan (WHO, 2013). WHO's goal and vision is to have a blended system which takes the best of both types of medicine and compensates for the potential weaknesses in each (Lin et al., 2015b; WHO, 2013). Lin et al. studied the current and future movements of CM and WM integration, and suggested that some developed countries (such as Australia, Canada, and England) are in a situation where WM predominates, with CM as a complementary and alternative medicine (CAM). National regulation, policies and standards are established and CM practices are partially integrated in these settings (Lin et al., 2015b). Furthermore, health insurance companies cover percentages of CM claims, and qualified CM practitioners must comply with the regulations.

In the process of this WM/CM integration, Information Systems and Technology (IS/IT) can play a key contribution. Developments can already be found in various applications and systems. For example, these include expert systems (Lam, Leung, Heng, Lim, & Wong, 2012), knowledge-based systems such as database/warehouse functions (Huang & Chen, 2007) and diagnosis and treatment assistant systems (He, Huang, Lu, Xue, & Lu, 2006). These systems have shown that IS/IT is an essential tool in assisting CM to be accepted into mainstream medicine practices. Nonetheless, literature reviews show that the existing CM IS/IT developments have limitations and there is a lack of suitable synthesis for this unique combination (Lin et al., 2015a; Yang, Allan, Li, & Xue, 2009).

This paper serves to extend Churchman's Inquiring Systems to depict CM as a combination of Hegelian and Kantian inquiring systems with the support of Singerian, Lockean, Leibnizian inquiring systems and Knowledge Management (KM) features and by so doing enable a deeper understanding of CM so that it might be then possible to design a patient management system (PMS) to support CM practice in a given clinic.

2. Problems and Challenges of CM developments

Medical developments in the 21st century have arisen from a multitude of factors, including a rapid increase in chronic diseases such as diabetes, a lack of resources in both drug manufacturing and medical funding, as well as educated patients who seek for better and holistic treatment of their illnesses and well-being (Lin et al., 2015b). Integrating WM with CM is a new approach that has shown some remarkable achievements in this aspect (E. Chan et al., 2010). Like any major change, challenges and problems are to be expected (Savery, 2015). This section reviews some of the major concerns in this regard.

2.1 Different regulations and standards

Research shows that most developed countries classify CM as a type of CAM (WHO, 2013). Regulations and experiences differ between countries; for example, Australia is at a stage where CM practitioners are expected to be qualified, and WM doctors who are trained and have knowledge in CM can be found in many medical clinics (Lin et al., 2015b). Specifically, with regard to Australia: 1) The CM profession is included in the National Registration and Accreditation Scheme (NRAS). A national registration of practitioners, acupuncturists, and dispensers of Chinese herbal medicine commenced on the 1st July, 2012 (AHPRA, 2014; CMBA(c), 2012). 2) Policies, registration guidelines, codes and standards are created and published to assist the CM medical profession. Accreditation standards and processes for consultation were developed by the Australian Health Practitioner Regulation Agency (AHPRA) and Chinese Medicine Board of Australia (CMBA) (AHPRA, 2014). 3) CM undergraduate and postgraduate courses are offered in the Australian tertiary education system. 4) A CMBA website was created which enables online service delivery and communication. The Chinese Medicine Portal was created in 2009 and serve as an online CM knowledge pool where information and clinical data can be retrieved and accessed (Yang et al., 2009). 5) AHPRA will directly allocate cost funding to CMBA to assist various activities undertaken by the agreement and strategies (AHPRA, 2014).

Regarding other western jurisdictions, in Switzerland CM was covered by the nation's basic health insurance program in 1999, but was taken out in year 2005 except CM acupuncture (Busato, Eichenberger, & Kunzi, 2006; Okma et al., 2010) . In most of Europe, it is illegal to sell manufactured unlicensed herbal medicines without the appropriate license (Fan et al., 2012). In the UK, the 2009 "Statutory Regulation of Practitioners of Acupuncture, Herbal Medicine, Traditional Chinese Medicine and other Traditional Medicine Systems Practised in the UK" states that all CM practitioners must be qualified and regulated (Holmes, 2011). In the USA, CM is recognised as dietary supplements and is regulated by the Dietary Supplement Health and Education (DSHEA) (C. F. Chau & Wu, 2006). Hence, CM is loosely regulated and assessed compare to WM. Patients' safety is a major concern.

In summary, different levels of legal foundations to establish quality and safety standards for CM and its practice exist in some countries on a national basis. An internationally recognised standard should be enforced to avoid confusion, aid in coordination and mitigate any health risks. Building on the existing contributions from Australia and other countries, future works may include increasing all aspects of WM and CM integration (Lin et al., 2015a) . For example: a) combine and integrate existing CM databases to international recognised format and standards; b) make global standardised CM practice regulations and guidelines what can be accessed online; c) develop suitable IS/IT solutions for various CM practice, and gradually achieve WHO's goal – a blended system. In this research, it is focused on finding the suitable synthesis to justify the IS/IT development in supporting managing the patients information at the clinic level.

2.2 CM IS/IT developments and challenges

The rich traditional knowledge of CM has helped the Chinese for thousands of years, integrating this medicine practice to the western world involves transferring this massive knowledge (K. Chan, Hu, Razmovski-Naumovski, & Robinson, 2015). So far many databases, repositories and information systems (IS) have been created (K. Chan et al., 2015). For example, the Traditional Chinese Medicine Information Database from the National University of Singapore contains information on 1588 commonly used prescriptions, 1313 herbs and 5669 herbal ingredients (E. Chan et al., 2010; TCM-ID, 2015). The University of Michigan Comprehensive Herbal Medicine Information System for Cancer includes 527 anticancer herbal formulations (E. Chan et al., 2010; Fang, Shao, Zhang, & Wang, 2005). Some CM expert systems and applications are developed for certain diseases or particular treatment. For example, a Chinese acupuncture expert system can assist physicians on acupuncture prescription, needle insertion position, and acupuncture points usage (Lam et al., 2012). Recent research studies addressing major IS/IT activities in CM are summarised in Table 1 below.

IS/IT	Group	Description	Examples
Databases	Database Dictionary Knowledge base grid Information System	• Repository, database containing detailed information on CM formulas, syndromes, herbs information including: pharmaceutical name; botanical name; multilingual pronunciation; distribution of the herb; properties (characteristics); Channels (meridians) entered; medical functions; actions & indications; chemical ingredients; recommended dosage; samples of formulae, toxicity, side effects and cautions; basic molecular properties; optimized 3D structures; origins; clinical effects.	Chinese Herbs Dictionary: Complementary and Alternative Healing University (Chu, 2013) 3D structure database of components from Chinese traditional medicinal herbs (Qiao, Hou, Zhang, Guo, & Xu, 2002). Phytochemical Databases of Chinese Herbal Constituents and Bioactive Plant Compounds with Known Target Specificities (Ehrman, Barlow, & Hylands, 2007)
Data mining	CM data mining & biomedical mining systems	• Data mining tools for CM herbs and formulations • Information Management System of CM Syndrome • Study on combination of hierarchical cluster approach and Bayesian networks. • Research approach and method including harmony learning and model selection	MeDisco/3T - text mining for clinical Chinese herbal medical knowledge discovery (Zhou, Liu, & Wu, 2005). Data mining system for multi-dimensional data analysis (Li et al., 2004). Structural learning of graphical models and its applications (Deng, Liu, Gao, & Geng, 2005).
CM diagnosis assistance	Diagnosis systems & approaches	• Individual diagnosis and treatment assistance system including: pulse-measuring points on wrists and their corresponding organs; electronic-brain medical erudite medical expert system; analysis packages of tongue and facial images, odour, speech and pulse; fuzzy expert systems assisting diagnosis for certain disease	Expert system for diagnosis in CM (Xuewei Wang, Qu, Liu, & Cheng, 2004). Web-based CM diagnosis system (Huang & Chen, 2007). Pulse analysis & diagnosis system (He et al., 2006). Fuzzy logic and its applications in medicine (Phuong & Kreinovich, 2001)

Table 1: Summary of existing CM IS/IT developments (sourced from (Lukman, He, & Hui, 2007)).

Studies have shown that the existing IS/IT developments have several limitations, such as: 1) selective information and lack of comprehensive data on the number of Chinese herbs with no or limited resources in Chinese acupuncture or vice versa (Yang et al., 2009); 2) most of the IS/IT system solutions are created in China or Asia, with limited scientific and evidence–based research in western countries (Lukman et al., 2007); 3) There is not a theory to support the IS/IT development in the integration of these medicines (Lin et al., 2015b).Further, a study of the current CM clinic management systems (consisting of SmartTCM Australia, TCM Herbalist Israel, TCM Organiser Canada, and Shen Professional Venezuela) also indicates some significant concerns including: a) Incorrect use of the Chinese language as well as lack of translation into other languages apart from Chinese and English (Lin et al., 2015b); b) Lack of a multi-user systems which can accommodate administrator, physician, and dispenser (Lin et al., 2015b); and c) current systems cannot be used on multiple platforms and devices (Lin et al., 2015b).

The most important limitation to the further application of CM is that the synthesis of IS/IT developments so far has been mainly studied and applied to WM (Lin et al., 2015b). This study suggests that blindly adopting these theories and technologies is not the best solution for CM. This view is supported in practice in other domains for example when we look at Enterprise Resource Planning (ERP) systems, such as SAP and Oracle, as they have failed to conquer the Chinese market by simply applying the same tools and techniques without first understanding and mapping the underlying circumstances and requirements (Xue, Liang, Boulton, & Snyder, 2005). To avoid similar failures, it is therefore necessary to systematically examine past experiences with WM IS/IT developments, and develop a theoretical foundation that is suitable for CM practice. Hence, we analyse the different inquiring and knowledge management systems in this domain drawing upon the work of Churchman (1971).

2.3 Inquiring Systems

C. West Churchman defines the five inquiring systems as: Leibnizian, Lockean, Hegelian, Kantian, and Singerian (Churchman, 1971). Each of these represent a type of inquiring organisation from a system view of knowledge creation, examination, and management (Churchman, 1971). This theory has been adopted, improved and implemented in many IS/IT research paradigms and developments (Parrish Jr & Courtney, 2012; Wickramasinghe, 2005). Below is a summary of these systems.

The *Leibnizian* inquiring system uses formal logic and analysis to generate fact nets and manipulate explicit knowledge (Churchman, 1971; Courtney, Haynes, & Paradice, 2005; Hall & Croasdell, 2005). Tacit knowledge gets little emphasis and new knowledge is generated as an externalisation of editing and systemizing. Most suited IS/IT models to this type of systems are expert systems (Hall & Croasdell, 2005; Mason & Mitroff, 1973; Parrish Jr & Courtney, 2012). The *Lockean* inquiring system contains communities sharing a common mind-set, knowledge is constructed through attention to symbolic references such as legends and/or well-respected authorities (Hall & Croasdell, 2005; Mason & Mitroff, 1973; Nonaka, Reinmoeller, & Senoo, 1998; Parrish Jr & Courtney, 2012). IS/IT used in this type of system include data warehouses (storing observations), data mining (analysing the observations), and groupware tools like emails (facilitating the communication and sharing) (Parrish Jr & Courtney, 2012) . The *Singerian* inquiring system generates cycles of processes which resolves problems and disagreements by introducing new variables and laws to provide guidance and overcome inconsistencies at each cycle, until the problem is fully investigated and understood from all sides (Hall & Croasdell, 2005; Mason & Mitroff, 1973; Parrish Jr & Courtney, 2012). All forms of knowledge including tacit and explicit, deep and shallow, declarative and procedural, exoteric and esoteric are considered, measured for improvements, judged by both organisational and society ethical standards (Hall & Croasdell, 2005; Mason & Mitroff, 1973; Nonaka et al., 1998; Parrish Jr & Courtney, 2012). The *Singerian* approach is best supported by networks based on groupware and web-based to allow virtual information gathering and learning because of its need to include a wide range of individual stakeholders (Hall & Croasdell, 2005; Mason & Mitroff, 1973; Parrish Jr & Courtney, 2012). The *Hegelian* inquiring system builds new synthesis by reflecting and resolving diametrically opposed perspectives. It tries to understand all behaviours, forms, processes, methods, arguments, and technology (Hall & Croasdell, 2005; Mason & Mitroff, 1973; Parrish Jr & Courtney, 2012). IS/IT solutions that support *Hegelian* inquiring systems include groupware, document management solutions, repositories that hold the debate data for better understanding of each other's proposals (Hall & Croasdell, 2005; Mason & Mitroff, 1973; Parrish Jr & Courtney, 2012). The *Kantian* inquiring system generate hypothesis base on multiple perspectives and inputs from various knowledge sources. It use explicit and tacit knowledge to consider the many interpretations of the inputs, in this process, the inquirer can study and determine different ways, modelling, methods and techniques to incorporate the new knowledge (Hall & Croasdell, 2005; Mason & Mitroff, 1973; Parrish Jr & Courtney, 2012). Examples of IS/IT using Kantian systems are the World Wide Web (www), databases, model management systems, decision support systems (DSS) and effective information systems (Hall & Croasdell, 2005; Mason & Mitroff, 1973; Parrish Jr & Courtney, 2012).

2.4 Inquiring System for WM

Healthcare Information Systems (HIS) have been largely developed to produce expert systems, theorem-proving systems, problem-solving and DSS, algorithm-generating systems, databases, and repositories in WM (Ferlie, Crilly, Jashapara, & Peckham, 2012; Liao, 2003). Hence, the existing HIS developments and solutions are mostly in the categories of Leibnizian and Lockean inquiring systems. For example, these include electronic knowledge repositories storing codified knowledge for future reuse, clinical DSS linking characteristics of patients with chest pain to software algorithms recommending specific action (Ferlie et al., 2012). Early form of Kantian inquiring system can be found in some DSS which takes information from various data sources and use these data to provide assistance with the structured portion of the semi-structured, however the human decision maker must rely on intuition and experience to assist them with the unstructured portions (Parrish Jr & Courtney, 2012). Singerian inquiring system's emphasis on ethical behaviour can be seen in most HIS where medical ethics and professionalism are mandatory and expected to maintain strictly in practice. An example of this is a DSS which is developed and implemented with the guidance and principles of patient safety, quality performance, regulations, and policies (Parrish Jr & Courtney, 2012).

3. Methodology

A mixed research method was chosen to address the research question because it allows exploring the issues faced by individuals (Venkatesh, Brown, & Bala, 2013), in particular, the CM practitioners, and it enables identifying the facets and propose productivity framework in order to better understand the proposed concept. Specifically, the research adopts Case Study methodology techniques in selecting the case clinics as well as conducting the interviews. Design Science methodology was also employed in this research to carry out processes in producing the proposed PMS.

3.1 Case Study (CS)

CS methodology is a commonly used and well-recognised research strategy in Healthcare Services and IS research. It attempts to examine a contemporary phenomenon in its real-life context (Yin, 1999, 2013). Through a typical CS, the research solution will be further supported by experiments which capture the circumstances and conditions of everyday and/or commonplace situation. In selecting the case clinics, this research uses a range of selection criteria including, for example, clinic size, number of patients and clinical staffs, and usage of both Chinese herbal medicine and acupuncture. The sample clinics must meet all the requirements and sign ethics agreements to participate in this research. Interviewing is one of the most familiar strategies for collecting qualitative data. It can provide important insights into the events or shortcuts to the prior history which helps to identify other relevant sources of evidence (Flick, 2009; Yin, 1999, 2013). This research will conduct semi-structured interviews with questions that are designed with experts assistance and existing documents from the study field. It is anticipated that open and broad questions will be asked at the beginning of the interviewing process, where the interviewee groups can express their opinions and/or propose their own insights into certain occurrences and for further enquiries. Interviewee groups from the case clinic include the CM physician, acupuncturist, administrator, and dispenser. Each interview is scheduled for about 20 minutes, will be audio recorded and notes will be taken by the interviewer.

3.2 Design Science (DS)

DS methodology has its roots in the field of engineering and science. It "seeks to create innovations that define the ideas, practices, technical capabilities, and products through which the analysis, design, implementation, management, and use of information systems can be effectively and efficiently accomplished" (von Alan, March, Park, & Ram, 2004). DS has been commonly used in IS/IT researches because it is aimed at developing executive information systems and system support emerging knowledge processes with effective development methods and system solutions for particular user group requirements or models (Lewis, 2015; Vaishnavi & Kuechler, 2015; von Alan et al., 2004). Furthermore, Von Alan et al, provided a DS IS research framework and set of guidelines and practical rules for IS researchers to follow. Based on this framework, the research has four processes: 1) Problem verification - this means that the research problem is confirmed and documented as additional supporting evidence to the research literature. Interviews are carried out and guided by the interview questions. Data are collected, categorised, and stored in a database; 2) Solution design – the PMS is designed. A solution framework and structure is crafted for the research problem tailored to the current CM clinic practices. Therefore data analysis is performed in two major phases. First, the existing clinical (as-is) situation will be modelled, described, and analysed. Then, areas of improvements are identified according to the proposed PMS structure. The new (to-be) system is analysed, explained, and modelled. 3) Evaluation - this is conducted to ensure rigour; the modules of the proposed system are evaluated, refined and tested with specification, expectation, and precise scope. 4) Summarise results – this is the final stage of the research. Findings, publications and a thesis are the expected outcomes.

3.3 Data collection and analysis

A thematic analysis is used in this research as a facilitator to assist communication between the above mentioned research methodologies, as it allows communication between different qualitative methods (Boyatzis, 1998). When reviewing the collected data, the researchers identify themes, such as CM herbs, acupuncture, treatment formulas, etc. separate similarities and differences, then refine, sort the data into different categories for further analysis. Periodical and ad-hoc peers and participants debriefing and checking are mandatory in this research as it helps to increase the rigour of the research. This is because it can: 1) keep everyone informed and on-track; 2) reduce communication errors and prevent/remove potential risks that may be caused by lack of communication and misunderstanding; and 3) allow timely correction and recovery. Modelling and testing techniques are also used to capture the situation of the case clinics and the PMS solution.

4. Preliminary results

Apart from the inquiring systems, KM systems are designed and developed to enhance knowledge intense tasks, processes, and projects for the purpose of knowledge creation, storage, retrieval, transfer, refinement, reuse, revision, and feedback (Maier & Hädrich, 2011). Hence KM architecture and characteristics are important elements which should be considered in CM developments.

4.1 CM IS/IT Development Design

Typical KM systems contain data and knowledge sources (including organisational internal and external information, data warehouses, document management, personal information management, contents management, and groupware); infrastructure services (providing basic functionality for communication, data and electronic assets management, extraction, transformation, and loading); integration services (managing knowledge from a variety of sources); knowledge services (involving discovery functions such as searching, mining, navigation, and visualisation; publication functions like structuring, formats, and contextualisation; collaboration functions including skill/expert management, knowledge sharing, awareness, and experience management; learning functions that use tools and techniques for authoring, managing courses, tutoring, learning paths, and examinations); personalisation services; and access services (Maier & Hädrich, 2011).

This research analyses the CM clinics' information and knowledge through a case study approach. It looks into the clinics' IT infrastructure services for messaging and files transferring. It also investigates how the clinic manages external information such as films and laboratory test results in assisting diagnosis and treatments. The research analyses if any expert knowledge system is used in the clinic; if the physicians use any decision support system (DSS) in assisting diagnosis and treatments; how does the clinic manage its reporting and standards required by the authorities, and; how do the clinic practitioners search, order, and manage their medical/herb information. The research also addresses how the clinics manage its practitioners' personal devices and applications as well as access level and security.

4.2 Preliminary/expected results

Guided by the aspects from the inquiring systems and KM, this research propose that CM IS/IT developments should follow a synthesis that is a combination of Hegelian and Kantian inquiring systems with the support of Singerian, Lockean, and Leibnizian inquiring systems and KM features. This is discussed in details in the next section. As an extension of the proposal, a PMS is built for the CM clinics. Figure 1 maps the system architecture of the PMS.

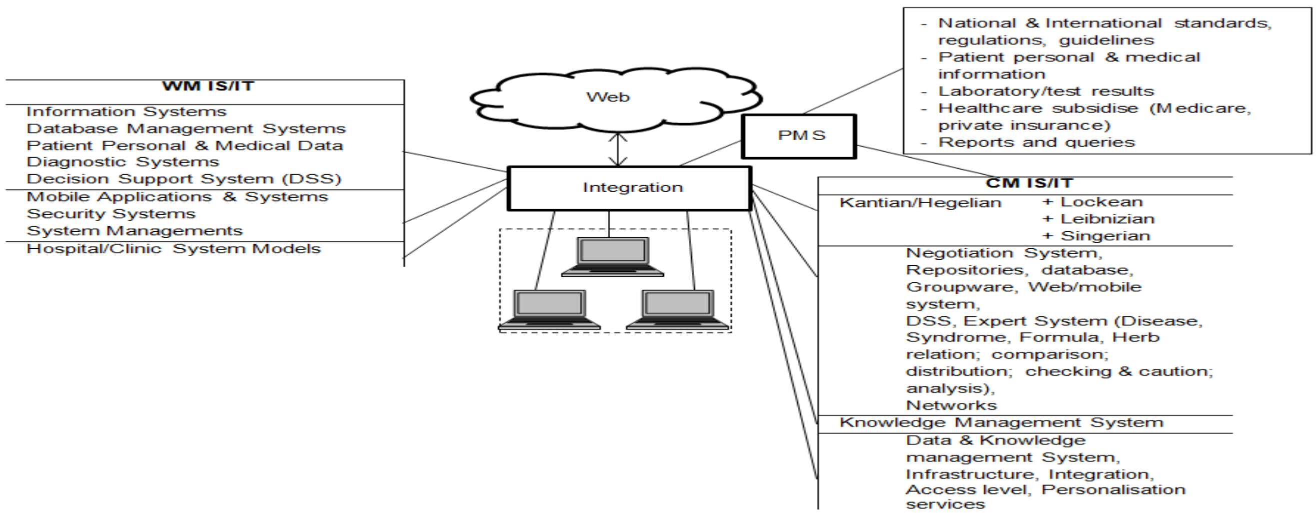


Figure 1: PMS system design

The PMS follows the CM IS/IT structure allowing negotiation and consultation between different systems, applications, and world views. It also has the intention to integrate WM and CM accordingly via the connection to different databases and accessing different network system functions for enquiring and confirmation. For example, a patient's medical history (other than CM medical history), which is stored in another database, can be obtained. Likewise, a WM doctor can access the patient's CM medical history (stored in bilingual format) to gain better understanding of the patient's overall health problem at the point of care.

The PMS is designed to comply with the national and international CM practice regulations, guidelines, and standards. According to CMBA, it should contain information about:

- Patient personal and medical data including cultural background information;
- Up-to-date sickness/problem/medication lists and its diagnosis and treatment plans;
- Record patients' progress, communications with other health service providers, and any discussion about possible side effects or alternative forms of treatments;
- Detailed record on prescriptions including name, strength, quantity, dose, instructions for use, number of repeats, start and end dates;
- Vital signs and changes including allergies and warnings;
- Incorporate clinical laboratory test results;
- Provide summary of care records for patients in case of referral or transition;
- All detailed procedures conducted (acupuncture points and stimulation methods);
- Generate reports, invoices, and rebates. (CMBA(d), 2012).

All of the above must be protected with access passwords and kept for at least seven years (CMBA(d), 2012). Therefore, a security archiving service may be necessary.

Information provided by the PMS can be used for: 1) knowledge sharing (Leibnizian inquiring system) between WM, CM, community and society; 2) further knowledge creation and transforming for both types of medicine practice; and 3) provide sources for studies on clinical trials and evidence-based research.

5. Discussion

CM is unique and follow a philosophy of systematic balance of Yin and Yang – opposite yet interdependent object (Bing & Hongcai, 2010; E. Chan et al., 2010). It emphasises inner, self-controlled system connectivity and balance between Yin and Yang energy, with any disorder being a result of failure and/or imbalance of the system (Huang & Chen, 2007; Lu, Jia, Xiao, & Lu, 2004; Zhao, Tsutsui, Endo, Minato, & Takahashi, 1994). Hence, an important element in CM practice is resolving, strengthening, and rebalancing the system with duality wisdom (Wickramasinghe, 2005). This is a typical Hegelian inquiring system which tries to resolve conflicts and proposes enlarged synthesis; as a result the problem is completely dissolved (Courtney et al., 2005; Hall & Croasdell, 2005; Morr, 2010). As indicated by Wickramashinghe that KM involves recognising the dualities in all knowledge creation and transform (tacit/explicit, Lockean & Leibnizian/Hegelian & Kantian, subjective/objective, people/technology), in so doing "a more complete and richer picture of knowledge is created and hence the impact to knowledge management" (Wickramasinghe, 2005). Hegelian's ability to understand all types of inputs support CM's comprehensive and systematic view of human diseases.

CM diagnosis methods are different to WM. In summary it uses four diagnosis methods: inspection (understand and predict the pathological changes by observing abnormal changes in the patient's vitality, colour, appearance, secretions, and excretions); auscultation and olfaction (listening and smelling); inquiring (asking the patient's condition); and palpation (place physician's first three fingers on the radial artery of a patient's wrist to detect different pulse qualities) (Huang & Chen, 2007; Zhao et al., 1994). These four approaches are used in combination in every diagnosis and cannot be separated or omitted (Zhu & Wang, 2011). A correct diagnosis can only be made based on a comprehensive and systematic analysis of a patient's condition at the point of care. CM physician's tacit knowledge and thorough analysis of each patient's unique health condition is a key which differentiates between the two types of medicinal practices. This is a category of Kantian inquiring systems, as hypotheses is generated on the basis of the inputs received from various knowledge sources (Churchman, 1971; Parrish Jr & Courtney, 2012).

CM treatments can be any of the following: herbs (including leaves, seeds, roots, flowers, fruits, minerals and animal products); acupuncture, moxibustion, tuina (Chinese remedial massage), cupping, qigong and diet therapy (Zhu & Wang, 2011). All treatments aim to increase human body's resistance to diseases and prevention by improving the inter-connections among self-controlled systems (Lu et al., 2004). This multiple compounds, methods, and diversities indicates that CM is a system of Kantian because it incorporates multiple perspectives and facts to determine different models and/or system design to discover and distribute information that it is the best-fit between itself and the environment.

To define a suitable CM inquiring system, we also need to consider that Kantian and Hegelian system rely on the Leibnizian inquiring system's fact net to generate knowledge (Churchman, 1971; Parrish Jr & Courtney, 2012), so the Leibnizian inquiring system is included as part of the knowledge base. Furthermore, Singerian inquiring systems' emphasis on ethical conduct is important. Patient safety, interests and social justice must be considered and built-in as principles and guidelines in any CM IS/IT developments and solutions. Table 2 illustrates this research's perspective.

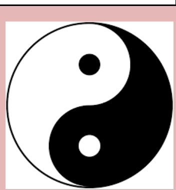
Inquiring Systems	Hegelian	Kantian	Singerian	Leibnizian	Lockean
Western Medicine					
Chinese Medicine	 Diagnosis: inspection, auscultation and olfaction, inquiring, palpation Treatments: herbs, acupuncture, moxibustion, tuina, cupping, qigong and diet therapy				

Table 2: CM Inquiring System (source from (Lin et al., 2015b))

6. Research Contribution and Future development

This research presents a synthesis which extends Churchman's inquiring systems theory into a new domain within healthcare and combining the inquiring system with a design science approach for actually designing and developing a proposed solution. The proposed PMS provide an example and suggestion for CM clinics to migrate from a manual system to a IS/IT solution. This in-progress research intends to also demonstrate integration between WM and CM through the designed system architecture is needed. The research project can be used as assistance for both the CMBA and the individual CM practitioners in maintaining regulations and standards. It is a reference and resource for both types of medicine research and education. This theoretical extension and the proposed system can be further developed and customised to other areas in the same domain.

References

AHPRA, C. (2014). *Chinese medicine regulation at work in Australia, 2013/14*. https://www.ahpra.gov.au/Publications/Corporate-publications/Annual-reports.aspx: AHPRA Retrieved from https://www.ahpra.gov.au/Publications/Corporate-publications/Annual-reports.aspx.

Bing, Z., & Hongcai, W. (2010). *Basic theories of traditional Chinese medicine*: Singing Dragon.

Busato, A., Eichenberger, R., & Kunzi, B. (2006). Extent and structure of health insurance expenditures for complementary and alternative medicine in Swiss primary care. *BMC Health Serv Res, 6*, 132. doi:10.1186/1472-6963-6-132

Chan, E., Tan, M., Xin, J., Sudarsanam, S., & Johnson, D. E. (2010). Interactions between traditional Chinese medicines and Western therapeutics. *Current opinion in drug discovery & development, 13*(1), 50-65.

Chan, K., Hu, X.-Y., Razmovski-Naumovski, V., & Robinson, N. (2015). Challenges and opportunities of integrating traditional Chinese medicine into mainstream medicine: A review of the current situation. *European Journal of Integrative Medicine, 7*(1), 67-75.

Chau, A. C., Cheung, R. T., Jiang, X., Au-Yeung, P. K., & Li, L. S. (2009). Increased brain activation in motor cortex after acupuncture treatment for motor recovery in chronic stroke patients. *The Open Rehabilitation Journal, 2*, 89-94.

Chau, C. F., & Wu, S. H. (2006). The development of regulations of Chinese herbal medicines for both medicinal and food uses. *Trends in Food Science & Technology, 17*(6), 313-323.

Chu, J. H. K. (2013). Chinese Herbal Medicine Dictionary. Retrieved from http://alternativehealing.org/chinese_herbs_dictionary.htm

Churchman, C. W. (1971). The Design of Inquiring Systems Basic Concepts of Systems and Organization.

CMBA(c). (2012). <CMBA-Continuing-Professional-Development.pdf>.

CMBA(d). (2012). *CMBA-Guidelines-for-Patient-Records*. Chinese Medicine Board of Australia: Chinese Medicine Board of Australia Retrieved from http://www.chinesemedicineboard.gov.au/Codes-Guidelines.aspx.

Courtney, J. F., Haynes, J. D., & Paradice, D. B. (2005). *Inquiring organizations: moving from knowledge management to wisdom*: IGI Global.

Deng, K., Liu, D., Gao, S., & Geng, Z. (2005). Structural learning of graphical models and its applications to traditional Chinese medicine *Fuzzy Systems and Knowledge Discovery* (pp. 362-367): Springer.

Ehrman, T. M., Barlow, D. J., & Hylands, P. J. (2007). Phytochemical databases of Chinese herbal constituents and bioactive plant compounds with known target specificities. *Journal of chemical information and modeling, 47*(2), 254-263.

Fan, T.-P., Deal, G., Koo, H.-L., Rees, D., Sun, H., Chen, S., . . . Shikov, A. N. (2012). Future development of global regulations of Chinese herbal products. *Journal of ethnopharmacology, 140*(3), 568-586.

Fang, X., Shao, L., Zhang, H., & Wang, S. (2005). CHMIS-C: a comprehensive herbal medicine information system for cancer. *Journal of medicinal chemistry, 48*(5), 1481-1488.

Ferlie, E., Crilly, T., Jashapara, A., & Peckham, A. (2012). Knowledge mobilisation in healthcare: a critical review of health sector and generic management literature. *Social Science & Medicine, 74*(8), 1297-1304.

Flick, U. (2009). *An introduction to qualitative research*: Sage.

Hall, D. J., & Croasdell, D. (2005). Inquiring organizations: an organizational form perspective. *Idea Group Inc*.

He, X., Huang, W., Lu, M., Xue, W., & Lu, Y. (2006). *Research and application of data mining in individual diagnosis and treatment based on chinese traditional medicine.* Paper presented at the GrC.

Holmes, D. (2011). UK moves to ensure “access to unlicensed herbal medicines”. *The Lancet, 377*(9776), 1479-1480.

Huang, M.-J., & Chen, M.-Y. (2007). Integrated design of the intelligent web-based Chinese Medical Diagnostic System (CMDS)–Systematic development for digestive health. *Expert Systems with Applications, 32*(2), 658-673.

Lam, C. F., Leung, K. S., Heng, P. A., Lim, C. E., & Wong, F. W. (2012). Chinese Acupuncture Expert System (CAES)-a useful tool to practice and learn medical acupuncture. *J Med Syst, 36*(3), 1883-1890. doi:10.1007/s10916-010-9647-0

Lewis, S. (2015). Qualitative inquiry and research design: Choosing among five approaches. *Health promotion practice*, 1524839915580941.

Li, C., Tang, C., Peng, J., Hu, J., Zeng, L., Yin, X., . . . Liu, J. (2004). TCMiner: a high performance data mining system for multi-dimensional data analysis of traditional Chinese medicine prescriptions *Conceptual Modeling for Advanced Application Domains* (pp. 246-257): Springer.

Liao, S.-h. (2003). Knowledge management technologies and applications—literature review from 1995 to 2002. *Expert Systems with Applications, 25*(2), 155-164.

Lin, C. H., Wei, A., Yang, H., Pittayachawan, S., Vogel, D., & Wickramasinghe, N. (2015a). *Inquiring Knowledge Management Systems--A Chinese Medicine Perspective.* Paper presented at the System Sciences (HICSS), 2015 48th Hawaii International Conference on.

Lin, C. H., Yang, A. W. H., Pittayachawan, S., & Wickramasinghe, N. (2015b). *An Analysis on the Utilisation of Health Information Technology to Support Clinical Operation of Chinese Medicine*. United States of America: IGI Global.

Lu, A.-P., Jia, H.-W., Xiao, C., & Lu, Q.-P. (2004). Theory of traditional Chinese medicine and therapeutic method of diseases. *World Journal of Gastroenterology, 10*(13), 1854-1856.

Lukman, S., He, Y., & Hui, S. C. (2007). Computational methods for Traditional Chinese Medicine: a survey. *Comput Methods Programs Biomed, 88*(3), 283-294. doi:10.1016/j.cmpb.2007.09.008

Maier, R., & Hädrich, T. (2011). Knowledge Management Systems.

Mason, R. O., & Mitroff, I. I. (1973). A program for research on management information systems. *Management science, 19*(5), 475-487.

Molassiotis, A., Fernadez-Ortega, P., Pud, D., Ozden, G., Scott, J. A., Panteli, V., . . . Selvekerova, S. (2005). Use of complementary and alternative medicine in cancer patients: a European survey. *Annals of oncology, 16*(4), 655-663.

Morr, C. E. (2010). Health Care Virtual Communities: Challenges and Opportunities. In M. M. Cruz-Cunha, A. J. Tavares, & R. J. Simoes (Eds.), *Handbook of Research on Developments in E-Health and Telemedicine: Technological and Social Perspectives* (pp. 278-298): Medical Information Science Reference.

Nonaka, I., Reinmoeller, P., & Senoo, D. (1998). TheART'of knowledge:: Systems to capitalize on market knowledge. *European management journal, 16*(6), 673-684.

Okma, K. G., Cheng, T.-M., Chinitz, D., Crivelli, L., Lim, M.-k., Maarse, H., & Labra, M. E. (2010). Six countries, six health reform models? Health care reform in Chile, Israel, Singapore, Switzerland, Taiwan and The Netherlands. *Journal of Comparative Policy Analysis, 12*(1-2), 75-113.

Parrish Jr, J. L., & Courtney, J. F. (2012). Inquiring Systems: Theoretical Foundations for Current and Future Information Systems *Information Systems Theory* (pp. 387-396): Springer.

Phuong, N. H., & Kreinovich, V. (2001). Fuzzy logic and its applications in medicine. *International journal of medical informatics, 62*(2), 165-173.

Qiao, X., Hou, T., Zhang, W., Guo, S., & Xu, X. (2002). A 3D structure database of components from Chinese traditional medicinal herbs. *Journal of chemical information and computer sciences, 42*(3), 481-489.

Savery, J. R. (2015). Overview of problem-based learning: Definitions and distinctions. *Essential Readings in Problem-Based Learning: Exploring and Extending the Legacy of Howard S. Barrows*, 5-15.

TCM-ID. (2015). Traditional Chinese Medicine Information Database. Traditional Chinese Medicine Information Database Retrieved 23/12/2015, from Depatment of Computational Science, National University of Singapore http://tcm.cz3.nus.edu.sg/group/tcm-id/tcmid_ns.asp

Vaishnavi, V. K., & Kuechler, W. (2015). *Design science research methods and patterns: innovating information and communication technology*: Crc Press.

Venkatesh, V., Brown, S. A., & Bala, H. (2013). Bridging the qualitative-quantitative divide: Guidelines for conducting mixed methods research in information systems. *MIS quarterly, 37*(1), 21-54.

von Alan, R. H., March, S. T., Park, J., & Ram, S. (2004). Design science in information systems research. *MIS quarterly, 28*(1), 75-105.

Wang, X., Qu, H., Liu, P., & Cheng, Y. (2004). A self-learning expert system for diagnosis in traditional Chinese medicine. *Expert Systems with Applications, 26*(4), 557-566. doi:10.1016/j.eswa.2003.10.004

Wang, X., Sun, H., Zhang, A., Sun, W., Wang, P., & Wang, Z. (2011). Potential role of metabolomics apporoaches in the area of traditional Chinese medicine: as pillars of the bridge between Chinese and Western medicine. *Journal of pharmaceutical and biomedical analysis, 55*(5), 859-868.

WHO. (2013). *WHO traditional medicine strategy: 2014-2023*: World Health Organization.

Wickramasinghe, N. (2005). The phenomenon of duality: A key to facilitate the transition from knowledge management to wisdom for inquiring organizations. *Inquiring organizations: Moving from knowledge management to wisdom, ed. J. Courtney, J. Haynes, and D. Paradice*, 272-315.

Xue, Y., Liang, H., Boulton, W. R., & Snyder, C. A. (2005). ERP implementation failures in China: Case studies with implications for ERP vendors. *International journal of production economics, 97*(3), 279-295.

Yang, A. W., Allan, G., Li, C. G., & Xue, C. C. (2009). Effective Application of Knowledge Management in Evidence-based Chinese Medicine: A Case Study. *Evid Based Complement Alternat Med, 6*(3), 393-398. doi:10.1093/ecam/nem124

Yin, R. K. (1999). Enhancing the quality of case studies in health services research. *Health services research, 34*(5 Pt 2), 1209.

Yin, R. K. (2013). *Case study research: Design and methods*: Sage publications.

Zhao, Y., Tsutsui, T., Endo, A., Minato, K., & Takahashi, T. (1994). Design and development of an expert system to assist diagnosis and treatment of chronic hepatitis using traditional Chinese medicine. *Informatics for Health and Social Care, 19*(1), 37-45.

Zhou, X., Liu, B., & Wu, Z. (2005). *Text mining for clinical Chinese herbal medical knowledge discovery.* Paper presented at the Discovery Science.

Zhu, B., & Wang, H. (2011). *Basic Theories of Traditional Chinese Medicine*: Singing Dragon.

29th Bled eConference

Digital Economy

June 19 - 22, 2016; Bled, Slovenia

Using Machine Learning to address Data Accuracy and Information Integrity in Digital Health Delivery

Zaid Zekiria Sako

Deakin University, Australia

zsako@deakin.edu.au

Vass Karpathiou

RMIT University, Australia

vass.karpathiou@rmit.edu.au

Sasan Adibi

Deakin University, Australia

sasan.adibi@deakin.edu.au

Nilmini Wickramasinghe

Deakin University and Epworth Healthcare, Australia

nilmini.wickramasinghe@epworth.org.au

Abstract

Today, much of healthcare delivery is digital. In particular, there exists a plethora of mHealth solutions being developed. This in turn necessitates the need for accurate data and information integrity if superior mHealth is to ensue. Lack of data accuracy and information integrity can cause serious harm to patients and limit the benefits of mHealth technology. The described exploratory case study serves to investigate data accuracy and information integrity in mHealth, with the aim of incorporating Machine Learning to detect sources of inaccurate data and deliver quality information.

Keywords: Data Accuracy, Information Integrity, mHealth, Machine Learning, Diabetes

1 Introduction

Reports from the World Health Organization (WHO) indicate that noncommunicable diseases are the leading cause of deaths worldwide, where the number of deaths from

2012 are projected to increase from 38 million to 52 million by 2030 (World Health Organization, 2014). Noncommunicable diseases according to WHO, are chronic diseases such as cardiovascular diseases, cancers, respiratory diseases and diabetes. Chronic diseases along with change in demographics, increasing costs of medical services, ongoing quality and safety issues in healthcare, are all major challenges to the delivery of healthcare services (Armstrong et al., 2007). These healthcare challenges mean finding new, effective and innovative solutions that ultimately lead to decreasing the pressure on Healthcare systems. Given today's digital economy, it appears logical to look for technology enabled solutions such as mobile phones.

The number of mobile phone subscriptions as per the 2015 statistics released by the International Telecommunication Union, is 7 billion worldwide (International Telecommunication Union, 2015). This presents an opportunity for mobile phones to be used as an intervention in the rising number of chronic diseases and for health management. As half of smartphone owners frequently browse for health information online and monitor their health using mobile health applications (Fox & Duggan, 2012), this gives mobile phones a new capacity to be used as mobile health. The definition of mobile health (mHealth) is the use of portable devices such as smartphones and tablets to improve health (Hamel et al., 2014).

While smartphones have a new role to play in the effective management of health and diseases, the technology must be clear of any medical errors. A medical error has been defined as a preventable adverse outcome that results from improper medical management (a mistake of commission) rather from the progression of an illness due to lack of care (a mistake of omission) (Van Den Bos et al., 2011). Errors in the medical field belong to a number of domains such as development and use of technologies, ergonomics, administration, management, politics and economics (Vincent, 2010).

A common root cause of medical errors is human error, where errors are of omission (forgetting to do something) and commission (intentionally doing something that is not meant to be done) (Health Informatics: improving patient care, 2012). However, medical errors have progressed from human to technological errors. Jenicek (2010) defines technological error in medicine as errors that relate to data and information recording, processing, and retrieval caused by information technology and its uses (information technology inadequacy and failure).

Using mobile phone technology as mHealth devices, has its own set of challenges. These challenges relate to data (accuracy, integrity, privacy, security and confidentiality) and information integrity. To break through these challenges and benefit from such promising technology, techniques such as Machine Learning, which apply probabilistic reasoning after the analysis of data, can help deliver robust and accurate mHealth solutions.

2 Literature Review

This section explores key areas of mHealth by first examining sources of inaccurate data, then information integrity and the role of Machine Learning in Healthcare.

2.1 Data Accuracy

At the centre of mHealth solution is data. The term data itself can be defined as information in the form of facts or figures obtained from experiments or surveys, and used as basis for making calculations or drawing conclusion, as defined by Dumas (2012). Accuracy according to WHO, is the original source of data and it is an element of data quality that is intended to achieve desirable objectives using legitimate means (World Health Organization, 2003). The quality of the data helps in evaluating health, assess effectiveness of interventions, monitor trends, inform health policy and set priorities (Van Velthoven et al., 2013). When data lacks accuracy, currency or certainty, it can have catastrophic results (Sadiq, 2013).

For mHealth solutions to be effective, the data collected from mHealth devices, wearables, and applications must be accurate and secure (Mottl, 2014). Accurate data ensures proper assessment and treatment of patients. Some of the traditional methods of assessing patients provide inaccurate data (Lin, 2013). The common standard for data collection in the medical field is direct observation. Direct observation is the observation of patients and the different patient characteristics at the clinic (Flocke & Stange, 2004). This allows for the collection of accurate data by directly observing the patients and their symptoms (Eisele et al., 2013). This standard is missing in mHealth solutions as there’s no direct observation of patients by the medical professionals during data collection.

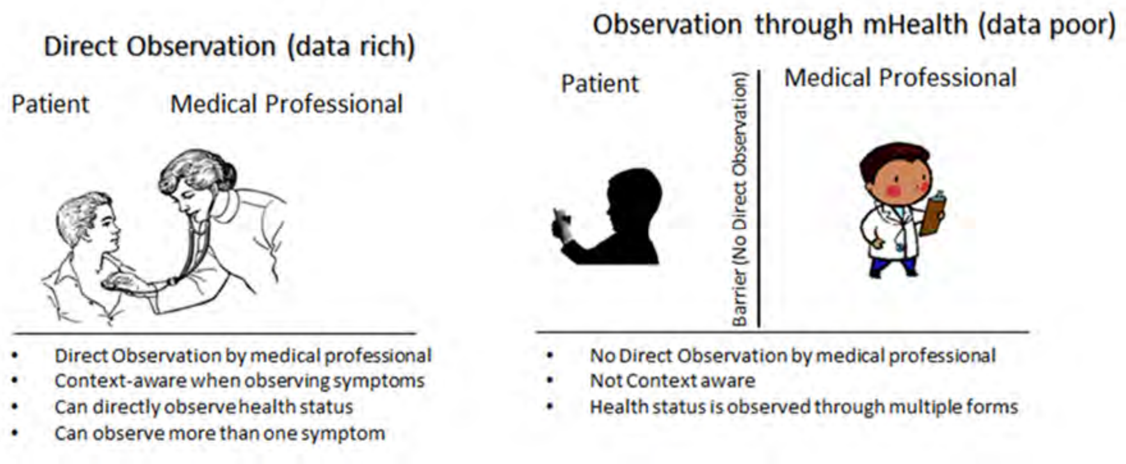


Figure 1: Direct Observation compared to Observation through mHealth (Characters obtained using Microsoft Online Pictures)

Figure 1 is an illustration of how observation through mHealth differs from the traditional direct observational method. This can introduce the risk of not conveying the full picture of a patient's health status.

The common methods of data collection in mHealth is through data entry by users or collected automatically if it is a sensor based solution. The issue of data inaccuracy can be classified into four categories. These categories are initial data entry, data decay, moving and restructuring, and using data (Olson, 2003).

1. **Initial Data Entry:** Mistakes, Data Entry Process, Deliberate, System Errors.
2. **Data Decay:** Accuracy of data when originally created over time
3. **Moving and Restructuring:** Extracting, Cleansing, Transformation, Loading, Integration
4. **Using:** Faulty Reporting, Lack of Understanding

In addition to the four (4) categories described above, intentional and unintentional wrong data entry and the speed at which data is collected can be misleading. Misleading data results in misallocating resources or interventions when needed for the patients (Patnaik, Brunskill, & Thies, 2009). Inaccurate readings, insufficient amount of data, movement and physical activities also contribute to inaccurate data provided through the mHealth devices (Mena et al., 2013). Another factor that affects the quality of the data is security breaches, where unauthorized modification or alteration is made to patients' data that compromise their confidentiality and privacy (Mena et al., 2013).

Concerns associated with data accuracy and validity are persistent and can become a risk to patients' safety (Linda, 2012). mHealth solutions must deliver accurate data. For data to be accurate, it must always consist of completeness, consistency, currency, relevance and accuracy (Narman el al., 2011). In mHealth, these elements of data quality can be compromised as data goes through 5 different stages. These are: (1) Collection, (2) Transmission, (3) Analysis, (4) Storage and (5) Presentation (Klonoff, 2013). This means data must be accurate and consistent over its entire life-cycle in order to conform to data integrity (Cucoranu et al., 2013).

Inaccurate data does not only affect data integrity, but also the information that are generated based on the collected data. This can compromise the integrity of the information and thus mislead patients and misguide treatments.

2.2 Information Integrity

Information at the very basic level, is raw data that is processed and transformed into information, from which then knowledge is extracted (Dumas, 2012). In mHealth, Information must conform to integrity. The Integrity of Information is about having the right properties of information including sensitivity in which information is used, as well as encompassing accuracy, consistency and reliability of the information content, process and system (Fadlalla & Wickramasinghe, 2004). mHealth can be used in a number of ways for the treatment of patients and delivery of healthcare services. It is vital that the information generated is accurate in order to avoid misdiagnosis, delayed care seeking, incorrect self-treatment, conflict over appropriate care or non-adherence to treatment and medication (Kahn, Yang, & Kahn, 2010).

The shift from clinician care towards patient centred model is encouraging patients to actively self-manage and make decisions concerning their health (Boulos et al., 2011). To sustain self-management using mHealth, patients must be provided with accurate information that are of high integrity. The integrity of information produced as a result of shift in the dynamics of technology has been getting more focus as the interaction experience has changed (Cunningham, 2012). What causes information to lack integrity is errors in healthcare systems due to data loss, incorrect data entry, displayed or transmitted data (Bowman, 2013).

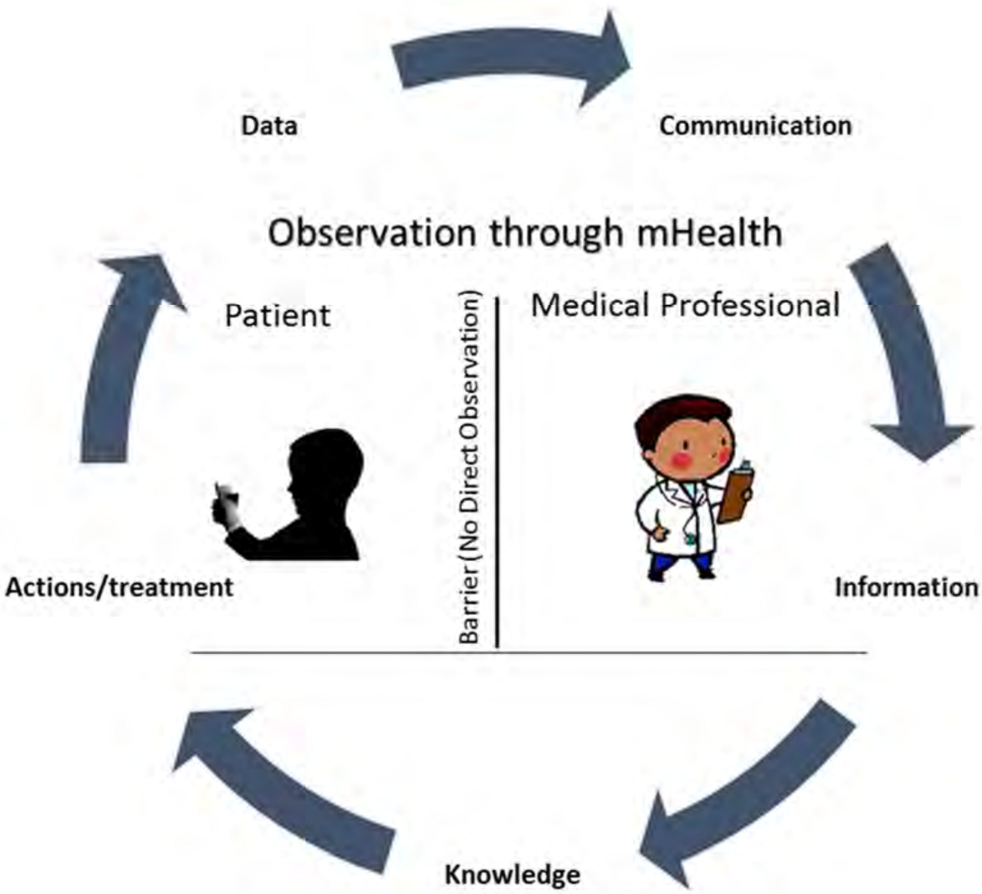


Figure 2: Transformation of data into knowledge in order to provide treatment (Characters obtained using Microsoft Online Pictures)

During the data collection stage, if the data is inaccurate, it continues through the data transformation cycle (See Figure 2). When data reaches the medical Professional, they apply their reasoning based on the provided data, from which then a recommended set of actions or treatment is suggested. If Information that's circled during this process lacks integrity, the outcome of the treatment or suggested set of actions can unintentionally harm the patient.

To treat patients correctly using mHealth and ensure information integrity, then data governance, information workflow management, internal controls, confidentiality and data privacy processes must exist (Flowerday & Solms, 2010). These processes along with information technology can improve the quality of care by decreasing medical errors due to inaccurate and untimely information (Mahmood et al., 2012). Using a semantic tool when processing data and transforming it into information, can prove critical in detecting errors in data and ensuring information are of relevance to the patients and treatments. One common and publicly available semantic tool is the Omaha System. The Omaha System 'is a complex, multi-axial, hierarchical, relational standardized health services taxonomy' as explained by (Monsen et al., 2009). The Omaha System has been integrated into software programs, recognized by nursing associations, and is in agreement with the International Organization for Standardization (ISO) (Monsen et al., 2009). The three (3) components of the Omaha System (See Figure 3) are the Problem Classification Scheme, the Intervention Scheme, and the Problem Rating Scale for outcomes. The first component of the Omaha System enables healthcare professionals to collect assessment data such as signs and symptoms, intervention scheme to design intervention and it is driven by the provider, and lastly is an outcome measurement scale for evaluating the interventions and the care process (Topaz, Golfenshtein, & Bowles, 2014).

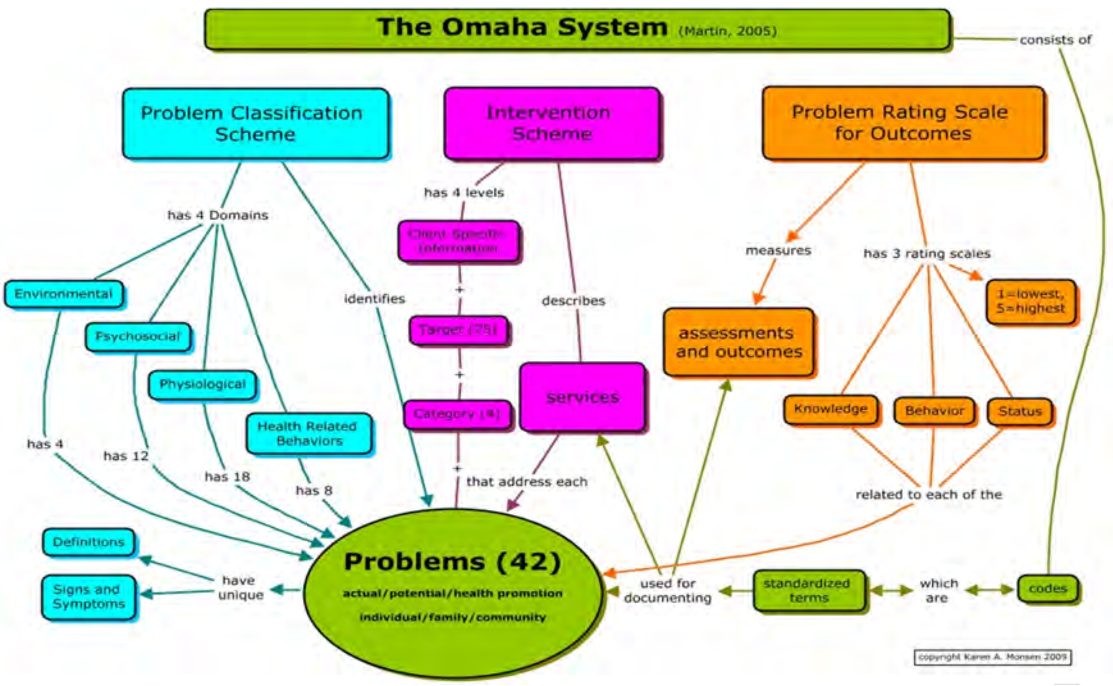


Figure 3: The Omaha System 2005 version (Adapted from The Omaha System Chart, 2015)

Using the Omaha System in an accurate and consistent way, would establish an effective basis for documentation, communication, coordination of care and outcome measurement (Garvin et al., 2008). Incorporating Omaha System in mHealth, can potentially increase the accuracy of data and information.

Elements from the Omaha System have also been incorporated into Machine Learning Algorithm studies (Monsen et al., 2009). This offers a role for Machine Learning to be adapted in mHealth technology to improve the detection of inaccurate data using the standardized taxonomy, that would enhance the quality and delivery of information of high quality.

2.3 Role of Machine Learning in Healthcare

Machine Learning has enabled smarter use of data in health by shifting from curing diseases to anticipating and preventing them before they occur through real time data analysis (Kumar et al., 2013). The prediction of diseases is the result of analysing large amount of data through different mHealth tools (Figure 4).

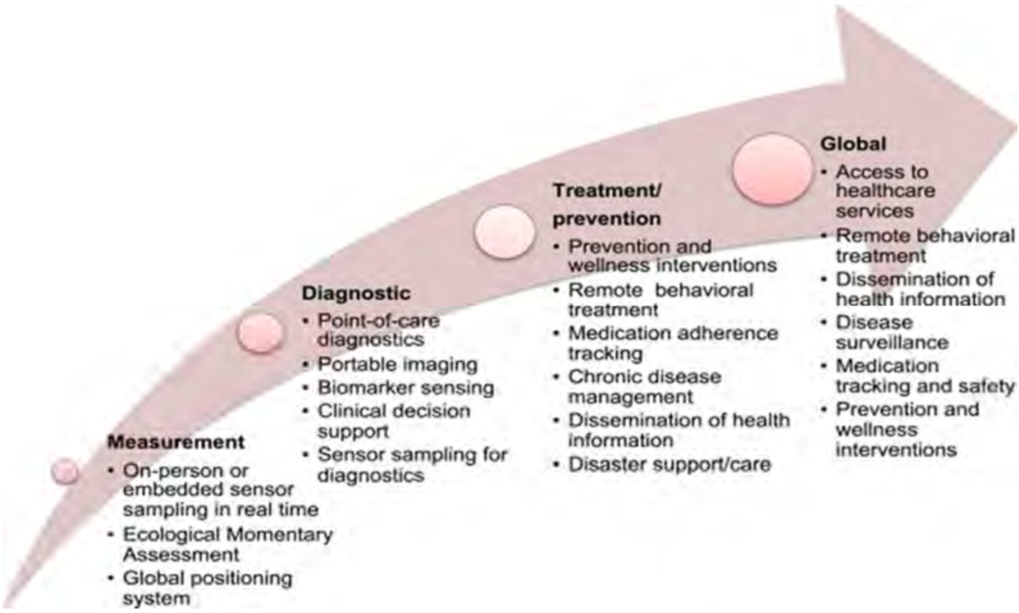


Figure 4: Continuum of mHealth Tools (Adapted from Kumar et al., 2013)

mHealth can be used as a tool for different purposes, such as the measurements of GPS locations and sensor readings, diagnosis, treatment and prevention, and access to global healthcare services. Despite the opportunities and benefits mHealth brings, the risk of medical errors occurring in mHealth must be constrained. Varshney (2009) describes common medical errors as those found during investigation, diagnosis, treatment, communication and office administrations errors.

Constraining these errors during those stages can be achieved by learning about the collected data and applying analysis techniques to find sources of inaccurate data. The analysis performed by Machine Learning, extracts new knowledge when there is great amount of data (Lambin el al., 2013). The machine learning algorithms learn and improve the outcomes through experience and observation (Oquendo et al., 2012).

The concept of Machine Learning is – Learning that improves with experience at some task. That is (Bell, 2014):

- Improve over task, T
- With respect to performance measure, P
- Based on experience, E

Machine Learning algorithms can play a pivotal role in acquiring accurate data through pre-trained algorithms that can be deployed in mHealth solutions. Support Vector Machines (SVM) algorithm was deployed in a blood pressure measurement application on an android tablet that detected the patient's arm and ensured stability, in order to acquire accurate reading of the data performed by the cuffs (Murthy & Kotz, 2014). In a fall detection scenario, recorded data were used from a database which contained 95 instances of recorded falls, from which then four types of machine learning algorithms were applied to accurately detect a fall (Sannino, De Falco, & De Pietro, 2014).

The role of Machine Learning in detecting inaccurate data through reasoning, could prove crucial in enhancing the quality of the data collection stage of mHealth, as the accuracy aspect of data is a major challenge in itself. Removing inaccuracy and assuring high data quality, would result in a deluge of solutions that can be developed to help manage diseases to reduce healthcare costs.

With Machine Learning having a role in the delivery of mHealth, the proposed study is to investigate data accuracy and information integrity in the context of mHealth solution by addressing the research question:

How can Machine Learning be applied in mHealth solutions to provide data accuracy and Information Integrity?

3 Conceptual Model

Figure 5: Conceptual Model

To help address the accuracy problem in mHealth, the conceptual model (See Figure 5) has been developed to facilitate the detection of data inaccuracy in mHealth and draws on providing high quality information using multiple agents. The conceptual model is built using the elements of data integrity that prove critical to generating high quality information that is free of errors.

The four (4) agents described in the conceptual model can perform smart functions which help detect and assess the accuracy of the value that is received from a patient during the use of mHealth:

1. **Time of the day:** The function of this agent is to check for data decay, currency and timeliness, which makes the treatment and actions to be relevant and provide information in a timely manner. Thus ensuring no delay in seeking treatment and allows for monitoring of the patient to be more relevant.
2. **Reading from previous day:** The function of this agent can detect mistakes by comparing the current value against what was provided previously. Where there's a significant difference, it will notify the medical professional of such event to raise awareness about the change in the value.

3. **Average value from previous reading:** The advice given to a patient during mHealth treatment is often based on the current value and does not take into an account the history of the patient. This agent performs calculations that finds the average value as well as providing a better insight of the patient's behavior by providing a trend using the available historical data.
4. **Medical standards:** This agent checks the current value against the standard, acceptable medical reading that is of the right range and conforms to medical data definition related to the disease.

4 The Proposed Research Methodology

In addressing this study's research question, a qualitative research method is applied using an exploratory case study. The following justifies the chosen research method, data collection, analysis and reporting.

4.1 Single Case Study

Yin (2014) defines case study as 'an empirical inquiry that investigates a contemporary phenomenon (the "case") in depth and within its real-world context, especially when the boundaries between the phenomenon and context may not be clearly evident'. Case studies are not considered a methodology but rather a choice of what is to be studied (Denzin and Lincoln, 2011), and they are for studying a single group, event or person (Donley, 2012). The selected case study is a mHealth solution for diabetes, with the case being patients' data. The selection of the case is guided by two principles. First is the form of question posed in this research where the form is 'How', requires no control over behavioural events (no control over how the data is produced) and focuses on contemporary events as the case (patients' data) is studied in its real-world context.

The second principle in selecting such case study is the single-case study rationale where the case is critical to the theory (Yin, 2014) and relevant to the research question. Treating patients via mHealth rather than at the clinic could allow a gap for errors. Accessing such case study, enables the research question to be addressed by examining patients' data and exploring the characteristics of the data, the intended meaning when data was produced and how it contributes towards the treatment of the patient.

4.2 Data Collection

The type of data collected for this study is qualitative secondary, de-identified data of patients with diabetes. Secondary, de-identified data is data that is used for research purposes and do not identify or represent a person (McGraw, 2012). The de-identified data will be of records of patients who have diabetes and contain information such as time and date of measurement, glucose reading and a description of the reading. The chosen method of data collection seeks data that presents a chronic disease that is relevant to the case study, it is produced by people in real world and is authentic.

4.3 Data Sampling

With the proposed method of data collection being Secondary data, the sampling technique employed in this study is convenience sampling. The selection of this sampling technique is due to the readily available and accessible secondary data that is used for this study, and conveniently recruited (Gideon, 2012) through two sources. The first sample is diabetes data from clinical solution for the treatment of diabetes, while the second source is data from mHealth solution. The sample represents one of the many developed mHealth solutions and the data characterize the type of data created when using mHealth.

4.4 Data Triangulation

The data is triangulated using triangulation of different data sources of information by separating the secondary data into different data sets to build coherent justification for themes (Creswell, 2009). The datasets will be numbered to represent different patients and for triangulation to confirm the accuracy of the findings.

4.5 Data Analysis

The data analysis is performed using Thematic and hermeneutics techniques. Thematic analysis is will be applied to aid in the interpretation of the texts by coding the data into organized segments of texts before bringing meaning to information (Creswell, 2009), and later underlining them for generating themes that describe passages in the data (Cohen, Steeves, & Kahn, 2000). In analysing the themes, Hermeneutics analysis is used to provide a detailed description of the text to capture and communicate the meaning of the lived experience (patients using mHealth) being studied (Cohen, Steeves, & Kahn, 2000). This is to seek interpretation of the mHealth data and understand the meaning of it, accuracy of the values and what the producers of the text initially intended it for (Flick, Kardorff, & Steinke, 2004).

5 Limitations

A key challenge for this research that requires mentioning is the use of secondary data. Using secondary data does not allow this research to observe the patients nor their behaviour during the use of the mHealth solution, specifically when the patient enters the data. Thus, this research does not take into consideration the human factors that can affect the accuracy of the data. Despite this difficulty, this is a major challenge in mHealth as there’s no direct observation of the patient or their behaviour when the data is collected. Using the secondary data helps establish methods that can overcome this challenge and ensure data accuracy and information integrity in mHealth through the use of machine learning.

Another limitation is the study's focus on a single chronic disease, diabetes. Diabetes is one of the many chronic diseases listed by World Health Organization. However, treatment of diabetes through mHealth is achieved through the transmission of text data that contain diabetes related information, which allows for the testing of Machine Learning algorithms to be done.

6 Discussion and Conclusion

The preceding serves to present a research in progress study that focuses on trying to optimize data assets for mHealth contexts. In particular, it focuses on critical considerations regarding data accuracy and information integrity. While still at an early stage, the research should provide important implications for theory and practice.

From the perspective of theory, the study will assist in developing a new area of knowledge that establishes methods similar to direct observation in mHealth using Machine Learning as a step to validate the accuracy of the data. As mHealth grows and the domain of consumer health informatics matures, we will see more and more mobile solutions being embraced to support health and wellness. Central to the success of these solutions is that they provide accurate data and information to consumers who in turn make decisions with far reaching implications and consequences based on the data and information received. The findings from this study will clearly be significant in ensuring optimal value from such mHealth solution. Upon the completion of the study, it will contribute to the hermeneutics field in information systems, and a reference for researchers to use analyse future empirical mHealth related studies and assist in the interpretation of their analysis.

Finally, given today's digital economy, findings from this study are relevant to not just for healthcare but transferable to other industries also concerned about accuracy of data input and information integrity.

7 Future Research Directions

The future direction for this research is to access the secondary data and complete the analysis (Figure 6). The findings from the analysis will then be used to identify the gaps with the current mHealth solution and match them with the most appropriate Machine Learning Algorithm. The selection of the algorithm will be based on one that best matches the conceptual model.

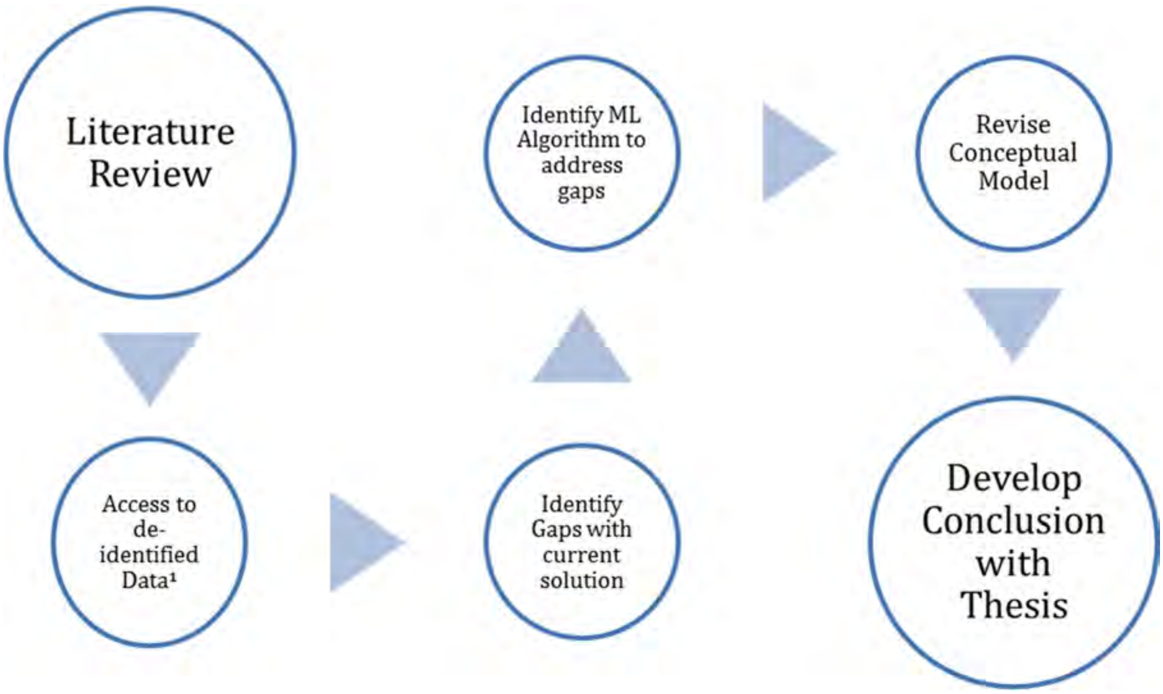


Figure 6: Flow of future research direction

Thus, a key expected finding from this study is an appropriate framework for streamlining the process of data collection in mHealth to include Machine Learning to assist in classifying data as they are captured to reduce erroneous data. Such a framework will have significant value to practice in a digital health environment.

References

Armstrong, B. K., Gillespie, J. A., Leeder, S. R., Rubin, G. L., & Russell, L. M. (2007). Challenges in health and health care for Australia. Medical Journal of Australia, 187(9), 485-489.

Bell, J. (2014). Machine learning: hands-on for developers and technical professionals. Indianapolis: Wiley.

Boulos, M. N. K., Wheeler, S., Tavares, C., & Jones, R. (2011). How smartphones are changing the face of mobile and participatory healthcare: an overview, with example from eCAALYX. BioMedical Engineering OnLine, 10, 24-24. DOI:10.1186/1475-925X-10-24

Bowman, S. (2013). Impact of Electronic Health Record Systems on Information Integrity: Quality and Safety Implications. Perspectives in Health Information Management, 1-19, 10p.

Caronna, C. A. (2010). 4. Why Use Qualitative Methods to Study Health Care Organizations? Insights from Multi-Level Case Studies. The SAGE Handbook Qualitatie Methods Health Research. SAGE Publications Ltd. London: SAGE Publications Ltd.

Cohen, M. Z., Steeves, R. H., & Kahn, D. L. (2000). Hermeneutic Phenomenological Research: A Practical Guide for Nurse Researchers. Thousand Oaks, Calif: SAGE Publications, Inc.

Cucoranu, I. C., Parwani, A. V. West, A. J., Romero-Lauro, G., Nauman, K., Carter, A.B., Pantanowitz, L. (2013). Privacy and security of patient data in the pathology laboratory. J Pathol Inform, 4(1), 23-29. DOI:10.4103/2153-3539.108542

Cunningham, P. (2012). It's most important role: ensuring information integrity. Information Management Journal, (3). 20.

Creswell, J. W. (2009). Research Design: qualitative, quantitative, and mixed methods approaches. Thousand Oaks, Calif.: Sage Publications.

Denzin, N. K., & Lincoln, Y. S. (2000). The handbook of qualitative research (2nd ed). Thousand Oaks, Calif.: Sage Publications, c2000.

Donley, A. M. (2012). Research Methods. New York: Infobase Publishing.

Dumas, M. B. (2012). Diving into the Bitstream: Information Technology Meets Society in a Digital World. New York: Routledge, 2012.

Eisele, T. P., Silumbe, K., Yukich, J., Hamainza, B., Keating, J., Bennett, A., & Miller, J. M. (2013). Measuring Coverage in MNCH: Accuracy of Measuring Diagnosis and Treatment of Childhood Malaria from Household Surveys in Zambia. PLoS Medicine, 10(5), 1-11. DOI:10.1371/journal.pmed.1001417.

Fadlalla, A., & Wickramasinghe, N. (2004). An integrative framework for HIPAA-compliant I* IQ healthcare information systems. International Journal of Health Care Quality Assurance, 17(2), 65-74.

Flick, U., Kardroff, E. V., & Steinke, I. (2004). A companion to qualitative research. London:SAGE.

Flocke, S. A., & Stange, K. C. (2004). Direct observation and patient recall of health behaviour advice. Preventive Medicine, 38(3), 343-349.

Flowerday, S., & Solms, R. V. (2010). What constitutes information integrity? South African Journal of Information Management, (2).

Fox, S., & Duggan, M. (2012). Washington, DC: Pew Internet & American Life Project.

Garvin, Jennifer H, PhD, RHIA, CPHQ, CCS,C.T.R., F.A.H., Martin, Karen S, RN,M.S.N., F.A.A.N., Stassen, Debee L,R.N., P.H.N., & Bowles, Kathryn H, PhD,R.N., F.A.A.N. (2008). The omaha system. Journal of AHIMA, 79(3), 44-49. Retrieved from http://search.proquest.com/docview/212624987?accountid=13552.

Gideon, L. (2012). Handbook of Survey Methodology for the Social Sciences. New York, NY: Springer New York.

Hamel, M. B., Cortez, N. G., Cohen, I. G., & Kesselheim, A. S. (2014). FDA Regulation of Mobile Health Technologies. The New England Journal of Medicine, 371(4), 372-379.

Health Informatics: improving patient care. (2012). Swindon: BCS The Chartered Institute of IT, [2012].

International Telecommunication Union. Key ICT Indicators for developed and developing countries and the world (totals and penetration rates). (2015). Retrieved February 2016, from http://www.itu.int/en/ITU-D/Statistics/Documents/statistics/2015/ITU_Key_2005-2015_ICT_data.xls.

Jenicek, M. (2010). Medical Errors and Harm Understanding, Prevention, and Control. Hoboken: Taylor and Francis.

Kahn, J. G., Yang, J. S., & Kahn, J. S. (2010). 'Mobile' health needs and opportunities in developing countries. Health Affairs, 29(2), 252-258.

Klonoff, D. C. (2013). The current status of mHealth for diabetes: will it be the next big thing? Journal of diabetes science and technology, 7(3), 749-758.

Kumar, S., Nilsen, W. J., Abernethy, A., Atienza, A., Patrick, K., Pavel, M., & ... Swendeman, D. (2013). Mobile Health Technology Evaluation: The mHealth Evidence Workshop. American Journal Of Preventive Medicine, 45(2), 228-236 9p. DOi:10.1016/j.amepre.2013.03.017.

Lambin, P., Roelofs, E., Reymen, B., Velazquez, E. R., Buijsen, J., Zegers, C. L., & ... Dekker, A. (2013). 'Rapid Learning health care in oncology' - an approach towards decision support systems enabling customised radiotherapy'. Radiotherapy And Oncology: Journal Of The European Society For Therapeutic Radiology And Oncology, 109(1), 159-164. DOI:10.1016/j.radonc.2013.07.007.

Lin, J. Y. (2013). Mobile Health Tracking of Sleep Bruxism for Clinical, Research, and Personal Reflection.

Linda, L. K. (2012). Information Integrity: A High Risk, High Cost Vulnerability.

Mahmood, N., Burney, A., Abbas, Z., & Rizwan, K. (2012). Data and Knowledge Management in Designing Healthcare Information Systems. Growth, 9(10),11.

McGraw, D. (2013). Building public trust in uses of Health Insurance Portability and Accountability Act de-identified data. Journal Of The American Medical Informatics Association: JAMIA, 20(1), 29-34. DOI:10.1136/amiajnl-2012-000936.

Mena, L. J., Felix, V. G., Ostos, R., Gonzalez, J. A., Cervantes, A., Ochoa, A., & ... Maestre, G. E. (2013). Mobile personal health system for ambulatory blood pressure monitoring. Computational And Mathematical Methods In Medicine, 2013598196. DOI:10.1155/2013/598196.

Monsen, K. A., Martin, K. S., Christensen, J. R., & Westra, B. L. (2009). Omaha System data: methods for research and program evaluation. Studies In Health Technology And Informatics, 146783-784.

Mottl, J. (2014). The imperative of safety in mHealth and why it can't be ignored. Newton: Questex Media Group LLC. Retrieved from http://search.proquest.com/docview/1529671809?accountid=13552.

Murthy, R., & Kotz, D. (2014). Assessing blood-pressure measurement in tablet-based mHealth apps. 2014 Sixth International Conference On Communication Systems & Networks (COMSNETS), 1.

Narman, P., Holm, H., Johnson, P., Konig, J., Chenine, M., & Ekstedt, M. (2011). Data accuracy assessment using enterprise architecture. Enterprise Information Systems, 5(1), 37-58. DOI:10.1080/17517575.2010.507878.

Olson, J.E. (2003). Chapter 3 – Sources of Inaccurate Data. In J. E. Olson (Ed.), Data Quality (pp. 43-64). San Francisco: Morgan Kaufmann.

Oquendo, M. N. (2012). Machine learning and data mining: strategies for hypothesis generation. Molecular Psychiatry, 17(10), 956-959.

Patnaik, S., Brunskill, E., & Thies, W. (2009, 17-19) April 2009). Evaluating the accuracy of data collection on mobile phones: A study of forms, SMS, and voice. Paper presented at the Information and Communication Technologies and Development (ICTD), 2009 International Conference on (pp 74-84). IEEE.

Sadiq, S. (2013). Handbook of data quality: research and practice. Berlin; New York: Springer-Verlag, 2013.

Sannino, G., De Falco, I., & De Pietro, G. (2014). A General-Purpose mHealth System Relying on Knowledge Acquisition through Artificial Intelligence Ambient Intelligence-Software and Application (pp. 107-115): Springer International Publishing.

The Omaha System. The Omaha System 2005 Chart. Retrieved June 10 2015, from http://cmapspublic3.ihmc.us/rid=1290438215218_1896624281_17913/2010-11-22%20Omaha%20System%20for%20NSFr.cmap.

Topaz, M., Golfenshtein, N., & Bowles, K. H. (2014). The Omaha System: a systematic review of the recent literature. Journal Of The American Medical Informatics Association, 21(1), 163-170 8p. DOI:10.1136/amiajnl-2012-001491

Van Den Bos, J., Rustagi, K., Gray, T., Halford, M., Ziemkiewicz, E., & Shreve, J. (2011). The $17.1 billion problem: the annual cost of measurable medical errors. Health Affairs, 30(4), 596-603.

Van Velthoven, M. H., Car, J., Zhang, Y., & Marušić, A. (2013). mHealth series: New ideas for mHealth data collection implementation in low- and middle-income countries. Journal Of Global Health, 3(2), 020101. DOI:10.7189/jogh.03.020101.

Varshney, U. (2009). Pervasive Healthcare Computing. Dordrecht: Springer.

Vincent, C. (2010). *Patient Safety (2nd ed)*. Hoboken: Wiley.

World Health Organization. (2014). Global status report on noncommunicable diseases. Retrieved April 27 2015, from http://apps.who.int/iris/bitstream/10665/148114/1/9789241564854_eng.pdf?ua=1.

World Health Organization. (2003). Improving data quality: a guide for developing countries. Retrieved August 26 2014, from http://www.wpro.who.int/publications/docs/Improving_Data_Quality.pdf.

Yin, R. K. (2014). Case study research: design and methods: Los Angeles: SAGE, 2014. Fifth edition. Page 16.

29th Bled eConference

Digital Economy

June 19 - 22, 2016; Bled, Slovenia

Standardisation of Supporting Processes in Healthcare
A case study of the APQC Healthcare Process Classification Framework

Teun Mantje, Tom Smit, David Sterk, Joris Mens

HU University of Applied Sciences Utrecht, The Netherlands

teun.mantje@student.hu.nl, tom.smit1@student.hu.nl, david.sterk@hu.nl, joris.mens@hu.nl

Abstract

Every patient is unique. This is why hospitals are characterised by highly complex and variable processes. We distinguish between two main categories of processes: The primary healthcare process concerned with the cure and care for the patient, and supporting processes such as logistics, planning, and administration. The American Productivity and Quality Center Healthcare Process Classification Framework (APQC-HPCF) is an open standard designed to support the standardisation of supporting processes in healthcare. In this paper, we perform case studies at two of the hospital's clinics. Through observations, interviews, and analysis of process descriptions, we establish to which extent the processes described by APQC-HPCF are implemented in practice. This is done to both identify differences between the clinics' supporting processes as well as to validate the efficacy of the APQC-HPCF, which has not been previously tested in scientific literature. Results show that the clinics perform nearly all of the prescribed processes. Deviation from the APQC-HPCF is mainly explained by the fact that some of its contents are designed for the American market and do not apply in the Dutch market. The clinics perform some additional supporting processes that are not present in the framework. Also, minor differences in supporting processes between the two clinics were found. The results show that the efficacy of the APQC-HPCF is validated by a large extent but cannot be proven completely.

Keywords: Healthcare, hospital, process management, quality management, process framework, process standardisation

1 Introduction

Hospitals have complex processes and organisational structures and operate within a demanding environment. The ageing population requires more long-term care, financial resources are strained, and the government, insurers and accreditation bodies demand stricter quality control and more transparency. In the global market, we see hospitals responding to these challenges by introducing standardisation efforts in order to achieve more efficient process management. Process management entails both the primary processes (cure and care) as well as supporting processes (logistics, planning, administration, etc.). A process is considered a set of activities that create value. In the case of hospitals, the focus is on creating value for the patient through curing and caring activities. In practice, hospitals may focus on one of many different factors, such as cost reduction, patient satisfaction, enforcing safety regulations, et cetera, in an effort to improve efficiency. The central goal should be the creation of value, defined in literature as 'the health outcomes for the patient relative to the costs incurred' (Porter, 2010). By improving the quality of processes, we enable value creation.

In this study, we focus on the standardisation of supporting processes. The hospital in which our study is performed has previously introduced a process management framework for the primary care process. This hospital is a mid-size (around 400 beds), public, and regional hospital in The Netherlands Now, it is looking to complement the primary process by also standardising supporting processes. The hospital currently has little insight into how its supporting processes are performed. However, supporting processes are instrumental in ensuring the desired execution of the primary process. We define supporting processes as: "Processes that contribute to and enable the execution of the primary healthcare process, through activities such as patient scheduling, materials planning and administration."

The American Productivity and Quality Center (APQC) provides open, standardised frameworks for processes. These include the Healthcare Process Classification Framework (HPCF). The APQC-HPCF is one of the few frameworks aimed specifically at the healthcare sector. In this study we compare a number of process frameworks to ensure that APQC-HPCF provides the best fit for the goal of standardising supporting processes. The efficacy of the APQC-HPCF is not yet proven in scientific literature and it has not previously seen implementation in Dutch hospitals. Therefore our study attempts to map the contents of APQC-HPCF onto the supporting processes performed in practice at two of the hospital's clinics. By performing observations, interviews, and by analysing process descriptions, we map the contents of APQC-HPCF onto the situation found in practice.

The study is performed in collaboration with the quality management department of the hospital. This department desires clear, structured processes and process descriptions. Two outpatient clinics were selected for performing the study. An outpatient clinic provides services to patients who do not stay overnight (as opposed to an inpatient clinic). The services provided include the examination and treatment of patients. The urology clinic and the obstetrics & gynaecology clinic were selected due to their willingness to participate in this study. By mapping the APQC-HPCF onto the working methods performed in these clinics, we attempt to identify and explain differences between the model and practice. This will give insight into the efficacy of the model in regards to standardising supporting processes and thereby improving the quality and value of healthcare.

The main research question for this study is defined as follows:

RQ: "To what extent can the efficacy of the APQC-HPCF model be proven in terms of quality improvement in standardising supporting processes?"

The following section describes a literature review on the dynamics of the healthcare market, the need for process standardisation, and a comparison of process frameworks. Section three describes the research approach. The results are presented in section four, by providing process descriptions as well as a matching of the supporting tasks and activities with APQC-HPCF. Finally we provide the conclusion and discussion of this study.

2 Literature Review

Healthcare expenditure in The Netherlands is relatively high, with 15.6% of the GDP spent on healthcare (Centraal Bureau Statistiek [CBS], 2014b). A yearly increase of 11.21% per capita healthcare expenditure was seen between 2001 and 2011 (Bloomberg, 2013). The National Institute for Health and the Environment (2014) states that volume growth is the main instigator of cost increase. Bloomberg (2014) compares efficiency of national healthcare systems based on life expectancy and per capita cost of healthcare (relative and absolute). Between 2013 and 2014, the Dutch healthcare system fell from 25th to 40th place. This indicates a decline in efficiency.

Previously collected data from over a thousand organisations in different sectors shows that the Dutch healthcare and public sector score lowest in terms of process management maturity when compared to other sectors (Luyckx, 2012). There is a large difference between the lowest-scoring healthcare sector and the highest-scoring financial and automotive sectors. Luyckx (2010) identifies that hospitals are complex organisations that need to align their processes externally with other organisations (general practitioners, insurance companies) as well internally, between departments. Rising costs and increased demand for healthcare, as well as efficiency obstacles, suggest the need for the improvement of process performance.

The complexity of process management in hospitals lies in its large variety of medical specialisations (Mans, Schonenberg, Song, van der Aalst, & Bakker, 2009). The variety of specializations and therapies increases, while patients demand higher quality services and shorter waiting times (Øvretveit, 2000). Patients may require the care of different medical specialists throughout their care process. This is also called the care pathway. A patient's care pathway can be highly variable and runs through different hospital departments. The complexities of healthcare processes introduce a risk of errors and unnecessary waiting times. Patients with the same diagnosis may encounter different waiting times in their process and the reasons for this are not always known (Mans et al., 2009).

Standardising healthcare processes contributes towards better process performance, by reducing costs and improving patient outcomes. For example, A study performed by Rozich et al. (2004) shows that the introduction of a standardised protocol for insulin administration for diabetes patients lead to a reduction in hypoglemic episodes from 2,95% to 1.1% over a period of 30 months. Medication errors decreased significantly with 213 errors per 100 admissions to fewer than 50 errors per 100 admissions. Arora & Johnson (2006) identified and standardised the patient hand-off process concerned with care transitions. This process occurs when patients transfer from one department to another or when a shift change occurs. The hand-off process is critical to patient safety, as inadequate communication of patient information in care transitions may lead to the unintentional discontinuation of essential medication (Bell et al., 2011). Reduction of errors and improving task and information hand-off are just a few examples of how patient outcomes are improved while avoiding the likelihood of costly incidents. Rozich et al. (2004) posit that standardisation of processes lead to reduced complexity, increased safety and possible cost savings. They recommend similar efforts to be taken in other clinical areas.

Based on literature studied in this section, we conclude that there is a desire for quality improvement in hospitals due to their internal and external dynamics. Standardisation of processes will help to realise greater coherence, reduced risk for errors and improved transparency. Hereby, the quality of processes can be improved. The following section explores available frameworks for process standardisation and substantiates the selection of the APQC-HPCF for standardising supporting processes in our case study.

2.1 APQC-HPCF and other process frameworks

The APQC Healthcare Process Classification Framework provides insight into business processes in a systemic manner, with a hierarchical structure (APQC, 2014). The Process Classification Framework (PCF) is an open standard to realise improvement of process management and benchmarking, regardless of type industry, size and geographic location of organizations, with offshoots provided for specific sectors such as healthcare. At the time of writing, no scientific literature was found in regards to testing the APQC-HPCF in practice. The consequence is that the APQC-HPCF is not scientifically proven and do not guarantee to achieve standardization within organizations. In this section, we describe the general layout of the framework and compare it with a set of other process standardisation frameworks.

There are two methods for organisations to adopt the process framework. The first method is full adoption, where changes are made in the organisations structure in order to achieve the structure as prescribed by APQC-HPCF. The second method is the custom interlayer adoption, where the process framework is adopted with only partial changes to the organisation (APQC, 2016). APQC-HPCF is divided in the following five levels (APQC, 2014):

1. Category
2. Process Group
3. Process (focus within this case study)
4. Activity
5. Task

The focus within this case study will be at level three, the process. Processes are a series of interrelated activities that convert inputs into results (output). As indicated in the introduction of this paper, the focus of our study on supporting processes. We defined supporting processes contribute to and enable the execution of the primary process. The first two levels of the APQC-

HPCF take a more abstract look at organisational processes, while the last two levels go into more specific detail. At this point, level three (process) was deemed most relevant by the quality management department, with a balance between abstraction and simplicity.

Level three of the APQC-HPCF, the process level, contains operational business processes and management and support services. These are subdivided into twelve categories. Because our scope is limited to supporting processes, we only focus on the related categories. These are category 4.0 'Deliver Products and Services' and category 5.0 'Manage Customer Services'. The fifteen supporting processes within these two categories are shown in the Table 1 below.

4.0 Deliver Product and Services	
4.2.2	Manage demand for materials
4.2.3	Create materials plan
4.5.1	Update medical records
4.5.2	Review completeness of medical records
4.5.3	Submit and respond to information queries
4.6.1	Schedule the patient
4.6.2	Verify insurance
4.6.3	Register the patient
4.7.2	Manage throughput and schedule resources
4.8.1	Provide patient with discharge instructions, care education, and orders
4.8.2	Solicit discharge paper signature from patient
4.8.3	Coordinate post-discharge services
4.8.4	Release patient
5.0 Manage Customer Services	
5.3.1	Plan and manage customer service work force
5.3.2	Manage customer service requests/inquiries

Table 1 Supporting processes of APQC-HPCF

There are different ways to identify and standardize business processes of healthcare organizations. During the literature study, information was collected on different existing process frameworks. These are compared and classified according to their goal, function and characteristics in Table 2.

	Goal	**Function**	**Characteristics**
EFQM model (EFQM, 2015)	Control, stabilize, standardize with a fixed order	A tool to determine a target and bring several areas clear through mapping	- Nine focus areas - Not specific for healthcare organizations - No framework
NICTIZ Hospital Domain Reference Model (NICTIZ, 2016)	Support hospitals with the organization of information technology	Reference overview of the relationship between business activities and information objects in a hospital	- Specific for hospitals - Coherence between domains - Framework for information provision
Smaller Hospitals Development Framework (Department of Health, 2013)	Achieve higher quality and efficiency	Realises uniform way of acting	- Provide insight into hospital processes - Specific to the Irish market
eTOM Business Process Framework (TM Forum, 2016)	Give a broad view of the organization	Framework where business descriptions, processes and workflows are described	- Not hospital-specific - Integral framework

Table 2 Overview of process frameworks

In conclusion, there are different frameworks to identify and standardise business processes. These frameworks focus at a specific aspect of organizations and two frameworks are not specific for healthcare organizations. We did not succeed to find a framework similar as APQC-HPCF, which describe in detail which processes occur in a hospital and also describe the mission, vision, objectives and strategies. For this reason, the APQC-HPCF is deemed to be the most suitable model for the purpose of standardising a hospital’s supporting processes.

3 Approach

As described in the introduction, two outpatient clinics of the Rivierenland hospital are included in our case study. The goal of a case study is to map processes by studying the environment and explaining phenomena in practice (Swanborn, 2013). Within the case study, we utilise interviews, observations and available documentation to gather information.

In order to map the processes in practice to those in the APQC-HPCF, the current situation was analysed at the clinic. This first done by consulting the Content Management System of the Rivierenland hospital, where process descriptions are stored. Secondly, six observational sessions were performed at the clinic with medical personnel. Observations will assist in understanding what actually happens in the clinical setting (Fox, 1998). During these observations the tasks performed by the clinic's staff were seen in practice, and in depth questions were asked to clarify where necessary. Finally, four interviews were performed with the unit manager of the clinic, the outpatient clinic coordinator, a medical secretary and a nurse. After collecting all necessary data, two additional interviews were held with the unit manager and the outpatient clinic coordinator of the obstetrics & gynaecology clinic to validate the results.

The three methods described above (analysing process descriptions, observations and interviews) have been used to identify the supporting processes that take place in practice.

4 Results

As a result of analysing the process descriptions in the hospital's content management system, it was found that only descriptions at the task (work activity) level were available. These include protocols that describe which steps to take in a specific situation. Looking back at the five levels of the APQC-HPCF model described in paragraph 2.1, we see that this kind of description is at a more detailed level than our intended level for mapping processes. However, during observations it was found that descriptions for specific care pathways (processes are used). These were present only for four different oncology care pathways for treatment of carcinoma at the urology outpatient clinic. In conclusion of our initial analysis, we found that there was insufficient documentation to describe processes at the process level. However, more detailed documentation in regards to tasks and activities was found.

In order to identify the supporting processes, several observations at the front office, back office, endoscopy room and medical secretary are conducted. In addition, several interviews with the unit manager, outpatient clinic coordinator and outpatient clinic employees are conducted. During the observations we identified all activities and tasks that are executed within the outpatient clinic. These activities and tasks were linked to processes.

This section describes which of the observed supporting processes we were able to map to APQC-HPCF. By mapping we mean the matching of activities and tasks that take place in practice to the processes mentioned in APQC-HPCF. Table 3 shows the supporting processes of urology outpatient clinic that are validated in the APQC-HPCF.

Besides the mapping of supporting processes, it was found that certain activities and tasks take place that we were not able to map to APQC-HPCF, but are of supportive value to the primary process. We contacted member of the PCF community and they suggested aggregating these tasks on a higher level within APQC-HPCF. However because we would like to find a consistent case-by-case match of the supporting processes, it was decided to group all supporting processes into distinctive sets. These are not defined in APQC-HPCF. The following groups of supporting processes were established:

- Logistics (the tasks and activities of the delivery of materials within the outpatient clinic)
- Pre-visit (the tasks and activities carried out prior to the patient's visit)
- Planning (the tasks and activities related to realise a patient and staff planning)
- Pre-treatment (the tasks and activities carried out before patient receives treatment)
- Post-treatment (the tasks and activities carried out after patient's treatment)
- Communication (the tasks and activities related to the communication between the staff and between the staff and patients.)

In conclusion twelve of the thirteen supporting processes of the category 4.0 'Deliver Products and Services' match case-by-case match with the urology outpatient clinic. The only supporting process that is not available within the urology outpatient clinic is 4.8.2 'Solicit discharge paper signature from patient'. In the obstetrics & gynaecology clinic, eleven out of thirteen processes are found to match with APQC-HPCF.

Within category 5.0 'Manage Customer Service' two of two supporting processes match case-by-case with the urology outpatient clinic. The same is true for the obstetrics & gynaecology outpatient clinic. Besides, there are supporting processes which are not described in the APQC-HPCF but which have supporting value to the primary process. From this we can conclude that important supporting processes not appear in the APQC-HPCF whereby this framework does not give a complete insight in the supporting processes performed at outpatient clinics.

The supporting processes were matched in both the urology clinic as well as the obstetrics & gynaecology clinic in order to compare and generalise the results. Due to time constraints, there were opportunities to include additional clinics in our case study. Observations at more clinics could provide further generalisation of results. An overview of the supporting processes provided by APQC-HPCF and matchings with the processes found in both clinics is provided in Table 3 on the following page. The presence of the supporting process defined by APQC-HPCF in the clinic is defined with a Y or N (Yes or No).

Supporting processes APQC-HPCF	Urology	Obstetrics & Gynaecology
Category 4.0 Deliver Healthcare Services		
4.2.2 Manage demand for materials	Y	Y
4.2.3 Create materials plan	Y	**N**
4.5.1 Update medical documentation	Y	Y
4.5.2 Review completeness of medical records	Y	Y
4.5.3 Submit and respond to information queries	Y	Y
4.6.1 Schedule the patient	Y	Y
4.6.2 Verify insurance	Y	Y
4.6.3 Register the patient	Y	Y
4.7.2 Manage throughput and schedule resources	Y	Y
4.8.1 Provide patient with discharge instructions, care education and orders	Y	Y
4.8.2 Solicit discharge paper signature from patient	**N**	**N**
4.8.3 Coordinate post-discharge services	Y	Y
4.8.4 Release patient	Y	Y
Category 5.0 Manage Customer Service		
5.3.1 Plan and manage customer service operations	Y	Y
5.3.2 Manage customer service requests/inquiries	Y	Y

Table 3 Overview of supporting processes matched between the clinics and APQC-HPCF

Considering the comparison between the urology outpatient clinic and obstetrics & gynaecology outpatient clinic, one supporting process is not matched, namely 4.2.3 ‘Create material plans’. This supporting process is performed at the urology outpatient clinic but not the obstetrics & gynaecology outpatient clinic. Staff indicated the use of critical medical instruments at the urology clinic, which require materials planning. Such a planning was not in place at the obstetrics & gynaecology clinic. Despite this deviation, we see a high level of consistency between the two clinics.

5 Conclusion & Discussion

In conclusion, fourteen out of fifteen supporting processes, as described in the APQC-HPCF, can be mapped to the practical situation found at the urology clinic of the Rivierenland hospital. This means that 93.3% of the supporting processes described in the APQC-HPCF occur at the urology outpatient clinic. The comparison between urology outpatient clinic and obstetrics & gynaecology outpatient clinic shows that 92.9% of the validated supporting processes of the urology outpatient clinic are match those of the obstetrics & gynaecology outpatient clinic. The use of critical tools within the urology outpatient clinic is the reason for this difference.

Both clinics deviate from APQC-HPCF in regards to process 4.8.2 ‘Solicit discharge paper signature from patient’. Upon further examination, we found that this process is never performed in hospitals in The Netherlands. The APQC-HPCF is designed in the United States, where regulations require hospitals to obtain a signature from the patient upon discharge. This practice is not seen in Dutch healthcare and therefore cannot be mapped to APQC-HPCF. This leads us to conclude that hospitals willing to implement process frameworks must take into account situational factors, such as local regulations and other external requirements.

There are also supporting processes present at the urology outpatient clinic that are not described in the APQC-HPCF, but are of supportive value for the primary care process. It can be concluded that important supporting processes are not described in the APQC-HPCF at level 3 ‘Processes’; this means that APQC-HPCF does not fully frame all of the supporting processes within outpatient clinic. An important point is that other hospitals should be aware the APQC-HPCF may not describe all supporting processes.

A point of discussion is that there are only two outpatient clinics observed and validated. This is not enough to be able to generalise the results other clinics in the hospital, or to the healthcare industry in general. It is recommended to validate the APQC-HPCF at other clinics and other hospitals to draw a validated conclusion.

Finally, we conclude that with a few exceptions, the APQC-HPCF provides a comprehensive view of supporting processes that should be present in healthcare providing organisations. Hospitals wishing to improve quality by standardising processes may find APQC-HPCF to be a useful tool, as it prescribes not only processes, but also tasks and activities at different levels of granularity. In this regard, APQC-HPCF proves to be valuable in increasing safety, reducing costs and improving performance in healthcare.

References

APQC. (2014). *APQC Healthcare Process Classification Framework*. Houston, Texas. Retrieved from https://www.apqc.org/knowledge-base/documents/apqc-process-classification-framework-pcf-healthcare-provider-members-excel

APQC. (2016). Getting Started With The PCF. Retrieved March 6, 2016, from https://www.apqc.org/getting-started-pcf

Arora, V., & Johnson, J. (2006). A model for building a standardized hand-off protocol. *Joint Commission Journal on Quality and Patient Safety*, *32*(11), 646–655. http://doi.org/10.1007/s11606-009-1170-y

Bell, C. M., Brener, S. S., Gunraj, N., Huo, C., Scales, D. C., Bajcar, J., … Urbach, D. R. (2011). Association of ICU or Hospital Admission of Medications for Chronic Diseases. *JAMA*, *306*, 840–847. http://doi.org/10.1001/jama.2011.1206

Bloomberg. (2013). Biggest Rise in Health-Care Cost Relative to Income: Countries. Retrieved from http://www.bloomberg.com/visual-data/best-and-worst/biggest-rise-in-health-care-cost-relative-to-income-countries

Bloomberg. (2014). Most Efficient Health Care 2014: Countries. Retrieved from http://www.bloomberg.com/visual-data/best-and-worst/most-efficient-health-care-2014-countries

Centraal Bureau voor de Statistiek. (2014). *Uitgaven als percentage van het bbp*. *Gezondheid, leefstijl, zorggebruik en -aanbod, doodsoorzaken; kerncijfers*. Retrieved from http://statline.cbs.nl/Statweb/publication/?DM=SLNL&PA=81628NED&D1=93&D2=a&HDR=G1&STB=T&VW=T

Department of Health. (2013). *Securing The Future of Smaller Hospitals: A Framework For Development*. Dublin, Ireland. Retrieved from http://health.gov.ie/wp-content/uploads/2014/03/SecuringSmallerHospitals.pdf

EFQM. (2015). EFQM Model in Action. Retrieved June 1, 2015, from http://www.efqm.org/efqm-model/efqm-model-in-action-0

Luyckx, F. (2010). Why does the healthcare industry has the lowest BPM maturity? Retrieved January 24, 2016, from http://www.ariscommunity.com/users/frlu/2010-05-23-why-does-healthcare-industry-has-lowest-bpm-maturity

Luyckx, F. (2012). *Enterprise BPM Roadmap Assessment*.

Mans, R. S., Schonenberg, M. H., Song, M., van der Aalst, W. M. P., & Bakker, P. J. M. (2009). Application of Process Mining in Healthcare – A Case Study in a Dutch Hospital. In A. Fred, J. Filipe, & H. Gamboa (Eds.), *Biomedical Engineering Systems and Technologies* (Vol. 25, pp. 425–438). Springer Berlin Heidelberg. http://doi.org/10.1007/978-3-540-92219-3_32

National Institute for Health and the Environment. (2014). *Dutch Health Care Performance Report 2014*. (M. J. van den Berg, D. de Boer, R. Gijsen, R. Heijink, L. C. M. Limburg, & S. L. N. Zwakhals, Eds.). Bilthoven. Retrieved from http://www.gezondheidszorgbalans.nl/dsresource?type=pdf&disposition=inline&objectid

=rivmp:259835

NICTIZ. (2016). NICTIZ Hospital Domain Reference Model. Retrieved March 6, 2016, from https://www.nictiz.nl/Paginas/Referentiedomeinenmodel-ziekenhuizen.aspx

Øvretveit, J. (2000). Total quality management in European healthcare. *International Journal of Health Care Quality Assurance*, *13*(2), 74–80. http://doi.org/10.1108/09526860010319523

Porter, M. E. (2010). What is value in health care? *The New England Journal of Medicine*, *363*(26), 2477–2481. http://doi.org/10.1056/NEJMp1011024

Rozich, J. D., Howard, R. J., Justeson, J. M., Macken, P. D., Lindsay, M. E., & Resar, R. K. (2004). Standardization as a mechanism to improve safety in health care. *Joint Commission Journal on Quality and Safety*, *30*(1), 5–14.

Swanborn, P. G. (2013). *Case Studies: Wat, Wanneer en Hoe?* (5th ed.). Boom Lemma.

TM Forum. (2016). GB921 Business Process Framework (eTOM). Retrieved March 6, 2016, from https://www.tmforum.org/resources/suite/gb921-business-process-framework-etom-r15-5-0/

29th Bled eConference

Digital Economy

June 19 - 22, 2016; Bled, Slovenia

Healthy lottery. A design theory for a mobile system to increase compliance of individuals with diabetes

Riccardo Bonazzi

University of Applied Sciences Western Switzerland,

riccardo.bonazzi@hevs.ch

Katherine Blondon

University Hospitals of Geneva, Switzerland

katherine.blondon@hcuge.ch

Abstract

This article shows the preliminary results of an ongoing study to develop a system that financially rewards individuals with diabetes. Previous studies have already shown that monetary incentives appear to be the strongest motivator for older individuals with type II diabetes. Nonetheless, design criteria for a mobile service are not well established and there is no study available to assess the viability of a system that financially rewards individuals for self-management. Therefore, in this paper we explore a design theory that describes a new mobile service that integrates data from existing mobile application, and includes a self-supported lottery in a business model, which allows patients with effective self-management to be rewarded without any deficit. Our prototype is based on a social business model, which aims at improving patients' health and that can be described as "healthy" for them.

Keywords: diabetes, financial incentives, design science, business model

1 Introduction

This article is addressed to designers of diabetes management software, and more broadly to caregivers and patients affected by type II diabetes. We are interested in *diabetes management software* on smartphones or tablets, which helps persons with type I and type II diabetes manage the data associated with: (a) blood test results from a glucose meter, (b) manual log entries for exercise and other factors, (c) coaching for dose corrections.

Although there is a plethora of websites and mobile applications for individuals with type 2 diabetes, there is a scarcity of reliable data concerning their added value for older patients. In a recent review of internet-based interventions to promote lifestyle modification among adults with type II diabetes, the authors found that (a) successful studies had interactive components with tracking and personalized feedback and opportunities for peer support, (b) website utilization declined over time in all studies and concluded that future research is needed on the engagement of patients over time (Cotter et al., 2014). In fact, the successful use and potential health benefits related to the electronic devices seems to depend more on the design of the engagement strategies than on the features of their technology (Patel, Asch, & Volpp, 2015). To be effective, technologies must be paired with approaches that create and maintain engagemen**t** (Sen et al., 2014). Therefore, we sought a solution to improve self-management of older patients with type II diabetes, using mobile technologies and incentives to guide and maintain long-term engagement.

A recent review of diabetes apps for iOS and Android operating systems examined whether the available applications serve the special needs of diabetes patients aged 50 or older by performing an expert-based usability evaluation. The authors recommended that (a) patients and physicians alike should be involved in the app development process to a greater extent (b) the usability of diabetes apps for patients aged 50 or older was moderate to good, but this result applied mainly to apps offering a small range of functions (Arnhold, Quade, & Kirch, 2014). Another study conducted by (Volpp et al., 2008) demonstrated that mobile phone-based treatment and behavioral coaching intervention had a positive impact on the reduction of glycated hemoglobin levels over one year in patients with type II diabetes.

Previous studies have already shown that monetary incentives appear to be a strongest motivator for older patients affected by type II diabetes (Blondon, 2015). Nonetheless, there are no clear recommendations to design a mobile service and there is no study available to assess whether a system that financially rewards patients could be economically viable.

Therefore, our research question is: **how to design diabetes management software that uses financial incentives to increase patient's compliance?**

The rest of the paper proceeds at it follows. In section two, we briefly introduce the recent stream of research concerning financial incentives to increase patient's compliance. In section three we describe our design theory and in section four we illustrate an example to show how our mobile service could be financially viable. Section five concludes the paper and shows some directions for further investigation.

2 Literature review on financial incentives to increase patient compliance

According to behavioral economics, human judgments are biased and make it difficult for people to make self-beneficial choices. In this sense, it appears that people place more weight on the present than the future and therefore, immediate costs and benefits exert disproportionate influence on people's choices relative to those that will be experienced in the future. Accordingly, increasing the immediate rewards may influence people's propensity to act (Mitchell & al. 2013).

Studies on behavioral economics emphasize (1) the importance of frequent feedback and incentives (2) the motivational power of lotteries regarding other financial features (3) the motivation force of anticipated regret (Volpp & al. 2006). In particular, lottery rewards have been found to be effective as incentives in various fields of healthcare such as medication adherence, weight loss, cholesterol reduction, and vaccinations (Haisley et al., 2011).

Financial incentives for diabetes self-management have only begun to be explored. One study explored patients' perceptions and expectations of financial incentives to improve diabetes self-management, and found that individuals were optimistic about the effectiveness of incentives and expected financial incentives to be a stronger motivation for behavior change(Blondon et al., 2014). (Sen et al., 2014) confirm these findings by demonstrating that a lottery-based incentive improved monitoring rates among patients with uncontrolled diabetes. They found (1) similar efficacy relative to the amount according to the average gain possible (average daily reward 1.40$ or 2.80$) (2) the smaller expected value lottery was considerably more effective in the post-incentives period than the larger expected value lottery. Finally, in an online survey of 132 patients with diabetes, nearly all participants showed positive expectations about financial incentives. They favored financial incentives for behaviors they considered less challenging, and non-financial incentives for more challenging behaviors. This survey also enquired about the expected amount of incentives, in particular for a 5 lb weight loss, maintained over a year (Blondon, 2015).

3 Our design theory

Since we did not find a theory to design a system, which properly addresses our research question, we follow the guidelines of Gregor & Jones (2007) to describe the eight components of a design theory. In this section we describe the six core components, whereas in the next section we describe the two additional components.

Purpose and scope. As previously mentioned, the purpose of our mobile service is to increase the therapeutic compliance of patients with type II diabetes. We take into account that there are two sets of users: the younger patients, who are more familiar with smartphones and that have to plan their adult life taking into account their diabetes, and older patients, who might need assistance to use a smartphone and that, after the occurrence of diabetes, need to change a lifestyle, which they have been keeping for several decades.

Constructs. Our design theory has four constructs illustrated in figure 1. We use two constructs to describe the system, which (1) monitors the evolution of the patient's clinical situation and (2) that gives monetary incentives. The monetary incentives are measured by the money delivered to the patient, whereas we use two performance indicators to monitor the evolution of patient's clinical situation: (1.1) the patient's improvement in the short term and (1.2) the patient's sustainable change in the long-term. In this paper, the short-term improvement of the patient can be measured by the adherence to medication and the meetings with the caregiver, which are often reported in the patient's logbook. The sustainable change of the patient can be measured by mobile applications that monitor (a) the level of blood glucose, (b) the level of HbA1c and (c) the Body Mass Index. Finally, we propose to add one construct to assess the change in the caregiver efficiency, which can be measured by the average amount of hours spent with patients, and the motivation of the patient, which can be measured by the technology acceptance model (Venkatesh, Morris, Davis, & Davis, 2003).

Functions of the artefact. Figure 1 shows how the system works and represents the two functions of the system by using two rectangles. The caregiver and the patient affected by diabetes meet to set the goals, in terms of diet, exercise, medications and smoking cessation. We assume that the patient uses a set of devices to automatically collect data every day, whereas we also expect the caregiver to spend some time to set up the platform at the beginning (this assumption is based on mobile applications like myDiabeticAlert, which have two roles: patient and caregiver).

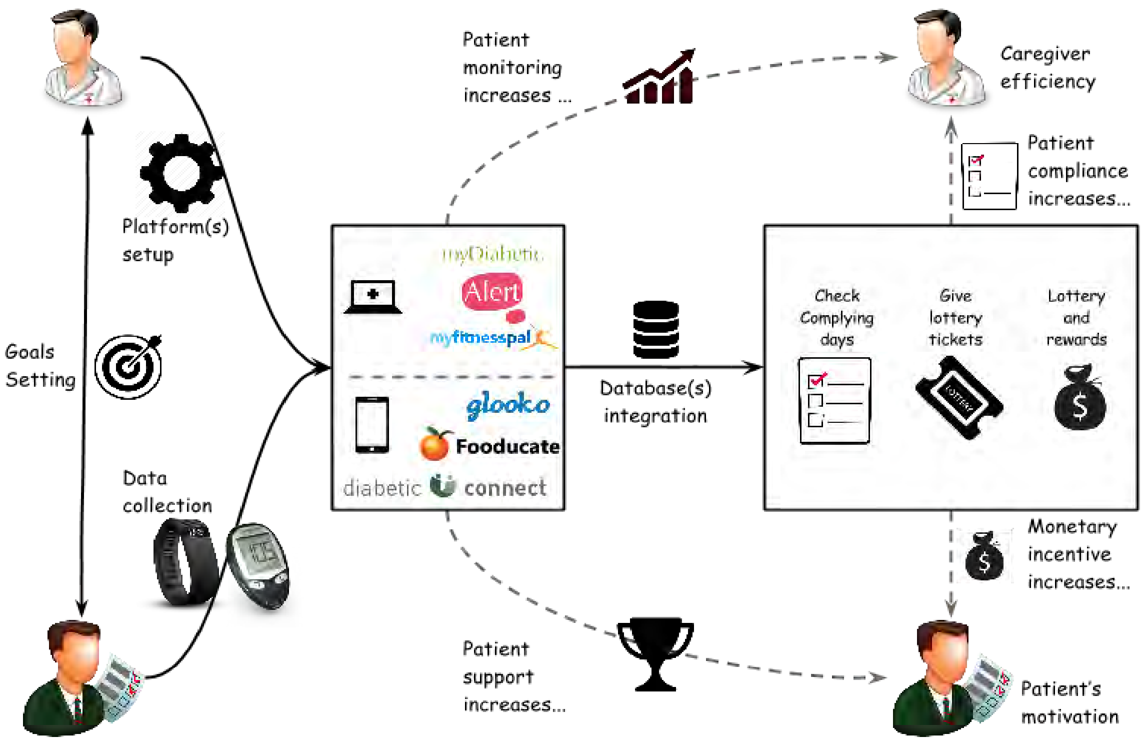


Figure 1: *Description of how goals are set, data is analysed, and rewards are given*

Our system gathers all the information collected by other mobile applications into one single database. We do not create our own mobile application, because we believe that there are already many that have a usable interface, a large community of users and a sufficient set of developers to maintain their constant improvement. Instead, we develop a back-end application that checks if the data is aligned with the goals, and assign a lottery ticket to each day the patient is compliant. At the end of each week, a lottery is done and the patient is notified of the result by email. A detailed explanation of how the second function of the system works can be found in the follow section.

Kernel theories. Our design theory extends the work of Blondon (2015) about financial incentives for patients affected by type II diabetes.

Testable propositions. By using our four constructs, we derive two sets of propositions. The first set concerns the effectiveness of our proposed solution, with respect to existing solutions. The second set of propositions assesses how our solution works.

- P1.1: *Monetary incentives* will decrease *patient HbA1c* in a greater amount than tested websites and mobile applications.
- P1.2: *Monetary incentives* will decrease *patient BMI* in a greater amount than tested websites and mobile applications.
- P2.1: *Monetary incentives* will increase *patient's motivation* in a greater amount than tested websites and mobile applications
- P2.2: *Monetary incentives* will lower *caregiver time spent per patient* in a greater amount than tested websites and mobile applications

Artefact mutability. The lottery system allows every patient, who tries to comply, to havea high chance to win something over the year. Indeed, a patient that complies only for one day gets already a lottery ticket and eventually will win once. Nonetheless, the system penalizes the patients who comply to win money. Indeed, if all patients fully comply, each one of them will get back the money that was initially spent. Hence, patients that are motivated only by money will stop complying and will earn less money over time. Although our system is conceived for older patients with type II diabetes, it would be reasonable to presume that the system would work with younger patients with type II or even type I as well. Some adaptations should be included, e.g., stronger social media component to share results and support online, but most of these requirements are already fulfilled by existing applications for smartphones. A possible extension of the system described in figure 1 allows for a sophisticated business model, which would include an additional set of participants to cover insurance costs without the need of insurance firms. Nonetheless, for sake of simplicity, we do not discuss this extension in this paper.

4 How to design a profitable mobile application by following our design criteria

In this section, we describe how to implement the lottery function of our system and we offer an illustratory instantiation by means of a simple example. In the fourth column of table 1, we assign fictive values to a set of variables, which are listed in the first column and that are needed to assess the revenue model of our service.

Variable	Code	Formula	Values	Comments
Number of participants	N	N	100	We assume to have 100 participants
Weekly inscription price	WIP	WIP	$1	Each patient pays in advance and has to comply all the week to expect to get the money back.
Weekly revenues	WR	N*WIP	$ 100	By assuming that there are 100 participants, every week the system handles $100
Financial support from insurances	FSI	FSI	$ 0	In this example, the insurance of the patient is assumed to not sponsor this system.
Total revenue	TR	WR + FSI	$ 100	The weekly revenue totally depends on the number of participants.
Profit	P	5%	5%	A percentage of the revenue is taken by the system to cover its costs
Total game revenue	TGR	TR*(1-P)	$ 95	Every week, $95 is distributed across the patients that complied.
Expected Compliance	EC	E	3	Each patient is expected to comply 3 days per week on average
Winning probabilities	P	P	7	If the patient complies every day, the system delivers 7 tickets every week
Expected winners	EW	N*EC/P	43	Since the average probability to win is 3/7, the number of winners is assumed to be 43
Rewards	Y	TGR / EW	$2.21	In the end, a complying participant, who paid $1, should expect to receive $2.21 dollars.

Table 1: *Example of a lottery system auto-financed by 100 patients with diabetes type II*

Table 1 shows how to assess the profitability of the system. Indeed, in our illustratory example, a complying participant is expected to earn 2.2 times what was initially spent, whereas the platform can cover its cost to not lose money at the end of the year.

Such results can be explained by the fact that each winner receives money from those who did not comply. Therefore, this approach is similar to the “speed camera lottery” (Sorrel, 2010), which gave to each car driver, who respected the speed limits, a ticket for a lottery made with the fees paid by the non-compliant drivers.

We believe that the random rewards delivered by e-mail will motivate the patients without requiring any additional effort on their side. Moreover, we suggest that a system that increases patients’ self-management on the long term will be more efficient than a system that simply shares the patient’s data with the doctor.

5 Discussion and conclusions

This article illustrates the preliminary results of an ongoing study that aims at designing diabetes management software, which uses financial incentives to increase patient compliance.

By following the guidelines for a design theory, we have described a system that combines existing mobile applications to deliver a new service and we explained how to implement a self-supported lottery with a business model that rewards compliant patients without financial deficit.

Our theory requires empirical testing to confirm its validity, and our interviews with field experts led us to be attentive at the ethical implications of the abuses of such a system. For that reason, we have decided to call our system “healthy lottery”.

Nonetheless, we believe that our research opens new interesting directions of investigations with financial rewards to improve patient compliance, which may also apply to other chronic diseases other than diabetes. Future research could also explore our proposed design of a self-supported lottery as a device for behavioral change.

Acknoledgements. *The authors would like to thank Michaël Poli for his useful insights, while developing the quantitative model described in table 1.*

6 References

Arnhold, M., Quade, M., & Kirch, W. (2014). Mobile applications for diabetics: a systematic review and expert-based usability evaluation considering the special requirements of diabetes patients age 50 years or older. *Journal of Medical Internet Research*, *16*(4). Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4004144/

Blondon, K., Klasnja, P., Coleman, K., & Pratt, W. (2014). An exploration of attitudes toward the use of patient incentives to support diabetes self-management. *Psychology & Health*, *29*(5), 552–563. http://doi.org/10.1080/08870446.2013.867346

Blondon, K. S. (2015). Patient attitudes about financial incentives for diabetes self-management: A survey. *World Journal of Diabetes*, *6*(5), 752–758. http://doi.org/10.4239/wjd.v6.i5.752

Cotter, A. P., Durant, N., Agne, A. A., & Cherrington, A. L. (2014). Internet interventions to support lifestyle modification for diabetes management: a systematic review of the evidence. *Journal of Diabetes and Its Complications*, *28*(2), 243–251.

Gregor, S., & Jones, D. (2007). The anatomy of a design theory. *Journal of the Association for Information Systems*, *8*(5), 312–335.

Haisley, E., Volpp, K. G., Pellathy, T., & Loewenstein, G. (2011). Promoting completion of health risk assessments with lottery incentives. *Am J Health Promot*. Retrieved from http://iucontent.iu.edu.sa/Scholars/Information%20Technology/haisleye_Promoting_Completion_of_HRAs.pdf

Patel, M. S., Asch, D. A., & Volpp, K. G. (2015). Wearable devices as facilitators, not drivers, of health behavior change. *Jama*, *313*(5), 459–460.

Sen, A. P., Sewell, T. B., Riley, E. B., Stearman, B., Bellamy, S. L., Hu, M. F., … Volpp, K. G. (2014). Financial Incentives for Home-Based Health Monitoring: A Randomized Controlled Trial. *Journal of General Internal Medicine*, *29*(5), 770–777. http://doi.org/10.1007/s11606-014-2778-0

Sorrel, C. (2010, December 6). Swedish Speed-Camera Pays Drivers to Slow Down. Retrieved May 16, 2016, from http://www.wired.com/2010/12/swedish-speed-camera-pays-drivers-to-slow-down/

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly*, 425–478.

Volpp, K. G., Loewenstein, G., Troxel, A. B., Doshi, J., Price, M., Laskin, M., & Kimmel, S. E. (2008). A test of financial incentives to improve warfarin adherence. *BMC Health Services Research*, *8*(1), 272. http://doi.org/10.1186/1472-6963-8-272

29th Bled eConference

Digital Economy

June 19 - 22, 2016; Bled, Slovenia

Intensive Lifestyle (e)Support to Reverse Diabetes-2

Luuk P.A. Simons

Delft University of Technology, Netherlands

L.P.A.Simons@tudelft.nl

Hanno Pijl

Leiden University Medical Center, Netherlands

H.Pijl@lumc.nl

John Verhoef

Leiden University of Applied Sciences, Netherlands

Verhoef.j@hsleiden.nl

Hildo J. Lamb

Leiden University Medical Center, Netherlands

H.J.Lamb@lumc.nl

Ben van Ommen

TNO, Netherlands

ben.vanommen@tno.nl

Bas Gerritsen

Health Coach Program, Netherlands

Bas.Gerritsen@deHealthCoach.org

Maurice B. Bizino

Leiden University Medical Center, Netherlands

M.B.Bizino@lumc.nl

Marieke Snel

Leiden University Medical Center, Netherlands

M.Snel@lumc.nl

Ralph Feenstra

Health Coach Program, Netherlands

Ralph.Feenstra@deHealthCoach.org

Catholijn M. Jonker

Delft University of Technology, Netherlands

C.M.Jonker@tudelft.nl

Abstract

Advanced diabetes-type-2 patients often have high insulin resistance. Over the years their insulin medication rises, which further increases their insulin resistance and glucose management problems.

A HINTc (High Intensity Nutrition, Training & coaching) pilot study was conducted with 11 insulin-dependent patients. Hybrid eHealth support was given, with electronic support plus a multi-disciplinary health support team.

Based on preliminary 12 week results, attractiveness and feasibility of the intervention were high: recommendation 9,0 out of 10 and satisfaction 9,1 out of 10. TAM (Technology Acceptance Model) surveys showed high usefulness, feasibility and intentions for future use. Acceptance and health behaviours were also reinforced by the rapid results (average 9% weight loss, 20% lower fasting glucose and 71% lower insulin medication, plus a 46% increase on the Quality of Life Physical Health dimension).

Our analysis supports three types of conclusions. First, patients' health literacy and quality of life improved strongly, both supporting healthier behaviours. Second, a virtuous cycle was started, helping patients reverse diabetes-2 progression. Third, a design analysis was conducted regarding service mix efficacy in relation to key requirements for designing ICT-enabled lifestyle interventions.

Keywords: Diabetes-2, eHealth, Lifestyle, Monitoring, Coaching, Blended Care, Service Design

1 Introduction

Our Western lifestyle plays a large role in the onset and progression of diabetes mellitus type 2 (Lim 2011). Insulin resistance has an important role in creating a vicious circle, where medication needs generally increase over time. Moreover, increasing blood glucose and insulin levels speed up the processes of weight gain, insulin resistance, inflammation, aging and comorbidity (like CVD, kidney failure, cancers, neuropathy and dementia) (Hotamisligil 2010). Hence, reducing insulin dependence and insulin resistance can be seen as an important therapeutic goal. This can be achieved with healthy lifestyle improvements.

Several lifestyle interventions have yielded improved outcomes in type 2 diabetes patients on insulin therapy, most notably: lower blood sugar and lower medication needs (Jenkins 2008; Esposito 2009). However, these are often highly controlled interventions. Moreover, the long-term sustainability of behaviours is limited. The question is: can we do this on a more 'Do-It-Yourself' and e-Supported basis? This would have two advantages. First, since behaviour improvements are implemented within patients' lives, it improves the chance of sustained health behaviour (Simons 2013). Second, it is cheaper. Since 2010 the Health Coach Program has been used to improve lifestyle and metabolic outcomes (including reduced insulin needs for diabetes-2 patients), via eSupport, improved self-management and rapidly improved health behaviours (Simons 2010, Simons 2015). To promote rapid health results, a HINTc (High Intensity Nutrition, Training & coaching) intervention was developed for this patient population. The intervention combines improving health literacy with active behaviour change support.

This paper discusses preliminary results after 12 weeks, as part of a larger 50-week study. Our focus here regards feasibility and attractiveness of the HINTc e-supported lifestyle intervention, plus design lessons. Medical results will be discussed in another paper.

Research Question:

What are the feasibility and attractiveness of the HINTc e-supported lifestyle coaching program; and what are the effects on quality of life?

As part of the design analysis we address: efficacy of the service mix deployed in eSupported lifestyle interventions. We combine the 12-week results from our measurements with a design analysis based on an evaluation framework of requirements for ICT-enabled healthy lifestyle interventions.

2 Theory

The eSupported lifestyle program combines coach sessions with electronic dashboarding and self-management. Hybrid programs (face-to-face plus tele-support) have been indicated to be attractive for some time (Demark-Wahnefried 2008). Finding the right mix between offline and online contacts is an ongoing design research challenge (Pekmezi 2011). A hybrid or multi-channel service mix is recommended (Sperling 2009, Simons 2002, 2006, 2010, 2010b), combining electronic and face-to-face interactions. For example, face to face 'on site' coaching and training have as benefits: a richer service experience with the coach, with other participants and with a health focused 'service scape'; group support experiences (obtaining additional social support and co-creating service experiences together); learning from each other; health experiences in healthy food-, sports- and relaxation exercises. Disadvantages are: more (travel) time needed; less flexibility regarding when and where; and not everyone likes group sessions (Demark-Wahnefried 2007). Electronic and (semi-)automated coaching has as benefits: more time-efficient; more flexibility in when and where to have contact; very explicit monitoring of your own progress online; having status reports including 'next steps' commitments always online. Disadvantages are: the sensory-, emotional- and group experiences are more limited. Also, the 'service scape' in which people are immersed is only virtual, not physical. In summary, often a hybrid service mix has most to offer.

Key functionalities to increase health motivations and behaviours in this eSupported lifestyle program are (Simons 2010, 2014 and 2016):

- Daily logging of insulin and blood sugar levels: for close progress monitoring of the health coaches, physicians and participants themselves.
- Close cooperation with physicians, for rapid medication adjustments initially (avoiding dangerously low blood sugars when insulin dosage is not reduced rapidly enough in the first days), plus medical monitoring/coaching in the following weeks.
- A personal online health dashboard with graphs of progress towards adherence targets on the various health behaviours;
- Automated feedback on lifestyle aspects where relatively positive scores have been achieved (nutrition, physical activity, stress management or an overall score);
- (Tele)coaching by a health coach, generating online reports on progress towards adherence targets in the personal dashboard;
- The (tele)coaching sessions can be flexibly planned, based on convenience and participant preference: during in-clinic visits or phone based from home;
- Options to ask questions to the coach: via messaging within the dashboard or via email;
- Online schedule indicating upcoming events: group sessions, individual coach sessions (when and where), physical measurements, surveys;
- A micro-learning Health Quiz accessible via smartphone, mail and/or web;
- Reading materials in the mail;
- Weekly tips via email on health, motivation and self-management;
- Besides individual coaching, group sessions are also used in order to stimulate group support, mutual inspiration and encouragement, plus peer education.

If we look at the design challenge of persuasive technology (Fogg 2002, 2009) for health, it was theorized and tested elsewhere that this challenge is not just located in the ICT design, but also in the design of the overall service scape, including health effects and coach relationship (Simons 2014b). It should generate positive, mutually reinforcing service experiences across communication channels and activate long term health motivation and -behaviours, in order to deliver long term results. This is reflected in the following design evaluation framework for health improvement ICT solutions (Simons 2014), see Figure 1. It helps evaluate the impact of ICT-enabled interventions on health effectiveness, coaching performance and ICT value adding.

Figure 1 addresses three evaluation domains. Domain 1 'health effectiveness' not only includes health outcomes, but also health literacy ('as a user I know how to best serve my health'), health behaviours and health well-being (meaning health related quality of life (Ware 1998) and the Seligman (2012) dimensions of well-being related to health). Preferably, health interventions have broader and deeper impacts rather than narrow ones, since the former will improve health well-being more significantly. Experiencing larger health well-being impacts forms an important intrinsic motivator for health behaviours in the longer term.

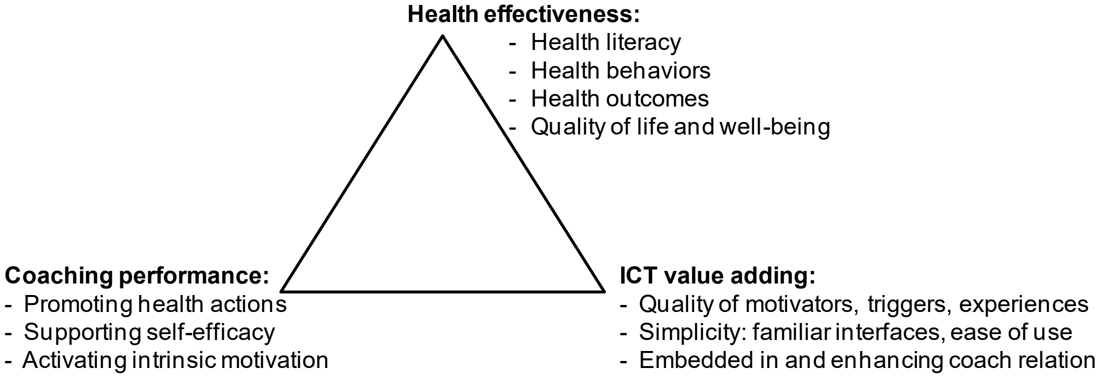


Figure 1: Basic requirements when designing ICT-supported healthy lifestyle interventions

Domain 2 'coaching performance' not only includes promoting health actions (improving health readiness by moving from awareness to intentions to behaviours as in the HAPA (Health Action Process Approach) and i-change models, Schwarzer 2010, Wiedeman 2011), but also activating intrinsic motivations, and supporting users in their self-efficacy (their day-to-day attempts and successes to turn their health behaviour experiments into health wellness experiences, Lipke 2009).

Domain 3 'ICT value adding' includes (Fogg 2002, Fogg 2009): value adding via high quality triggers, motivators and service experiences (which often involves using a mix of channels, each for their strengths – Demark-Wahnefried 2007, De Vries 2008, Sperling 2009, Simons 2004, Simons 2006), simplicity (which means using ICT interfaces that are mainstream for the user group, are attractive and easy to use - many initiatives underperform due to usability barriers, see Jimison 2008) and finally: embedding applications in an overall health provider or coach relationship (so that the meaning is enhanced of the coach relationship as well as the meaning of the data). For example, the foundations of coaching include 'building rapport or relationship', using different levels of listening based on empathy and intuition, see Starr 2008. This is best done by a person. This contrasts with the benefits (Simons 2010b) of automating processes of data logging and reporting.

3 Methods, Study Design, Intervention

This is a non-randomized, one arm, pilot intervention study of 12 weeks Sept-Nov 2015, plus effect measurement at 1 year of follow up; approved by the Leiden University Medical Center (LUMC) Ethics Board. The biomedical results will be addressed in a different paper. The study participants were 11 insulin-dependent Diabetes Mellitus Type-2 patients. Patients were volunteers, recruited by LUMC from the larger Leiden area in the Netherlands. They were 8 men and 3 women, ages 50-70 years (and 1 patient of 39 years old), with widely varying levels of education (mostly lower education levels) and of comorbidity.

Challenges regarding design of individual training schedules were posed by all the physical constraints in this group: 7 had significant movement restraints (knee- and hip-replacements, cardiovascular blood flow constraints, stents), 5 had neuropathy, and 7 had cardiovascular disease. On average they had been diabetes-2 patient for more than 10 years and they were motivated for trying lifestyle improvements. TAM surveys (Technology Acceptance Model, Venkatesh 2000) were used at weeks 4 and 12 to assess intervention feasibility and attractiveness, along with user satisfaction evaluations. Besides, a standardised sit/stand test is used to assess strength (Csuka 1985) and an Astrand test (1976) for endurance.

Study inclusion criteria

- Type 2 diabetes mellitus treated by oral medication and insulin therapy.
- BMI >= 25 kg/m2
- Age 30-80 yrs
- Dutch language and basic computer competence (for use of email and web based dashboard)

Exclusion criteria

- Recent (< 3 months) myocardial infarction
- Uncontrolled blood pressure (SBP > 170 mmHg and/or DBP > 100 mmHg, 2 out of 3 measurements)
- Any chronic disease other than type 2 diabetes hampering participation (at the discretion of the investigator)
- Low motivation to participate (score 2 ‘weak’ or 1 ‘very weak’ on a 5-point scale).
- Alcohol consumption of more than 28 units per week at present or in the past
- Psychiatric disease (as defined by DSM-V)
- Claustrophobia
- Metal implants or other contraindications for MRI

The eSupported lifestyle intervention HINTc (High Intensity Nutrition, Training and coaching)

An extensive eSupported lifestyle program is offered, which combines coach sessions with electronic dashboarding and self-management, plus electronic health tips and a digital health quiz game. Intensive coaching is offered for 4 weeks with the purpose of generating self-propelling behaviours and capabilities. In week 1 a low calorie approach is taken to enable rapid alleviation of fatty liver conditions. The support in weeks 5-12 is more lightweight, with group sessions at the end of weeks 6, 8 and 12, weekly electronic tips and a digital health game.

As an umbrella overarching the personalized coaching per participant, the general lifestyle advice follows the guidelines of the Harvard Epidemiology and Nutrition Group for nutrition and physical activity, with specific modifications for diabetics. The guidelines are to increase intake of vegetables and low sugar fruits (each 2,5 servings/day or more), to choose whole grains instead of refined grains, to limit sugar and other high glycaemic load foods, to have one daily serving of nuts and/or legumes, to limit intake of red meat and processed meat, to limit intake of trans and animal fats, and to have no more than 2 (male) or 1 (female) alcoholic beverages/day. Physical exercise guidelines are: at least 60 min/day moderate intensity activity (like walking or gardening) and at least 3x30 min/week intensive activity, which was also supported with group training sessions at the LUMC location three times per week (Borg level 12-14). Stress management guidelines are: relaxation exercises for >10 min/day.

4 Results

We discuss several types of results. We address answers to the research question: What are the feasibility and attractiveness of the HINTc e-supported lifestyle coaching program, including the positive feedback provided by the short term improvements in quality of life and physiology (insulin medication, blood sugar, physical stamina)? And we analyse efficacy of the service mix deployed in eSupported lifestyle interventions, following the framework of Figure 1 from Theory.

First, regarding attractiveness and feasibility, satisfaction and recommendation were not only high after 4 weeks (8,7 and 9,0 out of 10 respectively), but were even increased at the 12-week measurement: 9, 1 and 9,0 out of 10 respectively. This is in contrast with usual patterns where the initial enthusiasm of the first weeks wanes after 3 months. Moreover 'Health Related Quality of Life' as measured with the RAND SF-8 showed strong improvements over the 12-week period, especially on Physical Health (+46%): from 50.1 at start to 66.6 at week 4 to 73.1 at week 12, with 77 as the Dutch average. Mental Health went from 68.9 at start to 82.4 at week 4 to 80.6 at week 12, with 75 as the Dutch average. This further aided motivation to continue complying with these lifestyle guidelines. Added to the effects of self-efficacy and improved health, this motivated intrinsically and extrinsically. Qualitative feedback from the participants supports this interpretation: 'Have not felt so good in a long time' 'Now I understand much better how I can help myself' 'It is great to be less dependent on medication' 'I gained control' etc.

Second, there were physiological improvements in the first 12 weeks (average 9% weight loss, 20% lower fasting glucose, 13% lower HbA1C - an indicator for 3-month-averaged blood sugar levels - and 71% lower insulin medication). The majority of the insulin reduction even occurred in the first days and first week of the intervention. Biomedical details will be reported in a separate publication. However, it is clear that these rapid results helped motivate patients and provided positive feedback that they were on the right track. Besides, they started feeling more fit. The two measures for physical endurance (VO2max: + 45%) and strength (30 sec sit/stand test: +23%) both improved over the 12-week period, including significant and motivating improvements in the first 4 weeks.

Third, the TAM (Technology Acceptance Model) user evaluations of week 4 and 12 shed some further light on patients' experience and appreciation of the intervention, see also Table 1.

TAM Construct	Week 4 Score (out of 7)	Week 12 Score (out of 7)
1. Usefulness	All items ≥ 6.5	All items ≥ 6.8

2. Effortless	-Lowest (5.4): Food guidelines 5.55: Daily physical exercise 5.55: Health Quiz	-Lowest (5.0): Health Quiz -& Lowest (5.0): Food/exercise logging in dashboard 5.3: Food guidelines
3. Opinion of social circle	All items ≥ 5.9	All items ≥ 6.3; except 'other patients': 5.4
4. Support	All items ≥ 5.8	All items ≥ 6.0
5. Affect	All items ≥ 6.5	All items ≥ 6.4
6. Ability	All items ≥ 6.2	All items ≥ 6.0
7. Trust	All items ≥ 6.2	All items ≥ 6.2
8. Valuation (e)Support elements 'What helped most to build health behaviours?'	Top 3 (6.9): Support Health Coaches, Personal Trainers, Physicians 6.6: Daily eLog sugar/insulin; Group sessions; Health Literacy -Lowest (5.4): Homework physical exercise -2nd Low (5.5): Health Quiz	6.9: Personal Trainers 6.8: Health Literacy 6.7: Daily eLog sugar/insulin 6.7: Support Health Coaches 6.6: Support Physicians 6.6: Support/advice via mail -Lowest (4.6): Homework physical exercise -2nd Low (5.6): Health Quiz
9. Future Use Intention	All items ≥ 6.1 6.9: Ask advice Health Coaches or Physicians 6.7 Daily eLog sugar/insulin	6.7: Daily eLog sugar/insulin 6.6: Adopt regular training 6.6: Ask advice Health Coaches or Physicians Lowest (5.0): Food/exercise logging in dashboard All other items ≥ 6.0

Table 1: TAM (Technology Acceptance Model) user evaluation summary (n=11, weeks 4 and 12)

The TAM (Technology Acceptance Model, Likert scale 1 to 7, strongly disagree to strongly agree, with several negatively coded items) user evaluation at weeks 4 and 12 shows three patterns. First, these patients were relatively positive at 4 weeks and 12 weeks about all TAM constructs. Aspects that scored particularly high were: usefulness and the support offered by the multidisciplinary health team, and the simple solution for daily logging of sugar/insulin levels.

Besides, some patients were not ICT-literate and clearly had trouble with eTools like the Health Quiz of food/exercise logging. Some (not necessarily the same) patients experienced most challenges in implementing the food and exercise guidelines, fitting them into their daily lives.

Finally, some slight changes over time became apparent. At 4 weeks the main positive points were: support, results monitoring (sugar/insulin) and increased literacy. At 12 weeks the main positive points were: the personal trainers (4th year physiotherapy students who trained the groups 3x per week for 12 weeks), health literacy. The main challenges at week 4 were: Food guidelines, homework for physical exercise and the health quiz. At 12 weeks, the TAM scores on service mix elements that were experienced as challenging were slightly lower. The food/exercise logging and health quiz become more of an effort for several patients. Also, the homework for physical exercise received a relatively low score (4.6) when evaluating the (e)Support mix (construct 8). Finally, at 12 weeks it became more apparent for some participants that other patients outside the group did not always understand or appreciate the value of this intervention (TAM construct 3: opinion of social circle).

Part of the positive user evaluations regarded the quality of the multidisciplinary support team: health coaches increasing self-efficacy and health literacy, physiotherapy students conducting highly motivating group training sessions for 12 weeks, plus the clinical support team. Given the strong insulin therapy reduction in the first days and weeks (40%-50% reduction on day 1 and about 75% in week 1), close cooperation with the physicians was critical to avoid hypoglycemia in response to the HINTc intervention. Two patients were able to stop medication altogether in this period and were still without insulin medication at the 12-week measurement point. Throughout the 12-week period several medication changes were needed (like lower blood pressure medication), under close supervision of the physicians.

The final set of study results regard the efficacy of the hybrid eSupport mix deployed. Table 2 shows the authors' evaluation using the theory framework of Figure 1.

Health Effectiveness	**Coaching Performance**	**ICT Value Adding**
Health Literacy: ++ Much better than the relatively low literacy start. - Some kept falling back into certain old beliefs and coping patterns. *Health behaviours:* ++ In 12-week intervention. +/- After 12 weeks: More uncertain, plus variance *Health outcomes:* ++ Biomarkers & medication. *Quality of Life:* ++ Strong increase.	*Promoting health actions:* ++ (e)Coach mix promoted strong steps forward. +/- Uncertain after 12 weeks. *Supporting self-efficacy:* ++ Strongest impact in first weeks, via daily progress monitoring and (e)Coaching reinforcing impacts of health behaviours. *Activating intrinsic motivation:* ++ Getting results and feeling better.	*Motivators, triggers, experience*: ++ Daily monitoring & progress feedback on medication, blood sugar, food, exercise. + Sharing each other's progress. +/- Health quiz, start- & week tips: fun for most patients, but not all. *Simplicity:* ++ Simple daily mail reminder for sugar/insulin inputs. (Some were highly ICT-illiterate.) - Health Quiz and food logging being complex for some. *Fit with coach processes:* + eTools were integral part of coach processes. +/- Much motivation support still from the coaches, less from tools.

Table 2: Design evaluation on design requirements from Figure 1 (authors' opinions, 5-point scale from - - to ++)

Each column of Table 3 holds a few lessons. First, if we look at the Health Effectiveness of our HINTc approach, we see mixed results. Biologically, there were large effects. And within the first three weeks these effects became very pronounced within all 11 participants. Hence they were robust despite the large health, education and psychology differences within the group. However, regarding health literacy and self-management competence, large differences were observed: not only at the start, but some of these differences persisted across the 12 weeks. Second, one of our main coaching goals was fostering self-propelling behaviours, beliefs and motivations that continue after the 12 week HINTc intervention period. Some of these goals were met, via results, feeling better (intrinsic motivation), creating new habits, self-efficacy and literacy (understanding behaviour impacts). Third, for the column of ICT Value Adding, we observed large differences between the participants. What all valued was the simple eLogging of daily insulin/sugar values. How well this worked was also a pleasant surprise for the physicians involved. Also the options to ask for help via mail or the dashboard were valued by all. The other tools, like daily/weekly logging of food and exercise, the start and weektips, the microlearning health quiz, were really valued and used by several but not all participants. Lack of ICT literacy and/or time (some patients had very busy schedules, with full time jobs, families and regular training sessions several times per week) played a role here.

5 Discussion and Conclusion

This preliminary analysis has several limitations. First, the study is not finished. The study design was mainly aimed at testing eHealth intervention effects after 12 weeks, but there is also a 50-week follow up measurement planned in Aug 2016 to help assess long term effects. Second, the 12-week data analyses are not complete yet; more biometric and behaviour data analyses still need to be done and are planned for later in the year. Third, regarding external validity, these study results may only apply to motivated individuals, who volunteer for lifestyle training. Fourth, this was only a pilot study with 11 participants.

Still, on the positive side our results (biological, behavioural, TAM) proved relatively robust across the 11 participants, even though they were diverse in background (education, gender, age, insulin medication levels and co-morbidity, health literacy, coping and learning styles). And this pilot provided an opportunity to conduct a design analysis on the hybrid service mix deployed.

5.1 Design Lessons and Implications for Practice

Several lessons can be learned from this study. Two in relation to the HINTc (High Intensity Nutrition, Training and coaching) approach and three in relation to the suitability of hybrid eHealth support.

First, it is interesting to see in this HINTc intervention that satisfaction is high (at 4 weeks) and stays high (for at least 12 weeks), despite the fact that large lifestyle changes are requested from the participants. Our interpretation is that contributing factors for this satisfaction are: gains in self-efficacy and health literacy, seeing results fast and feeling results fast, which activates intrinsic motivation. In other words: the large and growing benefits that patients experience. The benefits, besides medication reduction, are also clearly visible in the rising average scores on the Physical Health dimension of the SF-8 Quality of Life survey. Second, based on qualitative feedback from the participants, it appears that a number of the new, healthier food and exercise patterns started to become 'the new normal' already after 4 weeks into the intervention.

Third, opinions varied regarding the suitability of most of the eTools provided (like the health quiz, the email weektips, food and exercise logging). In the short term of the first few weeks, virtually all tools were used by virtually all patients. After about 2 to 3 weeks, usage grew for some but declined for others. Two factors appeared important in determining adoption and use of these tools: availability of time, plus ICT literacy (with the latter appearing most important: four participants expressed aversion at using computers.

Fourth, the exception to this varied eTool adoption pattern was the simple, daily mail reminder for sugar/insulin inputs: everybody used it well and wanted to continue using it. It was constructed with the use of a personal, secure link: a simple click was enough to land on the right eDashboard page for sugar and insulin eLogging (however, others would not be able to enter the eDashboard with this link). We think that the combination of high simplicity with high usefulness was the key to its high adoption: this was an important basis for the daily feedback/coaching from the multidisciplinary support team.

Finally, the multidisciplinary support team was highly valued (health coaches increasing self-efficacy and health literacy, physiotherapy students conducting highly motivating group training sessions for 12 weeks, plus the clinical support team). This had two aspects. One: all support team members shared the same view on the patients' progress. Second, the group effects were strong and positive: 'we are all in this together and we support each other.' This fostered high levels of interpersonal commitment, which is something that is harder to achieve with eTools.

5.2 Implications for Theory

One of the most striking observations regarding some of the patients in this group was that their learning styles were highly non-cognitive. An (apparent) understanding of health cause and effect seemed to have less impact than experiencing cause and effect. Sometimes over and over again. Some of them would only consider trying new coping styles after many clear experiences of failure of their old coping styles. Daily feedback loops between behaviours and (negatively high) sugar values were useful in this regard. For this group, learning is not very much about explicit awareness, intentions, goals and behaviour plans (as postulated in models like HAPA and i-change, Schwarzer 2010, Wiedeman 2011). This is in contrast with other participants who were very keen on adopting new coping behaviours as soon as they understood cause and effect: the more cognitive approach.

Summarizing from this study, we can conclude a few key points. First, the intensive training and coaching strongly improved patients' health literacy and quality of life, both supporting healthier behaviours. Second, biologically a virtuous cycle was started, helping patients reverse diabetes-2 progression, lowering all from a toxic level of insulin therapy to on average 79% lower levels, with 2 patients able to stop insulin. Third, this is a challenging patient group with some being relatively low in health- and ICT literacy. Following the design analysis, the highly simplified solution we created for secure, daily eLogging for sugar/insulin for this group was relatively useful. All patients used it well and it enabled everybody involved to closely monitor progression. Regarding other eTools, appreciation and use varied more, largely depending on ICT literacy and partly depending on time (some patients had very busy schedules, with full time jobs, families and regular training sessions every week).

Acknowledgement
The authors are very thankful to the physiotherapy team of Amy Blansjaar, Jadira Breeveld, Tess Bakker and Monique Bagheri for their great dedication in providing training and support for these patients.

References

Astrand PO. (1976). Quantification of exercise capability and evaluation of physical capacity in man. Prog Cardiovasc Dis; 19(1):51-67.

Csuka M., McConnachie (1985). A Simple method for measurement of lower extremity muscle strenght. Am J Med;(78):77-81.

Demark-Wahnefried, W., Clipp, E., Lipkus, I., Lobach, D. et al. (2007). Main Outcomes of the FRESH START Trial: A Sequentially Tailored, Diet and Exercise Mailed Print Intervention Among Breast and Prostate Cancer Survivors. J Clin Oncol, 25(19), pp. 2709-2718.

Demark-Wahnefried W, Jones LW. Promoting a healthy lifestyle among cancer survivors. Hematology-Oncology Clinics of North America. 2008;22(2):319–342.

De Vries, H., et al. (2008). The effectiveness of tailored feedback and action plans in an intervention addressing multiple health behaviors. Am J Health Promot. 22(6): p. 417-25.

Esposito K, Maiorino MI et al (2009). Effects of a Mediterranean-Style Diet on the Need for Antihyperglycemic Drug Therapy in Patients With Newly Diagnosed Type 2 Diabetes; A Randomized Trial. Annals of Internal Medicine. 151(5):306-314.

Fogg, B.J. (2002). Persuasive technology: using computers to change what we think and do." Ubiquity, December (2002): 5.

Fogg, B. J. (2009). A behavior model for persuasive design. Proceedings of the 4th international conference on persuasive technology. ACM, 2009.

Hotamisligil GS (2010). Endoplasmic Reticulum Stress and the Inflammatory Basis of Metabolic Disease, Cell, 140; (6): 900-917. doi: 10.1016/j.cell.2010.02.034

Jenkins DJA, Kendall CWC et al (2008). Effect of a Low–Glycemic Index or a High–Cereal Fiber Diet on Type 2 Diabetes; A Randomized Trial. JAMA; 300 (23): 2742-2753. doi: 10.1001/jama.2008.808.

Jimison, H., Gorman, P., Woods, S., Nygren, P., Walker, M., et al. (2008). Barriers and drivers of health information technology use for the elderly, chronically ill, and underserved. Evid Rep Technol Assess (Full Rep) Nov;(175):1–1422.

Lim EL, Hollingworth KG et al. (2011) Reversal of type 2 diabetes: normalisation of betacell function in association with decreased pancreas and liver triacylglycerol. Diabetologia 54: 2506-2514.

Lippke, S., Wiedemann, A. U., Ziegelmann, J. P., Reuter, T. and Schwarzer, R. (2009). Self-efficacy moderates the mediation of intentions into behavior via plans. American Journal of Health Behavior, 33(5), 521–529.

Pekmezi DW, Demark-Wahnefried W. (2011). Updated evidence in support of diet and exercise interventions in cancer survivors. ActaOncol 50:167–78

Schwarzer, R., et al. (2010). Translating intentions into nutrition behaviors via planning requires self-efficacy: evidence from Thailand and Germany. Int J Psychol. 45(4): p. 260-8.

Seligman, MEP. (2012). Flourish: A visionary new understanding of happiness and well-being. Simon and Schuster, New York.

Simons, LPA. (2006). Multi-channel services for click and mortars: development of a design method. PhD Thesis, Delft University of Technology.

Simons, LPA and Bouwman, H. (2004). Designing a click and mortar channel mix. International Journal of Internet Marketing and Advertising 1(3): 229–250.

Simons LPA, Foerster F., Bruck PA, Motiwalla L & Jonker CM. (2014b). Microlearning mApp to Improve Long Term Health Behaviours: Design and Test of Multi-Channel Service Mix. Paper presented at the 27th Bled eConference. Bled, Slovenia, Proceedings. Retrieval from www.bledconference.org and http://aisel.aisnet.org/bled2014/4

Simons LPA, Foerster F., Bruck PA, Motiwalla L & Jonker CM. (2015). Microlearning mApp Raises Health Competence: Hybrid Service Design. *Health and Technology*, 5 pp 35-43. DOI 10.1007/s12553-015-0095-1

Simons LPA, Hafkamp MPJ, Bodegom D, Dumaij A, Jonker CM. (2016). Improving Employee Health; Lessons from an RCT. *IJVNO*, Accepted, to appear in 2016.

Simons, LPA, and Hampe, JF. (2010). Service Experience Design for Healthy Living Support; Comparing an In-House with an eHealth Solution. Paper presented at the 23rd Bled eConference. Bled, Slovenia, from www.bledconference.org.

Simons, LPA and Hampe, JF. (2010b). Exploring e/mHealth Potential for Health Improvement; A Design Analysis for Future e/mHealth Impact. Paper presented at the 23rd Bled eConference. Bled, Slovenia, from www.bledconference.org.

Simons, LPA, Hampe JF, and Guldemond NA. (2012). Designing Healthy Consumption Support: Mobile application use added to (e)Coach Solution. Paper presented at the 25th Bled eConference. Bled, Slovenia, from www.bledconference.org.

Simons LPA, Hampe JF, Guldemond NA. (2013). Designing Healthy Living Support: Mobile applications added to hybrid (e)Coach Solution, Health and Technology, 3 (1), pp.1-11.

Simons LPA, Hampe JF, Guldemond NA. (2014). ICT supported healthy lifestyle interventions: Design Lessons. Electronic Markets. 24 pp. 179-192. DOI 10.1007/s12525-014-0157-7.

Simons, LPA, Steinfield C and Bouwman H. (2002) "Strategic positioning of the Web in a multi-channel market approach." Internet Research 12 (4): 339-347.

Sperling, R., L.P.A. Simons and H. Bouwman. (2009). Multi-Channel Service Concept Definition and Prototyping, International Journal of Electronic Business, 7 (3), pp.237–255.

Starr, J. (2008). The coaching manual: the definitive guide to the process, principles and skills of personal coaching. New York, Prentice Hall.

Venkatesh, V. and Davis, F.D. (2000). "A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies," Management Science, 46, 186-204.

Ware Jr, J.E. and Gandek, B. (1998). "Overview of the SF-36 health survey and the international quality of life assessment (IQOLA) project." Journal of clinical epidemiology 51.11 (1998): 903-912.

Wiedemann, A. U., Lippke, S., Reuter, T., Ziegelmann, J. P. and Schwarzer, R. (2011). How planning facilitates behaviour change: Additive and interactive effects of a randomized controlled trial. European Journal of Social Psychology, 41, 42–51.

29th Bled eConference

Digital Economy

June 19 - 22, 2016; Bled, Slovenia

A Comparative Analysis of the Australian and German eHealth System

Isabella Eigner

University Erlangen-Nuremberg, Institute of Information Systems, Germany

Isabella.Eigner@fau.de

Andreas Hamper

University Erlangen-Nuremberg, Institute of Information Systems, Germany

Andreas.Hamper@fau.de

Nilmini Wickramasinghe

Deakin University, Australia

n.wickramasinghe@deakin.edu.au

Freimut Bodendorf

University Erlangen-Nuremberg, Institute of Information Systems, Germany

Freimut.Bodendorf@fau.de

Abstract

The Australian and German healthcare system share extensive similarities in their financial and administrative structures. Both countries follow a two-tiered system offering both public and private insurance. As Germany adapted the Australian DRG system in 2003 to bill patients according to diagnosis-related case rates, patient treatment and accounting also follow similar practices. Despite their common preconditions in the "offline" setting, the goals and execution of their nationally initiated eHealth solutions show vast differences. While Australia's platform-based My Health Record offers an opt-in solution for patients and doctors to exchange healthcare data under shared control between patient and service provider, Germany's Electronic Health Card (EHC) mandatorily includes personal and insurance data that can be further expanded with medical data and electronic health records. Information on the EHC is mainly managed by healthcare providers. The differing approaches are linked to different opportunities and weaknesses. This paper provides a systematic overview of the Australian and German eHealth system and gives suggestions on strategies and challenges from both countries. By conducting a SWOT analysis, both eHealth systems are critically reflected considering supported processes, applied technologies, and user acceptance. We furthermore discuss the impact of the individual systems on current healthcare issues and the success rate of their initial intentions.

Keywords: eHealth, SWOT analysis, Germany, Australia, DRG, healthcare system, EHC, PCEHR

1 Introduction

The use of technology to increase efficiency and transparency in organisations has been widely accepted worldwide and transformed operations in many sectors, e.g. commerce, finance or education. In healthcare, the need for technological support is becoming even more prominent. Developed countries are suffering from increasing cost pressure and rising consumer expectations. The lack of trained professionals leads to an expanding need for more efficient communication and collaboration between healthcare professionals. Even though many countries already adopted information and communication technologies to support individual healthcare processes, a comprehensive solution and infrastructure for integrated healthcare processes has yet to be developed. The requirements for the success and a positive effect of eHealth strategies is threefold. Firstly, the acceptance and access of both providers and consumers, i.e. healthcare professionals and patients, highly influences the actual increase in efficiency and speed of adoption. Secondly, governmental support and legal requirements have to be established to determine how and which processes in the healthcare ecosystem can be improved or have to be adapted. The required technology and nationwide standards are lastly essential to facilitate the introduction of networked applications. The forecast for the development of the global digital health market shown in Figure 1 projects a continous rise for eHealth applications worldwide, e.g. telehealth and electronic health records (Little, 2016). To support this steady growth and enable scalability throughout various eHealth application areas, national strategies for setting an eHealth vision and its implementation have been introduced by a majority of nations. Although healthcare systems in developed countries are confronted with similar issues, e.g an aging population and increasing cost pressure, approaches of national eHealth solutions vary in their execution.

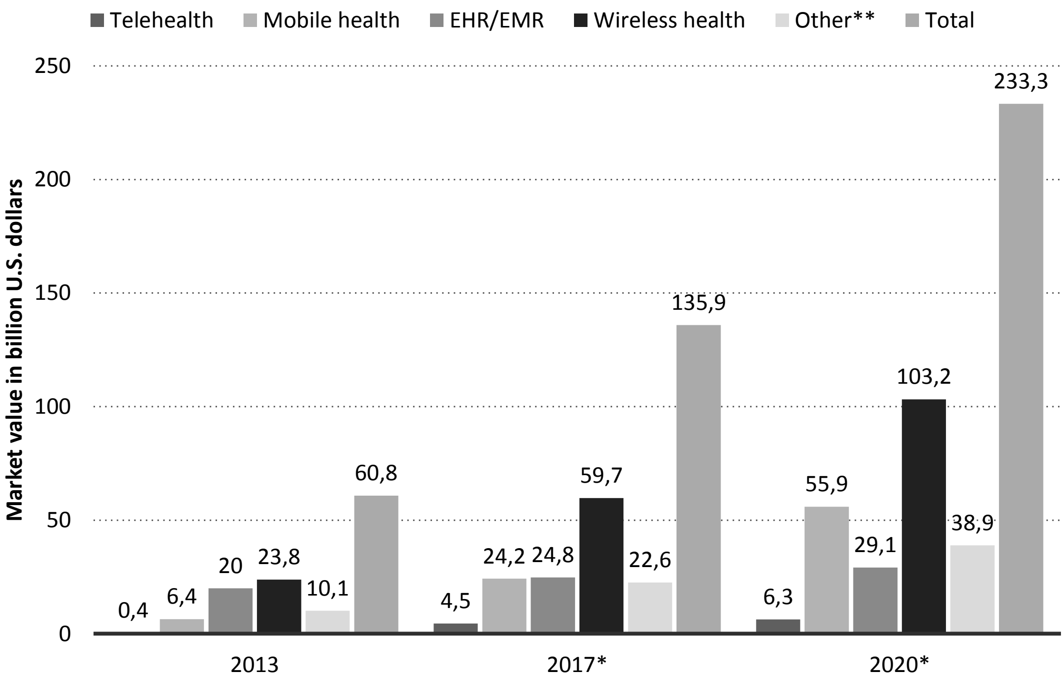


Figure 1: Global digital health market from 2013 to 2020, by segment (in billion U.S. dollars) (Little, 2016)

The aim of this paper is to identify strategies for the successful adoption of national eHealth projects, by comparing the Australian and German eHealth systems. While both countries' healthcare systems bear similar traits in the "offline" setting considering insurance and financial administration, the execution and goals of their nationally initiated eHealth solutions show vast differences. This contrast provides an interesting opportunity to detect challenges and implications of both approaches that can be used to find best practises, identify critical obstacles, and give suggestions for eHealth adaptions in other developed countries.

The paper is structured as follows: Section two gives an overview of the healthcare systems in Australia and Germany and relevant insights from eHealth research. In section three, both national eHealth strategies are analysed based on their macro-environmental factors, i.e. *Governmental and policy support, Technology and infrastructure* and *User access and accessibility.* Based on these findings, a SWOT analysis is conducted for both countries in section four, providing strategies for successful eHealth adoptions. The discussion in section five concludes with the results, implications and limitations of this paper.

2 Background

2.1 Healthcare Systems in Australia and Germany

Both Australia and Germany follow a universal two-tiered system, offering private and statutory health insurance. While public and private insurance can be taken complementary in Australia, Germany only allows one type of primary insurance and limits the transfer to the private system with a minimum required level of income. With health expenditures of 11.3 percent of the country's GDP Germany spends slightly more on healthcare compared to Australia's 9.4 percent (OECD, 2015). Both countries are also among the top rates in life expectancy and quality of care. Besides demographic similarities, hospital administration and billing follow similar approaches due to corresponding patient classification systems based on diagnosis related groups.

"Diagnosis related groups" (DRG) are admitted patient classification systems which provide a clinically meaningful way of relating a hospital's casemix to its required resources. Patients with similar clinical conditions requiring similar hospital resources are categorized in groups and priced accordingly (Fetter, Shin, Freeman, Averill, & Thompson, 1980). Initially originating in the US in 1980, the development of the Australian National DRG (AN-DRG) system began in 1988 and was released in July 1992. It is based on the US developed "All Patient Diagnosis Related Groups" (AP-DRG). The system has been renamed to Australian redefined DRG (AR-DRG) after introducing the ICD-10-AM diagnosis and procedure codes (Lüngen & Lauterbach, 2002). The current AR-DRG version 6.0 is mainly based on the seventh edition of ICD-10-AM, classifying patients based on major diagnostic categories (MDC), procedures medical conditions and other factors that differentiate processes of care (AIHW, 2016).

In 2003, Germany adapted the Australian DRG (diagnosis-related groups) system to bill patients according to diagnosis-related case rates. The goal behind this adaption was to reduce variation in pricing and provide more efficiency and transparency of hospital services. As the AR-DRG system was not commercially bound, but managed by the Australian government, the choice of adopting it to the German healthcare system was mainly supported by the lack of licencing costs and international acceptance (Lüngen & Lauterbach, 2002). Since then, hospital costs for health services have been reduced by 0.6 percent a year in Germany until 2012 with clear indication for this to be a result of the DRG implementation (Haeussler, Zich, & Bless, 2014). However, even with this increase in efficiency hospitals have suffered a funding gap of over 11 billion euro since 2004 due to continuously reduced compensation by health insurances. (Neumann, 2014). Since the implementation in 2003, the DRG system has undergone major revisions and changes from the first adaption of the Australian DRG system. The basis for the German DRG system relies on the ICD-10-GM, the international classification of diseases and health problems, and the OPS, the classification for operations and procedures (InEK GmbH, 2016).

2.2 eHealth

The rapid development of information and communications technologies in the past years has led to an increased usage of the internet and electronical devices to search, access and monitor health information, communicate with peers or health professionals and manage personal health records. This phenomenon termed eHealth has been broadly defined as the transfer of health resources and support of health care processes by electronic means. It comprises three main areas, i.e. the "delivery of *health information*, for health professionals and health consumers, through the Internet and telecommunications", "using the power of IT and e-commerce to improve *public health services*" as well as "the use of e-commerce and e-business practices in *health systems management*" (WHO, 2016). According to the 5 "C's" model by Eng (2001) the functions and capabilities of eHealth encompass *Content*, *Community*, *Commerce*, *Connectivity* and *Care*. Alongside these fields of eHealth, Eysenbach (2001) proposes ten characterizations for eHealth and its goals. The overall purpose of eHealth is the improvement of efficiency and enhancing quality of care by using evidence based methods and approaches. To improve community and connectivity, the empowerment of patients and the encouragement of better relationships between patient and health professionals is key. By providing online education for physicians and enabling information exchange and communication in a standardized way the scope of healthcare can be extended beyond its conventional boundaries. Ethical concerns arising through new methods of patient-physician interaction have to be considered and access and usage of eHealth has to be equitable to all populations.

Key to a successful use of eHealth technologies is the controlled access of information for relevant stakeholders. Although the concept of electronic medical records to store and share patient and treatment information, has already been implemented in some countries, including Australia and Germany, acceptance is not at a peak yet. Castillo et al (2010) identify six main issues for the adoption of electronic medical records comprising user attitude towards information systems, workflow impact, interoperability, technical support, communication among users, and expert support. This research shows that especially user acceptance and the technical infrastructure are vital to ensure successful eHealth operations. The framework for assessing eHealth preparedness proposed by Wickramasinghe et al. (2005) determines four main areas that influence a country's eHealth potential, i.e. Information and Communication Technology Architecture and Infrastructure, Standardization, Policies, Protocols and Procedures, User Access and Accessibility Policies and Infrastructure and Governmental Regulations and Roles. Based on these prior findings, influencing aspects for a national eHealth strategy can be viewed according to macro-environmental aspects, i.e. political, economic, social, technological, legal and environmental factors (Kotler & Armstrong, 2010).

3 Comparison of eHealth systems

To enable successful eHealth development, the various motivations and perspectives of key stakeholders have to be considered. According to Eng (2001) major stakeholders can be categorized into consumers, application developers, clinicians, policymakers, health care organizations, public health professionals, employers, and purchasers. The interactions and decisions of these individual groups has a high impact on acceptance and enablement of eHealth initiatives. Furthermore, Boonstra et al (2010) identify eight critical factors for the adoption of electronic medical records including Financial, Technical, Time, Psychological, Social, Legal, Organizational, and Change Process. Hage et al. (2013) argue that eHealth only leads to sustainable adoption when the implementation carefully considers and aligns the eHealth content, the pre-existing structures in the context and the interventions in the implementation process. Successful eHealth implementation therefore relies on the infrastructural prerequisites and technical standards, governmental and policy support as well as user acceptance and accessibility. Based on these influencing areas, the following sections analyse the implementation, key challenges and opportunities of eHealth systems in Germany and Australia and develop suggestions with regards to their present experiences. Figure 2 summarizes the scope of eHealth and its influencing macro-environmental factors that are considered in our analysis.

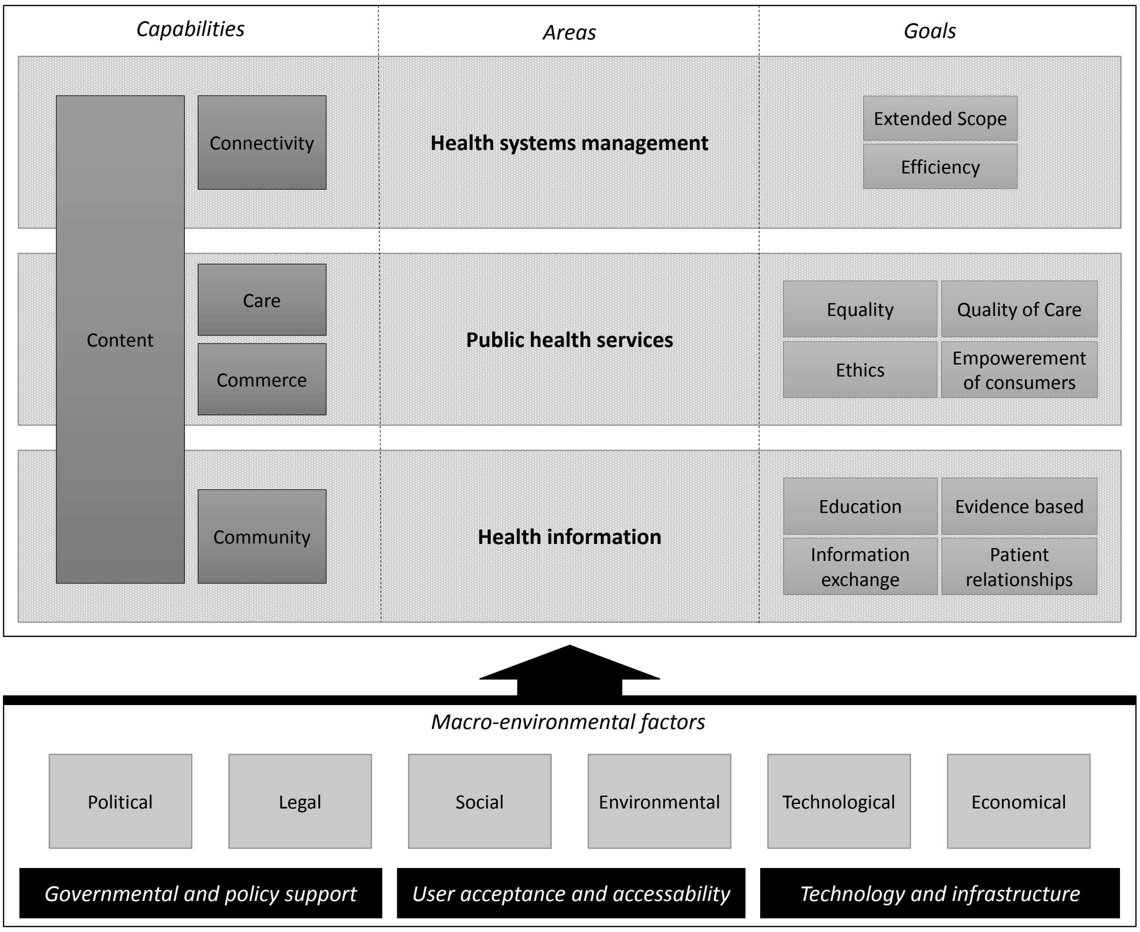


Figure 2: Scope of eHealth

3.1 eHealth in Australia

The Australian healthcare system is argued to be among the best providers of outstanding quality of care. In comparison to Germany, the unrestricted access to healthcare services is not as prominent, but the coordination of care shows overall better results (Davis et al., 2014). This stems from the early attempts on utilizing eHealth to increase transparency and efficiency in care, starting with the introduction of the eHealth technology program in 1991. Since then, the Australian eHealth strategy has been continuously refined and analysed to adapt to emerging issues in healthcare.

Governmental and policy support

In 2004-2005 the national eHealth transition authority (NEHTA) was established to develop the eHealth agenda with the development of eHealth standards, clinical terminologies and patient and provider identifiers. In 2008, the new Labour government asked consultants from Deloitte to help develop a new direction. They found that lack of financial support was one of the main problems. Three months after the submission of Deloitte's report, the government introduced its national eHealth strategy. This adoption strategy of eHealth in Australia was implemented incrementally following three main principles (Australian Health Ministers' Council, 2008):

- To leverage currently existing resources in the Australian eHealth landscape,
- To manage underlying variation in capacity across health sector and states and territories and
- To allow scope for change during the implementation process

In 2009 the National Health and Hospitals Reform Commission released a report advocating the introduction of personal electronic health records. In 2010-2012 the Personally Controlled EHealth Records (PCEHR) platform was founded and launched in July 2012. The objective behind this system was the establishment and operation of a voluntary national system for the provision of access to health information. The main goal of the PCEHR system was to improve availability and quality of health information and reduce fragmentation, minimize the occurrence of adverse medical events and duplication of treatment and support coordination of healthcare provided to consumers by different healthcare providers. Australia has passed a legislative framework that includes governance arrangements, a privacy and security framework and a registration regime or the My Health Record system (Australian Government, 2012). However, in contrast to Germany, Australia still lacks appropriate governance and regulatory mechanisms to manage, monitor and control the system.

Technology and infrastructure

Although Australia doesn't rank as high in international comparisons considering technology and R&D in general (Florida et al., 2011), the use of healthcare technologies has been developed Similar to Germany's gematik, Australia's NEHTA is leading a national approach to develop a national eHealth infrastructure and IT standards to enable connected health. So far, a national terminology for medicines (AMT), a clinical terminology (SNOMED) and a secure message delivery system (SMD) were implemented as a first step for setting national standards. The goal is to build this foundations within the My Health Record platform as the national eHealth infrastructure.

Table 1 summarizes the main components of the PCEHR system, intended services and solutions and the underlying infrastructure.

Table 1: Australian eHealth infrastructure (Bunker, 2011)

Personally Controlled Electronic Health Record	Clinical Information	Individual Information	Shared Information	Others
eHealth Services	Shared Health Profile	Event Summaries	Self Managed Care	Complex Care Management
eHealth Solutions	eDiagnostics	eDischarge	eReferral	eMedications
National Infrastructure Components	Clinical Terminology & Information	Secure Messaging	Identifiers	Authentication

User access and accessibility

Up until today, only 11 percent of the Australian population are yet registered on the platform and just slightly over 8,000 healthcare provider organisations, mainly general practices (Australian Department of Health, 2015). Without legal enforcement to adapt the platform for e.g. billing or insurance claims, usage rates have not yet reached the lower limit for a comprehensive adoption of eHealth services. Due to the lack of meaningful use of the PCEHR system, the platform will be changed to an opt-out solution and renamed to My Health Record in 2016. A resulting wider uptake of the system is projected to increase the value for healthcare professionals, and consequently their willingness to use the system. Registration barriers for healthy persons or disadvantaged patients thus should be eliminated (Australian Department of Health, 2013).

Key Challenges

The aging population, increasing incidence of chronic disease, rising customer demand for more costly, complex and technologically advanced procedures and the simultaneous lack of skilled health sector workers are causing a major rise in cost and complexity for the Australian healthcare system. Pre-existing eHealth solutions to counter these issues are implemented as discrete islands of information with significant barriers to effective sharing of information between health care participants. Without proper national coordination, extensive service duplication, avoidable expenditures and solutions that cannot be scaled or integrated can drastically decrease the potential of eHealth. In addition, Australia still lacks the required legal and infrastructural foundations to enable a nationwide implementation of their eHealth platform.

3.2 eHealth in Germany

The German healthcare system is suffering from demographic change, increasing costs, and lack of skilled professionals. Telemedicine can help counter these problems (TeleHealth 2011) by improving treatment efficiency and quality, increasing access speed to relevant information and enables networking between all stakeholders of the care value chain. EHealth can support current issues regarding coordination, integration and networks between stakeholders and enhance decision making and planning throughout the entire value care chain.

Governmental and policy support

Until 2004, Germany offered a basic health insurance card (KVK) providing minimum information about a patient's personal and insurance information as a credential for patients to claim health services. Due to limitations in storage and applications of this insurance card, the modernization act by the statuary health insurance in January 2004 proposed the extension of the insurance card to the electronic health card (EHC), which was finally implemented in early 2006. The goal behind the EHC was to provide health service providers access to patient information through IT to increase treatment quality, control health service processes and quality for medical treatments (GKV Spitzenverband, 2015a).

Since January 1st 2015, the "Electronic Health Card (EHC)" is the mandatory credential in Germany to claim services covered by the health insurance. Table 2 summarizes the required and optional information on the EHC with their respective legal codes.

Table 2: Required and optional information on the EHC

<table>
<tr><th>Information</th><th>Required/ Optional</th><th>Legal code</th></tr>
<tr><td>Name of the issuing health insurance</td><td rowspan="10">Required</td><td rowspan="10">SGB §291a (2)
SGB §291 (2)</td></tr>
<tr><td>First and last name of the insurant</td></tr>
<tr><td>Date of birth</td></tr>
<tr><td>Sex</td></tr>
<tr><td>Address</td></tr>
<tr><td>Insurance number</td></tr>
<tr><td>Insurance status</td></tr>
<tr><td>Out-of-pocket payment</td></tr>
<tr><td>Date of insurance commencement</td></tr>
<tr><td>Date of expiration time (for fixed-term insurance)</td></tr>
<tr><td>Medical prescriptions in electronic and machine-usable form</td><td rowspan="2">Optional</td><td rowspan="2">SGB §291a (2)</td></tr>
<tr><td>Credential for health treatment in an EU/EEA member state</td></tr>
<tr><td>Medical data</td><td rowspan="6">Optional</td><td rowspan="6">SGB §291a (3)</td></tr>
<tr><td>Medical reports</td></tr>
<tr><td>Electronic patient record</td></tr>
<tr><td>Additional data provided by the insurant</td></tr>
<tr><td>Information and consent form on organ and tissue donation</td></tr>
<tr><td>Information to verify drug therapy security</td></tr>
</table>

Data security is provided by following a two-key-principle. Both an electronic healthcare ID by the professional and the personal healthcare card and PIN code of the patient is required to access their medical data. Although not yet implemented, the EHC is designed to include electronic patient records, medical reports, care records and medication records in the future.

Besides internal regulations and investments, Germany can additionally benefit from EU initiatives and funding schemes. The topic of health, demographic change and wellbeing addressed in the Horizon2020 program provides extensive funding possibilities for eHealth applications and development. The Digital Agenda for Europe focuses an entire pillar of their Europe 2020 strategy on ICT-enabled benefits for the EU society, including actions to enable secure online access to medical health data and a widespread telemedicine deployment (Action 75), define a minimum common set of patient data (Action 76), foster EU-wide standards, interoperability testing and certification of eHealth (Action 77) and reinforce the Ambient Assisted Living (AAL) Joint Programme (Action 78) (European Commission, 2015).

Technology and infrastructure

Germany is a leading country in technology development considering financial and human resources devoted to R&D as well as patents granted per capita (Florida et al., 2011). In healthcare, Germany currently ranks high considering quality of care, access to healthcare services, efficiency and equity as well as expenditure per capita. Especially access to healthcare shows above-average results in international comparisons. Space for improvement is still found in the area of coordinated care, which constitutes a major issue to be solved by eHealth (Davis, Stremikis, Squires, & Schoen, 2014).

Besides access to advanced technology, a main requirement for a successful national eHealth strategy is the underlying infrastructure to integrate applications and provide and access data in a structured and protected environment. For a strategical conception and implementation of the EHC and telematics infrastructure, the company for EHC telematics applications *gematik* was founded in Germany in 2005 (gematik, 2016). The company's core responsibility lies in managing the development, implementation and maintenance of a country-wide telematics infrastructure. Although first rollout was projected for mid-2015, security issues and the highly technical requirements for connecting hospitals, apothecaries, medical practices and care facilities throughout Germany are still delaying deployment. In December 2015, the German parliament passed a new legislation for secure digital communication and applications in healthcare, legally replacing the preceding health insurance card with the EHC. This legislation lays down a timeframe for a nationwide integration of hospitals and practices into the developed infrastructure until 2018 (Deutscher Bundestag, 2015).

User access and accessibility

From a professional standpoint, the eHealth acceptance rate in Germany shows a below-average increase on an EU level of 31 percent since 2007. While the country's Professional-to-Patient initiatives in telehealth, e.g. remote monitoring and consultation, show good results in international comparisons, the Professional-to-Professional dimension including online education and joint consultation is still lagging behind. The combination of a mandatory insurance proof and an optional extension for further information lowers the barriers of adopting a new system for users. Since over 97 percent of the insured population is now provided with an EHC (GKV Spitzenverband, 2015b) the extension of additional services, e.g. electronic health records, can be added more easily to the already distributed systems. Issues with user participation for the basic system can therefore be eliminated, however the use of additional services could still be obstructed by user acceptance.

Key Challenges

Although the EHC was already implemented in 2006, an integrated, accessible and data security compliant infrastructure for telemedical services has yet to be developed. Through many regional projects, individual solutions have been brought up, that already exploit parts of what eHealth can offer, but further reinforce redundancies in development. Investments in healthcare structures and concepts are still scarce, leading to a pool of isolated applications within a diverse, fragmented market. Another issue obstructing eHealth development stems from the lagged development of IT standards in the healthcare sector and missing secure networks. Lack of investments, scarce awareness and indolence of decision makers also hinder a fast development of national eHealth initiatives. Questions of liability and security also cause for delay.

4 SWOT analysis

4.1 Comparison of the systems

Table 3 summarizes the advantages and handicaps of the Australian and German eHealth system in a SWOT analysis. The resulting strategies give suggestions on further developments eHealth can endorse to enhance quality of healthcare in Germany.

Table 3: SWOT analysis of Australian and German eHealth systems

	Germany	Australia
Strengths	**S1:** Advanced technological foundation and development **S2:** Legal requirements for eHealth explicitly defined in fifth social security code **S3:** Regulations for data safety and security **S4:** High mobile penetration and broadband coverage **S5:** Governmental support **S6:** Funding opportunities on international level (EU) **S7:** Integrated solution of mandatory EHC and optional eHealth applications in one system	**S1:** General guidelines based on the Commonwealth Privacy Act 1988 and the Australian Privacy Principles (APP) **S2:** Flexible infrastructural solutions **S3:** First attempts at national standards **S4:** Secure messaging system **S5:** High quality of care **S6:** Adaptability of eHealth strategy **S7:** Nationwide platform for interaction and information exchange **S8:** Lower usage barriers through change to an opt-out model
Weaknesses	**W1:** Lack of IT standards in healthcare **W2:** Isolated solutions **W3:** High bureaucracy through governmental involvement **W4:** Common infrastructure still not available **W5:** Lack of experience with patient involvement	**W1:** No legal binding to use or adapt eHealth **W2:** Isolated solutions **W3:** Fragmented system **W4:** Missing nationwide governmental cooperation **W5:** Dispersed data storage

Opportuni-ties	The mandatory cross-linkage between healthcare providers can enable an **uninterrupted communication network**	Flexibility in strategical decision enables **fast adjustments**
	Lower adoption barriers through combination of mandatory and voluntary services	**Lower adoption barriers** through change to an opt-out model
	Better **information exchange**	Better **information exchange**
	Increase in **efficiency** and **transparency** of healthcare delivery	Increase in **efficiency** and **transparency** of healthcare delivery
	Citizen's mobility requires **increased data sharing**	Citizen's mobility requires increased **data sharing**
	Increased **computer literacy** and **ICT skills**	Increased **computer literacy** and **ICT skills**
	Re-use of knowledge and applications	**Re-use** of knowledge and applications
	Reduced **unnecessary** and **duplicate treatments**	Reduced **unnecessary** and **duplicate treatments**
	Increased **scalability** of eHealth solutions	Increased **scalability** of eHealth solutions
Threats	**Delayed roll-out** of holistic infrastructure	Low **adoption rates** by healthcare professionals
	Protracted **legal changes**	Weighing between **effort** and **benefits** for individual providers
	High **bureaucracy implications** for nationwide decisions	Difficulties **integrating** fragmented eHealth market
	User acceptance of eHealth innovations	**User acceptance** of eHealth innovations
	Lack of **skilled professionals**	Lack of **skilled professionals**
	Incomplete documentation	**Incomplete documentation**
	Data privacy, confidentiality, liability and **data protection**	**Data privacy, confidentiality, liability** and **data protection**

4.2 Strategies derived from the SWOT analysis

Germany and Australia pursue different approaches with their national eHealth strategy. Whereas Australia initially invested in an open, voluntary platform solution, Germany instructed a long-term statutory basis for an integrated infrastructure for extensive eHealth services based on a mandatory insurance card. Changing the My Health Record platform to an opt-out model can reduce the barriers for user registration, meaningful use of the proposed service, however, will require additional effort by the Australian government. The German example shows that the utilization of national technology resources and know-how can be used to systematically invest and plan for comprehensive eHealth applications. Applications can therefore be developed on a common ground, facilitating the re-use of key insights and results. The downside in the implementation of a nationwide eHealth project is reflected in protracted legal changes and limited reaction to changing requirements. On the other hand, although development of individual applications may increase implementation flexibility and speed and allow for modular adjustments, the subsequent integration of fragmented solutions can result in major adaption requirements, insufficient scalability, and unnecessary duplicates.

Table 4 and Table 5 summarize the derived insights from the SWOT analysis, indicating strategies for Germany and Australia to utilize the countries' capabilities for exploiting the proposed opportunities and handle emerging threats.

Table 4: Opportunities for Australia and Germany

Opportunity	Australia	Germany
O1: Integrated healthcare data + applications	**W1/W2/S2:** Two-sided approach to integrate currently isolated solutions and adapt infrastructure accordingly	**S1/S2:** Use the mandatory linkage of all healthcare providers to combine health information from all linked partners as well as patients in an integrated system to gain holistic insights over bigger patient cohorts. **W4/S1/S5/S6:** Support and contribute to infrastructural development with funding projects
O2: Cross-linking of healthcare providers	**W1/S1:** Provide more binding regulations to join the nationwide network **S4:** Create awareness for eHealth advantages in field studies	**S2/S5:** The cross-linkage of healthcare providers is already determined by law and currently tested in field studies. Collaboration should be further supported and monitored by the government
O3: Increasing User acceptance + IT literacy	**S7/S8:** Engage consumers in participating in voluntary eHealth services by providing comprehensible personal insights	**S4:** With high mobile penetration and broadband coverage of German citizens and healthcare providers, mobile applications and IT solutions to link healthcare consumers should be implemented
O4: Better information exchange	**S3/S4:** Provide easy and secure methods to share and exchange data	**S3/S4/S7:** Provide easy and secure methods to share and exchange data
O5: Increase efficiency and transparency of healthcare delivery	**W4/S5/S6:** Continuous monitoring of healthcare expenditure and health quality indicators to monitor performance and impact of eHealth solutions **S8:** Engage consumers in participating in voluntary eHealth services by providing comprehensible personal insights	**S2/S5:** Continuous monitoring of healthcare expenditure and health quality indicators to monitor performance and impact of eHealth solutions **W5/S7:** Engage consumers in participating in voluntary eHealth services by providing comprehensible personal insights
O6: Increased communication and collaboration	**S4:** Secure messaging system already in place.	**S1/W5:** Implement secure messaging service to enable communication and coordination between patients and healthcare providers
O7: Re-use of knowledge and applications	**S1/S7:** Extend national platform for to share experiences in eHealth service development	**W1**: Develop open IT standards based on insights from pre-existing solutions **S1:** Initiate national open source platform for eHealth development to share experiences
O8: Reduce unnecessary and duplicate treatments	**W2/S2:** Two-sided approach to integrate currently isolated solutions and adapt infrastructure accordingly **S7:** Aggregate collected data on My Health Record platform to provide a structured history for each patient	**S7:** Create structured overviews / templates for patients including treatments, medications and personal data as a single source of truth **W2:** Integrate existing isolated solutions into national infrastructure

Table 5: Threats for Australia and Germany

Threat	Australia	Germany
T1: Incomplete documentation	**W1/S1:** Provide more binding regulations to participate in the nationwide network **S3/S4/S7:** Provide easy and secure methods to share and exchange data **S7:** Aggregate collected data on My Health Record platform to provide a structured history for each patient	**S3/S4/S7:** Provide easy and secure methods to share and exchange data **S7:** Create structured overviews / templates for patients including treatments, medications and personal data as a single source of truth
T2: Legal changes	**W4/S1:** Introduce legal regulations for eHealth on a national level	**W3/S2:** Systematically monitor issues in eHealth development to enable fast reactions for necessary changes
T3: Bureaucracy implications	**W4:** Increase national governmental cooperation	**W3:** Encourage close cooperation between government and healthcare providers for shorter discussion paths
T4: User acceptance	**S7/S8:** Engage consumers in participating in voluntary eHealth services by providing comprehensible personal insights	**S4:** With high mobile penetration and broadband coverage of German citizens and healthcare providers, mobile applications and IT solutions to link healthcare consumers should be implemented
T5: Data privacy, confidentiality, liability and data protection	**W5:** Appoint a single institution to store, manage and secure healthcare data in a structured and reliable way	**S1/S3/S5:** Ensure secure and stable networks and regulate data access according to different stakeholders; Data authority lies with the consumer
T6: Lack of skilled professionals	**S5:** Offer training and raise transparency for eHealth services	**S5:** Offer training and raise transparency for eHealth services

5 Discussion and Conclusion

In this paper, we analysed the potentials and challenges of national eHealth strategies in Australia and Germany. Based on macro-environmental factors, i.e. governmental support and policies, technology and infrastructure, and user acceptance and accessibility, key capabilities and handicaps were identified for each country. Based on these results we derived strategies on how to exploit the positive effects and opportunities of eHealth and how to handle challenges that might arise concurrently. Our results suggest similar findings for developed countries, especially with regards to major challenges in healthcare that are planned to be addressed by eHealth solutions. Both countries attempt to increase efficiency and transparency in healthcare, increase communication and collaboration between healthcare participants, and provide overall better quality of care. The meaningful use of health information, development of national standards and regulations, and application integration are also focused in the individual eHealth strategies. Two approaches to reach these goals have been identified: The German strategy combines partly statutory and voluntary information sharing within an integrated system, whereas the Australian platform-based solution relies on an entirely optional system. Both countries can profit from different insights already gathered from other national eHealth approaches. With Germany as a leading player in technology advancements and an already well-established legal foundation for eHealth regulations on the one hand and Australia's flexible adaptions and early experiences within eHealth in contrast, both countries can provide different knowledge aspects for successful eHealth implementation and a high level of quality of care to other countries.

The implications of this paper are threefold. From a research perspective, the proposed approach to analyse eHealth strategies based on macro-environmental factors, i.e. governmental support and policies, technology and infrastructure, and user acceptance and accessibility, can be adapted to other countries to provide a common ground for an in-depth, global analysis of national eHealth strategies. From a practical viewpoint, the recommendations resulting from the SWOT analysis can be further extended and adjusted to future developments and therefore allow for continuous improvement of both countries' eHealth initiatives. To that end, the comparative analysis can also ease the initiation of national strategies by identifying best practises and lessons learned from early eHealth adopters.

It has to be noted, that these results are based on the current legal and technological advances in eHealth in Germany and Australia. At the moment, however, major changes are taking place in both countries. In Germany, a new eHealth law has laid down an obligation to link healthcare providers in the national telematics infrastructure currently under development. First results and the impact of this regulation will be seen in the following years. The change of an opt-in to an opt-out model for the Australian eHealth platform My Health Record will also entail major alterations in the country's eHealth strategy and development that should be addressed in future studies. Furthermore, the implications of this study should be enriched, by analysing other national eHealth strategies in developed countries, to provide insights from a more global perspective. Through the ongoing digitization of healthcare services, eHealth strategies and solutions are of increasing importance and demand for an international exchange of best practises, the development of technology standards and sufficient infrastructure as well as governmental support on a global scale.

References

AIHW (2016). *Australian refined diagnosis-related groups (AR-DRG) data cubes: AR-DRG cubes for 1997–98 to 2013–14.* Retrieved February 03, 2016, from http://www.aihw.gov.au/hospitals-data/ar-drg-data-cubes/.

Australian Department of Health (2013). *Review of the Personally Controlled Electronic Health Record,* from http://www.health.gov.au/internet/main/publishing.nsf/content/17BF043A41D470A9CA257E13000C9322/$File/FINAL-Review-of-PCEHR-December-2013.pdf.

Australian Department of Health (2015). *My Health Record Statistics,* from https://myhealthrecord.gov.au/internet/ehealth/publishing.nsf/Content/pcehr-statistics.

Australian Government (2012). Personally Controlled Electronic Health Records Act 2012.

Australian Health Ministers' Council (2008). *National EHealth Strategy.*

Boonstra, A., & Broekhuis, M. (2010). Barriers to the acceptance of electronic medical records by physicians from systematic review to taxonomy and interventions. *BMC Health Services Research, 10*, 231.

Bunker, D. (2011). *EHealth and NEHTA: Integrating heterogeneous data sources: a technology or policy challenge.*

Castillo, V. H., Martínez-García, A. I., & Pulido, J R G (2010). A knowledge-based taxonomy of critical factors for adopting electronic health record systems by physicians: a systematic literature review. *BMC medical informatics and decision making, 10*, 60.

Davis, K., Stremikis, K., Squires, D., & Schoen, C. (2014). *MIRROR, MIRROR ON THE WALL: How the Performance of the U.S. Health Care System Compares Internationally,* from The commonwealth fund: .

Deutscher Bundestag (2015). Gesetz für sichere digitale Kommunikation und Anwendungen im Gesundheitswesen sowie zur Änderung weiterer Gesetze.

Dietzel, G. (2001). EHealth und Gesundheitstelematik: Herausforderungen und Chancen. *Deutsches Ärzteblatt,* 4.

Eng, T. R. (2001). *The eHealth landscape: A terrain map of emerging information and communication technologies in health and heath care.* Princeton, NJ: Robert Wood Johnson Foundation.

European Commission (2015). *Digital Agenda for Europe: A Europe 2020 Initiative,* from https://ec.europa.eu/digital-agenda/en/our-goals.

Eysenbach, G. (2001). What is eHealth? *Journal of medical Internet research, 3*(2), E20.

Fetter, R. B., Shin, Y., Freeman, J. L., Averill, R. F., & Thompson, J. D. (1980). Case mix definition by diagnosis-related groups. *Medical care, 18*(2), i-53.

Florida, R., Mellander, C., Stolarick, K., Silk, K., Matheson, Z., & Hopgood, M. (2011). *Creativity and Prosperity: The Global Creativitiy Index,* from http://martinprosperity.org/media/GCI%20Report%20Sep%202011.pdf.

gematik (2016). *gematik Unternehmensorganisation.* Retrieved February 06, 2016, from https://www.gematik.de/cms/de/gematik/unternehmensorganisation/historie_1/historie_1.jsp.

GKV Spitzenverband (2015a). *Elektronische Gesundheitskarte (eGK),* from https://www.gkv-spitzenverband.de/krankenversicherung/telematik_und_datenaustausch/egk/egk.jsp.

GKV Spitzenverband (2015b). *Das Wichtigste über Das Wichtigste über die elektronische Gesundheitskarte.*

Haeussler, B., Zich, K., & Bless, H.-H. (2014). Does the implementation of a new payment system for hospital services induce changes in the quality of health care?: Experiences from Germany. *BMC Health Services Research, 14*(Suppl 2), O18.

Hage, E., Roo, J. P., van Offenbeek, Marjolein A G, & Boonstra, A. (2013). Implementation factors and their effect on eHealth service adoption in rural communities: a systematic literature review. *BMC Health Services Research, 13*, 19.

InEK GmbH (2016). *G-DRG-System 2016,* from http://www.g-drg.de/cms/.

Kotler, P., & Armstrong, G. (2010). *Principles of marketing* (13th ed., Global ed.). Upper Saddle River, N.J., London: Pearson Education.

Little, A. D. (2016). *Global digital health market from 2013 to 2020, by segment (in billion U.S. dollars),* from http://www.statista.com/statistics/387867/value-of-worldwide-digital-health-market-forecast-by-segment/.

Lüngen, M., & Lauterbach, K. (2002). *Ergebnisorientierte Vergütung bei DRG: Qualitätssicherung bei pauschalierender Vergütung stationärer Krankenhausleistungen. Gesundheitsmanagement.* Berlin: Springer.

Neumann, K. (2014). *Blick für das Ganze,* from http://www.iges.com/kunden/gesundheit/forschungsergebnisse/2014/gesundheitswirtschaft/index_ger.html#ZMS_HIGHLIGHT=raw&raw=drg.

OECD (2015). *OECD Health Statistics 2015,* from http://www.oecd.org/els/health-systems/health-data.htm.

WHO (2016). *eHealth: Glossary of globalization, trade and health terms,* from http://www.who.int/trade/glossary/story021/en/.

Wickramasinghe, N. S., Fadlalla, A. M. A., Geisler, E., & Schaffer, J. L. (2005). A framework for assessing eHealth preparedness. *International journal of electronic healthcare, 1*(3), 316–334.

29th Bled eConference

Digital Economy

June 19 - 22, 2016; Bled, Slovenia

Using the Delphi Method to Identify Hospital-Specific Business Process Management Capabilities in The Netherlands

Joris Mens, Pascal Ravesteyn

HU University of Applied Sciences Utrecht, The Netherlands

joris.mens@hu.nl, pascal.ravesteijn@hu.nl

Abstract

Business Process Management (BPM) is an important discipline for organisations that are desiring quality improvement. Many models for assessing, comparing and improving the maturity of organisational BPM are found in literature. An effective BPM Maturity Model should contain a validated set of capability areas specific to the application domain. We attempt to fill a gap by providing a model specific to the hospital industry. This paper presents the first phase in the development of such a model. For this we use the Delphi Method, a multi-round technique for collecting rich data and gaining consensus among a panel of experts. Based on the opinions provided by experts in hospitals and academia in The Netherlands, we identify relevant and domain-specific capabilities for improving BPM maturity in the Dutch hospital industry. Hospitals are characterised by complex, multidisciplinary processes. Our findings reflect that capabilities related to people and organisational culture are most important for achieving BPM maturity.

Keywords: bpm, maturity, hospitals, healthcare, process management, Delphi method

1 Introduction

Business Process Management (BPM) is a discipline that aims to "support business processes using methods, techniques, and software to design, enact, control, and analyse operational processes involving humans, organisations, applications, documents and other sources of information" (Weske, 2012). 'BPM maturity' is a concept used to indicate the stage of development of BPM practices. The word mature is defined as "having reached the most advanced stage in a process" or "being fully grown or developed". Within BPM, it is understood that processes have lifecycles and can be improved throughout time (McCormack et al., 2009). Improving processes and process management practices therefore leads to higher maturity, or so-called BPM maturity. BPM maturity can be assessed, improved and benchmarked using Business Process Maturity Models (BPMMs) (De Bruin, Freeze, Kulkarni, & Rosemann, 2005). A BPMM usually defines a number of maturity levels, with specific capabilities for each level. These capabilities tell us how well the organisation performs a certain competence in relation to business process management.

BPM is seen as a holistic principle to which many organisational aspects contribute. Examples of high-level capabilities influencing maturity are the alignment of organisational strategy to its operational processes, a culture of continuous improvement and the use of IT systems for supporting processes (Rosemann & De Bruin, 2004, 2005a). A wide array of BPMMs are found in literature. Some are designed for general use while others are aimed at specific domains. In this paper, we establish that existing BPMMs do not meet the specific needs of the hospital industry. The hospitals assessed in this paper face industry-specific challenges and are characterized by low to average BPM maturity. Some key challenges facing these hospitals are the aging population, rising costs and increasingly complex care pathways. The variety of specialisations and therapies is rising , while patients demand services of higher quality and shorter waiting times (Øvretveit, 2000). In response to requirements imposed by the government and accreditation bodies, hospitals must integrate their information systems to better coordinate healthcare processes. Information systems in the hospital sector are underdeveloped when compared to other sectors (Helfert, 2009), particularly in terms of low technological sophistication and integration sophistication (Paré & Sicotte, 2001). Lack of funds, failure to recognize IT as a key stakeholder in hospital decisions and the implementation of Electronic Heath Records (EHRs) are shown to be some of the top IT management issues in hospitals (Jaana, Tamim, Paré, & Teitelbaum, 2011). Thus, a BPM Maturity Model for hospitals may assist in improving BPM maturity and help to tackle these challenges, thereby improving the overall quality of healthcare.

In this paper we attempt to identify the relevant capabilities for a hospital-specific BPMM. The Delphi method is used to gather consensus on these capabilities among a panel of experts. In the following sections, we describe the Delphi method and its use in developing domain-specific BPMMs. We then describe the set-up of our case study using the Delphi method and present the results for healthcare-specific capabilities relevant for BPM maturity.

2 Literature Review

The complexity of process management in hospitals lies in its large variety of medical specialisations (Mans, Schonenberg, Song, van der Aalst, & Bakker, 2009). Patients may require the care of different medical specialists throughout their care process. This is also called the care pathway. A patient’s care pathway can be highly variable and runs through different hospital departments. This proves to be a challenge, since data relating to the patient may be recorded inconsistently between specialists or stored in separate information systems (Mans, van der Aalst, Vanwersch, & Moleman, 2013). The complexities of healthcare processes introduce a risk of errors and unnecessary waiting times. Patients with the same diagnosis may encounter different waiting times in their process and the reasons for this are not always known (Mans et al., 2009). Earlier research shows a correlation between BPM maturity and process performance (Ravesteyn, Zoet, Spekschoor, & Loggen, 2012). Thus it follows that the improvement of BPM maturity and related capabilities may improve the process performance and quality of care in hospitals.

To identify the possibilities for improvement, we must first assess the current state of BPM maturity in hospitals. Previously collected data from over 1000 organisations shows that the Dutch healthcare and public sector score lowest when compared to other sectors (Luyckx, 2012).

The difference in maturity is significant when compared to the highest-scoring financial and automotive sectors. Luyckx (Luyckx, 2010) also identifies that hospitals are complex organisations that need to align their processes externally with other organisations (general practitioners, insurance companies) as well internally, between departments. Performance indicators and a proper reporting structure must be implemented to safeguard quality. Luyckx (Luyckx, 2010) concludes that one of the main obstacles of BPM maturity in hospitals is the unique organisational structure: Doctors are the main decision makers within their individual departments. It is further suggested that doctors and business/IT departments within the hospital must work together on BPM decision making in order to improve BPM maturity. For the reason of developing a practically relevant model, the Delphi study will include experts with sufficient experience in healthcare. The following paragraphs describe the elements of conducting such a study, as gathered from literature.

The Delphi method is a type of study used to gather a consensual opinion from a panel of experts on a complex subject (Dalkey, Brown, & Cochan, 1969). This is done using multiple rounds of anonymised surveys. Multiple-round techniques lead to richer and more refined data than single-round techniques (Yousuf, 2007). The Delphi method prescribes that respondents remain anonymous to one another to reduce group pressures and stimulate creativity (Hsu & Sandford, 2007). For this reason, electronic distribution of surveys or individual telephone interviews are the preferred channels for conducting the study. The data collected in a round is anonymised by the researcher for use in the next round. In this respect, the Delphi method is very different from the focus group method where direct interaction between participants is encouraged. However, both the Delphi method and focus groups allow for the use of a smaller group of respondents than is the case in traditional quantitative survey-based research. This is because in a Delphi study, the focus is on the quality and richness of the collected data rather than the sample size.

The Delphi method is set up in such a way that the respondents may progress from widely-diverging opinions in the first round and converge towards consensus in the final round. For this reason, the emphasis is on collecting qualitative data in the first round and quantitative data in subsequent rounds. In the first round, the researcher may employ open-ended questions to allow for the collection of any opinions the participant may have. In subsequent rounds, the opinions are anonymised and ranked numerically by participants. By converging towards quantitative surveys, the level of consensus can be expressed statistically. A Delphi study encompasses a minimum of three rounds. More rounds may be instated in case the desired level of consensus is not yet achieved.

The general process of conducting a Delphi study is outlined as follows:

1. Problem definition: The researcher uses existing literature to frame the problem statement and provide structure to the first survey round.
2. Candidate Selection: A list of candidates for the expert panel is established on the basis of predetermined criteria. The experts are invited for participation in the Delphi study.
3. First Delphi Round: The first survey is distributed for the purpose of collecting opinions using open-ended survey items.

4. Second Delphi Round: The opinions from the first survey are summarised by the researcher into a list of statements. The summarised statements are presented in the second survey for the purpose or ranking or rating by the experts.
5. Third Delphi Round: The results of the second survey are summarised by the researcher. This shows which statements have the highest support from the expert panel. In the third survey, the experts indicate to what extent they agree with the majority opinion. Reasons may be provided for disagreeing with the majority opinion. The results of the third survey are summarised by the researcher.
6. Conclusion: When sufficient consensus is achieved, the final results are presented to the expert panel. Otherwise, a fourth survey may be initiated where reasons for disagreeing with the majority opinion are evaluated by the panel.

In the final round of the Delphi study, quantitative survey items are used to be able to derive statistical proof of consensus. For example, the researcher may consider consensus to be achieved when the majority opinion receives an average satisfaction rating of 8 on a scale of 10 from the experts. The level of desired consensus may be predetermined by the researcher.

Delphi studies have been used in earlier research to successfully gather data for the creation on a BPM maturity model (Rosemann & De Bruin, 2005b). The Delphi study is considered suitable for BPM research as it is a mature field, in which a sufficient collection of existing literature is available to frame the initial problem and identify gaps. In addition, mature fields have a sufficient number of experts that could serve as participants to the study. Literature identifies a number of benefits and challenges relating to the use of Delphi studies. The benefits are described as follows (Hsu & Sandford, 2007; Rosemann & De Bruin, 2005b; Yousuf, 2007):

- Multi-round setup enables the formation of consensus on a complex subject, using controlled feedback to reduce discord.
- Respondent anonymity may lead to the elicitation of more creative responses.
- Social pressures are eliminated by ensuring respondents do not directly communicate with each other.
- Surveys are administered via electronic means, making them more practical for eliciting data from geographically dispersed respondents.
- Consensus is tracked and measured in a statistical manner.

Challenges relating to Delphi studies are defined as follows (Hsu & Sandford, 2007; Rosemann & De Bruin, 2005b; Yousuf, 2007):

- A sufficient number of experts willing to commit to participation in multiple rounds is needed.
- The experts must allocate a significant amount of time to complete all rounds and may drop out due to survey fatigue.
- Waiting times are introduced, as the panel can only progress to the next round after the current round has finished.
- Response coding is vulnerable to the introduction of bias by the researcher.
- Coding the responses is time consuming and requires more effort as the number of participants increases.

Existing literature on the Delphi method does not impose specific minimum or maximum limits to the number of respondents that must be included in a Delphi study. Compared to traditional quantitative research, a smaller number of respondents is deemed acceptable since rich data is gathered from a targeted group of experts. In this regard, the necessary number of respondents should be compared to that of a focus group session.

A wide variety of BPM Maturity Models is available in literature. Because of the many types of maturity models, each with their own measurement instrument and design principles, it becomes difficult to specify what makes a maturity model useful and applicable in practice. Previous research has attempted to provide design principles or frameworks for the design of maturity models (Becker, Knackstedt, & Pöppelbuß, 2009; De Bruin et al., 2005; Pöppelbuß & Röglinger, 2011). Critics state that maturity models may be too rigid (not responsive to characteristics of the organisation and its environment) or oversimplified (try to provide a one-size-fits-all formula for success) (Pöppelbuß & Röglinger, 2011). Some of the basic design principles include a clear definition of the target audience, the method of application, the application domain and the intended respondents (De Bruin et al., 2005). Defining these principles helps to frame and design the Delphi study. Vice versa, the Delphi study allows us to identify agreed-upon capability factors that are relevant to and applicable within the chosen domain. By using the Delphi method for capability identification and clearly describing the research process, we attempt to overcome the limitations of some earlier models.

3 Study Design

The study encompasses the application of the Delphi method in the hospital domain, for the purpose of identifying relevant capabilities for a BPM Maturity Model. A panel of participants was composed using pre-existing contacts from a research group at our institution. A minimum of five respondents was considered necessary for gathering sufficient variety in opinions. Contacting potential candidates resulted in a panel composed of six experts employed at Dutch hospitals and one academic researcher with prior experience in healthcare. The panel has an average of 11.7 years' experience ($s = 10.7$) in the healthcare industry, with a minimum of four years' experience.

Prior to starting the Delphi rounds, the six participants from practice were asked to rate the overall level of BPM Maturity of their organisations. This was done on the basis of the five levels of maturity defined in an established general-purpose model (Harmon, 2004). The model prescribes five distinct levels of organisational BPM Maturity: (1) Initial, (2) Repeatable, (3) Defined, (4) Managed, (5) Optimised. We also asked the participants to state their expected maturity level in five years. Two of the participants indicated currently being at level 2, while four participants indicated their organisation at level 3. All participants indicated an expected increase of one maturity level in the next five years. By using this quick assessment of self-perceived organisational maturity, we gain a general understanding of the characteristics of the sample.

We use a framework to define the necessary criteria for a Delphi study (Day & Bobeva, 2005). These criteria and the related characteristics form the starting point for conducting the study. These are listed in Table 1 below.

Criterion	Characteristic
Purpose of the study	Building
Number of rounds	Three
Participants	Homogeneous group
Mode of operation	Remote access
Anonymity	Full
Communication media	Internet, Telephone
Concurrency of rounds	Sequential set of rounds

Table 1 Characteristics of the Delphi study

The surveys used for data collection are distributed electronically. This facilitates the anonymous collection of data from geographically dispersed respondents. The participants are invited to the study via telephone, with additional details and instructions sent via e-mail. A period of three weeks is allotted to each round of the Delphi study to both ensure continuity of the study while allowing sufficient time for the experts to provide their response. Anonymous identifiers (ID codes) are used to track each participant in the study. This allows participants to see which responses belong to the same participant. The researcher uses these ID codes to keep track of the progress of each participant. Their true identities are known only to the researcher. An online survey platform is used that provides the functionality of setting pre-filled fields, so that ID codes can be attached to each survey individually.

The Delphi study was conducted in three rounds, which were set up as follows:

1. Round one: Collection of opinions on relevant capabilities for maturity in six factors derived from literature (Rosemann & Vom Brocke, 2010): Strategic Alignment, Governance, Methods, IT, People, Culture. Also rating each factors on a scale from one to ten
2. Round two: Rating each capability provided in a previous round on a scale from one to five.
3. Round three: Presenting an overall ranking of all capability, based on a weighted score based on the capability rating multiplied by the factor rating. Participants indicate a threshold value for relevant capabilities and rate their overall agreement with the findings.

The results of the Delphi study are described in the following section.

4 Results

At the end of the Delphi study, we arrive at a list of the most relevant capabilities that influence BPM maturity in hospitals. This list is based on the consensus achieved throughout the survey rounds by the participants involved in the study. During the survey rounds some participants were no longer willing or able to be involved in the study and therefore dropped out. Table 2 below shows the number of participants in each round.

	Practice	**Academia**
R1	6	1
R2	4	1
R3	3	1

Table 2 Number of participants in each round of the Delphi study

In the first round, participants rated their perceived importance of each of the six factors. Table 3 below shows the ratings given by the participants. Within each of the six factors, participants provided an open-ended answer with capabilities they deem important.

Factor	**Avg. score out of 10**	**Std. dev.**
People	9.14	1.60
Culture	8.86	1.27
Governance	8.57	0.90
Strategic Alignment	8.29	1.90
IT	7.57	0.69
Methods	6.86	0.90

Table 3 Factor ratings (average out of 10)

In the second round, all collected capabilities were rated for importance by the respondents, on a scale from one to five. The capability ratings were multiplied with the factor rating (seen in Table 3) to arrive at a weighted score for each capability. The weighted score is on a scale from 1 to 50. The distribution of weighted capability scores is shown in Figure 1. The capabilities are colour-coded depending on the factor they belong to. This shows that cultural and people capabilities are generally the highest-scoring. Scores for governance, strategic alignment and IT capabilities are more dispersed. Methods capabilities score lowly overall.

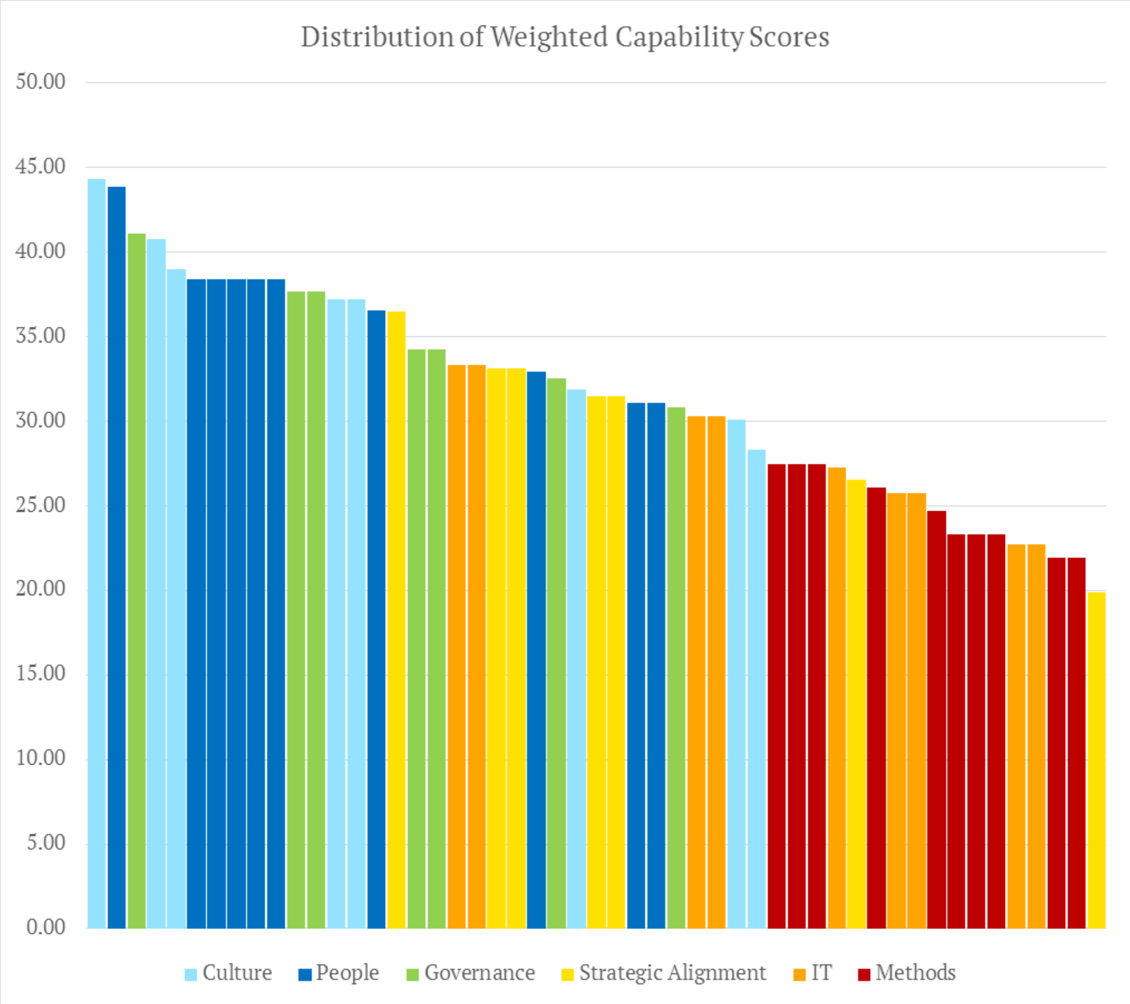


Figure 1 Distribution of weighted capability scores

In the third round of the Delphi study, participants were asked to provide an opinion on their agreement with the ranking of the entire set of capabilities. Also, they were asked to provide a threshold value for which capabilities should and should not be included in the final model. Based on the input, the threshold value was set at 30. Capabilities belonging to the methods factor are no longer included, since they all scored below 30. This results in a model with the most important capabilities across five factors. Table 4 shows the thirty-three included capabilities, grouped by factor and sorted by weighted score.

Factor	Capability	Capability Score	Weighted Score
People	Assigning Process Owners	4.8	43.87
	Availability of primary healthcare staff	4.2	38.39
	Knowledge sharing	4.2	38.39

	Training in describing and optimising healthcare processes	4.2	38.39
	Training in KPI-based steering	4.2	38.39
	Using pilot projects to foster participation	4.2	38.39
	Clarifying the importance of the individual in the process chain	4.0	36.56
	Training in combining line management and process management	3.6	32.90
	Flat organisational structure	3.4	31.08
	Freedom and responsibility to internalize processes	3.4	31.08
Culture	Management Commitment	5.0	44.30
	Involvement of Healthcare Professionals in Process Improvement	4.6	40.76
	Intrinsically motivated improvement culture and management style	4.4	38.98
	Assigning a process management ambassador within management or the board	4.2	37.21
	Creating awareness of current issues	4.2	37.21
	Culture elements from LEAN	3.6	31.90
	Open culture	3.4	30.12
Governance	Specification of tasks & responsibilities	4.8	41.14
	Use of outcome indicators	4.4	37.71
	Setting goals	4.4	37.71
	Governance based on soft skills (collaboration, behaviour, accountability)	4.0	34.28
	Prioritizing process management for high-risk business goals	4.0	34.28
	Agreeing on following process descriptions	3.8	32.57
	Frequent evaluation of progress in process management initiatives	3.6	30.85
	Providing insight into the value chain	4.4	36.48

Strategic Alignment	Process Improvement Business Cases	4.0	33.16
	Process Management Goals in organisational mission, vision and strategy	4.0	33.16
	Patient Reported Outcome Measures (PROM)	3.8	31.50
	Accreditation Standards (NIAZ, JCI)	3.8	31.50
IT	Use of BI Tools / KPI dashboard	4.4	33.31
	Securing process models in a digital quality management system	4.4	33.31
	Connecting process descriptions with working procedures	4.0	30.28
	EHRs for supporting the primary process	4.0	30.28

Table 4 Capabilities included in the proposed BPM Maturity Model for hospitals

5 Conclusions & Discussion

Considering the results of the Delphi study, we clearly see the human-related factors jump out (People & Culture). Participants agreed that hospitals are very people-driven organisations. Involvement and commitment of management executives as well as primary personnel (healthcare professionals) is paramount to achieving continuous process improvement. We also notice the need for soft skills such as knowledge sharing and intrinsic motivation.

When including the results of the Governance and Strategic Alignment factors, we notice that participants indicate a necessary shift towards process-based thinking. Traditionally, departments within hospitals are functionally divided. The results show that responsibilities must shift towards the process level in order to properly manage processes. Many of the hospitals included in the panel are taking steps to define the value of each activity in the process and thereby gaining insight into their value chain. This requires organisations to clearly define what exactly constitutes value for the patient.

The final two factors, IT and Methods, were rated relatively lowly. Participants agreed that these factors are supporting in nature, and should 'follow' the measures taken on other levels. Due to differing organisational characteristics, it is not possible to clearly rank a specific method or type of information technology as being the most suitable. This explains the relatively low ratings in these factors. We conclude that hospitals must select IT and Methods that best serve their strategic needs for process improvement as well as fit their organisational characteristics. In the IT factor, there was more consensus in regards to the use of business intelligence tools and electronic health records (EHRs). However, in the Methods factor, there was no sufficient consensus since Methods are deemed very situational. For this reason, the included capabilities no longer include the Methods factor and are therefore method-agnostic.

A possible limitation of this study is its limited sample size in a very specific domain. All participants came from institutions located in The Netherlands. Political, economic or demographic variables may influence the healthcare processes in other nations differently. In future research, we intend to generalise the model by testing its validity in other markets. Another caveat is the fact that the hospitals included in this study exhibit averagely developed BPM capabilities (maturity level 2 or 3). This may skew the findings towards capabilities most relevant for this level of maturity, as we have no data on hospitals with higher maturity levels. Through broader application of the model in Dutch and international markets, in institutions with different levels of maturity, we will attempt to gain a deeper understanding of the capabilities and how their maturity is improved.

Opportunities for future research include further development of the maturity model using the identified capabilities. This will require the establishment of maturity levels or stages against which an organisation can be measured. Furthermore, the actual measurement instrument must be developed and tested prior to deployment in the domain. Currently, the identified capabilities are purely descriptive. It is not yet known which interventions will lead to a higher level of maturity for a specific capability. Further applying and developing the model may eventually lead to a prescriptive model, which does not only help to assess maturity but also supports improvement.

This research paper identified relevant capabilities for improving BPM Maturity. This was done using the Delphi method, so that consensus could be established among a panel of experts. By applying the Delphi method and clearly describing the process, we attempted to overcome the limitations of some earlier models. We also aimed to fill a gap by identifying hospital-specific capabilities that are not yet captured in existing BPM Maturity Models.

References

Becker, J., Knackstedt, R., & Pöppelbuß, J. (2009). Developing Maturity Models for IT Management. *Business & Information Systems Engineering*, *1*(3), 213–222. http://doi.org/10.1007/s12599-009-0044-5

Dalkey, N. C., Brown, B. B., & Cochan, S. (1969). *The Delphi Method: An Experimental Study of Group Opinion*. *The RAND Corporation*. Santa Monica. Retrieved from http://www.rand.org/pubs/research_memoranda/RM5888/

Day, J., & Bobeva, M. (2005). A generic toolkit for the successful management of delphi studies. *Electronic Journal of Business Research Methods*, *3*(2), 103–116.

De Bruin, T., Freeze, R., Kulkarni, U., & Rosemann, M. (2005). Understanding the main phases of developing a maturity assessment model. In *ACIS 2005 Proceedings* (p. Paper 109). Retrieved from http://eprints.qut.edu.au/25152/

Harmon, P. (2004). Evaluating an Organization's Business Process Maturity. *BPTrends*, *2*(3). Retrieved from http://www.bptrends.com/publicationfiles/03-04 NL Eval BP Maturity - Harmon.pdf

Helfert, M. (2009). Challenges of business processes management in healthcare. *Business*

Process Management Journal, *15*(6), 937–952. http://doi.org/10.1108/14637150911003793

Hsu, C., & Sandford, B. (2007). The delphi technique: making sense of consensus. *Practical Assessment, Research & Evaluation*, *12*(10), 1–8. http://doi.org/10.1016/S0169-2070(99)00018-7

Jaana, M., Tamim, H., Paré, G., & Teitelbaum, M. (2011). Key IT management issues in hospitals: Results of a Delphi study in Canada. *International Journal of Medical Informatics*, *80*(12), 828–840. http://doi.org/10.1016/j.ijmedinf.2011.07.004

Luyckx, F. (2010). Why does the healthcare industry has the lowest BPM maturity? Retrieved January 24, 2016, from http://www.ariscommunity.com/users/frlu/2010-05-23-why-does-healthcare-industry-has-lowest-bpm-maturity

Luyckx, F. (2012). *Enterprise BPM Roadmap Assessment*.

Mans, R. S., Schonenberg, M. H., Song, M., van der Aalst, W. M. P., & Bakker, P. J. M. (2009). Application of Process Mining in Healthcare – A Case Study in a Dutch Hospital. In A. Fred, J. Filipe, & H. Gamboa (Eds.), *Biomedical Engineering Systems and Technologies* (Vol. 25, pp. 425–438). Springer Berlin Heidelberg. http://doi.org/10.1007/978-3-540-92219-3_32

Mans, R. S., van der Aalst, W. M. P., Vanwersch, R. J. B., & Moleman, A. J. (2013). Process Mining in Healthcare: Data Challenges When Answering Frequently Posed Questions. In R. Lenz, S. Miksch, M. Peleg, M. Reichert, D. Riaño, & A. ten Teije (Eds.), *Process Support and Knowledge Representation in Health Care* (pp. 140–153). Springer Berlin Heidelberg. http://doi.org/10.1007/978-3-642-36438-9_10

McCormack, K., Willems, J., Van Den Bergh, J., Deschoolmeester, D., Willaert, P., Štemberger, M. I., … Vlahovic, N. (2009). A global investigation of key turning points in business process maturity. *Business Process Management Journal*. http://doi.org/10.1108/14637150910987946

Øvretveit, J. (2000). Total quality management in European healthcare. *International Journal of Health Care Quality Assurance*, *13*(2), 74–80. http://doi.org/10.1108/09526860010319523

Paré, G., & Sicotte, C. (2001). Information technology sophistication in health care: An instrument validation study among Canadian hospitals. *International Journal of Medical Informatics*, *63*, 205–223. http://doi.org/10.1016/S1386-5056(01)00178-2

Pöppelbuß, J., & Röglinger, M. (2011). What makes a useful maturity model? A framework of general design principles for maturity models and its demonstration in business process management. In *ECIS 2011 Proceedings* (p. Paper28). Retrieved from http://www.fim-rc.de/Paperbibliothek/Veroeffentlicht/327/wi-327.pdf

Ravesteyn, P., Zoet, M., Spekschoor, J., & Loggen, R. (2012). Is There Dependence between Process Maturity and Process Performance? *Communications of the IIMA*, *12*(2), 65–80. Retrieved from http://www.questia.com/library/journal/1G1-335189055/is-there-dependence-between-process-maturity-and-process

Rosemann, M., & De Bruin, T. (2004). A Model for Business Process Management Maturity. In *ACIS 2004 Proceedings* (p. Paper 6). Retrieved from http://aisel.aisnet.org/acis2004/6

Rosemann, M., & De Bruin, T. (2005a). Application of a Holistic Model for Determining BPM Maturity. *BPTrends*, (February), 1–21.

Rosemann, M., & De Bruin, T. (2005b). Towards a business process management maturity model. In *ECIS 2005 Proceedings* (p. Paper 37). Retrieved from http://eprints.qut.edu.au/25194/

Rosemann, M., & Vom Brocke, J. (2010). The six core elements of business process management. In J. vom Brocke & M. Rosemann (Eds.), *Handbook on Business Process Management 1* (pp. 107–122). Springer-Verlag. http://doi.org/10.1007/978-3-642-00416-2

Weske, M. (2012). *Business Process Management: Concepts, Languages, Architectures* (2nd ed.). Berlin, Heidelberg: Springer Berlin Heidelberg. http://doi.org/10.1007/978-3-642-28616-2

Yousuf, M. I. (2007). Using experts' opinions through Delphi technique. *Practical Assessment, Research & Evaluation*, *12*(4), Available online: http://pareonline.net/getvn.asp? http://doi.org/May 2007

29th Bled eConference

Digital Economy

June 19 - 22, 2016; Bled, Slovenia

Perceived Well-being Effects During the Implementation of a Self-tracking Technology

Tuomas Kari

University of Jyvaskyla, Finland
tuomas.t.kari@jyu.fi

Sanna Koivunen

University of Jyvaskyla, Finland
koivunensanna100@gmail.com

Lauri Frank

University of Jyvaskyla, Finland
lauri.frank@jyu.fi

Markus Makkonen

University of Jyvaskyla, Finland
markus.v.makkonen@jyu.fi

Panu Moilanen

University of Jyvaskyla, Finland
panu.moilanen@jyu.fi

Abstract

In recent years, both individuals and the healthcare sector have become more interested to measure and improve health and well-being by using different self-tracking technologies. However, the number of studies concerning the experiences that people have with these technologies is still rather limited. This study investigates the expectations and perceived short-term effects of using self-tracking technologies on users' well-being. The focus is on the first weeks of usage i.e., the implementation phase. The study is qualitative in nature and based on thematic analysis of ten semi-structured interviews. The results reveal that the perceived well-being effects of using a self-tracking technology are relatively minor during the implementation phase and in line with the expectations. The increase in well-being is expected to occur in a longer time scale. Perceived psychological well-being is found to be affected the most during the implementation phase. The results also reveal interesting findings regarding the use of self-tracking technologies. The results are discussed and several important implications are drawn.

Keywords: Self-tracking, Activity Tracker, Mobile Application, Implementation, Well-being, Healthcare

1 Introduction

Technological development is revolutionizing several fields of society both in the work life and people's private lives with a variety of new kinds of products, applications, and services. It has also fostered the emergence of various new technologies and procedures that allow tracking, measuring, and evaluating one's own activities and bodily functions i.e., *self-tracking* or *self-measurement*. In recent years, both individuals and the healthcare sector have become increasingly interested to measure and improve health and well-being by using such self-tracking technologies. Physical measures, different biosignals, mood, nutrition, and sleep are all examples of the variables that can be self-measured with different technologies (cf., Quantified Self Guide to Self-Tracking Tools, 2015). Overall, different kinds of self-tracking technologies can be utilized by the individuals as well as by the health sector in disease prevention, treatment, and in promoting general well-being.

The popularity and significance of using self-tracking technologies in both individual level and in healthcare are rising. These technologies have also become a part of occupational healthcare. However, the number of studies concerning the experiences that people have with self-tracking technologies is still rather limited (Lupton, 2013). Therefore, it is important to start conducting more research regarding the topic. This kind of investigation can adduce several important implications for the development and utilization of these technologies. As the goal of self-tracking is often to examine and promote well-being, this research aims to find out whether these technologies influence the individuals' perceived well-being during the implementation phase. Examining the use experiences of the users of these technologies provides relevant information about how self-tracking affects the perceived well-being of users.

The adoption of some technologies is necessary to most people, but for the majority, starting to use self-tracking technologies is a voluntary choice, even if suggested by a healthcare professional. In this individual level adoption of a technology, the first few weeks are highly important: does the implemented technology provide sufficient value to the user or not? (Rogers, 2003). Thus, the implementation phase and the experiences during the implementation phase, for example, regarding the perceived well-being, can be crucial in the adoption process.

The main research questions of the paper are:

1) Do self-tracking technologies influence the users' perceived well-being during the implementation phase?

2) How the potential influence occurs?

3) What are the expected short-term well-being effects of using a self-tracking technology?

We use the term *technology* as an overall term for different technological devices, services, applications, and other products. The focus of the study is on the users' subjective experiences during the implementation phase of self-tracking technologies. The implementation phase is set to cover the first four weeks of use, as the study precisely focuses on the experiences and perceived well-being during the implementation phase, not on a long-term time scale. According to Rogers (2003), during the implementation phase the individual implements the innovation into use and determines its usefulness. We consider four weeks to be long enough for this, as Rogers (2003) also highlights the importance of first few weeks. The study is explorative in nature and follows a qualitative approach. More precisely, the study is based on thematic analysis of ten semi-structured interviews.

Our results can help the industry to develop and market more user-oriented technologies. In addition, our findings are of great value to the healthcare sector in employing self-tracking technologies as means of care to the patients.

This paper consists of the following sections. After this introductory section, the background is presented, followed by the sections for methodology, results, and the conclusion. Finally, the limitations and future research are presented.

2 Background

2.1 Self-tracking

Advancement of different wireless and wearable technologies has significantly improved the ability to track and measure one's own actions and to collect various data from everyday actions. Technological development also drives consumers to track and collect data about themselves (Wolf, 2010). There exists a growing number of various solutions that automatically collect data from different actions of everyday life and transform the otherwise meaningless numbers into something that the users can understand (Whitson, 2013). Instead of averages and generalisations, it is possible to get detailed information from specific actions. The information can include, for example, what has been done, when, where, how, and what has been the impact. This information, in turn, can potentially be used to improve, for example, related aspects of well-being.

The use of different self-tracking technologies has become a part of daily life for more and more people (McFedries, 2013). They are used, for example, as a tool to promote one's own health and well-being (Swan, 2013). Depending on the type of the technology, the use can also have a dual-purposed meaning. Previous studies have shown that the reasons behind the use can be utilitarian, hedonic, or both (e.g., Kari & Makkonen, 2014; Makkonen et al., 2012). Self-tracking has been applied to various areas of life, for example, social communications, travel, and the well-being and health context, "*where the expanded definition of health is embraced as applications address both medical issues and general wellness objectives*" (Swan, 2009, p. 509). The use of self-tracking has indeed increased in general healthcare (Paton et al., 2012; Swan, 2009), not just as means to support treatment and therapy, but also to cut the rapidly rising healthcare costs (Swan, 2013). In healthcare, there is also a growing trend that the role of the patient is shifting from a mere receiver to a more active self-tracker (Swan, 2009).

Different kinds of actions for quantified self-help and self-tracking can be placed under the *quantified self* umbrella. The term *Quantified Self*, coined in 2007 by two editors of the Wired magazine, Gary Wolf and Kevin Kelly (e.g., Combs & Barham, 2015; Strong, 2014) has evolved from its original meaning of collaboration of users and tool makers who share an interest in self knowledge through self-tracking. According to Swan (2013), quantified self refers to one's actions of monitoring any biological, physical, behavioural, or environmental factors regarding one's life. A fundamental part of the quantified self phenomenon and quantified self-help is increasing self-awareness through technology and measured data (Lupton, 2014) i.e., self-tracking.

According to the study by Fox and Duggan (2013), 69 % of U.S. adults track at least one health indicator such as exercise, weight, or diet. Out of them, 21 % do it with the help of some technology. For example, out of all the smartphone owners in the whole sample, 19 % had downloaded a health application. Out of the 69 % who were trackers, 46 % reported that tracking has changed their approach to managing personal health or the health of someone who they provide care to. 40 % reported that it has led them to consult doctors in new ways, and 34 % reported that self-tracking has affected how to treat a condition or illness. Generally, people who have a chronic condition or a more serious health issue take their tracking more seriously. These results show that tracking can indeed affect person's overall approach to health and well-being and technology can be an important part of it (Fox & Duggan, 2013).

2.2 Well-being

Well-being, both as a concept and phenomenon, is multi-faceted and something that changes over time. It is closely related to the concept of health and covers several dimensions. There are numerous definitions and dimensions of health and well-being found in the existing literature. World Health Organization (WHO) (2003) defines health as "*A state of complete physical, mental and social well-being and not merely the absence of disease or infirmity*". According to the U.S. Centers for Disease Control and Prevention (CDC) (2013), well-being includes such dimensions as physical well-being, emotions and moods, positive functioning, and satisfaction with life. We adhere to these definitions. According to WHO (1997), quality of life is a fundamental part of measuring health and well-being, and the organization has developed the World Health Organization Quality of Life Instruments (WHOQOL-100).

The WHOQOL-100 instrument includes six broad domains: physical health, psychological, level of independence, social relationships, environment, and spirituality/religion/personal beliefs. In addition, the instrument includes a number of facets incorporated within these domains. By measuring these domains, the quality of life, including well-being of the individual, can be evaluated (WHO, 1997). We use the relevant and applicable domains and their facets together with the previously mentioned definitions for health and well-being in evaluating whether the implemented self-tracking technologies influenced the individuals' perceived well-being during the implementation phase. This fits the focus of our study, perceived well-being of an individual, well.

3 Methodology

To investigate individuals' perceived well-being during the implementation phase, we chose to follow a qualitative approach. The goal of qualitative research is to understand reality and discover new knowledge. The aim is to understand people and their sayings and actions in the social and cultural context they live in. One of the key benefits of qualitative research is that it enables the researcher to view and understand the underlying contexts in which actions happen and choices are made (Myers, 2013).

To collect the data, we chose to use qualitative interview as the method. "*The qualitative interview is the most common and one of the most important data gathering tools in qualitative research*" (Myers & Newman, 2007, p. 3). As we wanted to collect meaningful experiences related to the theme of the research, the type of interview we chose was semi-structured interview. It is the most used type of interview among qualitative research in information systems. A semi-structured interview typically has an incomplete script, but includes a pre-formed structure developed for the interview (Myers & Newman, 2007). This was the case also in this study. In planning and conducting the interviews, we followed relevant guidelines for semi-structured interviews (e.g., Guest, Bunce & Johnson, 2006; Myers, 2013; Myers & Newman, 2007). This helped us to avoid the potential problems and pitfalls such as artificiality of the interview, lack of trust, constructing knowledge, or ambiguity of language (Myers & Newman, 2007), and to gain maximal benefit from using semi-structured interview.

Our study included two interviews for each interviewee, one before and one after the implementation. For these, we developed an interview script. Following Myers and Newman (2007), the script included the opening, the introduction, key questions related to certain themes, and the closing. We also presented questions regarding other aspects than well-being for the purpose of another study. The questions for the other study did not influence the well-being part of the script. The well-being part of the script is presented in Appendix A. The themes of the script were developed based on the research questions, previous literature, and determinants of well-being. The actual questions regarding well-being were adapted and modified from the WHOQOL-100 instrument (WHO, 1997) for the relevant and applicable parts.

As suggested by McCracken (1988), to maximize the depth and richness of the data, we aimed for fairly homogenous sample that share similarities regarding the research question. In selecting the interviewees, a certain criterion was also used. The person was deemed as a suitable candidate for interview if he or she: 1) had interest toward self-tracking technologies, 2) had the possibility to use and was about to implement one or more of these technologies, 3) was motivated to take part in the research. To obtain the interviewees, we used a snowball sampling approach (Patton, 2002). We first sought persons that met the set criterion and then suggested them with the possibility to participate in the study. Selected participants provided information on further possible participants and these again spread the word. All the interviewees stated that they would have implemented the technology at some point in the near future even without the suggestion of the researchers. As we were looking for authentic implementation situations, we did not require all the interviewees to implement the same technology, but allowed them to choose a technology that genuinely interested them. This was not in contradiction with the focus of the research, as the aim was not to examine one specific technology but rather self-tracking technologies on a general level.

The study was conducted with ten interviewees. Out of the ten interviewees, six implemented an activity tracker and seven implemented a mobile application for self-tracking. The total number of implemented technologies was higher than ten, as four of the interviewees simultaneously implemented an additional mobile application. All of the implemented technologies also supported some kind of social features such as sharing or web-based community.

In total, we conducted ten interviews before the implementation and ten interviews after the implementation. The first interview focused on the expected well-being effects and the second on the perceived well-being effects. The second interview was held approximately a month after the first one. The interviews were conducted during late 2014 by one of the authors. The interviews were held face-to-face with the interviewee. On average, the interviews lasted 30 minutes. The interviews were recorded and transcribed (in the interviewees' native language). Based on the transcriptions and notes made during the interviews, the analysis began.

To analyse the data, we used thematic analysis, which is the most widely used method of analysis in qualitative research (Guest, MacQueen & Namey, 2012). Thematic analysis is a method for "*identifying, analysing and reporting patterns (themes) within data*" (Braun & Clarke, 2006, p. 79). It allows to organize and describe the data set in rich detail and to interpret various aspects of the research topic (Braun & Clarke, 2006). In doing our analysis, we applied the guidelines for thematic analysis by Braun and Clarke (2006) and Patton (2002). As suggested (Braun & Clarke, 2006; Patton, 2002), we applied the guidelines flexibly to fit the research question and data. We began the analysis by familiarizing ourselves with the data and marking all the interesting features of it. We continued by first searching for recurring themes, which we then reviewed in relation to the data. We also defined and named them. Finally, we produced the report. As suggested by the followed guidelines, the analysis process was more a recursive one than a linear phase-to-phase process, as we moved back and forth between the different phases of the analysis. This is typical to thematic analysis and allows checking if the identified themes work in relation to the data set and the extracts from the data being analyzed (Braun & Clarke, 2006).

4 Results

The interviewed sample consisted of ten Finnish interviewees, out of which two were males and eight females. The age range was between 21 to 27 years with the average of 24,1 years. The interviewees were people interested in self-tracking technologies and generally had little or some previous experience of these technologies. Table 1 describes the characteristics of the sample and shows which type of technologies the interviewees implemented. Four of the interviewees implemented two different technologies, leading to a total of 14 implemented technologies.

	Gender	Age	Employment status	Implemented technology*
Participant 1	Male	27	Employee	AT + MA
Participant 2	Female	24	Employee	AT
Participant 3	Female	24	Unemployed	MA
Participant 4	Female	21	Student	AT
Participant 5	Female	24	Student	2x MA
Participant 6	Female	24	Employee	AT
Participant 7	Female	24	Employee	AT + MA
Participant 8	Male	25	Student	AT + MA
Participant 9	Female	24	Student	MA
Participant 10	Female	24	Employee	MA
*MA = Mobile application for self-tracking; AT = Activity tracker				

Table 1: Description of the Sample

4.1 Expected Well-being

The expected well-being effects before the implementation of a self-tracking technology were quite similar in general. The general expectation was that if the use would have positive effects on well-being, the technology would also provide positive information about this to the user. Receiving this kind of positive information was expected to cause pleasure, support the made choices, and foster the perceptions of increased well-being. Interestingly, would the received information be negative, for example, certain actions being insufficient, it was not expected to influence one's own mood or perceptions of well-being. It was, however, expected that negative information could influence the behaviour or help to see what kind of things are negative in the first place. Regarding the usability of received information, it was expected that the technology would provide reliable information that is clearly presented, relevant, and easy-to-understand.

When comparing the expectations between activity trackers and mobile applications for self-tracking, some differences arose. Activity trackers were expected to be more potential than different mobile applications in increasing the amount of physical activity, and this way, in influencing both physical and psychological well-being. However, if a mobile application would be designed for a specific purpose, it was expected to be more potential in improving that particular area.

The well-being effects during the implementation phase were expected to be relatively small and unrecognizable, and they were not seen as the primary goal of use for either type of technology on a short-term. Rather, the general expectation was that during the implementation phase, these technologies would mainly operate as an interesting supplement, and improving own activities and well-being would possibly take place in a more distant future. Regarding this, an interesting finding was that the potential increase in well-being was expected to originate from doing the activity itself and the pleasure caused by doing it rather than directly through using the technology. In other words, it was expected that a mere use of a self-tracking technology would not increase well-being, but rather the increase in well-being would derive from different actions that are supported or monitored by these technologies.

4.2 Perceived Well-being

The actual perceived well-being effects of using a self-tracking technology were relatively minor during the implementation phase. Perceived *psychological* effects mostly arose from those positive experiences where the technology verified or showed the user's successful performance, which caused pleasure and assurance to the user. Negative experiences were not perceived to affect well-being as they were mainly connected to the technology itself instead of own actions or failure. If the user perceived increase in psychological well-being, it increased the likeliness of the user continuing the use after the implementation phase.

Effects to *physical* well-being were perceived as minimal. Even when the use of technology supported and boosted, for example, exercise sessions, the physical well-being was perceived to grow because of the physical activity itself, not because of the use of technology. In other words, the interviewees did not experience that the technology itself would have improved the physical well-being.

Perceived effects to *social* well-being were related to the possibility of sharing and discussing meaningful use experiences, both positive and negative, among friends. In a way, this offered a sort of peer-support. Still, the overall perceived increase in social well-being was small. We also found that the shared personal use experiences served as positive or negative recommendations concerning the technology. Compared to sharing use experiences, the interviewees were more reluctant to share their personal data with others, because it was seen as more personal or uninteresting to friends. This is logical in the context of self-tracking technologies, as their main purpose is often to collect data from oneself and to increase self-awareness.

In addition, we found that the technology can influence the behaviour in unexpected and negative ways that do not improve performances, but instead hamper the daily activities. Some interviewees described how they had purposely changed their behaviour in order to receive better feedback from the technology, for example, by carrying bags in different hand than normally to avoid absence of hand movement that is detected by the tracker; or by having to plan when and how to charge their mobile phones due to the increased battery consumption caused by the self-tracking application. These kinds of negative changes in behaviour were seen to lower certain elements of well-being, namely, the *level of independence*. Thus, these technologies can even have a negative effect on some aspects of perceived well-being.

These findings regarding the relatively small actual perceived well-being effects during the implementation phase were in line with the pre-implementation expectations. There are two possible explanations for the minor perceived well-being effects. If the user did not have a clear felt need or a problem in mind when implementing the technology, then well-being was not perhaps seen as a subject of development and the user did not try to improve it during the implementation phase. Of course, the minor perceived effects on well-being could also have been caused by the relatively short usage period that was restricted to the implementation phase, preventing the perceptions of any longer-term benefits. In any case, this lack of perceived improvement in well-being was one of the reasons behind the fact that out of the 14 implemented technologies, the use of eight discontinued during or after the implementation phase. Other reasons for discontinued use included, for example, bad usability or functionality of the technology and the received information not being valid and reliable.

5 Conclusion

This study examined whether self-tracking technologies influence the individuals' perceived well-being during the implementation phase. In addition, the study also investigated what are the expected short-term well-being effects of using a self-tracking technology. The main research questions of the study were: 1) Do self-tracking technologies influence the users' perceived well-being during the implementation phase? 2) How the potential influence occurs?, and 3) What are the expected short-term well-being effects of using a self-tracking technology?

The short-term well-being effects before the implementation of a self-tracking technology were expected to be relatively small and unrecognizable, and they were not seen as the primary goal of use on a short-term. Rather, in general it was expected that during the implementation phase, these technologies would mainly operate as providers of interesting information, and improving own activities and well-being would take place on a longer time scale.

The actual perceived well-being effects of using a self-tracking technology were relatively minor during the implementation phase. Psychological well-being was perceived to grow with those positive experiences where the technology verified or showed the user's successful performance, subsequently causing pleasure and assurance for the user. With physical and social well-being the perceived effects were small. There are two possible explanations that could explain the relatively minor perceived well-being effects during the implementation phase. One, the user not having a clear felt need or a problem in mind when implementing the technology, and two, the relatively short usage period that was restricted to the implementation phase and prevented the perceptions of any longer-term benefits. These findings imply that the industry should take the well-being aspect into account even more when designing and marketing these technologies. As our results suggest, the lack of increase in perceived well-being was one of the reasons behind discontinued use. Thus, it would be valuable for the adoption, continued use, and success of the technology if it would be able to provide the users with perceived increased well-being effects already during the early stages of use.

To promote the diffusion of self-tracking technologies and increase their success in healthcare, new users and patients will need proper understanding and guidance on how to make the use of these technologies more goal-oriented, not just something to wear. This could be achieved if improving well-being would be a clearer and a more concrete target for usage. As our results show, the users want clear, relevant, and easy-to-understand information, so providing this could also advance the goal-oriented use of self-tracking technologies and subsequently increase perceived well-being. This would be valuable to acknowledge both in the industry and healthcare. The lack of increase in perceived well-being on a short-term is also something that the healthcare sector should acknowledge. It indicates that using self-tracking technologies will most probably be more successful in improving health and well-being if prescribed to the patient for a longer-term use. Also, when deploying these technologies for patients, the professionals should provide them with clear guidance and goals for use. The same applies for occupational healthcare and employees.

In addition, our study shows that acting or living on the terms of a self-tracking technology can have a negative influence on the daily activities and life of the user and thus even have a negative effect on some aspects of perceived well-being. This is important for the designers in the industry to take into account when designing these products.

In conclusion, the study provides valuable new insights regarding the experiences that people have with self-tracking technologies. We believe that the healthcare sector can use our findings and implications in employing self-tracking related means of care to the patients and subsequently in improving general health and well-being. We also believe that the different industry parties working among self-tracking technologies can utilize our findings in the development of self-tracking technologies and in providing products that are better welcomed by the users and gain success in the market.

6 Limitations and Future Research

We consider there to be three main limitations in the study. The first limitation concerns the general limitations of qualitative interview. However, in planning and conducting the interviews, we followed relevant guidelines for semi-structured interviews (e.g., Braun & Clarke, 2006; Guest et al. 2006; Myers, 2013; Myers & Newman, 2007) to gain maximal value and to avoid the potential problems and pitfalls of using the method. The identified themes in the thematic analysis are always based on the interpretations of the researchers (Guest et al., 2012). Therefore, we also applied relevant guidelines in doing the analysis. Typical to qualitative research, making generalizations from the sample to a larger population can be problematic (Myers, 2013) and should be done with caution. Second limitation concerns the focus being on the implementation phase, meaning the target group consisted of people just about to implement a self-tracking technology. Thus, the target group was rather small and to obtain the interviewees, we had to suggest the possibility to participate in the study. All interviewees could, however, choose the technology to implement themselves and reported that they would have started using the technology in the near future even without the suggestion of the researchers. Thus, the implementation was a natural situation based on own interests. We also followed previous guidelines (McCracken, 1988) in selecting the interviewees. Third limitation concerns the sample. Although providing a great amount of information, the number of interviewees could have been higher. However, we believe that an adequate number of interviews were conducted, as we continued to conduct interviews till we had recognized that their marginal benefit was significantly reduced. Regarding the gender distribution, it could have been more balanced. Also, the age difference among the sample is rather small, but as proposed by McCracken (1988), a fairly homogenous sample that shares similarities regarding the research question helps to maximize the depth and richness of the data.

Also, when examining well-being effects, it should be noted that well-being in itself is a multifaceted and abstract concept that may mean different things to different people. Hence, it can be challenging for the users to highlight concrete factors that affect their perceived well-being, especially from the implementation phase, as it is a relatively short period of time to recognise the effects. Future research can build on this notion: it could be valuable to study perceived well-being effects with longer periods of use and prolonged study duration. The findings of the study also provide other potential paths for future research. First, this study examined different self-tracking technologies, but it would also be interesting to investigate one specific technology. By investigating a specific technology, it would be possible to identify technology-specific characteristics in more detail. Second, the target group could be limited to a certain kind of users who have similar well-being goals, for example, weight loss, better sleep, or other specific area. The target group could also cover some different demographic such as elderly people.

References

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77–101. doi:10.1191/1478088706qp063oa.

Centers for Disease Control and Prevention. (2013). Well-being concepts. Retrieved 15.2.2016, from: http://www.cdc.gov/hrqol/wellbeing.htm.

Combs, C. D., & Barham, S. R. (2015). The quantifiable self: petabyte by petabyte. In C. D. Combs, J. A. Sokolowski, & C. M. Banks (Eds.) *The digital patient: advancing healthcare, research, and education* (pp. 63–72). Hoboken: John Wiley & Sons.

Fox, S., & Duggan, M. (2013). Tracking for health. Washington: Pew Research Center's Internet & American Life Project. (Report)

Guest, G., Bunce, A., & Johnson, L. (2006). How many interviews are enough? an experiment with data saturation and variability. *Field Methods, 18*(1), 59–82. doi:10.1177/1525822X05279903.

Guest, G., MacQueen, K. M., & Namey, E. E. (2012). *Applied thematic analysis*. Los Angeles: SAGE.

Kari, T., & Makkonen, M. (2014). Explaining the usage intentions of exergames. In The 35th International Conference on Information Systems (ICIS) 2014, 14.–17.12.2014 (pp. 1–18). Auckland: AIS.

Lupton, D. (2013). Understanding the human machine [Commentary]. *IEEE Technology and Society Magazine, 32*(4), 25–30. doi:10.1109/MTS.2013.2286431.

Lupton, D. (2014). Self-tracking modes: reflexive self-monitoring and data practices. In Imminent Citizenships: Personhood and Identity Politics in the Informatic Age' Workshop, 27.8.2014 (pp. 1–19). Canberra: ANU.

Makkonen, M., Frank, L., Kari, T., & Moilanen, P. (2012). Explaining the usage intentions of exercise monitoring devices: the usage of heart rate monitors in Finland. In The 18th Americas Conference on Information Systems (AMCIS) 2012, 9.–11.8.2012 (pp. 1–10). Seattle: AIS.

McCracken, G. (1988). *The long interview*. Newbury Park: SAGE.

McFedries, P. (2013). Tracking the quantified self. *IEEE Spectrum, 50*(8), 24. doi:10.1109/MSPEC.2013.6565555.

Myers, M. D. (2013). *Qualitative research in business and management* (2nd edition). Los Angeles: SAGE.

Myers, M. D., & Newman, M. (2007). The qualitative interview in IS research: examining the craft. *Information and Organization, 17*(1), 2–26. doi:10.1016/j.infoandorg.2006.11.001.

Paton, C., Margaret, M., Fernandez-Luque, L., & Lau, A. Y. S. (2012). Self-tracking, social media and personal health records for patient empowered self-care. In C. A. Kulikowski, & A. Geissbuhler (Eds.) *IMIA yearbook of medical informatics 2012* (pp. 16–24). Stuttgart: Schattauer GmbH.

Patton, M. Q. (2002). *Qualitative research & evaluation methods* (3rd edition). Thousand Oaks: SAGE.

Quantified Self. (2015). Guide to self-tracking tools. Retrieved 10.2.2016, from: http://quantifiedself.com/guide/tools.

Rogers, E. M. (2003). Diffusion of innovations (5th edition). New York: Free Press.

Strong, C. (2014). Will personal data in the hands of individuals revolutionise analytics? *Applied Marketing Analytics, 1*(1), 32–41.

Swan, M. (2009). Emerging patient-driven health care models: an examination of health social networks, consumer personalized medicine and quantified self-tracking. *International Journal of Environmental Research and Public Health, 6*(2), 492–525. doi:10.3390/ijerph6020492.

Swan, M. (2013). The quantified self: fundamental disruption in big data science and biological discovery. *Big Data, 1*(2), 85–99. doi:10.1089/big.2012.0002.

Whitson, J. R. (2013). Gaming the quantified self. *Surveillance & Society, 11*(1/2), 163-176.

Wolf, G. (2010). The quantified self [TED Talks]. Retrieved 10.2.2016, from: http://www.ted.com/talks/gary_wolf_the_quantified_self.

World Health Organization. (1997). World Health Organization quality of life instrument (WHOQOL-100). Geneva: World Health Organization.

World Health Organization. (2003). WHO definition of health. Retrieved 15.2.2016, from: http://www.who.int/about/definition/en/print.html.

Appendix A Interview Script and Examples of Questions

Opening		
Introduction		
Themes of the key questions		
1. Background	1.1 Demographics	1.2 Socioeconomic characteristics
2. Well-being aspect		
2.1 Physical health (energy and fatigue) e.g. *"Do you feel that the use of the technology has affected your physical well-being?"*	2.2 Psychological (feelings, self-esteem, cognitive functions) e.g. *"Do you feel that the use of the technology has affected your mental well-being?"*	2.3 Level of independence (work capacity, activity) e.g. *"Do you feel that the use of the technology has changed your activities of daily living?"*
2.4 Social relationships (social support, sexuality) e.g. *"Have you received support or negative reactions regarding the use of the technology from your social circle?"*	2.5 Environment (finance, health and social care, opportunities for acquiring new information, physical environment) e.g. *"How have the environmental factors supported the use of the technology?"*	2.6 Personal beliefs (religion, spirituality) e.g. *"Do you feel that your personal beliefs have affected the use of the technology?"*
Closing		

More detailed descriptions of the key questions are available from the authors by request.

29th Bled eConference

Digital Economy

June 19 - 22, 2016; Bled, Slovenia

To Gamify or Not to Gamify? Gamification in Exercise Applications and Its Role in Impacting Exercise Motivation

Tuomas Kari

University of Jyvaskyla, Finland
tuomas.t.kari@jyu.fi

Jenni Piippo

University of Jyvaskyla, Finland
jenni.j.piippo@student.jyu.fi

Lauri Frank

University of Jyvaskyla, Finland
lauri.frank@jyu.fi

Markus Makkonen

University of Jyvaskyla, Finland
markus.v.makkonen@jyu.fi

Panu Moilanen

University of Jyvaskyla, Finland
panu.moilanen@jyu.fi

Abstract

Gamification and different exercise applications have become increasingly popular in recent years. The common purpose of gamification is to enhance one's motivation and engagement to certain activities. Gamification has been commonly understood as the use of game elements in non-game context. In this paper, we propose a divide between the process and the experience of gamification. This paper is the first to propose such division and the results demonstrate its necessity. Gamification exists also in many exercise applications. The purpose of this study is to explore how the use of an exercise application affects users' exercise motivation and behaviour by concentrating especially on the role of gamification in terms of these effects. Empirically, the study is based on 11 qualitative interviews. The results show that the use of an exercise application can enhance the awareness of one's physical activity and progress, and in many cases it can also increase one's motivation to be physically active. Gamification is found to have potential impact on exercise motivation, although individual differences occur.

Keywords: Gamification, Exercise application, Sports technology, eHealth, Motivation, Process of gamification, Experience of gamification

1 Introduction

Games have been a part of human life for ages. Traditionally they have been played for entertainment and relaxation, as they offer a possibility to escape the rules of ordinary life. Games have features that make playing fun and enjoyable, but they can also include more goal-oriented features that can support, for example, development of new skills (Mitchell, 2012). Indeed, during the recent years, games have been used increasingly for developing skills that are needed outside the game or for some other more serious purpose like promoting physical activity (Kari, 2014). It has also become very popular to implement different game-like elements outside the gaming context and to create gameful experiences for the user (Hamari, Koivisto & Sarsa, 2014b). These kinds of actions are typically called *gamification*.

As the interest towards gamification has grown, it has become a subject of growing interest in academic research as well (cf., Hamari, Koivisto & Pakkanen, 2014a; Hamari et al., 2014b). However, there seems to be a dearth of studies on gamification in the context of health and exercise (Hamari et al., 2014b). This is obviously a severe shortcoming. As the benefits of physical activity to health and well-being are well established (e.g., Lee et al., 2012; Warburton, Nicol & Bredin, 2006), it is important to study how gamification is experienced and could be better utilized in this context.

In order to fill the aforementioned research gap regarding gamification in the context of health and exercise, the purpose of this study is to explore how the use of an exercise application affects users' exercise motivation and behaviour by concentrating especially on the role of gamification in terms of these effects. For example, does gamification actually have a positive or a negative effect on exercise motivation and behaviour and how do its effects relate to those of other motivational and behavioural antecedents. In the context of this study, exercise applications are regarded as mobile applications that can be used to track and measure physical activity. The study is explorative in nature and is carried out by using qualitative research methods. The qualitative data is based on 11 interviews regarding the topic and actual experiences of using the Suunto Movescount application.

The results of the study can benefit several actors. The vast number of exercise application developers can utilize the findings in designing the applications and in the process of gamification. Thus, the applications can be made more appealing to the users and can perhaps motivate them to increase physical activity. In this way, the results also pose value for the public health sector, as there is a great need to find new solutions to promote the physical activity levels.

The paper consists of the following sections: After the introduction, the background is presented. These are followed by the methodology and the results sections. We then discuss the results in the conclusions section. Finally, the limitations and future research are presented.

2 Gamification and Exercise Motivation

2.1 Definition of Gamification

The term gamification, originally gameification, has been presumably used since 2008 (Huotari & Hamari, 2012) but was first defined by Deterding et al. (2011, p. 9) as the "*use of game design elements in non-game contexts*". Following this definition, gamification simply refers to implementing game elements to different surroundings, tasks, software, hardware, and other targets that are not games. Compared to Deterding et al. (2011), Huotari and Hamari (2012, p. 20) emphasize the experiential nature and goals of gamification, as they define it as "*a process of enhancing a service with affordances for gameful experiences in order to support the user's overall value creation*". According to Ziesemer, Müller and Silveira (2013) the definition of gamification should not be solely restricted to the use of game-like elements, as all users are not aware of all game-like elements and have distinct knowledge and motivation about gamification. Ziesemer et al. (2013) see gamification to cover also those gameful experiences of the user that do not arise from pure gamified elements.

Considering these prior definitions, it seems that gamification can be understood both as a process and an experience. We do not suggest that one of the presented definitions would be better or worse than another but rather suggest that when discussing gamification, this difference should be noted. Thus, we propose that when discussing about gamification, there should be a divide between the *process of gamification* and the *experience of gamification*. The *process of gamification* is following more the definition by Deterding et al. (2011) and concerning the intentional use of different methods to gamify some certain aspect of use. On the contrary, the *experience of gamification* is following more the definitions by Huotari and Hamari (2012) and Ziesemer et al. (2013) and concerning the gameful experience of the user.

Based on the above, we propose the following definitions: We define the *process of gamification* as *'using a set of activities with the aim to implement game elements to non-game context'* and the *experience of gamification* as *'a use experience in non-game context that the user perceives as gameful'*. The common purpose of the *process of gamification* – as we define it – is to create more gameful and enjoyable user experiences, and thus motivate the user to behave in desired ways (Deterding et al., 2013). In other words, the *process of gamification* aims to arise an *experience of gamification* in the user. However, the *experience of gamification* can also emerge from non-gamified features, as our empirical result will demonstrate.

During the past years, the *process of gamification* has increased tremendously in several different fields, one such field being the sports and wellness industry. There are several different ways how to directly gamify physical activity and exercise applications (Zuckerman & Gal-Oz, 2014). Common ways of gamification in exercise applications are related to such aspects as social influence, scores, and competition. Many applications also have more indirect ways of gamification, which can be difficult for the user to identify as gamification (Ziesemer et al., 2013). Previous studies have suggested that gamification can have a positive effect on motivation in general, but differences occur both in individual level and between different solutions (e.g., Fitz-Walter, Tjondronegoro & Wyeth, 2012; Hamari et al., 2014b). Similarly, according to Zuckerman and Gal-Oz (2014), previous studies concerning the effects of gamification on motivation towards physical activity have had contradicting findings.

2.2 Utilizing Gamification to Affect Exercise Motivation

Motivation is an important driver and an explaining factor behind behaviour (Deci & Ryan, 1985; Ryan & Deci, 2000a). The orientation (type) and level (amount) of motivation can vary greatly between individuals and the target behaviours. The type of motivation concerns the "*underlying attitudes and goals that give rise to action*" (Ryan & Deci, 2000a, p. 54). Most typically, the concept of motivation is distinguished between intrinsic and extrinsic (or internal and external) types of motivation. Intrinsic motivation refers "*to doing something because it is inherently interesting or enjoyable*" (Ryan & Deci, 2000a, p. 55). Intrinsic motivation is probably the most important single factor reflecting the positive potential of human nature. Still, maintaining and enhancing this inherent propensity requires supportive conditions, as it can be disrupted by different non-supportive conditions (Ryan & Deci, 2000b). The concept of intrinsic motivation is often compared to extrinsic motivation, which refers to "*doing something because it leads to a separable outcome*" (Ryan & Deci, 2000a, p. 55), i.e., the persons acts because of external prods, rewards, or pressures. Extrinsic motivation also has differing degrees of relative autonomy that reflect the level of external control and self-regulation (Ryan & Deci, 2000a).

As mentioned earlier, the common purpose of the *process of gamification* – as we define it – is to create gameful and more enjoyable user experiences and thus, motivate the user to behave in desired ways (Deterding et al., 2013). Motivating is conducted through the use of game elements, that is, the aim is to utilize the positive aspects of games in generating gameful experiences and thus, affect the motivation. Gamification can be an effective strategy to influence the user's behaviour and use of an application such as mobile application (Law, Kasirun & Gan, 2011). Gamification can also have a positive effect on motivation in general, but differences occur both in individual level and between different solutions (e.g., Fitz-Walter et al., 2012; Hamari et al., 2014b). According to Knaving and Björk (2013), the *process of gamification* is often focused to certain elements as a separate layer from the main activity and thus, although commonly used as means to increase the intrinsic motivation, in many cases it mainly enhances the extrinsic motivation (Knaving & Björk, 2013). Extrinsic motivations, in turn, have been shown to reduce the intrinsic motivation (e.g., Cameron & Pierce, 2002; Deci, Koestner & Ryan, 1999). In other words, if the user centres the attention at the game elements only, it can move the user's focus off the behaviour itself and hinder the development of intrinsic motivation. However, in the absence of intrinsic motivation, generating extrinsic motivation can promote the behaviour. Gamification can generate extrinsic motivation, especially if it fosters the feelings of autonomy and competence (Knaving & Björk, 2013).

Previous studies have suggested that sports technology can be utilized in motivating people towards physical activity (e.g., Ahtinen et al., 2008; Bravata et al., 2007), and that the use of sports technology and feedback can increase the probability of motor learning and skill acquisition (Liebermann et al., 2002). Mobile smart phones are widely adopted and thus, a good platform for exercise and well-being related applications. Previous studies have shown, for example, that augmented feedback from a mobile exercise application during an exercise session can promote physical activity (Giannakis, Chorianopoulos & Jaccheri, 2013). According to Ryan & Deci (2000) social behaviour can increase the perceived communality and increase motivation, and Ahtinen et al. (2009) have found that this also applies in the context of physical activity. However, the role of social context seems to be two-fold in the use of sports technologies. When the use is mainly utilitarian, social context has a less significant role (Makkonen et al., 2012a), but when the use is mainly hedonic, the social context can be an important factor (Moilanen, Salo & Frank, 2014). Previous research (e.g., Kari & Makkonen, 2014; Makkonen et al., 2012a; Makkonen et al., 2012b) has shown that the reasons behind the use of different sports and wellness technologies are various and that they can be both hedonic and utilitarian. Thus, depending on the used sports technology, the elements that increase motivation can be different.

3 Research Method and Data Collection

Qualitative research was selected as the research method, as the aim was to understand phenomena from the point of view of the participants and to find out significant experiences of individual persons – something that would have been difficult to capture and understand by using quantitative methods (Myers, 2007). Qualitative research involves the use of qualitative data, such as interviews, to understand and explain social phenomena (Myers, 2007). It has been widely used in many fields and disciplines, including information systems, using a variety of well-established approaches, methods, and techniques (Myers, 2007). Qualitative research aims to understand people and their sayings and doings as well as the social and cultural context they live in. The goal is to understand real life and find new knowledge. One of the key benefits of qualitative research is that it enables the researcher to see and understand the underlying contexts in which actions happen and decision are made (Myers, 2013).

To collect the data, we chose interviews as the data collection method. Interviews are seen as the most common and among the most important qualitative research data gathering tools (Myers & Newman, 2007). Thus, semi-structured interviews were chosen for this study. They are the most common type of qualitative research in information systems (Myers & Newman, 2007). Semi-structured interviews typically include a pre-formed structure but an incomplete script, leaving room for the researcher to go deeper (Myers & Newman, 2007). The planning of and carrying out the interviews was conducted following set guidelines (Guest, Bunce & Johnson, 2006; Myers, 2013; Myers & Newman, 2007). For the interviews, we developed the mentioned pre-formed structure (Appendix A). Following Myers and Newman (2007), the structure included the opening, the introduction, key questions related to certain themes, and the closing. The thematic structure of the interviews consisted of sections regarding the earlier experience of sports technology and physical activity background, followed by a focus on the selected exercise application. The themes focusing on the exercise application consisted of sections on taking the application into use and using it, its effect on exercise behaviour, gamification in the application, the application's social features, and usage experience of the application.

In selecting the participants for the study, we used certain criteria. The person was considered as an appropriate candidate for the interview if he or she: 1) was a physically active adult but not an athlete nor a completely physically inactive person, 2) doing the kinds of exercises that could be measured with the selected application, 3) owned a mobile device with either Android or iOS operating system (to be able to use the selected application). To recruit the participants, we used the snowball sampling approach (Patton, 2002). We began by searching persons that matched the set criterion and then suggested them with the possibility to participate in the study. We asked the selected participants to provide information on further possible participants and then repeated this.

Before the interviews, the study participants used the selected exercise application Suunto Movescount. We selected Movescount for the following reasons. First of all, it has a low threshold to start using, as it is free of charge and it can be used with a mobile device on both iOS and Android platforms. Thus, it was available to all participants. In addition, the application can be used to measure different sports, and it includes various social features such as sharing one's exercise data (c.f., Movescount, 2015). Thus, it provided a variety of possibilities regarding the use for the participants. It also has a connected web-service where the exercise data can be stored and analysed in more detail. The exercise data compatible with the Movescount web-service can be measured directly by the mobile device or alternatively by using a Suunto sports watch. However, as the focus of the study was on the mobile exercise application, the participants were not using other Suunto products simultaneously. Also, we did not place any restrictions for the participants regarding the type or duration of physical activity during which to use the application, as we wanted the use to be as normal as possible for the participants. The Movescount mobile application in itself does not posses many explicitly added game elements, mainly some related to the visualization of the data and to the ability to compare own performances. However, as the main aim of the research regarding gamification was to investigate the *experience of gamification*, the selected application suited the study very well.

The participants were instructed to use the application for at least two weeks before the interviews. The two-week period was estimated to be long enough in order to generate multiple usage sessions and for the research participants to be able to evaluate their behaviour and possible changes in it. There were no specific instructions on the amount of exercise or on the use of the application, as the intention was not to control the use, as it might have affected the research results. The participants were also encouraged to note their experiences on the usage of the application in order to better memorize especially those experiences that arose in the early phases of the use.

The interviews were conducted between May and June 2015. The interviews were conducted about three weeks after the start of the use of the exercise application. The usage periods ranged from two to three weeks. The average length of the interviews was 24 minutes. The interviews were recorded and transcribed for analysis. In addition, three of the participants kept a diary from the use period, which were also used, together with the notes from all the participants, in the analysis.

The method of analysis we chose was thematic analysis. Thematic analysis was used to identify, analyse, and report patterns within the collected data. It is the most widely used analysis method in qualitative research (Guest, MacQueen & Namey, 2012) and allows organizing and describing the data in rich detail (Braun & Clarke, 2006). The analysis of the interview data of this study was guided by Braun and Clarke (2006) and Patton (2002). Following their suggestion (Braun & Clarke, 2006; Patton, 2002), we adjusted the guidelines to fit the research topic and data. The analysis began by familiarizing ourselves with the data and marking all the interesting features of it. The analysis continued by first searching for recurring themes, which were then reviewed in relation to the data. The themes were also defined and named. In doing this, we used the Microsoft Excel program. Finally, the report was produced. As suggested (Braun & Clarke, 2006; Patton, 2002), the analysis process itself was recursive and non-linear, moving back and forth between the different analysis phases. The thematic analysis also aimed to interpret specific aspects and exceptions on the research topic.

4 Results

The sample consisted of 11 research participants. Out of these 11 participants, six were male and five female. The age of the participants ranged from 23 to 53 years, with an average of 28.3 years. As to the mobile platform used, six were using the application on iOS and five on Android. Most of the participants had earlier experience of using sports technology, and they reported that their motivation to exercise emerges from mainly intrinsic factors. However, also extrinsic motivation factors could be identified from the participants' answers, for example, the requirements set by one's work or improving one's personal appearance. Table 1 describes the sample of this study.

	Gender	**Age**	**Operating system**
Participant 1	Female	23	iOS
Participant 2	Female	23	iOS
Participant 3	Female	31	iOS
Participant 4	Female	27	iOS
Participant 5	Male	28	iOS
Participant 6	Male	26	Android
Participant 7	Male	27	iOS
Participant 8	Female	24	Android
Participant 9	Male	24	Android
Participant 10	Male	25	Android
Participant 11	Male	53	Android

Table 1: Description of the Sample

Regarding the most important features of the exercise application, almost all of the participants (10 participants) named basic functions as the most important ones. These included, for example, measuring distance or time and calculating speed. Additionally, the map view, routes, and calorie calculation were highlighted. The most interesting feature was the ability to compare one's own exercise sessions between each other.

The tracking of one's own exercises was held as a motivating factor regarding physical activity by almost all of the participants (10). Many (7) of them reported that being able to follow personal development affected the exercise motivation positively. Also, being able to compare information from different exercises was perceived to affect the exercise motivation positively. The participants were also asked whether they could name some features that were missing from the application but would have probably improved their exercise motivation. The most noteworthy features named were a possibility to compare the exercises to some more significant personally set goal, the visualization of not only exercise data but also one's physical development, a more automatic summary of various sports activities (e.g., automatically generated reports), and clear conclusions and instructions instead of just data and numbers. Regarding additional devices that would have supported the use of the mobile exercise application, the participants' views varied. The majority (7) reported that a heart rate belt connected to a mobile application could have improved their motivation to exercise through providing more detailed and comparable information between different exercises and different kinds of exercise methods. While the rest (4) reported that an additional device would probably not have affected their exercise motivation.

The majority of the participants (8) perceived that the use of the exercise application had affected their actual exercise behaviour in a positive way. With the help of the application, they had, for example, experienced additional boost (i.e., support and encouragement) to their exercise. The application had also improved their awareness of own exercise and its effects, which affected the future behaviours. The application was also perceived as a kind of a supervisor operating in the background of one's exercise, which led the person to aim to improve his or her exercising. For some of the participants (3), the application had also created an aim to improve their previous performance results (records), as it was possible to measure and compare them with the application. If the application showed that some specific aspects of the performance were better than on the previous exercises, it caused positive feelings.

However, not all of the participants perceived the changes in their behaviour solely positive. In some cases (3), the effects of the exercise application on one's behaviour were perceived more or less negative or restricting. This was apparent especially during the first usage sessions when one was not yet accustomed to use of the application and it thus caused additional effort, inconvenience, and time loss. These negative experiences were, however, reduced by growth of usage experience. Also, experienced problems and difficulties related to the use of the exercise application formed some negative attitude towards them. Especially the problems caused by software errors were perceived very negatively and caused frustration. These situations were perceived as especially frustrating after an exercise session where the user had experienced positive feelings and would have liked to compare the data of the exercise with previous exercise data.

Regarding the sharing of exercise data, almost all of the participants (9) felt negatively about sharing it in social media. Also the exercises shared by other persons in social media did not cause thrills. However, the sharing of exercise data to others within the web-service connected to the exercise application was perceived more positively, and the service was also considered as a possible platform for sharing thoughts and ideas about exercising. About half (6) also mentioned that seeing other people's exercise data causes sort of a peer pressure to increase their own physical activity.

The meaning of the term gamification was already well known among the participants, but to make sure all had equal understanding, the basic concept was explained to them during the interviews (after first asking about it). This was done to minimize the variability in the results caused by the possible variability of the interpretation of gamification. The majority of the participants (8) were able to name some features of the exercise application they believed had been gamified by the developer. However, the views on which features were believed to be gamified varied between the participants. These included, for example, different ways of visualization, replaying the exercise as a video, possibility to share exercises, and the general possibility to save and compare exercises. The participants were also asked, whether the usage of the application had generated gameful experiences to them. Most (8) of the participants reported to have experienced gamefulness when using the application. These gameful experiences varied between participants and were related to such aspects as the comparison of own exercise data, self-competition, visualizations of exercise data and/or progress, and comparing own routes. In other words, participants' experiences of gamification were diverse – emerging from different elements or features. Interestingly, the *experience of gamification* also emerged from such features and elements that were most probably not gamified by the developer. The varied views between participants on which features were believed to be gamified and which features had generated gameful experiences, supports our division of gamification between the *process of gamification* and the *experience of gamification*.

The majority of the participants (7) perceived that an *experience of gamification* in using the application had affected their personal exercise motivation positively. This was apparent at least on short-term, but as the use period was only two to three weeks, the effects for a longer-term were difficult to be estimated. One subject was unsure about the effects, while three stated that gamification could not improve their exercise motivation as they already had a strong internal motivation towards conducting the exercise itself and getting the pleasure out of it. However, we also found that individual differences occur regarding how gamification can influence the exercise motivation, depending on the user's individual characteristics such as exercise habits, competitiveness, and attitudes towards sports technology.

5 Conclusions

The purpose of this study was to explore how the use of an exercise application affects users' exercise motivation and behaviour by concentrating especially on the role of gamification in terms of these effects. For example, does gamification actually have a positive or a negative effect on exercise motivation and behaviour and how do its effects relate to those of other motivational and behavioural antecedents. The research was carried out using qualitative research methods and the qualitative data was based on real experiences of using the Suunto Movescount application. The results of this research could be used for improving public health, as gamification was found potential in increasing exercise motivation, and exercise is known to be a significant factor of health (e.g., Lee et al., 2012; Warburton et al., 2006).

We also proposed that when discussing gamification, there should be a divide between the *process of gamification* and the *experience of gamification*. We defined the *process of gamification* as *'using a set of activities with the aim to implement game elements to non-game context'* and the *experience of gamification* as *'a use experience in non-game context that the user perceives as gameful'*. Our results, more specifically the varied views between participants on which features were believed to be gamified and which features had generated gameful experiences, supports our division of gamification between the *process of gamification* and the *experience of gamification*. To our knowledge, this kind of division has not been previously proposed. Yet, our results confirm its necessity. This can be seen as a significant theoretical contribution and as an important implication for future research.

Regarding the use of an exercise application, we found that using an exercise application can affect the exercise motivation and behaviour. This finding is in line with those of e.g., Ahtinen et al. (2008) and Bravata et al. (2007). Our findings complement previous studies by presenting sources from which this effect stems. The use of an exercise application can increase the exercise motivation of the user as the use increases the awareness of one's own exercise behaviour and its effects and enables the following of one's physical development. Following one's own exercises with the application was mainly perceived as motivating. Also, noticing one's physical development affected the exercise motivation positively and the exercise application helped to more easily observe such development. Some of the users, however, reacted negatively to the problems and restrictions imposed by the exercise application. Also software errors during the use caused negative reactions towards the exercise application.

Prior research suggests that gamification could affect exercise motivation positively. The results of this study support this. In most cases, the *experience of gamification* in using the exercise application affected the user's exercise motivation positively. A new finding from our results is that different people experience gamification in different ways and that personal characteristics such as exercise habits, competitiveness, and attitudes towards sports technology affect how gamification impacts the exercise motivation. Our results also highlight the role of *experience of gamification* in this. Figure 1 summarises the results of the perceived factors affecting exercise motivation.

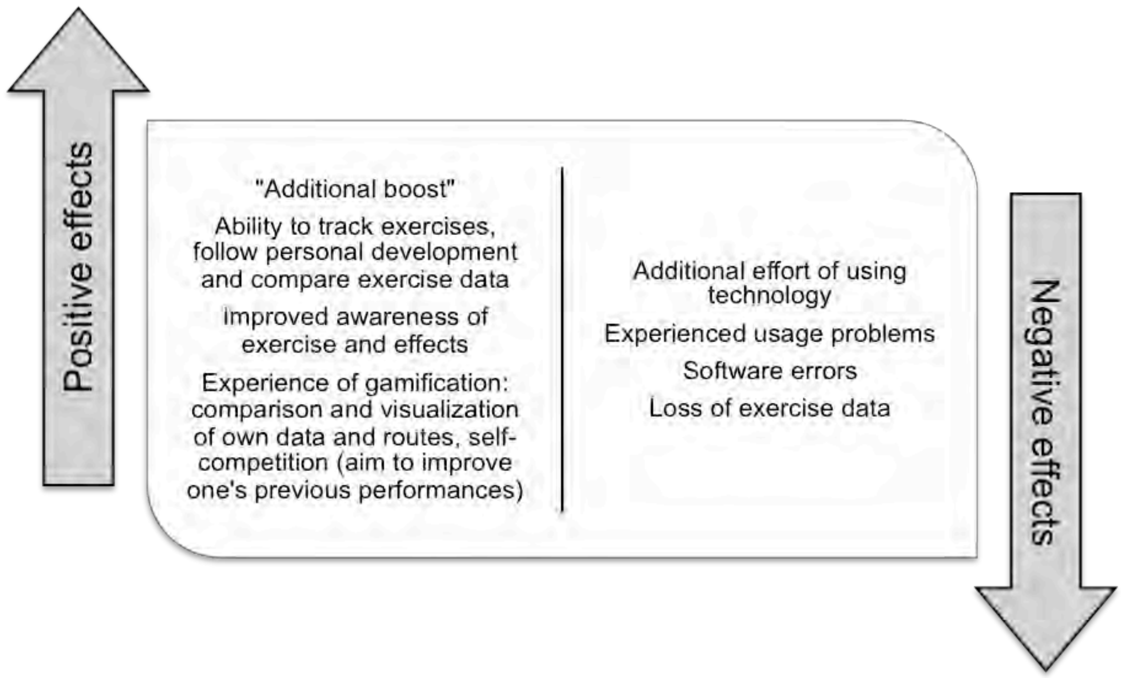


FIGURE 1: The perceived positive and negative effects on exercise motivation and behaviour from using the exercise application.

The concept of gamification was well known among the participants. The majority of the participants could name some features of the exercise application they believed had been gamified i.e., had gone through the *process of gamification*. However, as the views on which features were believed to be gamified varied between the participants, it is not unambiguous whether the developer had really gamified these features. This implies that the *experience of gamification* is more important than the *process of gamification* in affecting the user's motivation and behaviour. This is an important new finding.

It can be concluded that the *experience of gamification* can affect a user's exercise motivation positively, and it would be valuable for the developers of exercise applications to undertake the *process of gamification* to foster these experiences. Thus, the main practical implication of the study is that exercise applications should have gamified features and the developers should undertake the *process of gamification*. Further, for the *process of gamification* to be successful, it requires the understanding of the users regarding the *experience of gamification* and the developers should aim to achieve this. In other words, understanding the *experience of gamification* should work as a foundation for the *process of gamification* in designing technological products and services with gamified features.

6 Limitations and Future Research

There are few main limitations to the study. First, studies regarding health and exercise behaviour have been known to have the challenge that informants may intentionally bias their responses by reporting their behaviours as more positively than in reality. However, it was emphasized to the participants that the amount of exercise itself is not relevant regarding this study but rather the experiences generated from using the exercise application. The aim was to minimize the possibility that the participants would consciously change their exercise behaviour as a result of participating in the study. Second, the exercise application selected for this study did not posses many explicitly added game elements. Thus, another more gamified application might have provided more information on the effects of adding spesific game elements to an exercise application. However, as the main aim of the research regarding gamification was to investigate the *experience of gamification* and its effects to exercise motivation – not to the use of the exercise application, the selected application suited the study very well. Third, although the interviews produced a valuable amount of information, the number of participants could have been higher. Also, it is to be noted that one of the interviewees is significantly older than the other ten. The research, however, offers a good overview of the subject and provides some highly valuable insights. The fourth limitation concern the relatively short usage period of two to three weeks, which prevents us from making any long-term interpretations.

The study also raises some potential future research topics. First, quantitatively measuring users' physical activity before and after the use of the application could produce a deeper view on, for example, the effects of the use on the amount of physical activity. This could be done by using established questionnaires to measure physical activity. Second, as the exercise data is typically collected automatically on the application, it could be interesting to include that in the analysis. Third, it would be interesting to investigate the long-term effects of using exercise applications with varying degree of gamified features. Fourth, similar research could be repeated with the focus on some specific type of physical activity or with some other application.

References

Ahtinen, A., Isomursu, M., Huhtala, Y., Kaasinen, J., Salminen, J., & Häkkilä, J. (2008). Tracking outdoor sports–user experience perspective. In E. H. L. Aarts, J. L. Crowley, H. Gerhäuser, A. Pflaum, J. Schmidt, & R. Wichert (Eds.) *Ambient intelligence* (pp. 192–209). Springer-Verlag: Berlin Heidelberg.

Ahtinen, A., Isomursu, M., Mukhtar, M., Mäntyjärvi, J., Häkkilä, J., & Blom, J. (2009). Designing social features for mobile and ubiquitous wellness applications. In The 8th International Conference on Mobile and Ubiquitous Multimedia, 22.–25.11.2009 (pp. 1–10). Cambridge: ACM.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77–101. doi:10.1191/1478088706qp063oa.

Bravata, D. M., Smith-Spangler, C., Sundaram, V., Gienger, A. L., Lin, N., Lewis, R., ... & Sirard, J. R. (2007). Using pedometers to increase physical activity and improve health: a systematic review. *The Journal of the American Medical Association, 298*(19), 2296–2304. doi:10.1001/jama.298.19.2296.

Cameron, J., & Pierce, W. D. (2002). *Rewards and intrinsic motivation: resolving the controversy*. Westport: Greenwood Publishing Group.

Deci, E. L., Koestner, R., & Ryan, R. M. (1999). A meta-analytic review of experiments examining the effects of extrinsic rewards on intrinsic motivation. *Psychological Bulletin*, *125*(6), 627–668. doi:10.1037/0033-2909.125.6.627.

Deci, E., & Ryan, R. (1985). *Intrinsic motivation and self-determination in human behavior*. New York: Plenum.

Deterding, S., Björk, S. L., Nacke, L. E., Dixon, D., & Lawley, E. (2013). Designing gamification: creating gameful and playful experiences. In CHI'13 Human Factors in Computing Systems, 27.4.–2.5.2013 (pp. 3263–3266). Paris: ACM.

Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011). From game design elements to gamefulness: defining gamification. In The 15th International Academic MindTrek Conference: Envisioning Future Media Environments, 28.–30.9.2011 (pp. 9–15). Tampere: ACM.

Fitz-Walter, Z., Tjondronegoro, D., & Wyeth, P. (2012). A gamified mobile application for engaging new students at university orientation. In Proceedings of the 24th Australian Computer-Human Interaction Conference, 26.–30.11.2012 (pp. 138–141). Melbourne: ACM.

Giannakis, K., Chorianopoulos, K., & Jaccheri, L. (2013). User requirements for gamifying sports software. In The 3rd International Workshop on Games and Software Engineering: Engineering Computer Games to Enable Positive, Progressive Change, 18.5.2013 (pp. 22–26). San Francisco: IEEE Press.

Guest, G., Bunce, A., & Johnson, L. (2006). How many interviews are enough? an experiment with data saturation and variability. *Field Methods, 18*(1), 59–82. doi:10.1177/1525822X05279903.

Guest, G., MacQueen, K. M., & Namey, E. E. (2012). *Applied thematic analysis*. Los Angeles: SAGE.

Hamari, J., Koivisto, J., & Pakkanen, T. (2014a). Do persuasive technologies persuade? a review of empirical studies. In A. Spagnolli, L. Chittaro, & L. Gamberini (Eds.) *Persuasive technology 2014* (pp. 118–136). Cham: Springer International Publishing.

Hamari, J., Koivisto, J., & Sarsa, H. (2014b). Does gamification work? a literature review of empirical studies on gamification. In 47th Hawaii International Conference on System Sciences (HICSS) 2014, 6.–9.1.2014 (pp. 3025–3034). Waikoloa: IEEE.

Huotari, K., & Hamari, J. (2012). Defining gamification: a service marketing perspective. In The 16th International Academic MindTrek Conference, 3.–5.10.2012 (pp. 17–22). Tampere: ACM.

Kari, T. (2014). Can exergaming promote physical fitness and physical activity?: a systematic review of systematic reviews. *International Journal of Gaming and Computer-Mediated Simulations (IJGCMS)*, *6*(4), 59–77. doi:10.4018/ijgcms.2014100105.

Kari, T., & Makkonen, M. (2014). Explaining the usage intentions of exergames. In The 35th International Conference on Information Systems (ICIS) 2014, 14.–17.12.2014 (pp. 1–18). Auckland: AIS.

Knaving, K., & Björk, S. (2013). Designing for fun and play: exploring possibilities in design for gamification. In The First International Conference on Gameful Design, Research, and Applications, 2.–4.10.2013 (pp. 131–134). Waterloo: ACM.

Law, F., Kasirun, Z., & Gan, C. (2011). Gamification towards sustainable mobile application. In 5th Malaysian Conference in Software Engineering (MySEC) 2011, 13.–14.12.2011 (pp. 349–353). Johor Bahru: IEEE.

Lee, I. M., Shiroma, E. J., Lobelo, F., Puska, P., Blair, S. N., Katzmarzyk, P. T., & Lancet Physical Activity Series Working Group. (2012). Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy. *The Lancet*, *380*(9838), 219–229. doi:10.1016/S0140-6736(12)61031-9.

Liebermann, D., Katz, L., Hughes, M., Bartlett, R., McClements, J., & Franks, I. (2002). Advances in the application of information technology to sport performance. *Journal of Sports Sciences, 20*(10), 755–769. doi:10.1080/026404102320675611.

Makkonen, M., Frank, L., Kari, T., & Moilanen, P. (2012a). Examining the usage intentions of exercise monitoring devices: the usage of pedometers and route trackers in Finland. In The 25th BLED eConference, 17.–20.6.2012 *(*pp. 439–453). Bled: Moderna organizacija.

Makkonen, M., Frank, L., Kari, T., & Moilanen, P. (2012b). Explaining the usage intentions of exercise monitoring devices: the usage of heart rate monitors in Finland. In The 18th Americas Conference on Information Systems (AMCIS) 2012, 9.–11.8.2012 (pp. 1–10). Seattle: AIS.

Mitchell, B. (2012). *Game design essentials*. Indianapolis: John Wiley & Sons.

Moilanen, P., Salo, M., & Frank, L. (2014). Inhibitors, enablers and social side winds. Explaining the use of exercise tracking systems. In The 27th BLED eConference, 1.–5.6.2014 (pp. 23–37). Bled: Moderna organizacija.

Movescount. (2015). Suunto - Movescount. Retrieved 30.4.2015, from: http://www.movescount.com.

Myers, M. D. (1997). Qualitative research in information systems. *MIS Quarterly*, *21*(2), 241–242. *MISQ Discovery*, archival version, June 1997, http://www.misq.org/supplements/. *Association for Information Systems (AISWorld) Section on Qualitative Research in Information Systems*, updated version, last modified: September 8, 2014.

Myers, M. D. (2013). *Qualitative research in business and management* (2nd edition). Los Angeles: SAGE.

Myers, M. D., & Newman, M. (2007). The qualitative interview in IS research: examining the craft. *Information and Organization, 17*(1), 2–26. doi:10.1016/j.infoandorg.2006.11.001.

Patton, M. Q. (2002). *Qualitative research & evaluation methods* (3rd edition). Thousand Oaks: SAGE.

Ryan, R. M., & Deci, E. L. (2000a). Intrinsic and extrinsic motivations: classic definitions and new directions. *Contemporary Educational Psychology*, *25*(1), 54–67. doi:10.1006/ceps.1999.1020.

Ryan, R. M., & Deci, E. L. (2000b). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist*, *55*(1), 68-78. doi:10.1037/0003-066X.55.1.68.

Warburton, D. E., Nicol, C. W., & Bredin, S. S. (2006). Health benefits of physical activity: the evidence. *Canadian Medical Association Journal*, *174*(6), 801–809. doi:10.1503/cmaj.051351.

Ziesemer, A., Müller, L., & Silveira, M. (2013). Gamification aware: users perception about game elements on non-game context. In The 12th Brazilian Symposium on Human Factors in Computing Systems, 8.–11.10.2013 (pp. 276–279). Manaus: Brazilian Computer Society.

Zuckerman, O., & Gal-Oz, A. (2014). Deconstructing gamification: evaluating the effectiveness of continuous measurement, virtual rewards, and social comparison for promoting physical activity. *Personal and Ubiquitous Computing, 18*(7), 1705–1719. doi:10.1007/s00779-014-0783-2.

Appendix A. Structure of the Interview and Examples of the Questions

<table>
<tr><td colspan="6">1. Describing the research, the use of data, and progress of the interview</td></tr>
<tr><td colspan="6">2. Background</td></tr>
<tr><td colspan="3">2.1 Demographics</td><td colspan="3">2.2 Used operating system</td></tr>
<tr><td colspan="6">3.Physical activity background and previous experience of sports technology</td></tr>
<tr><td colspan="2">3.1 Amount and ways of exercising (amounts and sports)</td><td colspan="2">3.2 Prior use of sports technology (used technologies, reasons, goals)</td><td colspan="2">3.3 General perceptions on sports technology (the interesting aspects, appeal, motivational effect)</td></tr>
<tr><td colspan="6">4. Examined exercise application (Suunto Movescount) and its use</td></tr>
<tr><td colspan="6">4.1 Implementation and use (fluency of implementation and use experiences)
e.g., “Describe your use of the application as accurately as possible?”
“How did you experience different aspects of the use?”</td></tr>
<tr><td colspan="6">4.2 Effectiveness (perceptions of the application’s effect on behaviour)
e.g., “Did the use of the application affect your actual exercise behaviour and how?”
“Which features of the application did you perceive as most motivating?”</td></tr>
<tr><td colspan="6">4.3 Gamified features (perceptions of gamification in general and experiences of gamification in the application)
e.g., “How do you understand the concept of gamification?”
“Did you recognize gamified features in the app or experience gamification?”
“Did the experience of gamification affect you exercise motivation and how?”</td></tr>
<tr><td colspan="6">4.4 Social features (perceptions of using the social features in the application)
e.g., “Are you interested in sharing your own personal performances to others?”
“How do you feel about the exercise data shared by other people?”</td></tr>
<tr><td colspan="6">4.5 Use experience (use experiences; features that were valued or missed)
e.g., “Which features of the application were the most important ones to you?”
“Can you name some potentially influential features that were missing?”</td></tr>
<tr><td colspan="6">5. Closing</td></tr>
</table>

Detailed descriptions of the key questions are available from the authors by request.

29th Bled eConference

Digital Economy

June 19 - 22, 2016; Bled, Slovenia

INTERVENTIONS TO FORM WELLNESS ROUTINES AMONG YOUNG ELDERLY

Christer Carlsson

IAMSR/Abo Akademi University, Finland

christer.carlsson@abo.fi

Joanna P. Carlsson

IAMSR/Abo Akademi University, Finland

Abstract

The ageing population of Europe is a concern for political decision makers as the ageing population by 2020 will represent very large groups of people (18-23% of the population in most EU countries). The issues raised concern elderly people, the age group 75-90 years, as their need for health and social care is expected to grow beyond what national economies can afford. Not much thought is given the "young elderly"- the age group 60-75 years – as the serious age-related problems are yet not visible among them and, hence, they are not on the political radar. Nevertheless, interventions to form and sustain wellness routines among the "young elderly" as part of preventive action programs could significantly reduce the problems society faces when people become elderly. We propose that digital wellness services on smartphones can serve as interventions to form and sustain wellness routines.

Keywords*: digital wellness services, wellness, "young elderly", ageing population.* Introduction

1 Background and Introduction

The "ageing population of EU" is a broad and ill-defined segment of the population. The issues appear to be deteriorating health conditions of the 75+ aged citizens and questions of how a modern society should cope with them. The approach of a modern society is that the issues should be dealt with through tax-funded programs. As the proportion of ageing citizens is growing in most EU countries – relatively seen fastest in Germany, Finland and Italy – there is growing political pressure to find trade-offs between the costs of the care programs and the substance (read: quality) of the programs as it appears that the tax-paying part of the population simply cannot afford the programs from the year 2030 onwards (cf. [1]).

Thus we need to find another way. We should focus on pro-active prevention, i.e. to find measures that will reduce the growth of 75+ citizens that will need the health and social care support of the society; there is an age group we now call the young elderly – the age group 60-75 years – for which we should develop programs that now will keep them healthy, active and independent and also when they reach the 75+ age group; to be more precise, we should find ways to reduce or eliminate functional impairment with increasing age. The young elderly represent 18-23 % of the population in most EU countries (cf. [1]); this is a large segment of the population that according to recent statistical estimates will be about 97 million EU citizens by 2020. Thus the challenge is huge and will have even much larger consequences for national economies if we do not start to take care of the young elderly.

Functional impairment covers cognitive, physical, social and emotional impairment. Our work with young elderly groups (cf. [2]) has shown that functional impairments are (i) multi-dimensional, (ii) compensatory and (iii) non-static, i.e. (i) they can be described with multiple attributes, (ii) increasing impairment in one function can be compensated with improvement in some other function, and (iii) impairments change over time. In order to reduce functional impairment among the elderly we need to aim at a moving target.

We use wellness as the target concept for developing programs to tackle functional impairment as wellness will tackle all four aspects of functional impairment. The WHO defines wellness as "the complete mental, physical as well as social well-being of a person or groups of persons in achieving the best satisfying or fulfilling life and not merely the absence of disease or any form of infirmity (cf. [3]). There has been lively debate over the years about the dimensions of wellness, one of the most complete lists includes: (i) emotional, (ii) financial, (iii) occupational, (iv) environmental, (v) intellectual, (vi) physical, (vii) social and (viii) spiritual wellness (cf. [4]). Els and de la Rey (cf. [4]) show the need for holistic wellness models and have tested this approach with a large empirical study. The choice of wellness instead of health has the benefit that we are not dependent on access to health data that is strictly regulated in most EU countries with confidentiality and privacy limitations.

Pro-active prevention is done through interventions in daily routines of the young elderly that will introduce subsets of wellness routines. We propose that the interventions could be digital wellness services that are implemented with applications for mobile smartphones with effective back-end support from cloud services, that allow (i) simultaneous support of hundreds of thousands of users, (ii) analysis of wellness data produced by smartphones, sensor systems and digital add-on devices, and (iii) data and information fusion combined with knowledge mobilisation to offer the users statistics on their individual wellness programs, summaries on their progress relative to individual goals, suggestions for alternative activities, proposed development of the program and reports that can be transferred to health care and social care systems.

The interventions could work out in the following way: (i) the young elderly develop individual daily wellness routines supported by wellness services on an omnivore platform over mobile smartphones; (ii) the wellness routines are tailored by/for the users from selections of smartphone applications; (iii) cloud services support the wellness routines and collect and analyse user data for further and continuous development of wellness services.

There will be some positive, practical and immediate effects of the intervention program that can be monitored and measured, and some more long-term, assessable impacts. In common sense terms it is clear that if hundreds of thousands of young elderly citizens will have better health for 10 years or more, then the effects on the health and social care costs will produce savings on the scale of billions of euro annually (in Finland the estimate is around 1.0-1.2 B€ annually, cf. [2]).

There are of course challenges; the first challenge is that common wisdom has it that young elderly do not have smartphones. Statistics now show that smartphones are becoming general purpose instruments and will be even more so by the year 2020 (the mobile connection subscriptions are more than 100% of the population in most EU countries; the proportion of smart phones is closing on 70% in several EU countries). Among the young elderly the proportion was close to 70 % in Finland (in 2015) and it is reasonable to assume that this proportion will grow as most mobile phones sold in 2015 were smartphones.

A second challenge is the doubt that digital wellness services will be at all attractive to the young elderly; this follows on a belief we have found in the market for mobile value services (cf. [5], [6]) that (i) elderly people will not learn how to use services on mobile phones, (ii) there is no real use for mobile services in their daily routines, (iii) advanced technology should be developed for young people – and (iv) if elderly people use the services it will create the wrong brand image for the service developers. We have now been running a research and development program for digital wellness services 2014-15 over an omnivore platform on mobile smartphones with a back-end cloud service; the program has support from two associations for elderly with more than 100 000 members; our findings show that the mobile service market beliefs are misconceptions.

A third challenge is to work out research methodologies that will allow us to get (i) empirically verifiable results on the intervention with digital wellness services, (ii) valid, theory-based results on how the design of digital wellness services will match the multiple wellness criteria, and (iii) empirical verification on how digital wellness services will help reduce functional impairment.

Modern positivism was developed by Auguste Comte in the early 19th century; his key point was that all authentic knowledge allows verification and that all authentic knowledge assumes that the only valid knowledge is scientific. Verification should be carried out through empirical evidence. This is in line with our third challenge. Contemporary social science has largely abandoned positivism (cf. [7]) because of problems with observer bias, structural limitations of studies of important problems and the representativeness of data collected for verification.

Action research has been one of the key directions of service design for a couple of decades and would in our present case tackle problems with the development and implementation of digital artefacts. The development work is often described as co-creative – "to find solutions that work and to not care too much about scientific precision" – but the validation and verification remain subjective, i.e. we cannot be sure that the resulting constructs will work in other contexts and for other purposes.

Design science is another possibility; this is fundamentally a problem solving paradigm with roots in engineering and science and is working out designs in order to find ways to tackle real-world problems. Design science research is described as a paradigm in which a designer answers questions relevant to human problems via the creation of innovation artefacts that will contribute new knowledge (cf. [8]). The designs build on an understanding of what is needed to deal with the problems; the design is both a process (a set of activities) and a product (called an artefact) and both can be validated and verified to be logically consistent and technically free of errors. In our present context design science has a strong appeal. Digital services are software constructs (artefacts) that we can design and work through jointly with the coming users in co-creative processes; the usability of the artefacts can be tested and the functionality of the services can be worked out in the context and with the users. Most of the designs can be generalised in a positiv-istic sense and the insight can be reused for other contexts and the development and implementation of other artefacts.

Action design research (ADR) (cf. [9) found that design science is too technologically oriented and is not paying enough attention to the organisational or user context of the artefacts. The ADR works with digital artefacts that are ensembles shaped by the user context both when designed and developed and when used. The ADR deals with the dynamics and the complexity of the context – in our case the interventions to create wellness routines - that are problems for engineering-inspired methods. It appears that ADR is a promising methodological framework for the design and implementation of digital wellness services (and we are using this approach in our research program); this framework is now being developed as a performative research method-ology for information systems research.

The digital transition of business has created a number of surprises for the business world. Helmut Krcmar in his keynote to the 24th ISD Conference in Harbin (August 2015) noted the following features of the digital transition: (i) inevitable, (ii) irreversible, (iii) tremendously fast, and (iv) uncertain in execution. Digital wellness services for the young elderly – for which we aim to get 100 000 users in the first phase – is digital business. The fourth challenge is the realisation that we cannot just create digital services and everything will then take care of itself. This shows that we need to support the building of an infrastructure (of typically small and medium size companies) for design, development, implementation, commercialisation and maintenance; the approach that we have applied is to build an ecosystem of service and infrastructure developers and providers and to support them with theory and methodology for agile business Scrum processes (cf. [6]).

2 Young Elderly on Mobile Apps and Wellness

We will start by addressing the first two challenges ("young elderly do not have smartphones" and "the doubt that digital wellness services will be at all attractive to the young elderly"). We cooperated with the association for elderly in Mariehamn (in the Åland Islands, that with 28 000 inhabitants is a representative snapshot of the Finnish society) and asked them to invite their young elderly to participate in a survey in the fall 2015. A letter was mailed (the association did not have emails registered for its members) to 380 members with an invitation to answer a questionnaire through a link to Webropol; we collected 101 usable answers (a 26.6 % answering rate) in September-December 2015 that offer some insight into the group; the survey is followed up this spring by in-depth, semi-structured interviews with 25 young elderly in order to get a better insight in their daily routines and to get better knowledge of what wellness routines would be useful for them.

Data analysis was performed by using the SPSS 23 software and a for small samples developed R program in order to calculate confidence intervals when necessary. The characteristics of the Åland sample were reported using descriptive statistics to illustrate frequencies, central tendencies and dispersion of the given variables. Table 1 summarises the computed mode values for seven categorical variables together with a calculated median value for a continuous variable.

	Age	Gender	Highest level of education	Marital status	Current work status	Annual income before tax	Level of experience using mobile apps
N	99	100	99	100	100	100	74
Median	69						
Mode		2 = Female	7 = University	2 = Married	6 = Retired	3 = 20001–30000	2 = Advanced
SD	4.65						

Table 1: Median and mode values for variables of *young elderly* characteristics

The proportion male/female is 44.6/54.5%; 83.1% of the respondents belong to the young elderly, and a further 14.9% are a bit older; 65.3% are married and 14.9% are widowed; 77.2% have a university or technical/commercial degree (university education is rather rare for this age group, which is why we later combined it with second level degrees), 20.8% have a basic education.

In the sample 75.2% are retired and 23.8% are working full- or part-time or are carrying out voluntary work; the most typical annual incomes before tax is < 30 k€ (51.5%), 30-40 k€ (19.9%), 40-50 k€ (9.9%) and >50 k€ (17.8%).

These profiles are typical for the Åland Islands and are representative for the group of young elderly. As we plan to run the digital wellness services over smart mobile phones we wanted to find out how frequent they are in the sample; the summary shows that Nokia/Lumia/Microsoft is the most used phone (46.5%), followed by iPhone (23.3%), Samsung (14.0%) and Other (12.8%); we collected data on the actual types of phones in use and found out that a majority (about 73%, but not all) use smart mobile phones; this was confirmed with the result that 72.9% use mobile apps for navigation, weather forecasting, Internet search, etc.

The respondents answered questions about how useful, easy to use and valuable mobile apps are for them following the UTAUT2 structure of questions (cf. [10]); for the about 70 respondents that use mobile apps we found the adoption of mobile apps scored high on a 5-grade Likert scale on several items:

- mobile apps are useful in my daily life [4.32];
- I will continue to use mobile apps [4.19];
- mobile apps help me to carry out my tasks faster [4.08];
- using mobile apps helps me to carry out important tasks [3.94];
- I can use mobile apps without assistance [3.91];
- I have the necessary knowledge to use mobile apps [3.87];
- Iit is easy for me to learn to use mobile apps [3.79];
- I can use the mobile apps I need with the phone I have [3.75].

The results need to be tested with a larger sample (a study of a sample of 1800 participants is planned as the next step) but the indications are: (i) the young elderly use of smart mobile phones is sufficient to launch digital wellness services; (ii) the young elderly are confident users of mobile apps, which is a prerequisite for getting the wellness services adopted. On the other hand, the proposal

- I am addicted to the use of mobile apps [2.72].

shows that the young elderly are critical of how they spend their time with mobile apps. This meets the first challenge ("young elderly do not have smartphones") and as mobile apps are digital services we can also claim that the second challenge has been met (for the sample in the Åland Islands, which at least to some degree is representative for corresponding communities in mainland Finland). The results will be verified with a larger sample but so far we can stick to the vision that digital wellness services could be developed and offered on smartphones as they will be adopted by the young elderly.

All the 101 respondents answered questions relating to intellectual and physical wellness on a 6-grade forced scale and a number of proposals scored high:

- intellectual challenges are important for my wellbeing [4.91];
- I get sufficient intellectual stimulation from my everyday life [4.61];
- my physical health has been good compared to people around me [4.38];
- my resistance to illness is good [4.24];
- the amount of information I have to process in my daily life is suitable for me (not too much, not too little) [4.20];

- I expect my physical health to remain good [4.14];
- I expect my physical health to deteriorate with increasing age [3.94].

We wanted to find out if there are any relations in our sample between the characteristics of young elderly, their attitudes toward the use of mobile applications and their perceptions about their wellness. This should give us some idea about what potential users to look for when introducing digital wellness services. This turned out to require some work with statistical tools.

First we constructed eight sum variables to link the characteristics of young elderly, their attitudes toward the use of mobile applications and their perceptions about their wellness. Six of these instruments were obtained by running a factor analysis (Principal Component Analysis (PCA), Varimax rotation) first with 19 statements on mobile applications and then with 11 statements on wellness. The results gave an indication for possible sum variables, which were then constructed by combining a set of high-score statements and dividing the computed sum by the number of these used items. The acquired sum variables were:

- *Mobile_apps_positive,*
- *Mobile_apps_experienced,*
- *Mobile_apps_social,*
- *Mobile_apps_value,*
- *Physical_wellness_positive and*
- *Intellectual_wellness_positive.*

Furthermore, two additional sum variables were created by using seven, selected statements on mobile applications

- *Resulting Mobile_app_users*

and correspondingly, six wellness-related statements,

- *Wellness_positive.*

The constructed sum variables had the same scale as the individual items, thus the range of the sum variables was identical to the original statements.

By calculating the Cronbach's alpha coefficients the reliability of the created sum variables could be established. As shown in tables 2 and 3, all the obtained coefficients were over 0.7. Additionally, the corrected item-total correlation scores were - with one exception (I expect my physical health to deteriorate with increasing age [Wellness], 0.202) - above 0.3. We tested if we can get more cohesive sum variables, and thus a higher Cronbach's alpha, if we remove some statements; in this way a total of five statements were removed (tables 2 and 3) prior to constructing sum variables. Therefore, we can state that all (selected) items within the composed sum variable were measuring the same chosen value consistently.

Although the eight sum variables were found to be reliable ($\alpha > 0.7$), a test for normality showed that all instruments are negatively skewed. As the sample size was relatively small ($N = 101$), the recommended transformations for negatively skewed data did not produce desired outcomes and as there were several missing values for the statements on mobile applications (N = 67–75) the use of non-parametric tests were considered to be justified.

In the next stage all categorical variables reflecting young elderly characteristics were first recoded to comprise only two categories and then studied against the created eight instruments. The distributions for these dichotomous variables were not all similar in shape. For the purpose of analysis the variable age was made a two-category variable. A non-parametric Mann-Whitney U-test was run in order to explore possible differences between gender, age (–69 years; 70–), highest level of education (–higher vocational school; technical/commercial degreee + university), marital status (single; in a relationship), current work status (working (full, to some extent, volunteer); retired), annual income (–30000 €; 30001–) and the level of experience of using mobile applications (routine; advanced).

The Mann-Whitney U-test indicated that there were differences in the sum variable the mobile_ apps_ positive scores between age groups –69 years and 70+. The distributions of the mobile_ apps_ positive for –69 years and 70+ were not similar, as assessed by visual inspection. The mobile_ apps_ positive scores for 69-year olds and younger (mean rank = 39.27) and 70+ (mean rank = 23.22) were significantly different statistically (U = 249.0, z = -3.416, p = 0.001).

In the same way all the sum variables were worked out with the two-category variables; space does not allow that all of them are reported.

<u>Table 2:</u> Reliability analysis for two additional sum variables, obtained Cronbach's alpha (all items included, *-marked item removed; used value underlined) and corrected Item-Total Correlation.

<u>Table 3</u> summarises the obtained mean ranks and p-values; statistically significant p-values are presented in bolder typeface.

<u>Table 4:</u> Reliability analysis for six sum variables, obtained Cronbach's alpha (all items included; *-marked item removed; used value underlined) and corrected Item-total Correlation

There are some insight that can be built from the results in tables 2, 3 and 4. If we want the interventions with digital wellness services on smartphones to collect some first groups of supportive users we should start with young elderly who are,

- Active in full time/part time/volunteer work & advanced users of mobile apps & < 70 years
- Advanced users of mobile apps & more educated
- Males with good physical health & income > 30 k€ per year
- More educated & find mobile apps good value for the price

Table 2.

A set of using mobile application statements	Corrected Item-Total Correlation [>0.3 recomm.]
I think that mobile applications are useful in my everyday life [Q9_1]	0.803
I will continue to use mobile applications in the future [Q9_20]	0.694
Mobile applications will help me to accomplish tasks more quickly [Q9_5]	0.663
The use of mobile applications increases my ability to take care of things that are important to me [Q9_3]	0.794
I'm using mobile applications without the help of others [Q9_17]	0.725
I have the knowledge needed for using mobile applications [Q9_6]	0.691
It is easy for me to learn to use mobile applications [Q9_8]	0.773
I can use mobile applications that I want with my current phone [Q9_9] NOT included*	0.584
SUM variable VII: Mobile_app_users Cronbach's alpha	**0.832** | **0.858** when *item deleted
A set of well-being statements	Corrected Item-Total Correlation [>0.3 recomm.]
Intellectual challenges are important for my well-being [Q10_10]	0.504
I get sufficient amounts of intellectual challenges in my everyday life [Q10_3]	0.656
Compared to people around me my physical health has been good [Q10_2]	0.690
My resistance to physical illness is good [Q10_4]	0.700
The amount of information that I have to process during a normal day suits me very well (not too much, not too little) [Q10_7]	0.611
I can get help if I have any problems when using mobile applications [Q9_11]	0.531
I expect my physical health to deteriorate with increasing age [Q10_6] NOT included*	0.202
SUM variable VIII: Wellness_positive Cronbach's alpha	**0.832** | **0.858** when *item deleted

Table 3.

Mann-Whitney U-test, □ = 0.05	Age		Gender		Highest level of education		Marital status		Current work status		Annual income before tax €		Level of experience using mobile apps	
SUM VARIABLES	–69 yrs	70– yrs	male	female	– institute	higher vocational school –	single	in a relation-ship	in working life a/o volunteer	retired	-30000	30001–	routine	advanced
Mobile_apps_positive Mean rank	39.27	23.22	31.43	33.72	27.38	38.00	32.60	32.45	43.97	28.01	31.15	32.77	23.00	34.21
Asymp. Sig (2-tailed)	0.001		0.622		0.068		0.977		0.002		0.725		0.036	
Mobile_apps_experienced Mean rank	35.10	32.37	34.71	33.31	27.87	38.14	34.57	33.74	39.13	31.22	29.20	37.80	20.75	36.42
Asymp. Sig (2-tailed)	0.572		0.767		0.034		0.871		0.128		0.067		0.003	
Mobile_apps_social Mean rank	34.69	31.67	30.79	36.38	31.35	34.90	35.36	32.57	32.58	33.17	35.00	32.00	27.84	33.41
Asymp. Sig (2-tailed)	0.531		0.236		0.461		0.575		0.908		0.524		0.292	
Mobile_apps_value Mean rank	36.59	28.75	36.87	29.69	26.83	37.84	30.81	34.76	38.71	30.98	29.12	37.26	27.16	33.65
Asymp. Sig (2-tailed)	0.096		0.120		0.019		0.425		0.137		0.075		0.208	
Physical_wellness_positive Mean rank	48.88	45.79	57.27	40.00	44.48	50.16	48.41	47.78	54.16	45.47	40.84	54.45	40.13	33.45
Asymp. Sig (2-tailed)	0.580		0.002		0.309		0.915		0.186		0.015		0.237	
Intellectual_wellness_positive Mean rank	49.62	42.45	46.79	47.16	41.28	51.08	52.92	43.74	61.11	42.63	42.84	51.64	37.75	34.72
Asymp. Sig (2-tailed)	0.200		0.947		0.078		0.115		0.005		0.115		0.584	
Mobile_app_users Mean rank	38.01	26.29	32.25	31.74	26.38	35.46	31.63	32.17	38.69	28.56	29.58	33.30	16.50	34.93
Asymp. Sig (2-tailed)	0.037		0.912		0.055		0.912		0.044		0.416		0.001	
Wellness_positive Mean rank	48.23	42.09	50.09	42.65	42.30	48.30	46.66	45.64	51.93	43.54	41.22	50.17	39.84	32.88
Asymp. Sig (2-tailed)	0.268		0.180		0.275		0.861		0.197		0.104		0.215	
	N = 63 - 95		N = 63 - 95		N = 63 - 95		N = 63 - 95		N = 63 - 95		N = 63 - 95		N = 63 - 95	

Table 4.

Using mobile applications - statements		Corrected Item-Total Correlation [>0.3 recomm.]
I have the knowledge needed for using mobile applications [Q9_6]		0.727
It is easy for me to learn to use mobile applications [Q9_8]		0.819
I can use mobile applications that I want with my current phone [Q9_9] NOT included*		0.560
I think that mobile applications are user-friendly [Q9_10]		0.809
It is easy for me to become skilful in using mobile applications [Q9_12]		0.767
I'm using mobile applications without the help of others [Q9_17]		0.760
SUM variable I: Mobile_apps_positive	Cronbach's alpha	**0.904** | **0.913** when *item deleted
I think that mobile applications are useful in my everyday life [Q9_1]		0.814
People who are important to me think that I should use mobile applications [Q9_2] NOT included*		0.656
The use of mobile applications increases my ability to take care of things that are important to me [Q9_3]		0.836
Mobile applications will help me to accomplish tasks more quickly [Q9_5]		0.773
Using mobile applications increases my productivity [Q9_7]		0.709
Using mobile applications has become a routine for me [Q9_22]		0.829
I will continue to use mobile applications in the future [Q9_20]		0.754
SUM variable II: Mobile_apps_experienced	Cronbach's alpha	**0.925** | **0.926** when *item deleted
There are people who support me when I am using mobile applications [Q9_4]		0.461
I can get help if I have any problems when using mobile applications [Q9_11]		0.503
People whose opinions I value recommend me to use mobile applications [Q9_13]		0.584
Using mobile applications is very entertaining [Q9_19]		0.535
SUM variable III: Mobile_apps_social	Cronbach's alpha	**0.729**
Mobile applications that cost something are reasonably priced [Q9_18]		0.700
Mobile applications give good value for the price [Q9_21]		0.700
SUM variable IV: Mobile_apps_value	Cronbach's alpha	**0.820**
Compared to people around me my physical health has been good [Q10_2]		0.714
My resistance to physical illness is good [Q10_4]		0.774
I expect my physical health to remain good [Q10_11] NOT included*		0.593
SUM variable V: Physical_wellness_positive	Cronbach's alpha	**0.832** | **0.858** when *item deleted
I look for challenges that require thinking and reasoning [Q10_1]		0.585
The amount of information that I have to process during a normal day suits me very well (not too much, not too little) [Q10_7]		0.557
I get sufficient amounts of intellectual challenges in my everyday life [Q10_3]		0.619
Intellectual challenges are important for my well-being [Q10_10]		0.651
SUM variable VI: Intellectual_wellness_positive	Cronbach's alpha	**0.791**
I avoid tasks that require that I concentrate on them [Q10_5]		0.333
I expect my physical health to deteriorate with increasing age [Q10_6]		0.341
I have often found that my life lacks in intellectual challenges [Q10_8]		0.503
My physical health puts constraints on my everyday activities [Q10_9]		0.341
SUM variable NOT constructed	Cronbach's alpha	0.593

3 Design of Digital Wellness Services

As we now have identified potential user profiles for digital wellness services we will briefly address the third challenge ("to work out research methodologies for the design of digital wellness services"). In [11] Grönroos revisits service logic and works out service as a co-creation process between the service producer and consumer. This approach appears to be useful for the work with young elderly; we want to introduce wellness routines in their daily routines using digital wellness services as interventions. In work with young elderly groups we have found out (cf. [2]) that we cannot expect 60+ citizens to (i) change their routines without good reason, (ii) spend time on learning to use digital wellness services on smartphones without good reason, or (iii) adopt wellness services for sustained use without good reason. Digital services they have co-created and wellness routines they have formed themselves may lower the threshold for adopting wellness services for sustained use (which is the way to get health effects). Then we need a research methodology to support the study of the processes that we want to design and implement with the young elderly groups.

On a general level, IS research methodology should be developed to give us the instruments we need to study the development, implementation and acceptance of digital services in the 21st century environment, where the research process will be partially imbedded in and create the practices of the socio-technical world that is being studied. This is our understanding of per-formative IS research (cf. [12]).

Action design research (ADR) (cf. [9]) works with IT artefacts that are ensembles shaped by the organisational context both when designed and developed and also when used. The IS research process when guided by ADR allows the users to intervene in and concurrently evaluate the design and building of the artefact. This is, of course, an approach to deal with the dynamics and the complexity of the context that is a problem for engineering-inspired methods. ADR works towards generic solutions by constructing and evaluating artefacts that address classes of problems than can be typified and generalised from the context and the user experiences and feedbacks.

ADR builds on four stages and seven principles (cf. [9]):

1. Problem formulation: (i) practice-inspired research and (ii) theory-ingrained artefact
2. Building, intervention and evaluation: (iii) reciprocal shaping, (iv) mutually influential roles, (v) authentic and concurrent evaluation
3. Reflection and learning: (vi) guided emergence
4. Formalization of learning: (vii) generalized outcomes

ADR offers the flexibility and innovation processes of design science combined with the possibility to verify and validate the technical and logical correctness of artefacts through strict testing methods. Lessons learned from the design of mobile services and digital wellness services show (cf. [2], [5]) that the ADR may be too slow to capture the dynamics of the market for digital wellness services. Another lesson that we keep getting from the market is that business models should be part of any development of digital services; this has so far not been considered part of IS research methodology as the business models are considered part of the commercialisation on which researchers do not spend much or any time. It may be time to have a different opinion as IS research keeps missing some fundamental part of the process as prototypes are not being turned into actual use.

Agile Scrum should be worked out as part of stages 1-3 of the ADR. Scrum is part of modern agile software development but is being enhanced to guide project management and team work in projects. The Scrum is worked out in four steps (cf. [13]):

1. Visualisation of unique project reasons and core processes
2. Analysis of functionality needed to support core processes and system design
3. Realisation of the functionality; maintain communication between developers and stakeholders
4. Control if implementation fits the goal; evaluate the project process for logical consistency

At the moment we will have to gain experience from integrating the Scrum in ADR before we can start working out the benefits and problems of developing and implementing a performative IS methodology.

4 Summary and Conclusions

The young elderly 60-75 age group was first ignored by the developers of mobile technology and the designers of mobile services as "not interesting"[5] and then by the politicians worrying about the ageing population as they are "too active, and in too good shape" to request any budget-funded support from the society. Thus there are two cases of missed opportunities: (i) there is a potential market for digital (mobile) services that represents 18-23% of the population in most EU countries; the young elderly are estimated to be 97 million by 2020 in the EU countries (a market that should get some business attention); (ii) interventions that create sustainable wellness routines among the young elderly will reduce the probability for serious illness among the elderly (75+); this will reduce the need for budget-funded health and social care among the elderly. As the young elderly now represent the "baby boomer" generation they will represent large numbers when they become elderly which translates to significant costs for health and social care (3.8 billion € in Finland in 2014). We tested some fundamental assumptions on the use of mobile apps and the perceptions young elderly groups have on physical and intellectual wellness in order to find out if interventions to build wellness routines could be designed and implemented as applications on smart mobile phones. We found support for the visions on how this could be done. A research program – BeWell – is being run with groups of young elderly, supported by two large associations for elderly, to find and design proper digital wellness services.

References

1. United Nations Department of Economic and Social Affairs (2014), Population ageing and sustainable development, No. 2014/4; available at: http://www.un.org./en/deve-lopment/desa/population/publications/pdf/popfacts/-Popfacts_2014-4. Pdf; accessed on March 21, 2015.
2. Carlsson, C. and Walden, P. (2015), Digital Wellness Services for "Young Elderly" – A Missed Opportunity for Mobile Services , *Proceedings of the ICMB 2015*, Fort Worth

3. World Health Organization (2014), Preamble to the Constitution, www.who.int, retrieved March 28, 2015
4. Da, E. and de la Rey, RP (2006), Developing a Holistic Wellness Model, *SA Journal of Human Resource Management*, 4 (2), 46-56
5. Carlsson, C. and Walden, P. (2012), From Mcom Visions to Mobile Value Services, in: Roger Clarke, Andreja Puchar and Joze Gricar (eds.), The First 25 Years of the Bled eConference, University of Maribor, Bled 2012, pp 69-91
6. Carlsson, C. and Walden, P. (2014), Performative IS Research - Science Precision versus Practice Relevance, *Proceedings of PACIS 2014*, Section 9-7 #575
7. Gartell, D. and Gartell, J. (1996), Positivism in Sociological Practice: 1967-1990, *Canadian Review of Sociology*, vol. 33, No. 2
8. Hevner, A. and Chatterjee, S. (2010), *Design Research in Information Systems*, Springer
9. Sein, M.K., Henfridsson, O., Sandeep, P., Rossi, M. and R. Lindgren (2011), Action Design Research, *MIS Quarterly*, Vol.35, No.1, 37-56
10. Venkatesh, V., Thong, J. Y. L., and Xu, X. (2012), Consumer Acceptance and Use of Information Technology: Extending the Unified Theory of Acceptance and Use of Technology, MIS Quarterly, Vol. 36, No.1, pp 157-178
11. Gronroos, C., (2008), Service logic revisited: who creates value? And who co-creates? European Business Review, Vol. 20 Iss: 4, pp.298 – 314
12. Cecez-Kecemanovic, D. (2011), Doing Critical Information Systems Research – Arguments for a Critical Research Methodology, European Journal of Information Systems, Vol.20, 440-455
13. Bouwman, H., Vos, H. and Haaker, T. (2008), Mobile Service Innovation and Business Models, Springer, Berlin-Heidelberg

29th Bled eConference
Digital Economy
June 19 - 22, 2016; Bled, Slovenia

Effects of Using Standing Versus Sitting Workstations on the Well-Being at Work of Software Professionals

Markus Makkonen

University of Jyvaskyla, Finland
markus.v.makkonen@jyu.fi

Minna Silvennoinen

University of Jyvaskyla, Finland
minna.h.silvennoinen@jyu.fi

Tuula Nousiainen

University of Jyvaskyla, Finland
tuula.j.nousiainen@jyu.fi

Arto Pesola

University of Jyvaskyla, Finland
arto.j.pesola@jyu.fi

Mikko Vesisenaho

University of Jyvaskyla, Finland
mikko.vesisenaho@jyu.fi

Abstract

Although people admittedly are one of the most valuable assets of many software companies, relatively little academic research has been done from the well-being at work aspect of software professionals. This intervention study aims to address this gap in prior research by examining the potential effects of using standing instead of sitting workstations on the well-being at work of software professionals in terms of physical activity, mental alertness, and stress. The two measurements before and after the intervention were conducted in June and September 2015 for 29 employees of a local site of a large Finnish software company by using questionnaires and the Firstbeat Lifestyle Assessment service. The findings of the study suggest that using standing instead of sitting workstations results in only modest promotions of physical activity, does not to have an effect on mental alertness, and actually tilts the stress–recovery balance more towards stress, as least at the early phases of usage.

Keywords: Software Professionals, Standing Workstations, Sitting Workstations, Well-Being at Work, Physical Activity, Mental Alertness, Stress

1 Introduction

According to an old saying, people are the most valuable asset of a company. Although this traditional wisdom has lately begun to lose its validity due to more and more widespread usage of machines to substitute for human work, it still remains as true as ever especially in the software industry, where humans are still responsible for most of the creative engineering work related to various software products and services. Against this background, it is surprising how little academic research has actually been done from the well-being at work aspect of software as well as other information systems (IS) and information technology (IT) professionals. One particular aspect that has been entirely omitted are the effects of work posture on well-being at work. In this study, we aim to address this gap in prior research by examining what kinds of effects the usage of new types of workstation alternatives that substitute sitting for standing have on the well-being at work of software professionals. This topic can be considered an important one because although the potential dangers of prolonged sedentary behaviour and the potential benefits of using standing versus sitting workstations have previously been studied from a general perspective, the software profession possesses some special characteristics that set it apart from many other sedentary occupations and merit more context-specific examinations. For one, the software profession is a very mentally demanding occupation that requires high levels of mental alertness from its practitioners, typically throughout the working day when they are, for example, attempting to create solutions for complex computational problems or finding errors in thousands or even millions of lines of code. Perhaps partly because of this, software professionals have also been found to face very high levels of occupational stress and work exhaustion (e.g., Advani et al., 2005; Chilton, Hardgrave & Armstrong, 2005; Rajeswari & Anantharaman, 2005; Singh, Suar & Leiter, 2012; Amin et al., 2013). Therefore, it is interesting to study what kinds of benefits the usage of standing versus sitting workstations can provide in this specific context, not only in terms of promoting the physical activity, but also in terms of potentially promoting the mental alertness and reducing the stress levels of software professionals.

This paper consists of six sections. After this introductory section, we briefly discuss prior research on the topic in Section 2. Sections 3 and 4 present the methodology and results of the study. The results are discussed in more detail in Section 5, which also uses them to draw implications for both theory and practice. Finally, Section 6 considers the limitations of the study and potential paths of future research.

2 Prior Research

As it was already mentioned in the introduction, the well-being at work aspect of IS and IT professionals in general, as well as software professionals in particular, has received relatively little attention in academic research. For example, in the more general IS and IT context, most prior studies have concentrated only on the quite limited "ill-being" themes of occupational stress, work exhaustion, and "burnout" (e.g., Ivancevich, Napier & Wetherbe, 1983, 1985; Weiss, 1983; Li & Shani, 1991; King & Sethi, 1997; Sethi, Barrier & King, 1999; Moore, 2000; Thong & Yap, 2000; Sethi, King & Quick, 2004; Pawlowski, Kaganer & Carter, 2007), which have typically been the most commonly studied themes also in the more specific software context (e.g., Sonnentag et al., 1994; Advani et al., 2005; Chilton, Hardgrave & Armstrong, 2005; Rajeswari & Anantharaman, 2005; Singh, Suar & Leiter, 2012; Amin et al., 2013). In contrast, few studies have adopted a more holistic view of the topic, with the most prominent exceptions being the studies concentrating on themes like quality of work life (Igbaria, Parasuraman & Badawy, 1994; Rethinam & Maimunah, 2007; Korunka, Hoonakker & Carayon, 2008) and work–life balance (Hyman et al., 2003; Scholarios & Marks, 2004). However, no prior studies have concentrated on sedentary behaviour and workstation alternatives aspects in the context of software professionals.

Up to now, numerous studies have associated sitting, or more generally sedentary behaviour, with several serious physiological, psychological, and social issues, such as weight gain and obesity, cardiovascular diseases, diabetes, depression, cancer, and ultimately premature mortality (Teychenne, Ball & Salmon, 2010; Tremblay et al., 2010; Proper et al., 2011; Thorp et al., 2011, Wilmot et al., 2012). Therefore, it seems obvious that sitting for prolonged periods of time and the resulting physical inactivity is simply not good for our health and well-being. As a way to combat these issues especially in office environments, new types of alternatives to the traditional sitting workstations have been proposed. According to a taxonomy presented by Tudor-Locke et al. (2014), these can be divided by (a) *movement* into *static* or *active* alternatives, (b) *position* into *fixed* or *adjustable* alternatives, and (c) *posture* into *seated* or *upright* alternatives. Examples of them include sitting workstations that require a worker to sit on a stability ball, standing workstations that require a worker to stand continuously, adjustable sit–stand workstations that accommodate both sitting and standing, treadmill workstations that accommodate walking or running while working, and pedal workstations that accommodate pedalling or stepping while working.

All in all, the findings of prior studies on the effects of using the aforementioned new workstation alternatives instead of the traditional sitting workstations have been quite mixed (e.g., Neuhaus et al., 2014; Torbeyns et al., 2014; Tudor-Locke et al., 2014; Cao et al., 2015; MacEwen, MacDonald & Burr, 2015), which can be explained not only by the differences in how the studies were conducted, but also by the different settings in which they were conducted. For example, some have concentrated only on laboratory settings and others on real-life office settings. In addition, in the real-life office settings, the exact case context and profession under examination is likely to significantly influence the findings, which once again emphasises the need for not only general level examinations on the topic, but also more context-specific studies concentrating on a specific line of profession, such as software profession.

3 Methodology

The research setting of this study was based on the relocation of the local site of a large Finnish software company from old to new office premises during the late summer and early autumn of 2015. In the old premises, most of the employees had been using traditional sitting workstations, whereas in the new premises all of them would have adjustable workstations, which they could use in either sitting or standing position. This offered us an ideal setting for an intervention study, in which we first measured the well-being at work of the employees before the relocation and then repeated these measurements after the relocation while asking the employees to use their adjustable workstations mainly in the standing instead of sitting position. These two measurements, which are from now on referred to as measurements A and B, were conducted in June and September 2015.

As participants for the study, we were able to recruit 30 volunteers from the total of 115 employees working at the site. The recruitment process was conducted in co-operation with one manager, who briefly told the employees about the study and also accepted the registrations. After the registration, the 30 participants were divided into an intervention group of 20 people and a control group of 10 people. The division was done partly in random but partly based on the preferences of the participants, because we did not want to force any of them into a particular group due to their voluntary participation. This is also why the group sizes and distributions in terms of gender, age, and work position ended up being not entirely balanced. The members of the intervention group sat during measurement A and stood during measurement B. In contrast, the members of the control group retained their work posture the same during both the measurements. Of them, nine sat during both the measurements, whereas the remaining one person had been working in a standing posture already in the old premises and retained this posture also in the new premises.

During the measurements, we employed three different measurement instruments to measure the potential changes in our three variables of interest: physical activity, mental alertness, and stress. All the measurements were conducted identically for both the groups. The first measurement instrument was a questionnaire, part of which the participants filled in offline by using pen and paper and part of which they filled in online by using a computer or a mobile phone. It contained several questions and rateable statements related to well-being at work, of which the relevant one for this study was a set of ten statements rated with a standard 5-point Likert scale, which concerned and were used to control the potential changes in the overall life situation of the participants between the measurements. Such control was obviously important because if there had been significant changes in the overall life situation of the participants, it would have been impossible to say whether the potential alterations in their well-being at work were actually caused by these changes rather than by the investigated intervention. However, if the overall life situation of the participants had remained unchanged, it was more likely that the investigated intervention was the prime cause for the potential alternations in their well-being at work.

The second measurement instrument was another questionnaire, which was used to measure the changes in the mental alertness of the participants based on their self-reported scores from three days at four different times of a day: at the beginning of a working day, before lunch, after lunch, and at the end of a working day. That is, this questionnaire was not filled in only once at the beginning of each measurement but continuously during the measurements. The questionnaire was pen-and-paper based and used the Karolinska sleepiness scale (KSS) as a measurement scale. KSS is a 9-point verbally anchored scale, in which the response options range from extreme alertness to extreme sleepiness (Åkerstedt & Gillberg, 1990). KSS has been successfully applied to various contexts, such as driving (e.g., Kecklund & Åkerstedt, 1993; Horne & Reyner, 1996) as well as shift work (e.g., Lowden et al., 1998; Sallinen et al., 1998), and it has been found as a highly valid scale for measuring sleepiness (Kaida et al., 2006). Thus, inversely, it can be considered a valid scale for measuring also alertness.

As the third measurement instrument, we employed the Firstbeat Lifestyle Assessment service, in which the participants were asked to wear a Firstbeat Bodyguard heart rate monitor continuously for three days (both day and night but excluding showers and other situations of extreme humidity) and to report their daily activities as well as information on their potential usage of medicines and alcohol to an online diary by using a computer or mobile phone. This collected data was then analysed by using the Firstbeat Analysis Server to produce reports on their well-being. The variables in these Firstbeat Lifestyle Assessment reports included not only basic heart rate (HR), but also various other physiological variables estimated from heart rate variability (HRV), such as respiration rate (RR), oxygen consumption (VO_2), and energy expenditure (EE). The exact estimation methods are described in more detail in the white papers published by Firstbeat (2012a, 2012c). All the four aforementioned variables (HR, RR, VO_2, and EE) were utilised in this study as measures of physical activity.

In addition, HRV and its known associations with the sympathetic and parasympathetic divisions of the autonomic nervous system (ANS) can also be used to make estimations on the physiological states of the assessed individuals, such as the balance between stress and recovery. Also this estimation method is described more detail in a white paper published by Firstbeat (2012b). In the Firstbeat Lifestyle Assessment reports, the estimations are presented as profiles exemplified in Appendix A, in which the red bars indicate a stress state and the green bars indicate a recovery state. In addition, the profiles contain light and dark blue bars. These indicate the states of more intensive physical activity, in which one’s VO_2 rises to 20–30 % (light blue) or to over 30 % (dark blue) of one’s maximum VO_2. However, these states were not of interest in this study. The height of the bars represents the intensity of the respective physiological state, but on a subjective scale relative to one’s maximum and minimum intensity, which does not enable comparisons between individuals. Therefore, from the reported profiles, we utilised only the ratio between stress and recovery time, which we from now on refer to as stress–recovery balance.

Both measurements lasted three days, and although the data obtained from the Firstbeat Lifestyle Assessment service covered also non-work time, only the work time data based on the work times self-reported by the participants to the online diary was included in the analysis. In addition, any unusual off-workstation times, such as working at home, being on a business trip, or running personal errands during work time, were excluded from the analysed data. The analysis of the data was done with the SPSS Statistics version 22 software by using the Student’s t-test for paired samples to test the statistical significance of the potential changes between the measurements. As a precaution, we also replicated these tests by using the Wilcoxon signed rank test to make sure that our small sample and the slightly non-normal distributions of data did not distort the results. The results of both the tests were practically identical in terms of statistical significance.

4 Results

As mentioned in the previous section, we were able recruit a total of 30 participants for our study, of whom 20 were placed in the intervention group and 10 were placed in the control group. However, between the measurements, there was one dropout in the control group, which resulted in an actual sample size of 29 participants, of whom 20 were placed in the intervention group and 9 were placed in the control group. The descriptive statistics of this sample in terms of gender, age, and work position are reported in Table 1. Here, the non-manager level positions include work titles such as software developer, software specialist, systems architect, systems designer, and documentation specialist. In contrast, the manager level positions include work titles such as project manager, group manager, development manager, product manager, and quality manager. In terms of the data from the Firstbeat Lifestyle Assessment service, the amount of analysed data was about 655.2 hours for measurement A and about 671.4 hours for measurement B, which averages to about 22.6 hours and 23.2 hours per participant, respectively.

	All		Intervention		Control	
	N	%	N	%	N	%
Gender						
Male	22	75.9	13	65.0	9	100.0
Female	7	24.1	7	35.0	0	0.0
Age						
–30 years	1	3.4	0	0.0	1	11.1
30–39 years	11	37.9	8	40.0	3	33.3
40–49 years	14	48.3	11	55.0	3	33.3
50–59 years	2	6.9	1	5.0	1	11.1
60– years	1	3.4	0	0.0	1	11.1
Position						
Non-manager	17	58.6	13	65.0	4	44.4
Manager	12	41.4	7	35.0	5	55.6

Table 1: Sample statistics (N = 29)

4.1 Life Situation

Table 2 reports the ratings given by the intervention group (N = 20) and control group (N = 9) to the ten statements on their overall life situation as well as the results of the Student's t-tests that were used to examine the statistical significance of the potential changes in these ratings between measurements A and B. The rating scale that was used ranged from 1 = strong disagreement to 5 = strong agreement. As can be seen, there were no statistically significant changes in any of the areas covered by the ten statements between the measurements, at least when examined at a group level. This suggests that if any differences in the measurement results of the intervention group are found in the next two subsections, they are more likely to be caused by the investigated intervention rather than by other factors, such as the changes in the overall life situation of the participants.

	N	A		B		Difference				
		Mean	SD	Mean	SD	Δ	SD	t	df	p
I think I am physically active enough to get health benefits	20	3.6	1.2	3.4	1.4	-0.2	0.7	-1.000	19	0.330
	9	3.1	1.6	3.3	1.6	0.2	0.7	1.000	8	0.347
I think my physical activity is intensive enough to improve my fitness	20	3.4	1.2	3.4	1.3	0.1	0.9	0.237	19	0.815
	9	3.3	1.6	3.4	1.7	0.1	0.8	0.426	8	0.681
In my opinion, my eating habits are healthy	20	4.2	0.7	4.3	0.6	0.1	0.7	0.326	19	0.748
	9	3.9	0.9	3.9	0.8	0.0	0.9	0.000	8	1.000
I feel that my alcohol consumption is not excessive	20	4.7	0.7	4.7	0.8	-0.1	0.4	-0.567	19	0.577
	9	4.4	1.0	5.0	0.0	0.6	1.0	1.644	8	0.139
I don't generally feel stressed	20	3.0	1.4	3.0	1.3	0.1	1.2	0.181	19	0.858
	9	2.3	1.3	2.1	0.8	-0.2	1.5	-0.450	8	0.665
My days include breaks that allow me to recover	20	3.9	1.1	4.0	0.9	0.2	1.0	0.645	19	0.527
	9	4.0	0.5	3.4	1.0	-0.6	1.0	-1.644	8	0.139
I usually feel rested and energetic	20	3.5	1.2	3.4	1.0	-0.1	0.6	-0.370	19	0.716
	9	3.2	1.2	3.1	0.9	-0.1	1.4	-0.244	8	0.813
I feel that I sleep enough	20	3.2	1.2	3.3	1.0	0.1	1.1	0.213	19	0.834
	9	3.0	1.3	2.8	1.1	-0.2	1.3	-0.512	8	0.622
I feel that I can influence the things that affect my health	20	4.5	0.6	4.5	0.6	0.1	0.5	0.438	19	0.666
	9	4.4	0.7	4.2	0.8	-0.2	0.8	-0.800	8	0.447
In my opinion, I feel well at the moment	20	3.9	1.0	4.2	0.5	0.3	0.9	1.552	19	0.137
	9	3.4	1.0	3.6	1.0	0.1	0.9	0.359	8	0.729

Table 2: Results on overall life situation (bolded are statistically significant at $p < 0.05$)

4.2 Physiological Activity and Stress

Table 3 reports the results obtained from the Firstbeat Lifestyle Assessment service for the intervention group (N = 20) and control group (N = 9) as well as the results of the Student's t-tests that were used to examine the statistical significance of the potential changes in these results between measurements A and B. Here, HR, RR, VO_2, and EE are all mean values of the measurements. As can be seen, there was a statistically significant change in the physical activity of the intervention group between the measurements in terms of HR, VO_2, and EE, with an average increase in HR of 4.2 beats per minute, in VO_2 of 0.3 ml per kg per minute, and in EE of 10.2 kcal per hour. Also RR seemed to have increased slightly, but this change was not statistically significant. In contrast, practically no change was found in the physical activity of the control group between the measurements in terms of any of the four variables.

The stress–recovery balance variable, indicating the ratio of the time spent by an individual in stress and recovery states, was scaled to vary from -1 to 1, in which -1 indicates time spent only in stress state and not at all in recovery state, 0 indicates an equal amount of time spent in both states, and 1 indicates time spent only in recovery state and not at all in stress state. As can be seen, there was a statistically significant change in the stress–recovery balance of the intervention group between the measurements, with a considerable increase in the amount of time spent in stress state. In contrast, in the control group, there seemed to be a slight increase in the amount of time spent in recovery state between the measurements, but this change in the stress–recovery balance was not statistically significant.

	N	A		B		Difference				
		Mean	SD	Mean	SD	Δ	SD	t	df	p
Heart rate (beats / min)	20	72.0	10.5	76.2	9.4	4.2	5.7	3.303	19	**0.004**
	9	70.0	7.7	69.5	7.9	-0.6	3.0	-0.550	8	0.597
Respiration rate (breaths / min)	20	13.4	1.5	13.5	1.8	0.2	0.8	0.931	19	0.364
	9	12.7	1.8	12.7	2.0	0.0	0.4	0.141	8	0.891
O_2 consumption (ml / kg / min)	20	4.1	0.7	4.4	0.8	0.3	0.5	2.804	19	**0.011**
	9	3.9	1.0	3.9	1.0	0.0	0.2	0.342	8	0.741
Energy expenditure (kcal / h)	20	92.8	35.4	98.9	35.1	6.1	10.2	2.666	19	**0.015**
	9	98.6	39.7	98.5	36.3	-0.1	5.6	-0.054	8	0.958
Stress–recovery balance (from -1 to 1)	20	-0.68	0.46	-0.90	0.17	-0.22	0.40	-2.418	19	**0.026**
	9	-0.75	0.20	-0.66	0.38	0.10	0.23	1.256	8	0.244

Table 3: Results on physical activity and stress (bolded are statistically significant at $p < 0.05$)

4.3 Mental Alertness

Table 4 reports the ratings given by the intervention group (N = 20) and control group (N = 9) on their mental alertness at four different times a day as well as the results of the Student's t-tests that were used to examine the statistical significance of potential changes in these ratings between measurements A and B. As the rating scale, we used an inverted version of KSS in order to better reflect that we were measuring alertness and not sleepiness, meaning that the rating scale ranged from 1 = extremely sleepy to 9 = extremely alert. As can be seen, there were no statistically significant changes in the mental alertness of the intervention group or the control group between the measurements, although there seemed to be, for example, a slight decrease in the mental alertness of the intervention group before lunch as well as in the mental alertness of the control group at the end of a working day. In addition, there also seemed to be a slight increase in the mental alertness of the control group both before and after lunch, of which the latter was also the change that was closest to being statistically significant.

	N	A		B		Difference				
		Mean	SD	Mean	SD	Δ	SD	t	df	p
Beginning of a working day	20	6.3	1.1	6.3	1.1	0.1	1.3	0.207	19	0.838
	9	5.9	1.0	5.9	0.7	0.0	0.8	0.000	8	1.000
Before lunch	20	6.8	1.1	6.4	0.8	-0.4	1.1	-1.765	19	0.094
	9	6.2	0.7	6.5	0.9	0.3	1.0	0.815	8	0.439
After lunch	20	6.2	0.9	6.1	0.9	-0.0	1.1	-0.132	19	0.896
	9	6.0	0.8	6.3	0.9	0.4	0.5	2.169	8	0.062
End of a working day	20	5.9	1.2	6.0	1.1	0.2	1.0	0.691	19	0.498
	9	6.3	0.9	5.7	0.7	-0.6	1.1	-1.631	8	0.142

Table 4: Results on mental alertness (bolded are statistically significant at $p < 0.05$)

5 Discussion and Conclusions

In this study, we examined the potential effects of using standing instead of sitting workstations on the well-being at work of software professionals in terms of physical activity, mental alertness, and stress. The findings of the study suggest that also in the context of software professionals, the usage of standing instead of sitting workstations results in a promotion of physical activity, although a relatively modest one, with an average increase in HR of 4.2 beats per minute, in VO_2 of 0.3 ml per kg per minute, and in EE of 10.2 kcal per hour. These findings are in line with those of prior studies, which have reported increases in HR varying from 3.6 beats per minute to 13.2 beats per minute and increases in EE varying from 4.1 kcal per hour to 20.4 kcal per hour (MacEwen, MacDonald & Burr, 2015). In practice, this means that during a typical eight-hour working day, one is able consume only about 80 kcal more when using standing instead of sitting workstations, equalling approximately to one large apple. Thus, also in the context software professionals, we concur with the general position presented previously by Tudor-Locke et al. (2014) that standing workstations cannot be considered an efficient tool for short-term weight management, although they are likely to have other health benefits typically associated with the reduction in sedentary time. However, in a longer term, the changes in energy balance of even this magnitude may potentially be enough to prevent weight gain (Hill et al., 2003).

In contrast, the effects of using standing instead of sitting workstations on mental alertness of software professionals were found to be almost non-existing, suggesting that standing workstations cannot also be considered an efficient tool for promoting the work performance of software professionals by enabling them to perform better especially in tasks requiring intensive concentration. However, the findings do not suggest that standing workstations would hinder the work performance of software professionals either, meaning that their adoption is not likely to entail any significant risks from this point of view. Also these findings are in line with those of prior studies, which have, for example, presented only relatively weak evidence for the ability of using standing instead of sitting workstations to reduce fatigue (Neuhaus et al., 2014; MacEwen, MacDonald & Burr, 2015). In this respect, rather than just changing one static posture to another, a more essential issue would seem to be dynamic postural variety (e.g., Hasegawa et al., 2001), suggesting that also in the context of software professionals, more attention should be paid to the frequent changes of work posture.

Finally, in terms of stress, the usage of standing instead of sitting workstations was not found to reduce stress time and add more recovery breaks to the working days of software professionals, which have been suggested as critical, for example, in terms of supporting creativity (Elsbach & Hargadon, 2006). In contrast, the effects were found to be exactly the opposite, thus suggesting that the usage of standing workstations cannot also be considered an efficient tool for stress management in the context of software professionals. However, here, it must be noted that our measurements of stress in this study were based on ANS balance as described in the methodology, in which stress can be broadly defined as increased activation of the body caused by the domination of the sympathetic division over the parasympathetic division (Firstbeat, 2016b). Thus, the measurements cannot, for example, separate between the so-called “bad” stress with negative feelings and the so-called “good” stress with positive feelings, making interpretations more difficult. It is also difficult to compare our findings to those of prior studies because none of them seem to have measured stress in a similar manner than in this study. However, related to stress, the usage of standing instead of sitting workstations has been found to have positive effects on mental well-being and mood (Neuhaus et al., 2014; MacEwen, MacDonald & Burr, 2015), which can be seen as indications of reduced stress and, thus, would seem to conflict with our findings. However, because of the aforementioned interpretation issues, it is difficult to say whether this conflict actually exists without further examinations.

From a theoretical point of view, this study extends the perspective of the prior studies on the well-being at work of software professionals in particular as well as IS and IT professionals in general from the traditional “ill-being” themes of occupational stress, work exhaustion, and “burnout” to the novel themes of sedentary behaviour and workstation alternatives, which have not been researched in this specific context by any prior studies of which we are aware of. At the same time, it also contributes to the more general research on these themes by illustrating that many of the findings of the prior studies on sedentary behaviour and workstation alternatives are applicable also to the specific context of software professionals. From a practical point of view, the findings of the study offer the managers of software companies insights on the potential of the new types of workstation alternatives to promote the well-being at work of software professionals, which they can use as a basis of their decisions to invest or not to invest in them in the future.

6 Limitation and Future Research

We consider this study to have five main limitations. First, we collected the data only from 29 software professionals working in one site of one Finnish software company, which obviously limits the generalisability of our findings. In addition, when dividing this sample into an intervention and control group, the division was partly based on the preferences of the participants, which resulted in less than ideally balanced group sizes and distributions in terms of gender, age, and work position and may have introduced some bias into the findings. Thus, future studies should replicate the study also in other companies both in Finland and in other countries by using larger samples consisting ideally of at least a few hundred participants. The division of the participants into an intervention and control group of approximately the same size should also be done totally at random.

Second, although we tried to control the potential effects of any external factors by using a control group and control variables in our study setting, it is difficult to reliably determine how much of the changes in the well-being at work of the participants can actually be attributed to the investigated intervention of using standing instead of sitting workstations and how much to these other factors. For example, when moving from the old to the new premises, the participants were not only provided with new workstations, but they were also subjected to several other changes, such as the change of the whole office layout towards a more open-plan theme and the relocation of the premises from 10th and 11th floors to 3rd and 4th floors. The potential effects of such external factors should by placed under even tighter scrutiny in future studies.

Third, a control variable that was completely missing in our study was the measure of the actual sitting and standing times, because although we had requested the participants to report also this data to the online diary, only a few of them complied with this request. This data would have been very valuable, because in a real-life office setting, the participants obviously did not sit or stand at their workstations all the time but had lunch, coffee, and toilet breaks, attended meetings, and so on. Thus, future studies should collect also this data, preferably in an as automated manner as possible by using activity bracelets or other corresponding technologies.

Fourth, the duration of our study was relatively short because only two measurements lasting three days were conducted, during the latter of which many participants started using standing workstations for the very first time. This obviously limits our findings only to short-term effects of using standing instead of sitting workstations and makes it difficult to say anything conclusive about the longer-term effects. Thus, future studies would benefit from more longitudinal study settings consisting of more than only two measurements and lasting ideally at least one year.

Fifth, as already mentioned in the conclusions, the study concentrated on measuring stress from a quite limited physiological aspect, meaning that future studies would also benefit from better considering its psychological and other aspects, such as individual differences in experiencing stress. In addition, the current measurements obtained from the Firstbeat Lifestyle Assessment service must be interpreted by bearing in mind that the service does not have a medical classification. However, its estimates on oxygen consumption and energy expenditure have been found as sufficiently accurate for field studies (e.g., Montgomery et al., 2009; Smolander et al., 2008; Smolander et al., 2011), and many prior studies have successfully used the service as a measurement instrument of these variables (e.g., Finni et al., 2014; Mutikainen et al., 2014) as well as stress (e.g., Salonen et al., 2013; Jaatinen et al., 2014; Föhr et al., 2015).

Acknowledgements

This study has been funded by the Need for Speed (N4S) program of DIGILE.

References

Advani, J. Y., Jagdale, S. C., Garg, A. K., & Kumar, R. (2005). Antecedents and Consequences of “Burnout” in Services Personnel: A Case of Indian Software Professionals. *South Asian Journal of Management*, *12*(3), 21–34.

Amin, A., Basri, S., Hassan, M. F. B., & Rehman, M. (2013). Identification of Stressors and Development of Survey Instrument to Measure Software Engineering Occupational Stress in GSD. *International Journal of Information Processing and Management*, *4*(6), 99–113.

Cao, C., Lin, Y., Zhu, W., & Ma, J. (2015) Effect of Active Workstation on Energy Expenditure and Job Performance: A Systematic Review and Meta-Analysis. *Journal of Physical Activity & Health*, *12*(11). doi:10.1123/jpah.2014-0565

Chilton, M. A., Hardgrave, B. C., & Armstrong, D. J. (2005). Person-Job Cognitive Style Fit for Software Developers: The Effect on Strain and Performance. *Journal of*

Management Information Systems, *22*(2), 193–226. doi:10.1080/07421222.2005.11045849

Elsbach, K. D., & Hargadon, A. B. (2006). Enhancing Creativity Through “Mindless” Work: A Framework of Workday Design. *Organizational Science*, *17*(4), 470–483. doi:10.1287/orsc.1060.0193

Finni, T., Haakana, P., Pesola, A. J., & Pullinen, T. (2014). Exercise for Fitness Does Not Decrease the Muscular Inactivity Time During Normal Daily Life. *Scandinavian Journal of Medicine & Science in Sports*, *24*(1), 211–219. doi:10.1111/j.1600-0838.2012.01456.x

Firstbeat (2012a). *An Energy Expenditure Estimation Method Based on Heart Rate Measurement*. White Paper. Retrieved from https://www.firstbeat.com/app/uploads/2015/10/white_paper_energy_expenditure_estimation.pdf

Firstbeat (2012b). *Stress and Recovery Analysis Method Based on 24-hour Heart Rate Variability*. White Paper. Retrieved from https://www.firstbeat.com/app/uploads/2015/10/Stress-and-recovery_white-paper_20145.pdf

Firstbeat (2012c). *VO_2 Estimation Method Based on Heart Rate Measurement*. White Paper. Retrieved from https://www.firstbeat.com/app/uploads/2015/10/white_paper_vo2_estimation.pdf

Föhr, T., Tolvanen, A., Myllymäki, T., Järvelä-Reijonen, E., Rantala, S., Korpela, R., Peukuri, K., Kolehmainen, M., Puttonen, S., Lappalainen, R., Rusko, H., & Kujala, U. M. (2015). Subjective Stress, Objective Heart Rate Variability Based Stress, and Recovery on Workdays among Overweight and Psychologically Distressed Individuals: A Cross-Sectional Study. *Journal of Occupational Medicine and Toxicology*, *10*(39), 1–9. doi:10.1186/s12995-015-0081-6

Hasegawa, T., Inoue, K., Tsutsue, O., & Kumashiro, M. (2001). Effects of a Sit–Stand Schedule on a Light Repetitive Task. *International Journal of Industrial Ergonomics*, *28*(3–4), 219–224. doi:10.1016/S0169-8141(01)00035-X

Hill, J. O., Wyatt, H. R., Reed, G. W., & Peters, J. C. (2003). Obesity and the Environment: Where Do We Go from Here? *Science*, *299*(5608), 853–855. doi:10.1126/science.1079857

Horne, J. A., & Reyner, L. A. (1996). Counteracting Driver Sleepiness: Effects of Napping, Caffeine, and Placebo. *Psychophysiology*, *33*(3), 306–309. doi:10.1111/j.1469-8986.1996.tb00428.x

Hyman, J., Baldry, C., Scholarios, D., & Bunzel, D. (2003). Work–Life Imbalance in Call Centres and Software Development. *British Journal of Industrial Relations*, *41*(2), 215–239. doi:10.1111/1467-8543.00270

Igbaria, M., Parasuraman, S., & Badawy, M. K. (1994). Work Experiences, Job Involvement, and Quality of Work Life among Information Systems Personnel. *MIS Quarterly*, *18*(2), 175–201. doi:10.2307/249764

Ivancevich, J. M., Napier, H. A., & Wetherbe, J. C. (1983). Occupational Stress, Attitudes, and Health Problems in the Information Systems Professional. *Communications of the ACM*, *26*(19), 800–806. doi:10.1145/358413.358432

Ivancevich, J. M., Napier, H. A., & Wetherbe, J. C. (1985). An Empirical Study of Occupational Stress, Attitudes and Health among the Information Systems Personnel. *Information & Management*, *9*(2), 77–85. doi:10.1016/0378-7206(85)90029-1

Jaatinen, N., Korpela, R., Poussa, T., Turpeinen, A., Mustonen, S., Merilahti, J., & Peuhkuri, K. (2014). Effects of Daily Intake of Yoghurt Enriched with Bioactive Components on Chronic Stress Responses: A Double-Blinded Randomized Controlled Trial. *International Journal of Food Sciences and Nutrition*, *65*(4), 507–514. doi:10.3109/09637486.2014.880669

Kaida, K., Takahashi, M., Åkerstedt, T., Nakata, A., Otsuka, Y., Haratani, T., & Fukasawa, K. (2006). Validation of the Karolinska Sleepiness Scale against Performance and EEG Variables. *Clinical Neurophysiology*, *117*(7), 1574–1581. doi:10.1016/j.clinph.2006.03.011

Kecklund, G., & Åkerstedt, T. (1993). Sleepiness in Long Distance Truck Driving: An Ambulatory EEG Study of Night Driving. *Ergonomics*, *36*(9), 1007–1017. doi:10.1080/00140139308967973

King, R. C., & Sethi, V. (1997). The Moderating Effect of Organizational Commitment on Burnout in Information Systems Professionals. *European Journal of Information Systems*, *6*(2), 86–96. doi:10.1057/palgrave.ejis.3000259

Korunka, C., Hoonakker, P., & Carayon, P. (2008). Quality of Working Life and Turnover Intention in Information Technology Work. *Human Factors and Ergonomics in Manufacturing*, *18*(4), 409–423. doi:10.1002/hfm.20099

Li, E. Y., & Shani, A. B. (1991). Stress Dynamics of Information Systems Managers: A Contingency Model. *Journal of Management Information Systems*, *7*(4), 107–130. doi:10.1080/07421222.1991.11517906

Lowden, A., Kecklund, G., Axelsson, J., & Åkerstedt, T. (1998). Change from an 8-Hour Shift to a 12-Hour Shift, Attitudes, Sleep, Sleepiness and Performance. *Scandinavian Journal of Work, Environment & Health*, *24*(3), 69–75.

MacEwen, B. T., MacDonald, D. J., & Burr, J. F. (2015). A Systematic Review of Standing and Treadmill Desks in the Workplace. *Preventive Medicine*, *70*, 50–58. doi:10.1016/j.ypmed.2014.11.011

Montgomery, P. G., Green, D. J., Etxebarria, N., Pyne, D. B., Saunders, P. U., & Minahan, C. L. (2009). Validation of Heart Rate Monitor-Based Predictions of Oxygen Uptake and Energy Expenditure. *Journal of Strength and Conditioning Research*, *23*(5), 1489–1495. doi:10.1519/JSC.0b013e3181a39277

Moore, J. E. (2000). One Road to Turnover: An Examination of Work Exhaustion in Technology Professionals. *MIS Quarterly*, *24*(1), 141–168. doi:10.2307/3250982

Mutikainen, S., Helander, E., Pietilä, J., Korhonen, I., & Kujala, U. M. (2014). Objectively Measured Physical Activity in Finnish Employees: A Cross-Sectional Study. *BMJ Open*, *4*(12). doi:10.1136/bmjopen-2014-005927

Neuhaus, M., Eakin, E. G., Straker, L., Owen, N., Dunstan, D. W., Reid, N., & Healy, G. N. (2014). Reducing Occupational Sedentary Time: A Systematic Review and Meta-Analysis of Evidence on Activity-Permissive Workstations. *Obesity Reviews*, *15*(10), 822–838. doi:10.1111/obr.12201

Pawlowski, S. D., Kaganer, E. A., & Carter, J. J. III (2007). Focusing the Research Agenda on Burnout in IT: Social Representations of Burnout in the Profession. *European Journal of Information Systems*, *16*(5), 612–627. doi:10.1057/palgrave.ejis.3000699

Proper, K. I., Singh, A. S., van Mechelen, W., & Chinapaw, M. J. M. (2011). Sedentary Behaviors and Health Outcomes Among Adults: A Systematic Review of

Prospective Studies. *American Journal of Preventive Medicine*, *40*(2), 174–182. doi:10.1016/j.amepre.2010.10.015

Rajeswari, K. S., & Anantharaman, R. N. (2005). Role of Human-Computer Interaction Factors as Moderators of Occupational Stress and Work Exhaustion. *International Journal of Human-Computer Interaction*, *19*(1), 137–154. doi:10.1207/s15327590ijhc1901_9

Rethinam, G. S., & Maimunah, I. (2007). Constructs of Quality of Work Life: A Perspective of Information and Technology Professionals. *European Journal of Social Sciences*, *7*(1), 58–70.

Sallinen, M., Härmä, M., Åkerstedt, T., Rosa, R., & Lillqvist, O. (1998). Promoting Alertness with a Short Nap During a Night Shift. *Journal of Sleep Research*, *7*(4), 240–247. doi:0.1046/j.1365-2869.1998.00121.x

Salonen, M., Kokko, J., Tyyskä, J., Koivu, M., & Kyröläinen, H. (2013). Heart Rate Variability Recordings Are a Valid Non-Invasive Tool for Evaluating Soldiers' Stress. *Journal on Defence Studies & Resource Management*, *2*(1), 1–4. doi:10.4172/2324-9315.1000107

Scholarios, D., & Marks, A. (2004). Work–Life Balance and the Software Worker. *Human Resource Management Journal*, *14*(2), 54–74. doi:10.1111/j.1748-8583.2004.tb00119.x

Sethi, V., Barrier, T., & King, R. C. (1999). An Examination of the Correlates of Burnout in Information Systems Professionals. *Information Resources Management Journal*, *12*(3), 5–13. doi:10.4018/irmj.1999070101

Sethi, V., King, R. C., & Quick, J. C. (2004). What Causes Stress in Information System Professionals? *Communications of the ACM*, *47*(3), 99–102. doi:10.1145/971617.971623

Singh, P., Suar, D., & Leiter, M. P. (2012). Antecedents, Work-Related Consequences, and Buffers of Job Burnout Among Indian Software Developers. *Journal of Leadership & Organizational Studies*, *19*(1), 83–104. doi:10.1177/1548051811429572

Smolander, J., Ajoviita, M., Juuti, T., Nummela, A., & Rusko, H. (2011). Estimating Oxygen Consumption from Heart and Heart Rate Variability without Individual Calibration. *Clinical Physiology and Functional Imaging*, *31*(4), 266–271. doi:10.1111/j.1475-097X.2011.01011.x

Smolander, J., Juuti, T., Kinnunen, M.-L., Laine, K., Louhevaara, V., Männikkö, K., & Rusko, H. (2008). A New Heart Rate Variability-Based Method for the Estimation of Oxygen Consumption without Individual Laboratory Calibration: Application Example on Postal Workers. *Applied Ergonomics*, *39*(3), 325–331. doi:10.1016/j.apergo.2007.09.001

Sonnentag, S., Brodbeck, F. C., Heinbokel, T., & Stolte, W. (1994). Stressor-Burnout Relationship in Software Development Teams. *Journal of Occupational and Organizational Psychology*, *67*(4), 327–341. doi:10.1111/j.2044-8325.1994.tb00571.x

Teychenne, M., Ball, K., & Salmon, J. (2010). Sedentary Behavior and Depression Among Adults: A Review. *International Journal of Behavioral Medicine*, *17*(4), 246–254. doi:10.1007/s12529-010-9075-z

Thong, J. Y. L., & Yap, C.-S. (2000). Information Systems and Occupational Stress: A Theoretical Framework. *Omega*, *28*(6), 681–692. doi:10.1016/S0305-0483(00)00020-7

Thorp, A. A., Owen, N., Neuhaus, M., & Dunstan, D. W. (2011). Sedentary Behaviors and Subsequent Health Outcomes in Adults: A Systematic Review of Longitudinal Studies, 1996–2011. *American Journal of Preventive Medicine*, *41*(2), 207–215. doi:10.1016/j.amepre.2011.05.004

Torbeyns, T., Bailey, S., Bos, I., & Meeusen, R. (2014). Active Workstations to Fight Sedentary Behaviour. *Sports Medicine*, *44*(9), 1261–1273. doi:10.1007/s40279-014-0202-x

Tremblay, M. S., Colley, R. C., Saunders, T. J., Healy, G. N., & Owen, N. (2010). Physiological and Health Implications of a Sedentary Lifestyle. *Applied Physiology, Nutrition, and Metabolism*, *35*(6), 725–740. doi:10.1139/h10-079

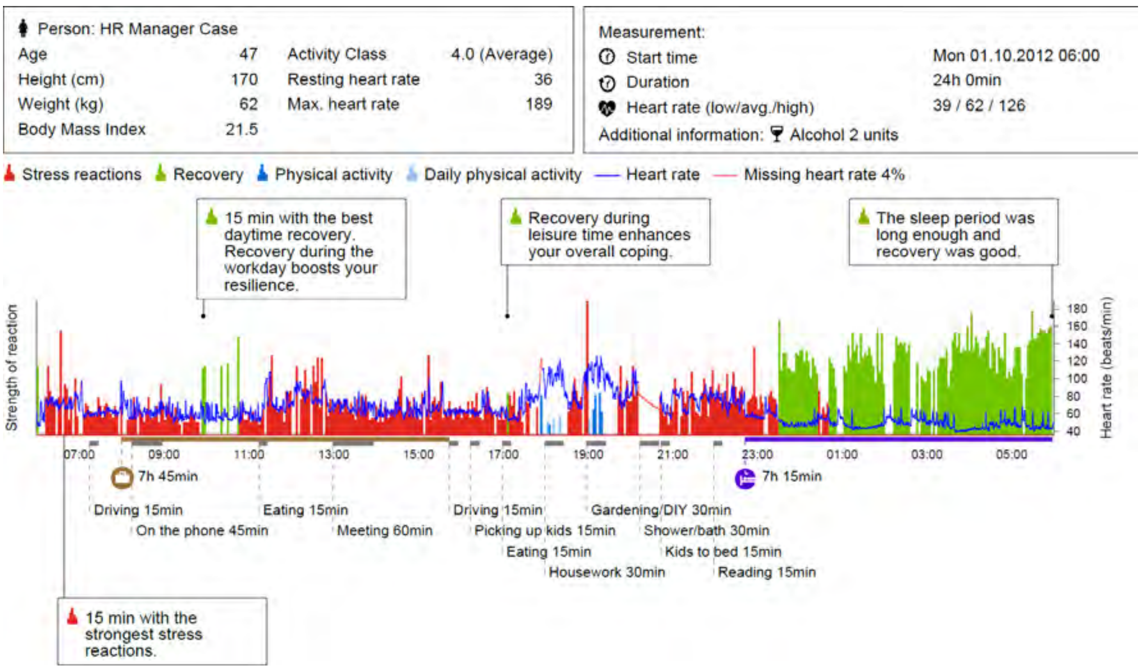
Tudor-Locke, C., Schuna, J. M. Jr., Frensham, L. J., & Proenca, M. (2014). Changing the Way We Work: Elevating Energy Expenditure with Workstation Alternatives. *International Journal of Obesity*, *38*(6), 755–765. doi:10.1038/ijo.2013.223

Weiss, M. (1983). Effects of Work Stress and Social Support on Information Systems Managers. *MIS Quarterly*, *7*(1), 29–43. doi:10.2307/249075

Wilmot, E. G., Edwardson, C. L., Achana, F. A., Davies, M. J., Gorely, T., Gray, L. J., Khunti, K., Yates, T., & Biddle, S. J. H. (2012). Sedentary Time in Adults and the Association with Diabetes, Cardiovascular Disease and Death: Systematic Review and Meta-Analysis. *Diabetologia*, *55*(11), 2895–2905. doi:10.1007/s00125-012-2677-z

Åkerstedt, T., & Gillberg, M. (1990). Subjective and Objective Sleepiness in the Active Individual. *International Journal of Neuroscience*, *52*(1–2), 29–37. doi:10.3109/00207459008994241

Appendix A: Firstbeat Lifestyle Assessment Report



29th Bled eConference
Digital Economy
June 19 - 22, 2016; Bled, Slovenia

Adoption and Adoption Interests of Self-Tracking Technologies: *Single and Multiple Technology Perspectives*

Markus Makkonen

University of Jyvaskyla, Finland
markus.v.makkonen@jyu.fi

Tuomas Kari

University of Jyvaskyla, Finland
tuomas.t.kari@jyu.fi

Lauri Frank

University of Jyvaskyla, Finland
lauri.frank@jyu.fi

Panu Moilanen

University of Jyvaskyla, Finland
panu.moilanen@jyu.fi

Abstract

During the past few decades, different forms of technology based self-tracking have become increasingly common but received little attention in academic research. In this study, we aim to address this gap by examining the adoption and adoption interests of four different self-tracking technologies: exercise, activity, sleep, and nutrition tracking. The examination is conducted from both single and multiple technology perspectives and by concentrating particularly on the potential gender and age dependencies in the adoption rates and adoption patterns of the technologies. By analysing the responses collected from 824 consumers through an online survey, the results of the study are able to reveal that although the adoption rates of all the four self-tracking technologies still remain relatively low, there is considerable interest towards the adoption of all of them. In addition, based on the differences in their adoption patterns, four distinct consumer segments can be identified.

Keywords: Self-Tracking Technologies, Adoption, Adoption Interests, Single Technology Perspective, Multiple Technology Perspective, Survey

1 Introduction

During the past few decades, the developments in information and communication technology (ICT) have vastly expanded the range of variables that we are able to track in ourselves and made different forms of technology based self-tracking increasingly common. For example, many of us wear an activity tracker on one's wrist to keep in track of the daily step count or strap a heart rate monitor around one's chest to get more detailed data on the effects of exercising. Respectively, it is common for many to keep a diary on their daily intake of food and drinks or track their nightly sleep with sensors placed onto one's body or into one's bed. At the same time, self-tracking has also become major business. For example, the market of health self-monitoring technologies has been expected to grow from $3.2 billion in 2014 to $18.8 billion by 2019 (BCC Research, 2015) and the market of smart wearables for sports and fitness from $3.5 billion in 2014 to $14.9 billion by 2021 (Wintergreen Research, 2015).

In spite of all this, self-tracking has so far received relatively little attention in academic research, with most prior studies being only opinion or commentary type of papers introducing the phenomena of self-tracking (e.g., Smarr 2012, Lupton, 2013b; Swan, 2013) or considering its implications on areas like health care (e.g., Swan, 2009, 2012; Lupton, 2013a). In contrast, there have been few actual empirical studies concentrating, for example, on the adoption of self-tracking technologies in an attempt to answer such fundamental questions as how widely these technologies are actually used and by whom as well as what kind of factors drive or deter their adoption. In addition, the few prior studies that have been made on the topic, have all examined the phenomenon from a relatively narrow single technology perspective, such as the adoption of heart rate monitors (Makkonen et al., 2012a) or pedometers and route trackers (Makkonen et al., 2012b), whereas none of them have taken a wider multiple technology perspective concentrating on the simultaneous adoption of not only one, but several different self-tracking technologies. Such a wider perspective can be considered beneficial especially because it enables us to study also the potential dependencies in the adoption patterns of different technologies. For example, some technologies may act as "gatekeeper" technologies whose adoption is a necessary prerequisite for the adoption of other technologies. Similarly, there may also be technologies whose adoption hinders or totally blocks the adoption of others. Of course, also many other kinds of dependencies are possible, but observable only through the aforementioned multiple rather than single technology perspective.

In this study, we aim to address this gap in prior research by examining the adoption of four different self-tracking technologies from both single and multiple technology perspectives: exercise tracking, activity tracking, sleep tracking, and nutrition tracking. These four technologies can be seen as covering the most typical cases in which individuals today track themselves. We concentrate on adoption mainly from a macro-level diffusion perspective by examining the adoption rates and adoption patterns of the aforementioned technologies as well as their potential dependencies on gender and age, which have been found affecting technology adoption or acceptance in theories like the unified theory of acceptance and use of technology (UTAUT) by Venkatesh et al. (2003) as well as its successor UTAUT2 by Venkatesh, Thong and Xu (2012). However, our study differs from many adoption studies in terms of operationalising adoption not as a simple dichotomous variable, but taking into account also adoption interests. These adoption interests can be assumed to correlate with adoption intentions, which have been found as crucial antecedents of actual adoption in the aforementioned UTAUT and

UTAUT2 as well as also in their predecessor the technology acceptance model (TAM) by Davis (1989) as well as Davis, Bagozzi and Warshaw (1989).

This paper consists of six sections. After this introductory section, we briefly discuss the concepts of self-tracking and self-tracking technologies in Section 2. Sections 3 and 4 report the methodology and results of the study. The results are discussed in more detail in Section 5, which also uses them to draw implications for both theory and practice. Finally, Section 6 considers the limitations of the study and potential paths of future research.

2 Self-Tracking and Self-Tracking Technologies

In this study, with *self-tracking*, we refer to the activity of tracking one's physiological or psychological properties, behaviour, thoughts, or any other relevant aspect of oneself independent of the tracking context. However, there are also several other terms which are commonly used to refer to similar activities, such as quantified self, personal informatics, personal analytics, lifelogging, self-monitoring, and self-surveillance (Choe et al., 2014). Some of these can be considered synonyms to self-tracking, whereas others are more commonly used in specific tracking contexts.

Quantified self is nowadays one of the most commonly used of the aforementioned terms. Originally coined by Gary Wolf and Kevin Kelly (Wolf, 2009, 2010), it refers both to a community of people interested in self-tracking (Quantified Self Labs, 2016) as well as to self-tracking activity itself. In quantified self, there is typically a strong proactive stance towards not only obtaining data on oneself but also reflecting it and acting on it in a spirit of self-experimentation (Swan, 2013). Closely related concepts emphasising not only the data collection but also the data reflection aspect are *personal informatics* (Li, Dey & Forlizzi, 2010) and *personal analytics* (Wolfram, 2012). *Lifelogging*, in turn, refers to the activity of recording aspects of one's life in a digital form (Doherty et al., 2011) in an attempt to create a sort of a digital memory (Bell & Gemmel, 2009). Such activity may be passive, in which one only collects and stores the by-products of one's life, or active, in which one surrounds oneself with self-tracking technologies to create as rich a picture of one's life as possible (O'Hara, Tuffield & Shadbolt, 2008). A division can also be made between total capture and situation-specific capture, of which the former aims at a complete record of one's life, whereas the latter limits itself to specific situations (Sellen & Whittaker, 2010). However, lifelogging typically concentrates more on the data collection than on the data analysis aspect of self-tracking. Finally, *self-monitoring* is more commonly used in health care or mobile health (m-health) contexts (e.g., Lupton, 2013a). This also applies to self-surveillance, although it is typically used in more critical discussions about self-tracking (e.g., Lupton, 2012).

Respectively, with *self-tracking technologies*, we refer in this study to the technological solutions that enable self-tracking activities, such as the devices used in collecting the data on ourselves through sensors and other methods as well as the services used in storing and analysing this data. The variables tracked through these technologies can be categorised, for example, into diet, physical activities, psychological states and traits, mental and cognitive states and traits, environmental variables, situational variables, and social variables (Swan, 2013) or alternatively into exercise, work, mind, sleep, and nutrition (Arina, Sovijärvi & Halmetoja, 2016). This latter categorisation acts as a basis for the categorisation used in this study, in which we separate self-tracking technologies into exercise, activity, sleep, and nutrition tracking technologies.

3 Methodology

The data for this study comes from a self-administered online survey commissioned by the Finnish insurance company LähiTapiola and conducted by the market and opinion research company YouGov Finland between 9–11 February 2015 by using their panel of over 20,000 Finnish consumers. In the survey questionnaire, the respondents were first asked about their background information, such as gender, age, household income, and socioeconomic status. This was followed by questions on various health and well-being related topics, such as their insurances, health and well-being related spending, and opinions on public and private health service providers. Finally, the respondents were also asked about their adoption of exercise, activity, sleep, and nutrition tracking, and the responses to this question were used as the data for this study alongside with the information on gender and age. The question was a multiple-choice question consisting of two sub-questions in which the respondents reported (A) which of the four self-service technologies they had already adopted (i.e., were already using for self-tracking) and (B) which of the four self-service technologies they were interested in adopting (i.e., were interested in using for self-tracking). The exact wording of the question, translated from Finnish to English, is presented in Appendix A. Based on their answers to the question, the respondents were categorised as (1) adopters of a specific self-tracking technology if they had selected it in sub-question A, (2) being interested in adopting a specific self-tracking technology if they had not selected it in sub-question A but had selected it in sub-question B, and (3) non-adopters of a specific self-tracking technology if they had selected it in neither of the sub-questions. In addition, the respondents also had the option to indicate that they did not want to disclose their adoption or adoption interests, in which case they were excluded from further analyses.

This collected and categorised data was then analysed with the SPSS Statistics version 22 software in two phases. In the first phase, we concentrated on single technology perspective and conducted simple frequency analyses in order to examine the adoption and interest rates of each self-tracking technology. We also used contingency tables, the Pearson's residuals (or adjusted standardised residuals), and the Pearson's χ^2 tests to examine the dependencies of these rates on gender as well as one-way analysis of variance (1-ANOVA) and post-hoc multiple comparisons based on the Tukey's test to examine their dependencies on age. In the second phase, we concentrated on multiple technology perspective and conducted a latent class analysis with the Mplus version 7.11 software in order to examine whether the respondents could be categorised into two or more latent classes based on their adoption and adoption interest. The number of the latent classes was determined without any *a priori* assumptions in an explorative manner, meaning that we begun with a two-class model and incrementally increased the number of classes, each time testing whether the fit of the k-1 class model was as good or better than the fit of the k class model to the data (k being the number of classes). As a test for this, we used the three likelihood ratio tests implemented in Mplus, which are the Vuong-Lo-Mendell-Rubin likelihood ratio test (Vuong, 1989), the Lo-

Mendell-Rubin adjusted likelihood ratio test (Lo, Mendell & Rubin, 2001), and the parametric bootstrapped likelihood ratio test (McLachlan & Peel, 2000). In addition, we also used the information provided by Mplus on the most likely latent class membership of the respondents to conduct analyses on the potential dependencies of latent class membership on gender and age in a similar manner than in the first phase.

4 Results

The conducted online survey was responded by a total of 1,003 adult Finnish consumers. Of them, however, 179 had to be excluded as they had not disclosed their adoption and adoption interests, resulting in a sample of 824 respondents to be used in the actual analyses. Descriptive statistics of the sample before and after the exclusion are reported in Table 1. As can be seen, the exclusion did not seem to result in any serious distortions in terms of gender, age, income, and socioeconomic status of the respondents. Also when compared to the gender and age distributions of the adult Finnish population in 2015 (Statistics Finland, 2016), which are also reported in Table 1, the final sample can be considered to represent reasonably well the adult Finnish consumers. For example, the age of the respondents ranged from 18 to 81 years, with the mean age being 46.9 years (SD = 14.8 years).

	N = 1,003		N = 824		Finland
	N	%	N	%	%
Gender					
Male	476	47.5	382	46.4	48.8
Female	527	52.5	442	53.6	51.2
Age					
18–29 years	163	16.3	140	17.0	18.3
30–39 years	163	16.3	140	17.0	15.9
40–49 years	176	17.5	140	17.0	15.1
50–59 years	261	26.0	212	25.7	16.8
60– years	240	23.9	192	23.3	33.9
Household income					
–26,999 €	242	24.1	204	24.8	
27,000–53,999 €	290	28.9	244	29.6	
54,000–80,999 €	196	19.5	158	19.2	
81,000–107,999 €	70	7.0	60	7.3	
108,000– €	35	3.5	32	3.9	
No response	170	16.9	126	15.3	
Socioeconomic status					
Working	613	61.1	510	61.9	
Student	69	6.9	60	7.3	
Pensioner	217	21.6	168	20.4	
Other	90	9.0	75	9.1	
No response	14	1.4	11	1.3	

Table 1: Sample statistics before (N = 1,003) and after (N = 824) the exclusion

4.1 Results from Single Technology Perspective

The absolute number and the relative percentage of respondents who had not yet adopted (and were not interested in adopting), who were interested in adopting, and who had already adopted a specific self-tracking technology are reported in Table 2. As can be seen, exercise tracking was by far the most commonly adopted self-tracking technology among the respondents with an adoption rate of 22.6 %, followed by activity tracking with an adoption rate of 13.6 %, sleep tracking with an adoption rate of 5.2 %, and finally nutrition tracking with an adoption rate of 3.4 %. Respectively, the self-tracking technology that clearly arouse most interest among the respondents was sleep tracking with an interest rate of 37.7 %, followed by activity tracking with an interest rate of 30.1 %, nutrition tracking with an interest rate of 28.4 %, and finally exercise tracking with an interest rate of 19.9 %.

		N	%
Exercise tracking	Not adopted	474	57.5
	Interested	164	19.9
	Adopted	186	22.6
Activity tracking	Not adopted	464	56.3
	Interested	248	30.1
	Adopted	112	13.6
Sleep tracking	Not adopted	470	57.0
	Interested	311	37.7
	Adopted	43	5.2
Nutrition tracking	Not adopted	562	68.2
	Interested	234	28.4
	Adopted	28	3.4

Table 2: Numbers and percentages of non-adopters, interested, and adopters

Table 3 reports the percentage of non-adopters, adopters, and those interested in adopting a specific self-tracking technology separately for men and women, whereas the results of the Pearson's X^2 tests that were used to examine the statistical significance of the potential differences in the percentages are reported in Table 4. As can be seen, the tests supported the null hypothesis of no difference in the case of exercise and sleep tracking but rejected it in the case of activity and nutrition tracking, thus suggesting that the adoption and adoption interests of these two self-tracking technologies were dependent on gender. To investigate these dependencies in more detail, Table 3 reports also the Pearson's residuals, which can be used to examine the statistical significance of each potential difference individually. As can be seen, statistically significant differences were found only in the interest rates of activity and nutrition tracking, which suggested women being more interested in both of these two self-tracking technologies. Although the same seemed to apply also to exercise and sleep tracking, these differences were not statistically significant. In turn, men seemed to have somewhat higher adoption rates of exercise, sleep, and nutrition tracking than women and women a somewhat higher adoption rate of activity tracking than men, but none of these differences were statistically significant.

		Men		Women	
		%	Residual	%	Residual
Exercise tracking	Not adopted	58.4	0.460	56.8	-0.460
	Interested	17.0	-1.930	22.4	1.930
	Adopted	24.6	1.299	20.8	-1.299
Activity tracking	Not adopted	63.1	3.647***	50.5	-3.647***
	Interested	24.6	-3.194**	34.8	3.194**
	Adopted	12.3	-1.003	14.7	1.003
Sleep tracking	Not adopted	58.9	1.004	55.4	-1.004
	Interested	34.6	-1.755	40.5	1.755
	Adopted	6.5	1.591	4.1	-1.591
Nutrition tracking	Not adopted	72.8	2.619**	64.3	-2.619**
	Interested	23.3	-3.018**	32.8	3.018**
	Adopted	3.9	0.779	2.9	-0.779

Table 3: Percentages of adopters, interested, and non-adopters in terms of gender

Dependency	X^2	df	p
Gender x exercise tracking	4.379	2	0.112
Gender x activity tracking	13.812	2	0.001
Gender x sleep tracking	4.750	2	0.093
Gender x nutrition tracking	9.289	2	0.010

Table 4: Results of the Pearson's X^2 difference tests

Table 5 reports the mean age of the non-adopters, adopters, and those interested in adopting a specific self-tracking technology, whereas the results of the 1-ANOVA tests that were used to examine the statistical significance of the potential differences in the mean ages are reported in Table 6. As can be seen, in the case of all the four self-tracking technologies, the test rejected the null hypothesis of no difference, thus suggesting that their adoption and adoption interests were dependent on age. However, it must be noted that in most of the examined groups, the normality assumption of ANOVA was not met when it was investigated by using the Kolmogorov-Smirnov test. Although this is likely to result in some underestimations of the p values, these underestimations are likely be quite insignificant because prior studies have found ANOVA to be very robust against non-normality (e.g., Schmider et al., 2010). In contrast, the homoscedasticity assumption of ANOVA was met in all the examined groups when tested with the Levene's test. To investigate the dependencies in more detail, Table 5 reports also the results of the Tukey's tests, which can be used to examine the statistical significance of each potential difference individually. As can be seen, in the case of all the four self-tracking technologies, the mean age of the non-adopters was found to be about 4–6 years higher in comparison to adopters and those interested in adoption, and this difference was found to be statistically significant in all cases except for nutrition tracking. In contrast, in the case of any of the four self-tracking technologies, no statistically significant differences were found between adopters and those interested in adoption, although the adopters were found to be slightly younger in comparison to those interested in adoption in all cases except for activity tracking.

		Mean (years)	SD (years)	Mean difference (years)		
				Not adopted	Interested	Adopted
Exercise tracking	Not adopted	49.1	14.8	–	4.9***	5.3***
	Interested	44.1	13.8	-4.9***	–	0.4
	Adopted	43.8	14.6	-5.3***	-0.4	–
Activity tracking	Not adopted	49.1	14.9	–	5.2***	4.5**
	Interested	43.9	14.0	-5.2***	–	-0.7
	Adopted	44.6	14.8	-4.5**	0.7	–
Sleep tracking	Not adopted	49.0	14.7	–	4.6***	6.2*
	Interested	44.3	14.5	-4.6***	–	1.6
	Adopted	42.7	13.4	-6.2*	-1.6	–
Nutrition tracking	Not adopted	48.2	14.9	–	3.9**	5.0
	Interested	44.3	13.9	-3.9**	–	1.1
	Adopted	43.1	15.5	-5.0	-1.1	–

Table 5: Mean ages of non-adopters, interested, and adopters

Dependency	F	df_1	df_2	p
Age x exercise tracking	12.374	2	821	< 0.001
Age x activity tracking	11.858	2	821	< 0.001
Age x sleep tracking	11.242	2	821	< 0.001
Age x nutrition tracking	6.802	2	821	0.001

Table 6: Results of the 1-ANOVA tests

4.2 Results from Multiple Technology Perspective

Table 7 reports the results of the Vuong-Lo-Mendell-Rubin likelihood ratio test (VLMR), the Lo-Mendell-Rubin adjusted likelihood ratio test (LMR), and the parametric bootstrapped likelihood ratio test (BLRT), which were used to test the null hypothesis of the fit of the k-1 class model being as good or better than the fit of the k class model to the data (k being the number of classes). As we can see, all the tests started to support the null hypothesis when k = 5, thus suggesting that four latent classes were sufficient for our estimated model.

k-1 vs. k latent classes	p of VLMR	p of LMR	p of BLRT
1 vs. 2 latent classes	< 0.001	< 0.001	< 0.001
2 vs. 3 latent classes	0.001	0.001	< 0.001
3 vs. 4 latent classes	0.001	0.001	< 0.001
4 vs. 5 latent classes	0.253	0.259	0.286

Table 7: Results of the likelihood ratio tests

Table 8 reports the model estimation results in a probability scale. The probabilities are conditional probabilities indicating how likely a member of a particular latent class is to not have adopted (and not being interested in adopting), be interested in adopting, or have already adopted a specific self-tracking technology. For example, we can see that the members of the first latent class are almost certain to have adopted activity and exercise tracking and also quite likely to have adopted sleep and nutrition tracking or at least being interested in adopting them. In contrast, the members of the second latent class are quite likely to have adopted exercise and activity tracking but unlikely to have adopted sleep and nutrition tracking. However, they are quite likely to be interested in adopting especially sleep tracking but also activity and nutrition tracking. In turn, the members of the third latent class are unlikely to have adopted any of the four self-tracking technologies, with the potential exception of exercise tracking, but they are extremely likely to be interested in adopting activity, sleep, and nutrition tracking as well as potentially also exercise tracking if not having already adopted it. Finally, we can see that the members of the fourth latent class are extremely unlikely to have adopted or being interested in adopting any of the four self-tracking technologies, with the slight exception of exercise tracking.

		LC1	LC2	LC3	LC4
Exercise tracking	Not adopted	0.000	0.533***	0.018	0.920***
	Interested	0.198*	0.191***	0.664***	0.029
	Adopted	0.802***	0.275***	0.319***	0.051**
Activity tracking	Not adopted	0.000	0.445***	0.000	0.982***
	Interested	0.011	0.389***	0.935***	0.018
	Adopted	0.989***	0.166***	0.065	0.000
Sleep tracking	Not adopted	0.068	0.431***	0.041	0.988***
	Interested	0.547***	0.509***	0.934***	0.009
	Adopted	0.385***	0.060**	0.024	0.003
Nutrition tracking	Not adopted	0.235*	0.690***	0.027	0.996***
	Interested	0.582***	0.290***	0.886***	0.000
	Adopted	0.183**	0.019	0.087**	0.004

Table 8: Results of the latent class analysis

The model estimation results also include the most likely latent class membership of each respondent, which can be used to approximate the absolute and relative sizes of the latent classes. In terms of size, the fourth latent class was found as the largest of the four (43.6 % of population), followed by the second latent class (33.6 % of population), the third latent class (15.8 % of population), and finally the first latent class (7.0 % of population). In addition, the most likely latent class memberships were also used to examine the potential dependencies of latent class membership on gender and age in similar manner than in the previous sub-section.

Table 9 reports the sizes of latent classes separately for men and women. When the statistical significance of the potential differences in these sizes was tested with the Pearson's X^2 test, its results rejected the null hypothesis of no difference ($X^2(3) = 8.238$, $p = 0.041$), thus suggesting a dependency between gender and latent class membership. However, when using the Pearson's residuals to examine this dependency in more detail, a statistically significant difference was found only in the fourth latent class, which was more dominated by men than women. In contrast, the second and third latent class seemed to be more dominated by women than men, but these differences were not statistically significant. The first latent class practically consisted of an equal number of men and women.

	Men		Women	
	%	Residual	%	Residual
Latent class 1	6.8	0.010	6.8	-0.010
Latent class 2	30.6	-1.755	36.4	1.755
Latent class 3	13.6	-1.500	17.4	1.500
Latent class 4	49.0	2.766**	39.4	-2.766**

Table 9: Gender differences between the latent classes

Table 10 presents the mean age of the members of each latent class. When the statistical significance of the potential differences in the mean ages was tested with the 1-ANOVA test, its results once again rejected null hypothesis of no differences ($F(3, 820) = 8.988$, $p < 0.001$), thus suggesting a dependency between age and latent class membership. Also in this case, the normality assumption was not met in any of the latent classes but the homoscedasticity assumption was met in all of them. When examining this dependency in more detail with the Tukey's test, statistically significant differences were found only between the mean age of the fourth latent class and the mean ages of all the other three latent classes. In the first and third latent classes, the mean ages were about 6–7 years lower in comparison to the fourth latent class, whereas in the second latent class, the mean age was about three years lower in comparison to the fourth latent class.

	Mean (years)	SD (years)	Mean differences (years)			
			LC1	LC2	LC3	LC4
Latent class 1	43.6	14.5	–	-2.7	1.2	-5.8*
Latent class 2	46.3	14.9	2.7	–	3.9	-3.1*
Latent class 3	42.4	13.7	-1.2	-3.9	–	-7.1***
Latent class 4	49.5	14.6	5.8*	3.1*	7.1***	–

Table 10: Age differences between the latent classes

5 Discussion and Conclusions

In this study, we examined the adoption and adoption interests of four self-tracking technologies related to exercise, activity, sleep, and nutrition tracking from both single technology and multiple technology perspectives and by concentrating especially on the potential gender and age dependencies in their adoption rates and adoption patterns. From single technology perspective, we found that the adoption rates of all the four self-tracking technologies still remained relatively low. Exercise tracking had the highest adoption rate of about 20–25 %, which was expected as this technology has the longest history of the four. For example, the first wireless wearable heart rate monitors were launched already in the early 1980s (Polar Electro, 2016), whereas most of the modern activity trackers, such as Fitbit, date back to the late 2000s or early 2010s (TechCrunch, 2009). However, although having not yet adopted, many consumers were interested in adopting self-tracking technologies. Sleep tracking had an interest rate of about 40 %, followed closely by activity and nutrition tracking with interest rates of about 30 %. Also some clear gender and age dependencies were observed. In terms of gender, women seemed to be more interested in adoption but men actually being more apt adopters with the exception of activity tracking. In terms of age, the non-adopters with no adoption interests were found to be slightly older in comparison to the adopters and those interested in adoption in the case of all the four self-tracking technologies.

From multiple technology perspective, we were able to identify four different consumer segments with distinct adoption patterns. We interpret and label the first of these segments as “pro-trackers” because it consisted of individuals who typically had adopted all or almost all of the four self-tracking technologies or at least were very interested in their adoption. As such, they seemed to be very into the whole self-tracking phenomenon and potentially members of the quantified self community. The second segment is the most ambiguous of the four and we interpret and label it cautiously as “semi-trackers” because the individuals in it clearly lagged behind the previous segment in terms of the actual adoption and adoption interests of all the four self-tracking technologies but seemed to be on a way of becoming more and more active self-trackers based on their adoption and interest rates. This segment was also found to be more dominated by women than men. The third segment is interpreted and labelled as “interested” because it consisted of individuals who had not yet actually adopted any of the four self-tracking technologies, with the potential exception of exercise tracking, but had extremely high adoption interests towards all of them. This unspecified nature of the interests would seem to imply that these individuals were actually not so familiar with the whole self-tracking concept in comparison to the previous two segments but simply liked the general idea of being able to track various aspects of themselves. This was the segment with the lowest mean age and also more dominated by women than men. Finally, we interpret and label the fourth segment as “non-trackers” because the individuals in it were clearly non-adopters of and not interested in any of the four self-tracking technologies, thus suggesting that the whole concept of self-tracking most likely felt strange or awkward to them. This segment was found to be significantly more dominated by men than women and also having the highest mean age, which is in line with our previous findings from single technology perspective.

An alternative interpretation of the segments can also be drawn from the theorisation by Rogers (2003) that the potential adopter population of an innovation can be divided into five different adopter categories based on their innovativeness (i.e., relative time of adoption): innovators (2.5 % of population), early adopters (13.5 % of population), early majority (34.0 % of population), late majority (34.0 % of population), and laggards (16.0 % of population). When these five adopter categories are compared to the four segments we identified in this study, a striking resemblance can be observed both in terms of adopter characteristics and category proportions. Therefore, “pro-trackers” may also potentially be interpreted as the innovators or as a combination of innovators and early adopters of self-tracking technologies, “semi-trackers” as the early majority, “interested” as the more innovative part of the late majority, and “non-trackers” as a combination of the less innovative part of the late majority and laggards.

From the aforementioned findings, three main practical implications can be drawn. First, there seem to be considerable business opportunities for the providers of self-tracking technologies especially among the slightly more female than male dominated segments of “semi-trackers” and “interested”, who were found to constitute almost half of our sample. In them, the adoption rates of self-tracking technologies still remained very low but the interest rates very high. Of the two, the most potential segment is probably the "semi-trackers", not only because of its larger size, but because its members are more likely to already have experience on some self-tracking technologies and therefore more easily persuaded into adopting also others. In contrast, the members of the "interested" segment with a very unspecified initial interest towards the self-tracking concept in general may be more challenging to be converted into actual adopters of specific self-tracking technologies.

Second, if the identified segments are interpreted as adopter categories in accordance with the theories of Rogers (2003), then the resulting temporal connection between the segments can potentially be used to extrapolate the future adoption of each of the four self-tracking technologies. In addition to such macro-level predictions, it may also be used on a micro-level to explain how the adoption process of these technologies is likely to progress in the case of an average consumer: first from a "non-adopter" with no adoption interests to an "interested" with an initial interest towards the self-tracking concept in general and potentially also some initial experiences of exercise tracking, then to a "semi-tracker" with more specified interests and also more experiences of exercise as well as activity tracking, and finally to a "pro-tracker" with a varied usage and vast interest towards all the four technologies. How fast or slowly a particular individual transits from one phase to another on this "adoption path", is ultimately determined by his or her innovativeness.

Third, regarding to this "adoption path", there are also indications that exercise tracking plays a central role in the aforementioned transitions from one phase into another. As mentioned above, exercise tracking was found as the most commonly adopted or at least one of the most commonly adopted self-tracking technology not only among "pro-trackers", but also among "semi-tackers" and "interested". Although our data does not tell anything about the temporal order in which the different technologies were adopted, this could imply that exercise tracking is typically the first or one of the first self-tracking technologies that individuals adopt and which then introduces them to the whole concept of self-tracking and increases their interest towards other self-tracking technologies. Of course, over time, this increasing interest towards other self-tracking technologies may cause some individuals to actually switch exercise tracking to these other technologies and result in discontinued adoption. For example, among "pro-trackers", we found that the adoption rate of activity tracking was actually higher than the adoption rate of exercise tracking, which could be an indication of such switching. Respectively, among "semi-trackers" the relative difference between the adoption rates of exercise and activity tracking was actually smaller than among "interested", which could also be caused by similar kind of switching. However, in spite of whether or not such switching occurs at a later occasion, the central role of exercise tracking as an introductory technology obviously means that the most potential segments for adopting activity, sleep, and nutrition tracking technologies are the consumers who already track their exercise in one way or another, making it more sensible for businesses to take this segment as a target of different kinds of marketing activities rather than consumers who do not yet track any aspect of themselves. Of course, it must be noted that this central role of exercise tracking may change over time as technologies continue to develop and new consumer generations enter the market. For example, among "semi-trackers", one explanation for the relatively more even adoption rates of exercise and activity tracking in comparison to "interested" may also be the fact that activity tracking has already begun to take the role of exercise tracking as an introductory technology.

Finally, as a main theoretical implication, the findings of the study underline the value of the utilised multiple technology perspective in examining technology adoption in terms of being able to highlight the potential dependencies in the adoption patterns as discussed above. Although this perspective has been commonly used in adoption studies especially in the agricultural context (e.g., Dorfman, 1996), the studies utilising it in the context of information systems (IS) have been relatively rare, with most studies and theories, such as TAM, UTAUT, and UTAUT2, typically taking only a single technology perspective. However, this study can hopefully, for its part, act as an impetus for its more prevalent utilisation also in the IS context.

6 Limitations and Future Research

The main limitation of this study is that it concentrated on examining the adoption of self-tracking technologies only in the case of Finnish consumers and by using a relatively simple research setting and operationalisations of the adoption and adoption interest concepts, which did not consider, for example, how frequently the four self-tracking technologies were used or how frequently the data collected by using them was viewed or otherwise accessed. This obviously limits the generalisability of its findings and calls for future studies in which these limitations are addressed. In these studies, more attention should also be paid on potential sampling biases in terms of, for example, technology readiness and lifestyle issues. In addition to the macro-level perspective taken in this study, future studies would also benefit from taking a more micro-level perspective to the topic and examining, for example, what kind of concrete antecedents can be found behind the decisions of individual consumers to adopt or not to adopt a specific self-tracking technology. However, also in this case, it is preferable to do such examinations from a multiple rather than single technology perspective in order to be able to perceive the potential homogeneity or heterogeneity in these antecedents between different technologies.

References

Arina, T., Sovijärvi, O., & Halmetoja, J. (2016). *Biohacker's Handbook*. Retrieved from http://biohackingbook.com

BCC Research (2015). *Health Self-Monitoring: Technologies and Global Markets*. Retrieved from http://www.bccresearch.com/market-research/healthcare/health-self-monitoring-technologies-global-markets-report-hlc185a.html

Bell, G., & Gemmell, J. (2009). *Total Recall: How the E-Memory Revolution Will Change Everything*. New York, NY: Penguin Group.

Choe, E. K., Lee, N. B., Lee, B., Pratt, W., & Kientz, J. A. (2014). Understanding Quantified-Selfers' Practices in Collecting and Exploring Personal Data. In *Proceedings of the 32nd ACM Conference on Human Factors in Computing Systems (CHI 2014)*, April 26–May 1, 2014 (pp. 1143–1152). Atlanta, GA: ACM. doi:10.1145/2556288.2557372

Davis, F. D. (1989). Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Quarterly*, *13*(3), 319–340. doi:10.2307/249008

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1989). User Acceptance of Computer Technology: A Comparison of Two Theoretical Models. *Management Science*, *35*(8), 982–1003. doi:10.2307/ 2632151

Doherty, A. R., Caprani, N., Conaire, C. Ó., Kalnikaite, V., Gurrin, C., Smeaton, A. F., & O´Connor, N. E. (2011). Passively Recognising Human Activities through Lifelogging. *Computers in Human Behavior*, *27*(5), 1948–1958. doi:10.1016/j.chb. 2011.05.002

Dorfman, J. H. (1996). Modeling Multiple Adoption Decisions in a Joint Framework. *American Journal of Agricultural Economics*, *78*(3), 547–557. doi:10.2307/1243273

Li, I., Dey, A., & Forlizzi, J. (2010). A Stage-Based Model of Personal Informatics Systems. In *Proceedings of the 28th ACM Conference on Human Factors in Computing Systems (CHI 2010)*, April 10–15, 2010 (pp. 557–566). Atlanta, GA: ACM. doi: 10. 1145/1753326.1753409

Lo, Y., Mendell, N. R., & Rubin, D. B. (2001). Testing the Number of Components in a Normal Mixture. *Biometrika*, *88*(3), 767–778. doi:10.1093/biomet/88.3.767

Lupton, D. (2012). M-Health and Health Promotion: The Digital Cyborg and Surveillance Society. *Social Theory & Health*, *10*(3), 229–244. doi:10.1057/sth.2012.6

Lupton, D. (2013a). The Digitally Engaged Patient: Self-Monitoring and Self-Care in the Digital Health Era. *Social Theory & Health*, *11*(3), 256–270. doi:10.1057/sth.2013.10

Lupton, D. (2013b). Understanding the Human Machine. *IEEE Technology and Society Magazine*, *32*(4), 25–30. doi:10.1109/MTS.2013.2286431

Makkonen, M., Frank, L., Kari, T., & Moilanen, P. (2012a). Examining the Usage Intentions of Exercise Monitoring Devices: The Usage of Heart Rate Monitors in Finland. In *Proceedings of the 18th Americas Conference on Information Systems (AMCIS 2012)*, August 9–11, 2012 (Paper 13). Retrieved from http://aisel. aisnet.org/amcis2012/proceedings/AdoptionDiffusionIT/13/

Makkonen, M., Frank, L., Kari, T., & Moilanen, P. (2012b). Examining the Usage Intentions of Exercise Monitoring Devices: The Usage of Pedometers and Route Trackers in Finland. In *Proceedings of the 29th Bled eConference (BLED 2012)*, June 19–22, 2012 (Paper 18). Retrieved from http://aisel.aisnet.org/bled2012/18/

McLachlan, G. & Peel, D. (2000). *Finite Mixture Models*. New York, NY: Wiley.

O'Hara, K., Tuffield, M. M., & Shadbolt, N. (2008). Lifelogging: Privacy and Empowerment with Memories for Life. *Identity in the Information Society*, *1*(1), 155–172. doi:10. 1007/s12394-009-0008-4

Polar Electro (2016). *Who We Are*. Retrieved from http://www.polar.com/us-en/about_ polar/who_we_are/

Quantified Self Labs (2016). *Quantified Self*. Retrieved from http://quantifiedself.com

Rogers, E. M. (2003). *Diffusion of Innovations* (5th ed.). New York, NY: Free Press.

Schmider, E., Ziegler, M., Danay, E., Beyer, L., & Bühner, M. (2010). Is It Really Robust? Reinvestigating the Robustness of ANOVA Against Violations of the Normal Distribution Assumption. *Methodology: European Journal of Research Methods for the Behavioral and Social Sciences*, *6*(4), 147–151. doi:10.1027/1614-2241/ a000016

Sellen, A., & Whittaker, S. (2010). Beyond Total Capture: A Constructive Critique of Lifelogging. *Communications of the ACM*, *53*(5), 70–77. doi:10.1145/1735223.1735243

Smarr, L. (2012). Quantifying Your Body: A How-To Guide from a Systems Biology Perspective. *Biotechnology Journal*, *7*(8), 980–991. doi:10.1002/biot.201100495

Statistics Finland (2016). *Statistics Finland*. Retrieved from http://www.stat.fi

Swan, M. (2009). Emerging Patient-Driven Health Care Models: An Examination of Health Social Networks, Consumer Personalized Medicine and Quantified Self-Tracking. *International Journal of Environmental Research and Public Health*, *6*(2), 492–525. doi:10.3390/ijerph6020492

Swan, M. (2012). Health 2050: The Realization of Personalized Medicine through Crowdsourcing, the Quantified Self, and the Participatory Biocitizen. *Journal of Personalized Medicine*, *2*(3), 93–118. doi:10.3390/jpm2030093

Swan, M. (2013). The Quantified Self: Fundamental Disruption in Big Data Science and Biological Discovery. *Big Data*, *1*(2), 85–99. doi:10.1089/big.2012.0002

TechCrunch (2009). *It Took a Year, But Fitness Gadget Fitbit Will Finally Launch*. Retrieved from http://techcrunch.com/2009/09/24/it-took-a-year-but-fitness-gadget-fitbit-finally-launches/

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User Acceptance of Information Technology: Toward a Unified View. *MIS Quarterly*, *27*(3), 425–478.

Venkatesh, V., Thong, J. Y. L., & Xu, X. (2012). Consumer Acceptance and Use of Information Technology: Extending the Unified Theory of Acceptance and Use of Technology. *MIS Quarterly*, *36*(1), 157–178.

Vuong, Q. H. (1989). Likelihood Ratio Tests for Model Selection and Non-Nested Hypotheses. *Econometrica*, *57*(2), 307–333. doi:10.2307/1912557

Wintergreen Research (2015). *Smart Wearables, Sport and Fitness: Market Shares, Strategy, and Forecasts, Worldwide, 2015 to 2021*. Retrieved from http://www.researchandmarkets.com/research/867x4t/smart_wearables

Wolf, G. (2009). Know Thyself: Tracking Every Facet of Life, from Sleep to Mood to Pain, 24/7/365. *Wired*, *17*(7), 92–95. Retrieved from http://www.wired.com/2009/06/lbnp-knowthyself/

Wolf, G. (2010). The Data-Driven Life. *The New York Times*. Retrieved from http://www.nytimes.com/2010/05/02/magazine/02self-measurement-t.html

Wolfram, S. (2012). *The Personal Analytics of My Life*. Retrieved from http://blog.stephenwolfram.com/2012/03/the-personal-analytics-of-my-life/

Appendix A: Question Wording

Do you track the following aspects of your health behaviour with a technological tool (e.g., a smart phone or smart bracelet) or which of them would you be willing to track with technological tools in the future?

I already track:	**I would be interested in tracking:**
□ Exercise (duration, amount, strain, calories, etc.)	□ Exercise (duration, amount, strain, calories, etc.)
□ Daily physical activity (steps, calories, etc.)	□ Daily physical activity (steps, calories, etc.)
□ Amount and quality of sleep	□ Amount and quality of sleep
□ Eating and nutritional intake	□ Eating and nutritional intake
□ I cannot say	□ I cannot say

29th Bled eConference

Digital Economy

June 19 - 22, 2016; Bled, Slovenia

Teaching Software Engineering in the Cloud: *Applying Cloud Computing Services in E-Business Education*

Prof. Dr. Markus Grüne

Frankfurt University of Applied Sciences, Germany

magruene@fb3.fra-uas.de

Abstract

Teaching Business Information Systems topics at academic institutions can profit a lot from applying the theoretical knowledge in hands-on exercises in- and outside the class room employing standard software. Most software vendors provide academic licenses for their products which can be utilized by academic institution. The installation and maintenance of software products especially at Universities of Applied Sciences is usually not feasible due to staffing, knowledge, and funding restrictions. Cloud services lower these "barriers of entry". This paper provides a show case which demonstrates how cloud services can be combined in a course setting teaching "E-Business" in an undergraduate course at Frankfurt University of Applied Sciences. During exercises in a PC lab and on their own devices, the usage of Cloud services allowed students to gain practical experience in working with an industry standard collaborative code versioning system (git).

Keywords: E-Learning, Software Engineering, Code Management, Cloud Computing Services

1 Introduction

Teaching Software Engineering, e.g., in undergraduate courses at academia, regularly requires the installation of information systems, integrated development environments, databases and other technological infrastructure components to allow students to gain hands-on experience and build up expertise for the job market (Zhu, 2015). The work spent on self-hosting information systems and IT products is usually wasted. This article describes a way for teaching Software Engineering principles on Cloud services and contrasts this to the "traditional way" of self-hosting products for teaching. Unfortunately, Cloud services are not used frequently in teaching. We hope to provide a relevant show case in this article which can be extended to future courses at Frankfurt University of Applied Sciences and beyond. It extends known solutions (Cloud Services) to a general problem in IS teaching (technology management for teaching). In terms of Design Sciences Research, the research focuses on improvement and exaptation (Gregor & Hevner, 2013). Further research is required to generalize the observations.

2 Related Work and traditional IS Teaching Approach

Although Cloud Services have matured over the recent decades, only few papers have been published addressing the differences in efforts when using Cloud Services instead of self-hosted Information Systems. Cloud Services are being used by many universities for teaching IT topics such as cyber security analysis skills (Weiss et al., 2015), big data analysis (Rabkin, Reiss, Katz, & Patterson, 2013), or programming in Java (Hollingsworth & Powell, 2010). The article tries to show case the benefits of Cloud Services in teaching IS.

2.1 Traditional Teaching Approach – Self-hosting

Many software products that can be used in teaching, e.g., relational database management systems (DBMS) or business process management systems (BPMS), are available under academic licensing and can be freely installed and used in the university's hosting environment. Teachers and instructors using these products in the curriculum have to invest a considerable amount of time for administration of the software and hardware (self-administration) and for their own training as well as to invest in training of administrative IT staff to keep pace with technological changes. Although this time is not wasted, it would be more beneficial, if it were used for working with the students.

The following list shows sample aspects / areas that need to be addressed, reflecting the author's experience when self-administering and installing a software product:

- *Ordering of hardware*– Often processes for ordering the hardware are unknown to the instructor. The IT department may be split across different organizational units, e.g., one team at departmental level plus a central IT which executes the final purchasing requests.
- *Configuring the server machines* and *installing the operating system* – Configuring the server machines and the operating system requires specialized knowledge on hardware and the operating system itself. Hardware can be anything from a server running at the teacher's individual desk up to blades running in data centre racks. For large, computation-intensive architectures, it is usually required to prepare server images that can be easily added to a grid of servers.
- *Installing the software products and running regular patches* – The installation of the product often requires setting up of individual user roles. Regular patches are necessary to keep the software up-to-date and for closing security gaps. Procedures for removal of the software and all associated sensitive data need to be defined.
- *Integration of the product into the academic institution's network* –Institutions should keep the "training infrastructure" on nodes that are separated from the core campus

network to avoid adverse impact on the daily work of the staff and IT-based operations of the university.

- *Defining a security concept including firewalls, identity and access management for administrators and student users* – Universities in Germany are subject to laws and policies which enforce privacy and security of the students' personal data. The storage of private user data in the university's network can be seen as a major driver to not use Cloud-based solutions.
- *Penetration testing in case the software product will be Web-facing*
- *Operating the new product* including backup of data, reacting to downtimes. This includes maintenance and migration of data to new versions of the software.
- Finally u*sing the product within the course context* Students will be measured e.g. by automated grading versus manual grading of assignments.

2.2 Taking IT and Teaching into the Cloud

The overheads for self-hosting the IT products required for teaching in the academic institution's network as highlighted in section 1 are often prohibitive for the instructors. The usage of Cloud Computing Services (CCS) being available for numerous software products can help to reduce these overheads. According to (Bengel, Baun, Kunze, & Stucky, 2015), the "basic concepts as well as [its] general objectives" of cloud computing are "undisputed: Cloud computing uses virtualizatioM8rxBrn and the modern Web to dynamically provide resources of various kinds as services which are provisioned electronically. These services should be available in a reliable and scalable way so that multiple customers can use them".

2.2.1 Cloud Computing

Cloud Computing Services (CSS) are based on *utility computing* where users pay for the amount of services used and on *grid computing* which allows consumers to share hardware resources and add resources to the grid when required (Marinescu, 2013). CCS can be set up in private environments (*private clouds*) or in public environments for use by many institutions and individuals (*public clouds*), or combining both (*hybrid clouds*) (NIST, 2011). CCS are meeting international standards for security such as the standards proposed by the Cloud Security Alliance and promise to be as reliable as self-hosted software installations. Cloud computing services reach from simple server and file hosting solutions up to complex IT products such as Enterprise Resource Planning (ERP) systems. Large software vendors consider cloud computing knowledge as a valuable asset for students when searching for a job and have established programs for academic institutions (e.g. (IBM, 2016), (AWS, 2016), (Microsoft, 2016)).

2.2.2 Scenarios for Cloud Computing in Teaching

The scenarios for usage of CCS in teaching can range from using Cloud-hosted infrastructure (IaaS, mainly in terms of operating system) up to Software-as-a-Service (SaaS) solutions in which the product is used directly over the cloud for teaching (Pardeshi, 2014). In the second scenario, all installation, maintenance and operation of the software product lie in the responsibility of the cloud provider. In the course setting which is described below, public cloud services of type SaaS and IaaS were used in combination.

2.2.3 Using cloud-based Solutions in Teaching E-Business

The module "E-Business" is lectured each summer term at Frankfurt University of Applied Sciences (UAS) for students of "International Business Information Systems" (IBIS). It consists of a lecture which highlights major concepts of E-Business and two exercise tracks. In the first track underlying economic principles of E-Business (market types, production functions, etc.) are explained (VanHoose, 2014), whereas the second exercise track focuses on the application of software development practices for engineering E-Business applications (so-called "*programming exercises*").

During the programming exercises students are asked to collaboratively build a small software application in HTML5 and JavaScript after an introduction to software delivery lifecycle models (waterfall, agile, continuous integration) and collaborative development concepts (code versioning systems, git, branching). Approximately 100 students were registered for the programming exercises.

3 Setting up a Cloud-based Course Environment

Setting up a course environment required the combination of multiple CCS from different providers. The CCS listed in Table 1 were used and integrated to provide a consistent user experience to the students in the course.

CCS services selected based on their prospective ease of use. Especially the user administration within Bitbucket helped to keep the setup of the Integrated Development Environment (IDE) to a minimum as Bitbucket user credentials could be re-used for log in. Only for the creation of the working environment within the IDE students had to copy a URL and key in the Bitbucket password for cloning the central repository.

The Elastic Cloud Virtual Server setup was straight forward, only requiring the installation of the Jenkins server and the Apache Web Server. Code deployment for the students on the server was automatically triggered by Jenkins based on a Bitbucket hook that checked whether a new commit version was available in the master branch of the central repository.

The following paragraph describes a typical scenario for code development and deployment in the programming exercise.

3.1 Using cloud services for programming exercises

Figure 1 summarizes the standard scenario which was used for the development and deployment of HTML5 code in the course setting. For the setup of Cloud 9 for personal use, students opened their "dashboard" in Cloud 9 and cloned the central repository from Bitbucket (not shown).

Cloud service used	Usage scenario	Advantages and comments
Cloud9 (www.c9.io)	An integrated development environment (IDE) that can be used for developing software applications in major programming languages	Installation of an IDE could be avoided, both on the participants' computers as well as on the computers in the PC pool. Integrates nicely with github.org and bitbucket.org. Bitbucket accounts can be used for log in. User interface shows a code editor, a bash console and a preview browser for test running code. JavaScript / HTML 5 and major JavaScript frameworks are supported. Students can use one personal "workspace" for free.
Atlassian Bitbucket (bitbucket.org)	A central service for hosting code repositories. Code repositories can either be git or mercurial repositories.	Unlimited use under an academic license. Visualization of the check ins, branching and versions of the centrally hosted repositories. Credentials could be used also to automatically log in into Cloud 9. Some training material from Atlassian could be used for teaching git. Apart from code management, Bitbucket was used for the management of support tickets for the course. Instead of git, also mercurial could be used.
Amazon Elastic Cloud (aws.amazon.com)	Server hosting (Apache Tomcat) for the HTML5 applications that were built by the students. Many more services are available at AWS.	Elastic Cloud (EC2) is part of the Amazon Web Services (AWS) technology products portfolio. EC2 Linux server was used for hosting a web server and a Jenkins server for continuous deployment. For demonstration purposes, both servers were hosted on the same virtual machine. AWS supports academic initiatives by offering grants and subsidized trainings. The usage of AWS was very basic, but will be extended in future.

Table 1: Cloud services used in the course

Afterwards they had to follow the Gitflow workflow for the management of code changes (https://de.atlassian.com/git/tutorials/comparing-workflows/ gitflow-workflow). In Gitflow, all changes and enhancements to a software product are based on feature branches that are derived from the develop branch. Besides the develop branch, the master branch is used to keep the latest stable version of a software product that was released. Usually, changes that were merged from feature branches into the develop branch will be included in the master / release branch once the develop branch is merged into it. The students created feature branches before they coded. After finishing the coding, every student had to raise a pull request against the teacher who then confirmed that the student's changes could be merged into the develop branch

For publishing the code changes to the Web Server two steps were required by the teacher:

1. The pull requests had to be confirmed before the students were permitted to merge their features into the develop branch and
2. All code changes had to be merged into the master branch.

Jenkins took notice of any new versions of the master branch and deployed the changes to the Apache Web Server without any further manual interaction (continuous integration).

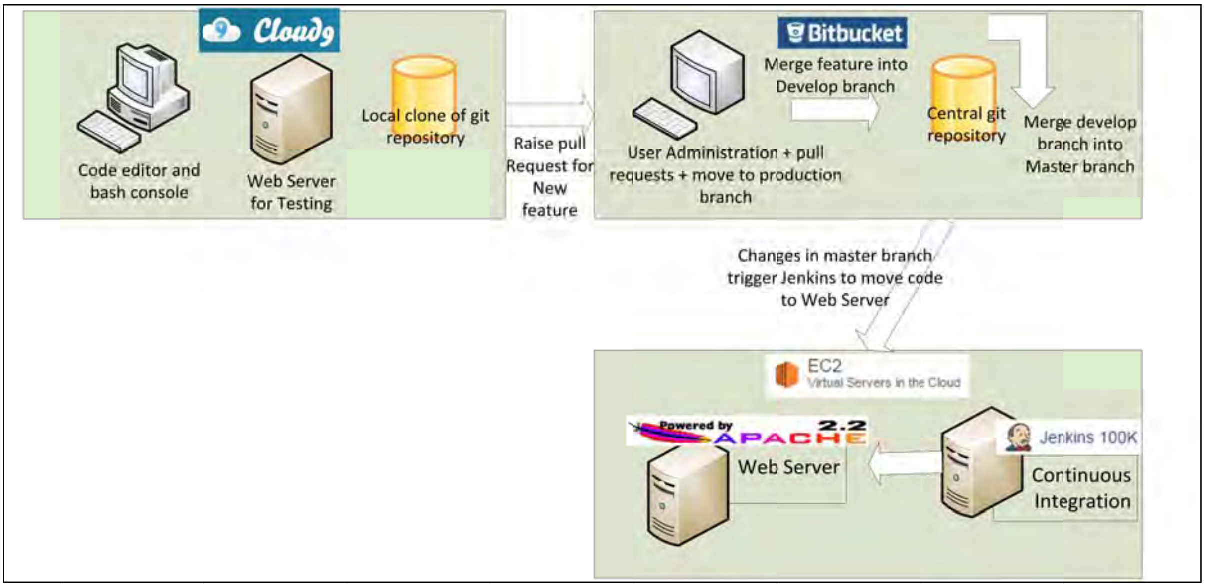


Figure 1: Orchestration of loud services to construct the learning environment

4 Results and Evaluation

The following paragraphs highlight benefits and limitations of cloud services in teaching. Further application scenarios and benefits for cloud computing in academic institutions can be found, e.g., in (Mokhtar, Ali, Al-Sharafi, & Aborujilah, 2013).

4.1 Benefits of using Cloud Service in Teaching

4.1.1 Independence of Devices and easy Re-installations

One of the main benefits for students working in the cloud is that they are not required to install any software on their personal devices. The only restriction is the availability of a current Web browser. The Cloud9 IDE was available with very small downtimes. After closing the browser session of the IDE, the users were able to log in exactly in the same environment setting as they left it. As all code was kept in a central repository, the users were able to re-install a cloud IDE workspace by cloning the central repository within less than 2 minutes. This was helpful as some student users misconfigured their frontends and it would have taken more time to undo the users' misconfigurations than simply setting up the IDE workspaces from scratch. At the time of writing, the Cloud 9 IDE does not support IE 10. All other browsers, irrespective of operating system, could be used. Students accessed their IDE from multiple devices (tablets, laptop computers, and the computers at the university's PC lab). Users also did not have to care about backups. As a positive side effect, the students did not raise any OS specific support cases regarding the installation of software, missing drivers, hardware issues, etc.

4.1.2 Independence from local IT Teams and Hardware Provisioning

The local IT team was not involved in the maintenance of the PC pool or for installing software for the specific purpose of the course. For future courses, the IT team will be involved for the creation of higher level services by integrating the IDE and the source code repository with Moodle, the E-Learning System at UAS. The independence from technical infrastructure also means that all organizational processes for the provisioning of hardware were irrelevant and therefore, the administrative overhead could be reduced to a bearable minimum. The goal of the course could be reached with minimal effort avoiding the overheads of a "traditional installation" that were described in section 1.

4.1.3 Public private partnerships

Cloud computing service providers like Amazon do have an interest in spreading the knowledge on their cloud products by engaging with academic institutions as this helps to train students in technologies that are used in industry and gain direct access to trained resources. The engagement varies from the provisioning of "grants" for infrastructure, subsidized training courses for teaching staff up to the contribution of courseware and whole training courses that can be offered also to students.

4.1.4 Benefits from the Architecture used in the Course

The environment set up for the course allowed for teaching current software engineering practices. It helped to demonstrate to the students how to work with source code and to learn agile development practices. For a full "simulation" of industry practices which would include staging, quality assurance and automated deployments, the architecture would need to be enhanced by adding applications.

4.1.5 Didactical Concept

First and foremost, CCS enable the students to play with technological concepts in a very lean way. Installation of software is not required which lowers the barriers of entry for many students focusing more on managerial areas within their studies of Business Information Systems than on technological aspects. Secondly, students could directly gain practical knowledge by learning collaborative coding in a team. The knowledge gained is important to understand the software delivery lifecycles in large IT organizations.

4.2 Limitations of using the Cloud in Teaching

4.2.1 Compliance Aspects

Using cloud services means that students had to create one account with Atlassian to use Bitbucket. In future courses, especially for course settings where the usage of cloud services is mandatory, compliance to the university's rules and regulations regarding private data needs to be confirmed. Compliance also needs to be checked when integrating cloud services with Moodle, the university's learning management and courseware system.

4.2.2 Budgeting and Cost Management

Extending the usage of cloud services means that the instructor needs to overlook the resulting costs. Before planning a cloud-based course, it is important to ensure that the budgets provided by the cloud service providers are not exceeded by the students' usage of resources to avoid disputes. (Gonzalez, Border, & Oh, 2013) describe sample cost of cloud services in a course on principles of system administration.

4.2.3 Administrative aspects and extension of the concepts

There are many areas for improvement. Firstly, the administration of users should be automated, e.g., by scripting. Also, scripts are required to monitor whether students provided the expected artifacts. Secondly, users currently work on the same code base and directory structure. It would be better, if every student worked within her own environment without the ability to see code in other directories. Docker might be a solution here to set up server environments based on scripting. It is also not necessarily required to set up a complete server for "playing with" HTML5. Thirdly, cloud services make sense as they scale up and down. For the course this means that all environments should be frozen and taken down once the course is complete. Freezing would allow keeping the final code state for documentation purposes.

5 Discussion

This short paper looked at Cloud Services for teaching an undergraduate course in software development practices. The usage of Cloud Services does not completely free the teacher from tasks such as user management and integrating services into a consistent experience / environment for the students and it incurs costs that need to be closely watched (Gonzalez et al., 2013). But it helps a lot in reducing the workload when trying out new software products as hardware provisioning is no longer required and a large number of software products that are required for Business Information System teaching are made available as a packaged version by cloud service providers. For Germany, data security aspects need to be considered, e.g., when maintaining personal student information in a Cloud. Regarding pedagogy, special attention should be paid to the varying knowledge on programming that the students show. In future courses, it makes sense to distinguish between different knowledge levels and embed a strategy for addressing these levels in a didactical concept. This article starts the observations. Additional research is required to establish a sound basis for evaluating specific Cloud Services for teaching and abstract the observations. Also, additional research is required to check on the "willingness" of teachers to employ Cloud Services. To broaden the view on Cloud Computing Services, a seminar was held in winter term 2015 with 25 students who conducted research on various cloud topics (legal aspects, architectures, business models, etc.)

6 Outlook / Conclusion

The application of cloud services has shown new perspectives and makes appetite for more. Cloud providers such as Amazon and Google continuously increase their portfolio. Cloud services can not only be used in teaching, but also in research and enhancing general services offered by data centers at universities. Although, migration to cloud-based solutions requires critical evaluation, the integration of cloud-based services into the IT portfolio would allow IT staff to focus more on service delivery than maintenance of infrastructure.

References

- **Books**

Christian Baun, Marcel Kunze, Jens Nimis & Stefan Tai. (2011). Cloud Computing. Berlin: Springer.

David D. VanHoose. (2014). E-commerce economics. Critical concepts in economics. London: Routledge.

Dan C. Marinescu. (2013). Cloud Computing – Theory and practice. Boston: Morgan Kaufmann / Elsevier.

- **Proceedings from conferences**

Carlos Gonzalez, Charles Border, and Tae Oh. (2013). Teaching in amazon EC2. In Proceedings of the 13th annual ACM SIGITE conference on information technology education, 11 – 13-Oct-2012 (149). New York: ACM. DOI:10.1145/2512276.2512322

Joel Hollingsworth and David J. Powell. (2010). Teaching web programming using the Google Cloud. In Proceedings of the 48th Annual ACM Southeast Regional Conference, 15 - 17-Apr-2010 (1). New York: ACM. DOI:10.1145/1900008.1900110

Shamsul Anuar Mokhtar, Siti Haryani Shaikh Ali, Abdulkarem Al-Sharafi, and Abdulaziz Aborujilah. (2013). Cloud computing in academic institutions. In Proceedings of the 7th International Conference on Ubiquitous Information Management and Communication, 17 – 19-Jan-2013 (1-7). New York: ACM, 1–7. DOI:10.1145/2448556.2448558

Richard S. Weiss, Stefan Boesen, James F. Sullivan, Michael E. Locasto, Jens Mache, and Erik Nilsen. (2015). Teaching Cybersecurity Analysis Skills in the Cloud. In Proceedings of the

46th ACM Technical Symposium on Computer Science Education, 04 - 07-Mar-2015 (332-337). New York: ACM. DOI:10.1145/2676723.2677290

Weiying Zhu. (2015). Hands-On Network Programming Projects in the Cloud. In Proceedings of the 46th ACM Technical Symposium on Computer Science Education, 04 - 07-Mar-2015 (326-331). New York: ACM. DOI:10.1145/2676723.2677257

- **Journal Articles**

Ariel Rabkin, Charles Reiss, Randy Katz, and David Patterson. (2013). Using clouds for MapReduce measurement assignments. Trans. Comput. Educ. 13 (1), 1–18. DOI: 10.1145/2414446.2414448

Shirley Gregor and Alan R. Hevner. (2013): Positioning and presenting Design Science Research for maximum Impact. MIS Quarterly 37 (2), 337-355.

Vaishali H. Pardeshi. (2014). Cloud Computing for Higher Education Institutes: Architecture, Strategy and Recommendations for Effective Adaptation. Procedia Economics and Finance. 11, 589–599. DOI:10.1016/S2212-5671(14)00224-X

- **Web pages**

Amazon. (2016). Amazon Web Services (AWS) Educate Program. Retrieved 03-Mar-2016, from http://aws.amazon.com/ de/education/awseducate/

IBM. (2016). IBM Academic Initiative. Retrieved 03-Mar-2016, from https://developer .ibm.com/academic/

Microsoft. (2016). Microsoft Azure in teaching. Retrieved 03-Mar-2016, from http://azure.microsoft.com/en-us/community/education/

- **Standards**

NIST - National Institute of Standards and Technology. (2011). NIST Cloud Computing Reference Architecture. NIST SP 500-292. http://www.nist.gov/customcf/ get_pdf.cfm?pub_id=909505.

29th Bled eConference
Digital Economy
June 19 - 22, 2016; Bled, Slovenia

Mapping the European e-Competence Framework on the domain of Information Technology: *a comparative study*

Henk Plessius
HU University of Applied Sciences, Utrecht, the Netherlands
henk.plessius@hu.nl

Pascal Ravesteyn
HU University of Applied Sciences, Utrecht, the Netherlands
pascal.ravesteijn@hu.nl

Abstract

In the field of IT, many competence frameworks exist. An important framework is the European e-Competence Framework (e-CF) that quite recently has been appointed as a standard by the European Committee for Standardization CEN. In this paper we define quality characteristics for competence frameworks and show how the e-CF has been mapped on descriptions of the IT domain. Our conclusion is that the e-CF does comply almost fully with the formulated quality standards. According to our mappings, the e-CF covers the IT domain, albeit on some topics better than on others. To overcome the deficiencies identified, we advise to add to the e-CF a more explicit mentioning of attitude aspects and of the contexts in which the various competences are to be employed.

Keywords: IT competence framework, IT domain, Mapping of competence frameworks, European e-competence framework

1 Introduction

The famous expression πάντα χωρεῖ καὶ οὐδὲν μένει (Everything changes and nothing stands still) - attributed to the Greek philosopher Heraclitos [1] - seems very apt to describe the field of Information Technology (IT) where new areas of expertise arise almost every year and old areas are getting less important or even disappear totally (Benamati & Lederer, 2001). The implication is that for a career in IT, it is of paramount importance to keep up-to-date with current technology and its usage in business and society (Rong & Grover, 2009). Stated differently: IT-professionals must develop their IT-competences continually to be able to cope with the challenges of modern IT.

To express one's competences in the field of IT, various competence frameworks have been developed. Some widespread examples are the Information Technology Competency Model (ITCM, 2012), the European e-Competence Framework (e-CF,

[1]) As quoted by Plato in his dialogue Cratylos.

2014) and the Skills Framework for the Information Age (SFIA, 2015), but many more frameworks (with a national or international scope) exist. Ferrari (2012) for example gives an overview of 15 frameworks used in Great Britain alone. In our opinion, this multitude of frameworks justifies the need for a meta-framework of IT competences on which other frameworks can be mapped.

In the long run this study is concerned with the establishment of such a meta-framework, either by using one of the existing frameworks or by constructing a new one. In this research we have chosen the e-CF as a foundation because it is the first sector-specific implementation of the European Qualifications Framework (EQF). Furthermore, as of January 2016 the e-CF is approved as standard by the European Committee for Standardization (CEN, 2016), which means that it has to be implemented by all EU member states. The e-CF, as expressed by CEN (CEN, 2016) “provides a common language for competences, skills and proficiency levels that can be understood across Europe”. For these reasons we have started our research with determining if the e-CF can function as a meta-framework for IT competences.

A necessary (but not sufficient) condition for the e-CF to be able to function as a meta-framework is that the domain of IT should be covered wholly by the e-CF. This paper reports the results of our research on this topic where the research question underlying our work is: *To what extent does the e-CF cover the domain of IT?*

The paper is structured as follows: in the next section we discuss the theoretical background of our research question and discuss definitions of the main concepts like competence, competence framework and IT-domain as well as the quality aspects of mappings. This discussion is followed in section 3 with an outline of our research method and an overview of the mapping itself in section 4. In section 5, we discuss our findings and compare our results with those of other authors and give suggestions for further research.

2 Theoretical Background

2.1 Competence

‘Competence’ is an abstract concept, created to represent something that is not directly apparent in the world. This is, according to Lundqvist, Baker & Williams (2011), the reason that no uniform definition exists of the term. In most definitions, a competence consists of “a combination of knowledge, skills and attitude that results in successful behavior in a specific context” (Dochy & Nickmans, 2005). Based on this definition it can be deducted that to describe a competence, at least four elements are necessary: the *knowledge* base that can be called upon, the *skills* and the *attitude* characteristics necessary to perform and the *context* in which to perform.

However, in practice many specifications of competences focus on the knowledge and skills part and do not explicitly state the attitude part and/or the context. For example, in the e-CF a competence is defined as: “Competence is a demonstrated ability to apply knowledge, skills and attitudes for achieving observable results” (e-CF, 2014) and no mention is made of the context.

An attempt at handling the issues of behavioral and context specific aspects of competences can be found in an earlier research by Ravesteyn, Bosman & Mens (2015). Another route is chosen in the ITCM framework where attitude and context are represented as different competences that can be combined with IT knowledge and skills (ITCM, 2012). In this approach professional competences, personal effectiveness and contextual skills are separate classes of competences.

2.2 Competence Frameworks

A coherent set of competences is called a competence framework. A competence framework offers "generic and theoretical solutions for comparing and harmonizing competencies" (Lundqvist, Baker & Williams, 2011). A competence framework usually has a scope, e.g. to make the distinction between functions in an organization, to develop courses, etcetera. In some frameworks this scope is quite broad: The European/International Computer Driving License (ECDL/ICDL, 2007) for example is targeted at raising computer literacy for every citizen. Other frameworks are more specific, e.g. the e-CF (2014) provides "a tool to support mutual understanding and provide transparency of language through the articulation of competences required and deployed by ICT professionals (including both practitioners and managers)".

A competence framework is essentially a classification of competences (Markowitsch, & Plaimauer, 2009) along one or more axes or dimensions. Competences in a competence framework are at least ordered along a domain axis: a (structured or unstructured) list of competences, where each competence-class may be subdivided further (Markowitsch, & Plaimauer, 2009). Quite often we see a second axis with proficiency levels. The e-CF for example uses five proficiency levels ranging from associate to principal (e-CF, 2014). Examples of other classification dimensions are knowledge and skills versus attitude and context (ITCM, 2012) and threshold versus performance competences (Eschenbrenner & Nah, 2014).

Following the observations above we call a classification scheme like a competence framework *simple* when it exists of a set of (competence-)classes only. If there exist relations between the classes as well (often expressed in other dimensions) we call the scheme *complex*.

For a competence framework to be a meaningful and broadly applicable standard, it should at least comply with two general classification requirements (Cobbold et al., 2002):

- *Completeness*, i.e. every competence in the domain targeted by the framework can be mapped on the framework.
- *Unambiguous*, i.e. a competence in the domain targeted by the framework can be mapped on the framework in only one way.

For a complex framework a third requirement is necessary:

- *Orthogonality*, i.e. every dimension of the framework has a meaning independent of the other dimensions.

Together these requirements guarantee that every combination of dimensions in the framework has one and only one meaning.

2.3 The e-CF

As stated in the Introduction, we have chosen to use the e-CF as the competence framework underlying our research because of its increasing importance in the European Union. The e-CF can be considered as a complex framework with two axes: the competence-classification axis and the proficiency-level axis.

In the description of the structure of e-CF (e-CF, 2014) four so-called dimensions are distinguished (note that the word dimension has a slightly different meaning in the e-CF then in our use of the term in the previous paragraph):

"These dimensions reflect different levels of business and human resource planning requirements in addition to job/work proficiency guidelines and are specified as follows:

- *Dimension 1*: Five e-Competence areas, derived from the ICT business processes PLAN – BUILD – RUN – ENABLE – MANAGE
- *Dimension 2*: A set of reference e-Competences for each area, with a generic description for each competence. Currently 40 competences are identified that together provide the European generic reference definitions of the e-CF 3.0.
- *Dimension 3*: Proficiency levels of each e-Competence provide European reference level specifications on e-Competence levels e-1 to e-5, which are related to the EQF levels 3 to 8.
- *Dimension 4*: Samples of knowledge and skills relate to e-Competences in dimension 2. They are provided to add value and context and are not intended to be exhaustive." (e-CF, 2014)

e-CF dimension 2 and 3 define the two axes of the framework, where dimension 1 is an overall classification to relate the framework to the business process of IT. Dimension 4 describes in more detail the knowledge and skills elements constituting the various competences. The attitude aspect is kept quite implicit in all dimensions.

2.4 The IT Domain

Just like competences and competence frameworks, no universally accepted description of the IT domain exists. Several organizations have published classifications of the IT-domain and by doing so, marked out the territory of the IT domain. The largest and probably best known of these organizations is the ACM, the Association for Computing Machinery that has published a taxonomy of IT terms (ACM-1, 2012). Quite recently, a first version of the European foundational ICT body of knowledge has been published as well (ICTBOK, 2015) by the European Union.

The IT-domain is implicitly outlined in IT curricula as well. So a second source of descriptions of the IT domain can be found in IT curricula; a very extensive example can be found in the description given by the Association of Computing Machinery (ACM-2, 2013).

Professionals who are confronted with questions around classification on an almost daily base are librarians. Library classifications have been used and adapted to the state-of-the-art for many centuries. Examples of such classifications are the Dewey Decimal Classification (DDC, 2012) and the Universal Decimal Classification (UDC, 2012). Most countries have their own system(s), for example in our country the 'Nederlandse Basisclassificatie' [2] (NBC, 2004) is used by most scientific libraries.

Other sources that in some way demarcate the IT domain are frameworks that structure the world of IT in relation to the enterprise. The best known example here is the Zachman framework for enterprise architecture (Zachman, 2006). In this framework six different aspect systems in an organization can be modeled on five abstraction levels, ranging from the context of the organization to a detailed description of its technology.

All descriptions of the IT domain have in common that they classify the IT domain along its content. It follows that these classification schemes are simple, using only one axis.

2.5 Mappings

Because there are many different competence frameworks available it is often needed for mutual comparisons to map frameworks onto each other. When mapping one framework upon another, it is desirable to be as complete as possible, meaning first of all that all classes of the source framework are mapped on classes of the destination framework. Secondly, when the source framework is complex, all relations of the source framework should (where possible) be mapped on relations in the destination framework as well.

So a mapping of one framework upon another framework consists of:

- A mapping of the classes of each dimension of the framework upon classes (possibly from more dimensions) in the other framework.
- When the framework is complex: a mapping of the relations between the classes in the framework upon the relations in the other framework.

With the plethora of IT competence frameworks, many efforts have been made to compare competence frameworks and relate the included competence-classes. As discussed in the preceding paragraphs, there is ample discussion on the meaning of competences and competence frameworks are developed from very different perspectives. So the mapping from one framework upon another is not very straightforward and in practice is usually done by experts in the field and validated by other experts (e-CF, 2014). To the best of our knowledge only Lundqvist, Baker & Williams (2011) have build a limited prototype of a system for mapping competence frameworks, applying ontologies and ontology toolsets, but their approach seems to have had no continuation.

[2]) Dutch basic classification

Since descriptions of the IT domain are essentially simple classifications, a mapping of a complex competence framework like the e-CF is reduced to mapping the classes of the e-CF on the classes as discerned in the descriptions of the IT domain, thereby losing the information described in the proficiency levels.

3 Research Approach

Our research question has led us to use an evaluative research approach. Evaluation is defined by Mertens (2014, p.48) as: “Evaluation is an applied inquiry process for collecting and synthesizing evidence that culminates in conclusions about the state of affairs, value, merit, worth, significance or quality of a program, product, person, policy, proposal or plan…”

The research process started with an initial literature study (summarized in the preceding section) in order to define the concepts used and to embed our research in existing theories. The literature study was followed by a mapping of the 40 competencies as distinguished in dimension 2 of the e-CF (e-CF, 2014) on five different descriptions of the IT domain. The result of this work was a first impression of the way in which the IT domain is covered by the e-CF.

To get more detail, we decided to refine one of the mappings. This refinement was performed by two teams of two IT students from our university, the HU University of Applied Sciences with the teams working *independently* of each other. For the refinement, the (435) knowledge and skills elements that constitute the 4th dimension of the e-CF (2014) have been used. By using two independently working research teams, we were able to analyze the differences in mappings between the teams and from there infer how reliable the mappings have been done.

The research approach chosen is depicted in figure 1.

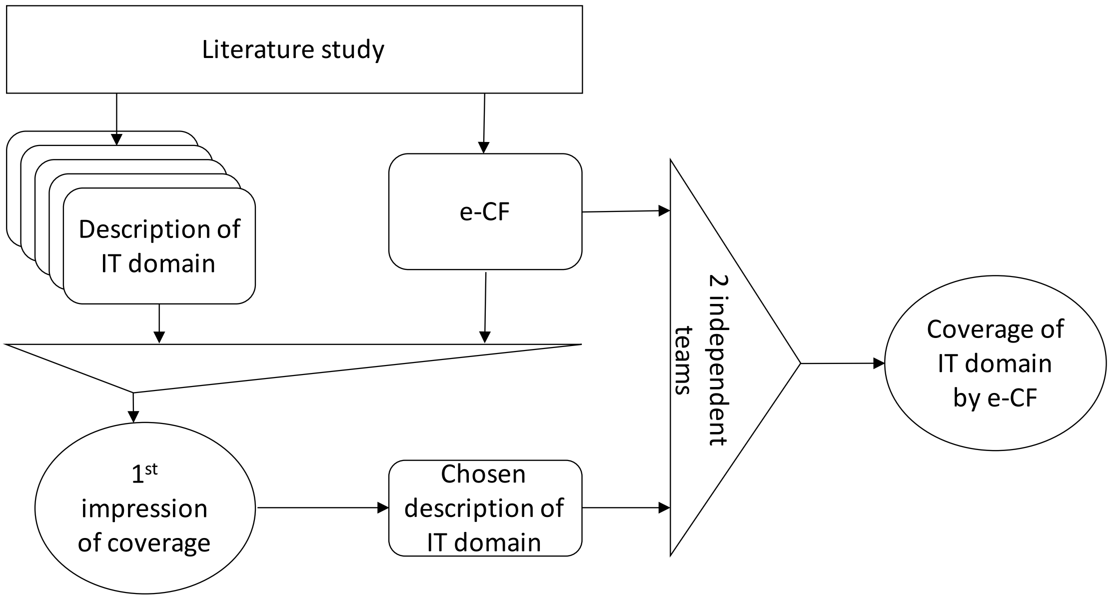


Figure 1: Research process

4 Mapping the e-CF on the domain of IT

4.1 Initial Mappings

In section 2.4 we have argued that descriptions of the IT domain can be obtained from different sources. For our first mappings of the e-CF on the domain of IT, we have used a well-known example from the various sources mentioned in section 2.4, supplemented with the recently published description of the IT domain by the European Union (ICTBOK, 2015);

1. Taxonomy of IT terms (ACM-1, 2012).
2. IT 2013 Curriculum (ACM-2, 2013).
3. Nederlandse Basisclassificatie (NBC, 2004).
4. Zachman Framework (Zachman, 2006).
5. ICT body of knowledge (ICTBOK, 2015).

For the first four descriptions above, the mapping has been done by the authors of this paper. The mapping of e-CF on 5) the ICT Body of Knowledge has been done by its authors (ICTBOK, 2015).

From these mappings, the following preliminary conclusions were drawn:

- The e-CF basically covers the IT domain – albeit on some topics better than on others. Moreover, it covers topics from other domains as well, for example business administration and marketing.
- IT fundamentals and mathematical background are implicitly covered in the competences of the e-CF. This is something to keep in mind when e-CF is used as foundation to assessments (e.g. of IT professionals or students) where the risk is that these topics may be inadequately tested.
- Due to the lack of domain knowledge in the e-CF, some topics have a very broad range. An example is competence B1: Application Development, which covers a wide range from very technical systems to games to administrative systems, etcetera.
- Competence class C (RUN) consists of (only) four competences. This seems rather restricted and competences around security for example are not very comprehensively defined.

From the preliminary research we also learnt that some descriptions of the IT-domain were more useful for our purpose than others. The Zachman framework proved not very suitable as it lacks detail and the various categories are not well-defined. The Nederlandse Basisclassificatie (dating from 2004) was lacking in detail as well and on several topics outdated. The IT 2013 curriculum turned out to be quite usable, but very much tuned to education. So, for our purpose, the best descriptions of the IT-domain were given by ACM's taxonomy of IT terms from 2012 and by the ICT Body of Knowledge dating from 2015. We have chosen to use ACM's taxonomy in the more detailed research as the ICT Body of Knowledge stems from the same source as the e-CF itself, the European Union, and a bias towards the way of thinking underlying the e-CF may be present in this description.

4.2 Detailed Mapping

In the e-CF, a detailed description of every competence is given in dimension 4 where knowledge and skills that relate to the competences, are provided. The 40 competences of dimension 2 are subdivided in 435 knowledge/skills-descriptions in dimension 4. These were compared with the classification of ACM's taxonomy (ACM-1, 2012), consisting of 12 classes on the first level and 82 (sub)classes on the second level. More detailed subdivisions of the taxonomy were used to clarify meanings on this second level.

As stated before, the detailed mapping has been done by two teams of two IT-students each group working independently of one another. For the mappings we used a three-phase approach. In the first phase every team was asked to map one competence of e-CF to the second-level subclasses of ACM's taxonomy. The teams needed approximately two hours and the results were extensively discussed with both groups together to understand the process and create a common understanding of both the e-CF and the ACM terminology.

In the second phase the other 39 e-CF competences were mapped on the taxonomy by both research teams independently. For the mapping the research teams were asked to relate every knowledge/skill element of the e-CF to the terms in the second level of ACM's taxonomy, using a 3-point scale:

0 – no relation present

1 – sometimes, in some domains, related

2 –overall clearly related.

After the mappings of both groups were completely finished (it took the teams around 40 hours each) we organized the third phase: a session to compare the differences in the mappings from the two research teams. From the more than 35,000 comparisons, initially only 4% differed. The different scores were typically found in clusters in a combination of an e-CF competence and an ACM class. These clusters were subsequently discussed to determine the cause of the different mapping ratings. We found that the differences could be explained by slightly different interpretations of the various terms in the taxonomy.

The results of the final comparison are summarized in figure 2. In this figure (with e-CF competences as rows and the first level terms of ACM's taxonomy in the columns) every cell reflects the total score of all knowledge/skills elements from the corresponding competence and from the sub-terms of the corresponding first level term of the taxonomy. Because the number of knowledge/skills elements in the e-CF differs between competences as does the number of sub-terms of each first level term in the taxonomy, these scores were classified in four categories and color coded as explained in figure 3.

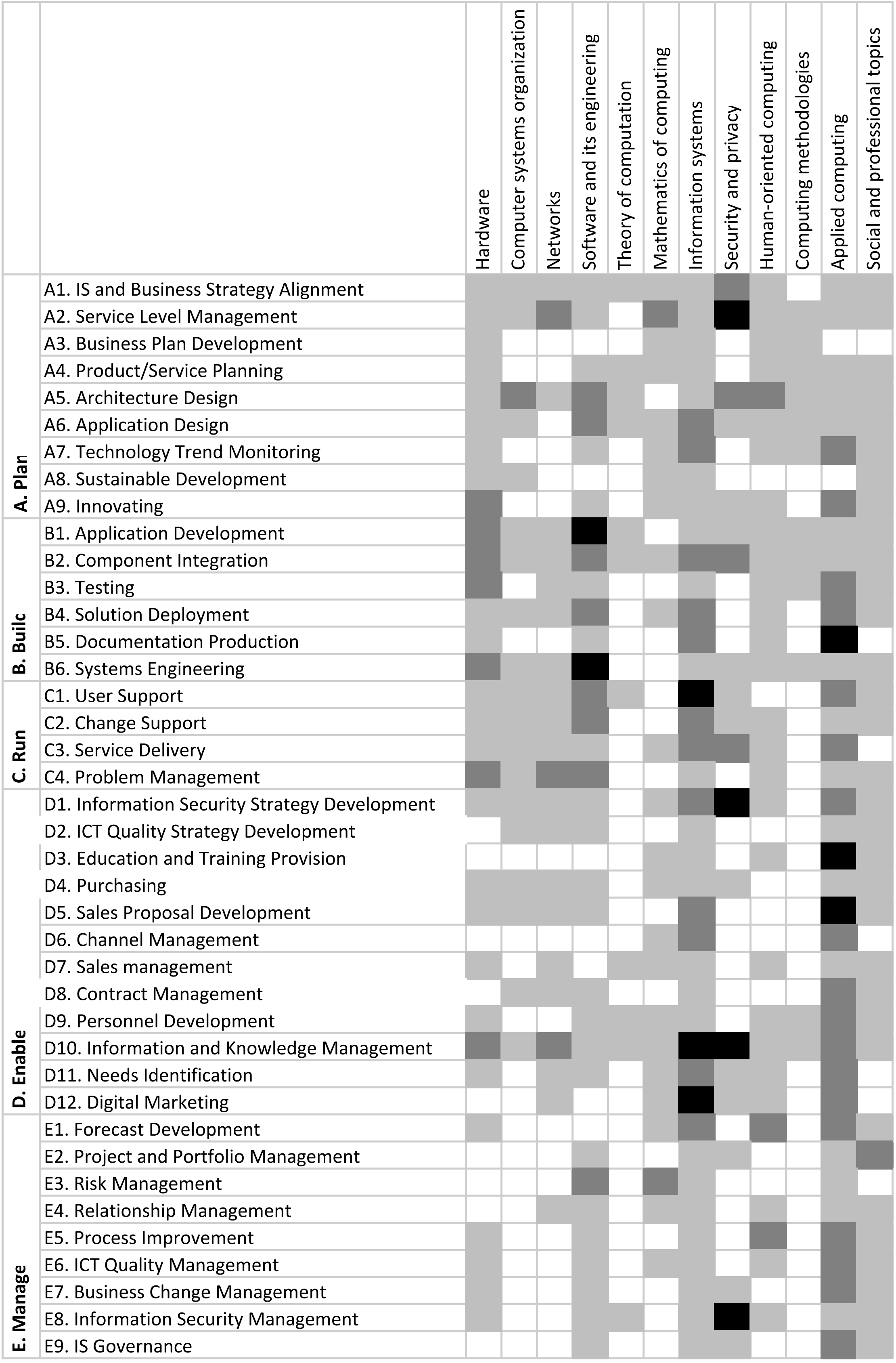


Figure 2: Mapping of e-CF on ACM's taxonomy (legend in figure 3)

	white	The knowledge/skills descriptions for this competence could not be matched to any of the terms in the second level of ACM's taxonomy
	light grey	The knowledge/skills descriptions for this competence could be matched to some (i.e. less than 35%) of the terms in the second level of ACM's taxonomy
	dark grey	The knowledge/skills descriptions for this competence could be matched to various (i.e. between 35% and 70%) terms in the second level of ACM's taxonomy
	black	The knowledge/skills descriptions for this competence could be matched to most (i.e. at least 70%) terms in the second level of ACM's taxonomy

Figure 3: The four classes and their color coding

The results of this detailed mapping support our preliminary conclusions: the e-CF more or less covers the IT domain, but some themes from the IT domain (like 'Theory of computing', 'Mathematics of computing' and 'Computing methodologies') appear only superficially in the e-CF. Remarkable is the low score on 'Social and professional topics' as competences in the e-CF are meant to include attitude aspects as well (e-CF, 2014). This result may well be due to the fact that only knowledge and skills descriptions are present in dimension 4 of the e-CF and attitude aspects are kept implicit in these descriptions.

5 Discussion, limitations and further research

In the preceding paragraph we have shown how the e-CF can be mapped on the IT domain. As a result, we can now reflect upon how meaningful and applicable e-CF as a standard is. For this we use the general classification requirements *completeness, unambiguous* and *orthogonality* as discussed in section 2.

Based on this study we conclude that while the e-CF seems *complete* and adequate in covering the IT domain, there are some themes (like 'Theory of computing', 'Mathematics of computing' and 'Computing methodologies') that appear only superficially in the e-CF. Furthermore, for the description of the competences of IT professionals, some additions to the e-CF could be worthwhile:

- A more explicit occurrence of attitude aspects, especially in dimension 4 of the e-CF.
- A new dimension describing various IT contexts. In this way differences in for example application development in different contexts (like technical, administrative, games, etcetera), can be made visible.

However, we would like to state a word of caution here. While extensions to the e-CF framework might increase its coverage of the IT domain, it might also cause the framework to become overloaded and less usable in practice. As frameworks become more popular and are used by more organizations there is a tendency to expand them and incorporate aspects and wishes of different user groups. This may lead to large and difficult to understand frameworks that are hard to use in practice. Especially now that e-CF is on the road to become a European standard, the maintenance and extension process should be carefully considered.

Regarding how *unambiguous* the e-CF is, we find that although there is room for interpretation on how a competence can be mapped on the ACM taxonomy, in practice the interpretations don't really differ that much (as the 4% differences in 35.000 comparisons has shown). We conclude that the strength of the e-CF in this respect is very high.

The third requirement states that for a complex framework *orthogonality* is required. In other words, every axis of the framework should have a meaning independent of the other axes. Concerning this aspect, we conclude that e-CF is well constructed as the proficiency levels are independent of the competence classes.

Together the requirements, as described above, guarantee that every combination of dimensions in the framework has one and only one meaning. As we have seen there is some room for interpretation but very limited. So while the e-CF might not be a framework in which every combination of dimensions in the framework has one and only one meaning, it comes however quite close.

Looking at the mapping itself, the information present in the proficiency-level descriptions has not been used in our research. Our mapping with its 3-point scale is of a qualitative nature as well. However, when we lay the threshold in the mapping at including only the cells where the descriptions at least match various terms of the taxonomy (dark grey or black in the figure), we found it quite in line with the mapping of the e-CF on the ICT Body of knowledge description (ICTBOK, 2015).

Our research does have its limitations. First of all, our mappings – though they seem quite consistent – rely strongly on the interpretations of various competences and terms and the consistency thereof in the comparisons. In the second place the results are not (yet) validated by other experts with the exception of the mapping of e-CF on the ICT Body of Knowledge (ICTBOK, 2015) that essentially gives the same results as our mappings. The results as summarized in figure 2 should therefore not be seen as absolute, rather they give a qualitative image of the degree to which the e-CF covers the IT-domain.

Finally, the ACM's taxonomy is biased towards a more technical definition of the IT domain and does not do justice to the more business-oriented scope of the e-CF. As stated in the introduction, IT has an enormous impact on traditional business and the orientation chosen for the e-CF may make it easier to adopt in practice. In our opinion, adoption of the e-CF may even be accelerated by stating more explicitly attitude aspects, as the soft skills of the IT professional can make the difference in success or failure of an IT project.

We think the results of our research are encouraging and give a good insight in the strengths and shortcomings of the e-CF. For future research we plan to extend our mapping towards the business aspects of the e-CF and try to relate the e-CF to other competence frameworks by making direct mappings.

Acknowledgements

This research was supported by an EXIN Foundation grant to the research group Process Innovation & Information Systems at the HU University of Applied Sciences.

Furthermore the authors like to thank Sven van Doorn, Prevesh Soebedar, Mark Smits and Daan Vos for their patient mapping work.

References

- ACM-2, the Association of Computing Machinery. Information Technology 2013 Curriculum Guidelines for Undergraduate Degree Programs in Computer Science. ACM, 2013. Information retrieved from https://www.acm.org/education/CS2013-final-report.pdf on January 25, 2016.
- ACM-1, the Association of Computing Machinery. Computing Classification System, 2012 Revision. Downloaded from http://www.acm.org/about/class/2012 on December 14, 2015.
- Benamati, J. & Lederer, A.L. (2001). Rapid information technology change, coping mechanisms, and the emerging technologies group. *Journal of Management Information Systems*, *17*(4), 183-202.
- CEN, the European Committee for Standardization (2016). Information retrieved from http://standards.cen.eu/dyn/www/f?p=204:110:0::::FSP_LANG_ID,FSP_PROJECT:25,41798&cs=15705901062517177686CDB3508D90E56 on February 22, 2016.
- Cobbold, I.C., Lawrie, G.J.G., House, A., Street, M. (2002). Classification of balanced scorecards based on their intended use. *Proceedings of the 3rd international conference on performance measurement and management* (PMA 2002).
- DDC, the Dewey Decimal Classification, 23 ed. (2012). Information retrieved from https://www.oclc.org/dewey.en.html on January 22, 2016.
- Dochy, F., & Nickmans, G. (2005). *Competentiegericht opleiden en toetsen: theorie en praktijk van flexibel leren*. Utrecht: Lemma B.V.
- ECDL/ICDL, the European/International Computer Driving Licence, syllabus 5.0 (2007). Information retrieved from http://www.ecdl.org on January 20, 2016.
- e-CF, the European e-Competence Framework, version 3.0 (2014). Information retrieved from http://www.ecompetences.eu on December 14, 2015.
- Eschenbrenner, B., & Nah, F. F. H. (2014). Information systems user competency: A conceptual foundation. *Communications of the Association for Information Systems*, *34*(1), 80.
- Ferrari, A. (2012). Digital Competence in practice: An analysis of frameworks. *Sevilla: JRC IPTS. (DOI: 10.2791/82116)*.
- ICTBOK, the European Foundational ICT Body of Knowledge (2015). Information retrieved from http://www.ictbok.eu on January 25, 2016.
- ITCM, the Information Technology Competency Model (2012). Information retrieved from http://www.careeronestop.org/competencymodel on December 14, 2015.
- Lundqvist, K. Ø., Baker, K., & Williams, S. (2011). Ontology supported competency system. *International Journal of Knowledge and Learning*, *7*(3-4), 197-219.

- Markowitsch, J., & Plaimauer, C. (2009). Descriptors for competence: towards an international standard classification for skills and competences. *Journal of European Industrial Training*, *33*(8/9), pp. 817-837.
- Mertens, D. M. (2014). *Research and Evaluation in Education and Psychology: Integrating Diversity with Quantitative, Qualitative, and Mixed Methods.* 4th ed. Sage Publications.
- NBC, the Nederlandse Basisclassificatie, 4th ed (2004). Information retrieved from https://www.kb.nl/sites/default/files/docs/bc04.pdf on December 14, 2015.
- Ravesteyn, P., Bosman, A., & Mens, J. (2015). A competence-mapping method to transform organizations. *In Conference Proceedings of The 11th European Conference on Management Leadership and Governance ECMLG 2015*, Lisbon, Portugal, pp. 369-376
- Rong, G., & Grover, V. (2009). Keeping up-to-date with information technology: Testing a model of technological knowledge renewal effectiveness for IT professionals. *Information & Management*, *46*(7), 376-387.
- SFIA, the Skills Framework for the Information Age, version 6 (2015). Information retrieved from http://www.sfia-online.org on December 14, 2015.
- UDC, the Universal Decimal Classification, release 11 (2012). Information retrieved from http://www.udcc.org/index.php/site/page?view=factsheet on January 22, 2016.
- Zachman, J. (2006). *The Zachman framework for enterprise architecture*. Zachman Framework Associates.

29th Bled eConference
Digital Economy
June 19 - 22, 2016; Bled, Slovenia

Exploring Design Principles for Technology-Enhanced Workplace Learning

Esther van der Stappen, Ilya Zitter
HU University of Applied Sciences Utrecht, the Netherlands
esther.vanderstappen@hu.nl, ilya.zitter@hu.nl

Abstract

Technology-enhanced learning can be used to replicate existing teaching practices, supplement existing teaching or transform teaching and/or learning processes and outcomes. Enhancing workplace learning, which is integrated into higher professional education, with technology, calls for designing such transformations. Although research is carried out into different kinds of technological solutions to enhance workplace learning, we do not know which *principles* should guide such designs. Therefore, we carried out an explorative, qualitative study and found two such design principles for the design of technology-enhanced workplace learning in higher professional education. In this research, we focused on the students' perspective, since they are the main users of such technology when they are learning at the workplace, as part of their study in becoming lifelong learning, competent professionals.

Keywords: Higher Professional Education, Blended Learning, Workplace Learning, Technology-Enhanced Learning

1 Introduction

Institutes offering higher professional education programs face changing demands from society and industry. These changing demands on the starting professional call for adaptive curricula, which results in the need for a mature pedagogy and a suitable integration of workplace learning in higher professional education (Tynjälä, Slotte, Nieminen, Lonka, & Olkinuora, 2006; Zitter, Hoeve & De Bruijn, 2016).
The rapid change towards a worldwide digital economy has lead to innovative educational technologies. E-learning, Massive Open Online Courses (MOOCs) and Computer-supported collaborative learning (CSCL) are examples of recent developments in Technology-Enhanced Learning (TEL). Blended learning (Garrison & Kanuka, 2004) started out as a mix between face-to-face and online learning, giving rise to virtually limitless design possibilities. Generally speaking, TEL can be used to replicate existing teaching practices, supplement existing teaching or transform teaching and/or learning processes and outcomes (Kirkwood & Price, 2014).
The integration of workplace learning in higher professional education calls for designing these transformations. In this paper, we explore which design principles (Sein et al, 2011) help guide the design for technology enhancing workplace learning. We focus on the students' perspective, since (s)he is the main user of such technology

when learning at a workplace, as part of their study in becoming a lifelong learning, competent professional.

1.1 Integrating workplace learning in higher professional education

Workplace learning has broadened from professional development of employees to taking an important role in formal professional education (Tynjälä, 2008). In professional Bachelor programs, students are taking internships in real-world workplaces for a significant part of their education. This has raised the attention to the role of reflection in learning, guiding and assessing learning processes in increasingly complex and unpredictable workplaces (Embo, 2015).

Learning in professional workplaces is often implicit in nature - it occurs during (collaborative) work activities such as problem solving and often results in tacit knowledge (Eraut, 2000). Consequently, it is hard to explicate what is learned by a specific learner at the workplace. Institutes offering professional and vocational education often tackle this problem by asking students to set their own learning goals and reflect on them, to assess the learning that took place while they were 'out of school' (Tynjälä, 2008).

Recently, efforts have been made to mature the design of learning environments for professional and vocational education, by suitably integrating workplace and school-based learning. To this aim, several models have been proposed such as Integrative Pedagogy (Tynjälä et al, 2006; Tynjälä, Stenström & Saarnivaara, 2012) which focuses on different types of knowledge and skills as learning outcomes, and Hybrid Learning Environments (Zitter et al, 2016), focusing on invoking different learning processes that result in integrated and contextualized knowledge.

1.2 Technology-enhanced workplace learning

Meanwhile, tools supporting professional development in certain professions have been analyzed and evaluated. Firstly, the focus was on explicit workplace learning (e.g., trainings and workshops). For instance, Dolog et al (2007) studied how e-learning systems for the workplace can be adapted for personalization.

Several recent studies consider the support of learning for professional development, i.e., after formal education has ended. In one study, the use of mobile devices by nurses for informal learning and continuing professional development is analyzed (Fahlman, 2013). In another study, the possibilities and challenges of using social media to stimulate reflection and sharing tacit knowledge with others in the workplace was studied (Tynjälä, 2014). Gamrat (2014) introduced a framework for professional development for teachers, including an online workplace learning tool using digital badges. Recently, Hämäläinen and Cattaneo (2015) studied TEL environments for vocational education from a teacher's instructional perspective.

Concluding, different studies were carried out to analyze to what extent existing tools and technologies can support workplace learning. Still unexplored is *which design principles* guide technology that effectively enhances workplace learning. Especially such design principles from a student's perspective - as main users of such technology - have not been studied systematically yet.

1.3 Research Question

This paper builds on the above work by exploring design principles that help guide the design of technology to enhance workplace learning by students in higher professional education. These design principles will guide the subsequent process of requirements engineering, necessary to successfully develop new technological solutions to enhance workplace learning. The research question is formulated as follows:

Which design principles guide the design of technology-enhanced workplace learning from a students' perspective?

2 Method

To achieve our research goal, we adopted an inductive approach by conducting an explorative, qualitative study. The context of this study was a Bachelor program educating Information and Communication Technology professionals (at the HU University of Applied Sciences Utrecht). We focused on the third-year internships; a compulsory part of 30 EC[1] of this Bachelor program.

To answer the research question, we carried out interviews (Mears, 2012). We interviewed six third-year students doing their internships at that time. The interviews all took between 45 and 75 minutes and were audio-recorded.

The interviews we conducted were semi-structured, because of the research's explorative nature. We took a user-centered design approach, in which an explicit understanding of users, their processes, tasks and environments is the basis for determining the kind of support technology can offer (ISO, 2015). The precompiled list of interview questions was composed of four categories:

1. Students' awareness of their learning process in the workplace;
2. Transitions to facilitate their learning process - based on the framework of Zitter et al. (2016); we searched for activities related to what the Integrative Pedagogy model (Tynjälä, 2006; Tynjälä et al, 2012) calls *mediating activities;*
3. Technology currently used to organize working and learning;
4. Wishes for future technology to enhance workplace learning.

Next, we analyzed the audio-recordings with Atlas.ti (Atlas.ti, 2016). First we used qualitative analysis (Miles, Huberman & Saldana, 2014) in the form of open coding on all relevant audio segments. Next, we generated and analyzed a code co-occurrence table to compile code groups to simplify analysis. For this paper, we summarized the results of this analysis. A more extensive analysis will be performed in the near future.

3 Results

The results of our explorative, qualitative study are presented in this chapter.

---

1) European Credit Transfer and Accumulation System (ECTS), 1 EC is equivalent to 28 hours of study in the Netherlands.

3.1 Workplace learning process

Firstly, we analyzed the working and learning processes that take place during internships. Students tend to be capable of explicating what work they do, however, they all indicate they are hardly aware of what they learn. One student stated: "*I don't realize I'm learning, I'm just busy doing my work."* They all set learning goals at the start of their internship, but hardly follow these up. University demands do not trigger students to do so until the very end of the internship. Students don't see the need for more attention on learning and learning goals, primarily because "*the grade does not depend on it*". To write their final internship report, they have to reflect on what they did; only then they (partly) realize what they learned in the preceding months. However, they do fill out log sheets with day-by-day activity listings (because they are required to do so by their university). They don't like filling out the sheets, since they perceive this as a tedious task.

They do realize what their main learning resources are: they mention publications, online lectures, programming community sites like Stackoverflow, and feedback from their daily supervisor in the workplace. They receive feedback on task performance, teamwork and communication at least once a week, still this does not seem to increase their learning awareness. They have contact with their supervising teacher a few times during their five-month internship, and the feedback they get from them is mainly about the deliverables for the university.

3.2 Technology support

The above analysis implies major gains can be achieved by using technology to increase the awareness of workplace learning of students. The greater part of the day, they are 'stuck' in being busy with their work and learning is implicit to a high degree. Technology can be designed to trigger them to reflect on their experiences by invoking reflective practice (e.g., Thompson & Pascal, 2012), to help students make implicit knowledge more explicit. Besides, automating the tedious activity logging could serve as the means to this end: e.g., automated, formative reports on their activities based on text analysis, could create awareness of what is being learned and facilitate reflection and interventions during the internship.

Students often make the transition between theory and practice. Technology can offer support by automatically collecting information about which resources they used, to facilitate future reference by the student and increase awareness of this type of learning process.

In general, these findings are consistent with (Tynjälä et al, 2014), stating that technology can support workplace learning by serving as mediating tools – tools that help a student either 1) make connections between theory and practice or 2) to reflect on their experiences.

3.3 Design principles

From the above analysis, we infer that the nature of workplace learning asks for technology of the type *Low effort - High frequency – High impact*. To really capture implicit learning, learners should use – and keep using - the technology regularly throughout their workplace activities.

Combined with the wishes expressed by students during the interviews, we conclude this study by formulating two design principles to help guide the design of technology to enhance workplace learning.

Ease of use

Students indicate the need for a system with an easy and accessible user interface with a natural user experience (ISO, 2015) extended with options for customization and personalization, e.g. the system could pre-enter activities in the log sheet based on the students' project planning.

Surprise effect

Students should be positively surprised by the technology. Firstly, it creates awareness. Surprising a student by stating explicitly which implicit knowledge they have gained, can stimulate learning in a positive way. Secondly, it has a positive effect on their willingness to keep using the technology. The surprise effect can be two-fold:

1) Students get feedback when they don't expect it (i.e., early in time).
2) Students get feedback they don't expect (i.e., the technology supplies previously unknown information).

4 Conclusion and Next Steps

We propose two major design principles for technology-enhanced workplace learning from a students' perspective: *ease of use* and *surprise effect*. We believe these principles are essential for new technology designed to support workplace learning.

Over the next months, a group of Bachelor ICT-students will design and implement a tool prototype guided by these design principles. In the fall of 2016, this prototype will be tested and evaluated with a group of third year students doing their internship.

We are aware of the fact the students we interviewed all work in the domain of ICT, therefore we expect that our findings are not easily generalizable to other professional domains. Therefore, we plan to interview students from other domains in the future.
This study focuses on the design principles from the students' perspective. Other groups of stakeholders are the teachers and the professionals from industry acting as the daily supervisor during the internship. We plan to study the needs and wishes from their perspectives in future research.

References

Atlas.ti. (2016). ATLAS.ti: The Qualitative Data Analysis & Research Software. Retrieved February 2, 2016, from http://atlasti.com

Dolog, P., Kravcik, M., Cristea, A., Burgos, D., Bra, P., Ceri, S., … Tattersall, C. (2007). Specification, authoring and prototyping of personalised workplace learning solutions. International Journal of Learning Technology. 3(3), 286–308. http://doi.org/10.1504/IJLT.2007.015447

Embo, M. (2015). Integrating workplace learning, assessment and supervision in health care education. PhD Thesis, Maastricht University.

Eraut, M. (2000). Non-formal learning and tacit knowledge in professional work. British Journal of Educational Psychology. 70(1), 113–136. http://doi.org/10.1348/000709900158001

Fahlman, D. (2013). Examining Informal Learning using Mobile Devices in the Healthcare Workplace. Canadian Journal of Learning and Technology. 23(4).

Gamrat, C., Zimmerman, H. T., Dudek, J., & Peck, K. (2014). Personalized workplace learning: An exploratory study on digital badging within a teacher professional development program. British Journal of Educational Technology. 45(6), 1136-1148.

Garrison, D. R., & Kanuka, H. (2004). Blended learning: Uncovering its transformative potential in higher education. The Internet and Higher Education. 7(2), 95–105. http://doi.org/10.1016/j.iheduc.2004.02.001

Hämäläinen, R., & Cattaneo, A. (2015). New TEL Environments for Vocational Education – Teacher's Instructional Perspective. Vocations and Learning. 8(2), 135–157. http://doi.org/10.1007/s12186-015-9128-1

ISO 9241-210:2010 - Ergonomics of human-system interaction - Part 210: Human-centred design for interactive systems. (2015). Retrieved February 26, 2016 from http://www.iso.org/iso/catalogue_detail.htm?csnumber=52075

Kirkwood, A., & Price, L. (2014). Technology-enhanced learning and teaching in higher education: what is 'enhanced' and how do we know? A critical literature review. Learning, media and technology. 39(1), 6-36.

Mears, C. L. (2012). In-depth interviews. In J. Arthur, M. Waring, R. Coe & L. V. Hedges (Eds.). Research Methods and Methodologies in Education. 170-176. SAGE Publications, Inc.

Mercer, N. (2013). The social brain, language, and goal-directed collective thinking: a social conception of cognition and its implications for understanding how we think, teach, and learn. Educational Psychologist. 48(3), 148–168.

Miles, M. B., Huberman, A. M. & Saldana, J. (2014). Qualitative data analysis: A Methods Sourcebook: Third edition. SAGE Publications, Inc.

Sein, M.K., Henfridsson, O., Purao, S., Rossi, M., and Lindgren, R. (2011). Action Design Research. MIS Quarterly (35), 37-56.

Thompson, N., & Pascal, J. (2012). Developing Critically Reflective Practice. Reflective Practice. 13(2), 311–325. http://doi.org/10.1080/14623943.2012.657795

Tynjälä, P., V. Slotte, J. Nieminen, K. Lonka, and E. Olkinuora. 2006. From university to working life: Graduates' workplace skills in practice. In Higher education and working life: Collaborations, confrontations and challenges, ed. P. Tynjälä, J. Välimaa, and G. Boulton-Lewis. 73-88. Amsterdam: Elsevier.

Tynjälä, P. (2008). Perspectives into learning at the workplace. Educational Research Review. 3(2), 130–154. http://doi.org/10.1016/j.edurev.2007.12.001

Tynjälä, P., Stenström, M.-L., & Saarnivaara, M. (Eds.). (2012). Transitions and Transformations in Learning and Education. Dordrecht: Springer Netherlands. http://doi.org/10.1007/978-94-007-2312-2

Tynjälä, P., Häkkinen, P., & Hämäläinen, R. (2014). TEL@work: Toward integration of theory and practice. British Journal of Educational Technology. 45(6), 990–1000. http://doi.org/10.1111/bjet.12164

Yin, R. K. (2014). Case Study Research: Design and Methods: Fifth Edition. SAGE Publications, Inc.

Zitter, I., Hoeve, A., & de Bruijn, E. (2016). A Design Perspective on the School-Work Boundary: A Hybrid Curriculum Model. Vocations and Learning. http://doi.org/10.1007/s12186-016-9150-y

29th Bled eConference

Digital Economy

June 19 - 22, 2016; Bled, Slovenia

Towards Understanding closed-loop PLM:
The Role of Product Usage Data for Product Development enabled by intelligent Properties

Manuel Holler

University of St.Gallen, Institute of Information Management, Switzerland

manuel.holler@unisg.ch

Emanuel Stoeckli

University of St.Gallen, Institute of Information Management, Switzerland

emanuel.stoeckli@unisg.ch

Falk Uebernickel

University of St.Gallen, Institute of Information Management, Switzerland

falk.uebernickel@unisg.ch

Walter Brenner

University of St.Gallen, Institute of Information Management, Switzerland

walter.brenner@unisg.ch

Abstract

Product lifecycle management (PLM) is a strategy of managing a company's products all the way across their lifecycles. Empowered by new capabilities, intelligent products enable seamless information flow and thus enable closed-loop PLM. Hence, one phenomenon of particular interest is the appreciation of beginning of life activities through middle of life information. Grounded on empirical data from a multiple-case study in three distinct manufacturing industries, we explore this emergent role of product usage data for product development. In detail, we address rationales, opportunities, conditions, and obstacles. Findings indicate that (1) heterogeneous motives drive the exploitation, (2) a positive impact on every product development stage is perceivable, (3) some products and industry ecosystems are more suitable than others, and (4) technical, economic, and social obstacles challenge the exploitation. With the limitation of an interpretive, qualitative research design, our work represents a first step to understand the role of closed-loop PLM.

Keywords: Closed-loop Product Lifecycle Management, Closed-loop PLM, Intelligent Product, Product Usage Data, Product Development, Case Study

1 Introduction

Product lifecycle management (PLM) is a strategy of managing a company's products all the way across their lifecycles (Stark, 2011). Within the context of manufacturing, an established conceptualization of the product lifecycle is the division into beginning of life (BOL), middle of life (MOL), and end of life (EOL). Thereby, BOL encompasses the actions *imagine/define/realize*, MOL encompasses the actions *support/maintain/use*, and EOL encompasses the actions *retire/depose* (Kiritsis, 2011; Stark, 2011).

The traditional understanding of PLM as design support system in BOL and as service support system in MOL does not satisfy future business needs anymore. In the light of changing value characteristics from product cost, quality, and time to market to holistic customer satisfaction through product-service-systems, a stronger focus on the entire product lifecycle becomes crucial (Terzi et al., 2010). Accordingly, the future role of PLM pursues a more comprehensive approach of lifecycle-oriented thinking – closed-loop PLM (Terzi et al., 2010; Kiritsis, 2011). Kiritsis (2011) describes the information flow in traditional PLM as forward-oriented and unidirectional. In contrast, the information flow in closed-loop PLM is characterized as seamless and multi-directional through all lifecycle phases (Kiritsis, 2011). These feedback loops are enabled by *intelligent products* (Terzi et al., 2010; Kiritsis, 2011), products characterized by sensing, memory, data processing, reasoning, and communication capabilities (Meyer et al., 2009; Kiritsis, 2011). These intelligent products are stated to be prospering areas: For example, the McKinsey Global Institute forecasts the number of connected devices from 25 billion to 50 billion in 2025. Thereby, an economic impact from 3.9 trillion to 11.1 trillion USD per year in 2025 is predicted (McKinsey & Company, 2015).

However, contingent upon its novelty, the idea of closed-loop PLM has been ideated at a comparatively conceptual level (Kiritsis et al., 2008). Comprehensive research in various fields is necessary for an advanced understanding (Kiritsis et al., 2003; Jun et al., 2007). As those new technologies make subsequent lifecycle stages more accessible for stakeholders in BOL, one phenomenon of particular interest is the appreciation of BOL activities through MOL information in order to improve subsequent product generations (Terzi et al., 2010). In other words, product information flows are not interrupted anymore as soon as a product is sold (Parlikad et al., 2003; Terzi et al., 2010; Lehmhus et al., 2015). Yet, literature is surprisingly sparse in investigating this emergent role of product usage data for product development (Shin et al., 2009; Shin et al., 2014). Above all, closed-loop PLM is considered as target state and long-term goal. Less evidence from the field is available what the current state in manufacturing enterprises is. Grounded on rich empirical data from a multiple-case study in three distinct manufacturing industries, the paper at hand addresses this research gap and explores the exploitation – i.e. the process from identification to analysis and application – of those backward-oriented data, information, and knowledge flows. In line with the exploratory nature of our research, we aim to investigate the manufacturers` points of view and examine potential positive and negative implications. Hence, we formulate the following research questions:

What is the role of product usage data for product development enabled by intelligent properties?
[RQ 1] Which rationales drive an exploitation?
[RQ 2] Which opportunities emerge from an exploitation?
[RQ 3] Which conditions support an exploitation?
[RQ 4] Which obstacles impede an exploitation?

For this purpose, the remainder of this paper is organized as follows: First, we provide relevant terms and related work. Second, we introduce the applied case study research methodology. Third, we present the study's findings in terms of rationales, opportunities, conditions, and obstacles. After a discussion, we conclude with our contribution, implications for scholars and practitioners, and research limitations.

2 Background

2.1 Product development and product lifecycle management

Product development describes the process of bringing new products to market (Eigner & Roubanov, 2014). As core process of industrial enterprises, a wide range of conceptualizations and process models has been proposed (e.g., Andreasen & Hein, 1987; Ulrich & Eppinger, 2008). According to a recent conceptualization by Eigner and Roubanov (2014, p.7), product development encompasses "all activities and disciplines that describe the product and its production, operations, and disposal over the product lifecycle, engineering disciplines, and supply chain with the result of a comprehensive product definition". Although most authors emphasize the integrative function of product development (Andreasen & Hein, 1987; Ulrich & Eppinger, 2008; Eigner & Roubanov, 2014), industrial enterprises traditionally have very restricted information about the actual usage of their products as soon as they are sold to their customers (Parlikad et al., 2003; Terzi et al., 2010; Lehmhus et al., 2015).

From a historical viewpoint, PLM and antecedent forms are rooted in the early 1980s (Ameri & Dutta, 2005). With the appearance of computer-based support in product development such as computer-aided design (CAD), the need for a control instrument became a necessity. Simultaneously as product data management (PDM) systems were developed to support the design chain, enterprise resource planning (ERP) systems were designed to assist the supply chain (Ameri & Dutta, 2005). In the 1990s, the concept of PLM evolved by a horizontal and vertical extension of PDM (Eigner & Stelzer, 2008). Empowered by advancements in ICT at item-level, the concept of closed-loop PLM appeared in the 2000s as response to the wish of designers, manufacturers, maintenance, and recycling experts to benefit from seamless transparency on information and knowledge from other phases and players in the product lifecycle (Terzi et al., 2010; Kiritsis, 2011).

2.2 Intelligent products

Aside from advanced methodologies and processes (Terzi et al., 2010), intelligent products represent the main enabler for closed-loop PLM from a technological perspective (Terzi et al., 2010; Kiritsis, 2011). Describing products or systems with *intelligent* properties, various labels are used in literature. Table 1 provides an overview on established concepts from different scientific domains.

The term *intelligent product* was first discussed in 1988 and represents the predominant concept in research on closed-loop PLM (Meyer et al., 2009; Kiritsis, 2011). As we strive to contribute to this research stream as well, this paper employs the same nomenclature. *Cyber-physical system* is a notion which is rooted in the engineering and computer science domain and known from the German political initiative Industrie 4.0 (Lee, 2008; Acatech, 2011; Park et al., 2012). In contrast, the concept of *digital innovation* is native in the domain of information systems research (Yoo et al., 2010; Yoo et al., 2012). The term *smart, connected product* became famous within a seminal Harvard Business Review article (Porter & Heppelmann, 2014; Porter & Heppelmann, 2015). *Smart objects* have similar origins as intelligent products, but have been conceptualized slightly different (Kortuem et al., 2010; López et al., 2011). Although certain proximity exists, intelligent products have to be demarcated from the *Internet of Things* paradigm which rather focuses on identification and connectivity than on intelligence (Meyer et al., 2009).

Concept	Conceptualization
Intelligent products	"[…] contain sensing, memory, data processing, reasoning, and communication capabilities […]" (Kiritsis, 2011, p.480; Meyer et al., 2009)
Cyber-physical systems	"[…] are integrations of computation with physical processes. Embedded computers and networks monitor and control the physical processes, usually with feedback loops where physical processes affect computations and vice versa […]" (Lee, 2008, p.1; Acatech, 2011; Park et al., 2012)
Digitized products	"[…] digitization makes physical products programmable, addressable, sensible, communicable, memorable, traceable, and associable […]" (Yoo et al., 2010, p.725; Yoo et al., 2012)
Smart, connected products	"[…] consist of physical components, smart components (sensors, microprocessors, data storage, controls, software, operating system), and connectivity components (ports, antenna, protocols) […]" (Porter & Heppelmann, 2014, p.67; Porter & Heppelmann, 2015)
Smart objects	"[…] possess a unique identity, are capable of communicating effectively with its environment, can retain data about itself, deploy a language, and are capable of participating in or making decisions […]" (López et al., 2011, p.284; Kortuem et al., 2010)

Table 1: Selected concepts related to intelligent products

2.3 Data, information and knowledge flows

Data, information, and knowledge flows in the product lifecycle were investigated from various perspectives. For the purpose of this paper, the terms *data* and *information* are used synonymously. From a holistic perspective, aspects of information flow in PLM were investigated by Jun and Kiritsis (2012). Beyond this comprehensive view, several publications address more specifically the information flow between individual lifecycle phases. Aligned with our research objective, we focus on product usage data. As necessary prerequisite, the definition of product usage data is a common research subject. For example, Wellsandt et al. (2015a) analyzed content of product usage information from embedded sensors and web 2.0 sources. Furthermore, Wellsandt et al. (2015b) investigated sources and characteristics of information about product use derived from real products. As subsequent step, gathering of product usage data has been examined from multifaceted perspectives. For example, Carlson and Murphy (2003) selected product failure information as main source. In contrast, Vichare et al. (2007) applied a more comprehensive approach and collected environmental and usage loads. In terms of utilization of those defined and gathered product usage data, applications can be found in BOL, MOL, and EOL. Applications targeting the MOL phase usually pursue to improve maintenance procedures (e.g., Lee et al., 2006). In contrast, Cao et al. (2011) provide an example how to leverage product usage data for EOL decisions. Although some publications try to harness product usage data for BOL (e.g., Stone et al., 2005), existing research predominantly addresses the operations phase (Shin et al., 2009; Shin et al., 2014).

Finally, looking at the body of knowledge as a whole in order to aggregate the results: First, the utilization of product usage data has been rather investigated from maintenance points of view than from design points of view. Second, existing work is highly specific and contextual. Third, the empirical perspective has been comparatively neglected. In spite of much efforts it is still challenging to understand the new role of product usage data for product development. In the following we address this research gap.

3 Research methodology

Since up to the authors' knowledge, no research with congruent goals and conditions has been published, an exploratory research strategy was selected. Guided by the study purpose, an interpretative research design and a case study approach following Yin (2009) was chosen. A case study represents an "empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident" (Yin, 2009, p.13). More specifically, a multiple-case study was selected, as those are more compelling and robust (Yin, 2009). As qualitative research is often criticized for limited transparency and generalizability (Myers, 2013), we pursue a transparent and rigorous approach despite the limited space available.

We applied theoretical sampling (Lincoln & Guba, 1989) to iteratively approach our study objectives. The rationale for the case selection was put forth along three lines in order to meet the exploratory nature of our study: First, we structured our research along the continuum from batch production to bulk production. Second, we included companies which already exploit, plan to exploit, and currently do not exploit those possibilities. Third, we pursued internationality by selecting cases from different European countries. Case organization ALPA is a special engineering company producing special machinery for luxury goods. ALPHA is characterized by the development and manufacturing of individual and rather incrementally enhanced industrial equipment with long lifecycles for internal use. Case organization BETA is a materials handling original equipment manufacturer (OEM). In their competitive market, BETA aims to differentiate their products by high quality and durability from their competitors. Case organization GAMMA is a first tier automotive supplier. Evolved from manufacturing solely mechanical components to the development of complex mechatronic systems, GAMMA supplies a large number of automotive OEMs. Table 2 provides an overview on the case organizations and interviewee profiles.

Organization	Industry	Revenue/employees	Interviewee profiles
ALPHA	Special engineering	< 1,000 MN €/ < 5,000	[A] Head of engineering design [B] Head of control engineering [C] Project lead control engineering [D] Head of manufacturing engineering [E] Head of technical IT
BETA	Materials handling (OEM)	> 2,001 MN €/ > 10,001	[F] Project lead strategic product platforms [G] Project lead advance development [H] Project lead advance development [I] Senior engineer advance development [J] Head of product lifecycle management [K] Head of master data management
GAMMA	Automotive (first tier supplier)	1,001–2,000 MN €/ 5,001–10,000	[L] Head of innovation and technology [M] Senior engineer product design [N] Senior engineer product simulation [O] Chief information officer

Table 2: Overview on case organizations and interviewee profiles

3.1 Data collection

For data collection, semi-structured interviews acted as main source of evidence (Eisenhardt, 1989; Yin, 2009). Thereby, the interviewee selection was guided by three criteria: First, we included professionals from relevant lifecycle phases, complemented by support functions such as IT management. Second, a mix of different seniorities was included to enclose those who drive decisions and those who are affected. Third, the sample comprised experts with a blend of operational reality and strategic vision. Interviews were conducted with a guiding questionnaire developed along recommendations by Schultze and Avital (2011). Thereby, the questionnaire encompassed sections related to the interviewee`s background and current trends and developments in product development. Subsequently, questions referring to actual strategies, processes, and information systems related to closed-loop PLM addressing rationales, opportunities, conditions, and obstacles were asked. Furthermore, additional sub-questions – wherever necessary – were posed for details. The interviews were completed from August 2015 to November 2015 on a face-to-face basis with a minimal interview length of 33 minutes and maximal interview length of 95 minutes, resulting in an average of 64 minutes. Interviews were recorded, anonymized, and transcribed with the result of 115 pages of single-spaced text. Furthermore, we included complementary sources of evidence such as artifacts and archival records (Yin, 2009). In detail, we had the opportunity to intensively explore ALPHA`s, BETA`s, and GAMMA`s product development-related (PLM) and industrial service-related (SLM) IT landscape. Furthermore, we included management presentations describing strategic initiatives: Machine connectivity at ALPHA (one document), smart, connected industrial equipment at BETA (two documents), and next generation PLM at GAMMA (four documents).

3.2 Data analysis

For data analysis, grounded theory analysis techniques (Strauss & Corbin, 1997) were employed. Following an inductive approach, open, axial, and selective coding procedures were applied which is an established methodology in qualitative research (Strauss & Corbin, 1997). With the objective of rigorous and efficient data analysis, computer-assisted qualitative data analysis software (CAQDAS) NVIVO 10 was utilized (Alam, 2005; Sinkovics et al., 2005). Upon the novelty of the subject and the exploratory nature of our study, codes were aggregated inductively without applying existing concepts or theories from the body of knowledge. In the open coding stage, we generated codes and categories of recurring salient concepts that guided us during the compilation of the interview questionnaire, but strived to remain as open and unbiased as possible. In the axial and selective coding stages, we identified relationships in-between and condensed our categories. In sum, 268 codes were identified as empirical evidence. As our research is interpretive in nature, the concepts of reliability and validity need to be substituted with credibility, corroboration, and generalizability (Lincoln & Guba, 1985; Klein & Myers, 1999; Myers, 2013): First, we planned, conducted, and documented the research process rigorously to our best knowledge. Second, we applied data and investigator triangulation (Yin, 2009) by applying multiple data sources and involving two independent researchers. Third, we are aware of contrary interpretations and strived to take alternative perspectives. Finally, we evaluated our findings within focus group workshops at the case organizations (Yin, 2009).

4 Results

In the case studies, rationales, opportunities, conditions, and obstacles for exploiting product usage data for product development enabled by intelligent properties were identified. Table 3 provides an overview. Following the Pareto principle, we seek to present the most impactful aspects with subsequent in-depth discussion, rather than outlining all identified factors. Accordingly, we list the first four factors in a compact form. Although differences in the cases were carved out in a cross-case analysis (Yin, 2009), this paper refers to their commonalities.

Perspective	Identified factors
RQ1: Rationales	R1.1 - Importance of customer- and user-centric innovations R1.2 - Resource-intensive back-loaded physical testing and feedback from field R1.3 - Demand for data- and information-driven decision making R1.4 - Ubiquitous available data from secondary sources
RQ2: Opportunities	R2.1 - Specification of requirements R2.2 - Customer- and user-centric product portfolio planning R2.3 - Design and process planning for usage R2.4 - Shortening and replacing of physical prototyping and field testing
RQ3: Conditions	R3.1 - Products with long and individual operations determining lifecycle costs R3.2 - Products with self-contained systems featuring high transferability R3.3 - Products with notably high share of intelligent components R3.4 - Products in homogeneous and standardized ecosystems
RQ4: Obstacles	R4.1 - Individual and complex character of products and development projects R4.2 - Identification, collection, storage, analysis, and application of data R4.3 - Quantification of costs and benefits for an investment decision R4.4 - Preservation of the ecosystem stakeholders` interests

Table 3: Overview on identified factors

4.1 Rationales

Addressing research question 1, we identified rationales that drive the exploitation of product usage data from intelligent products for product development. First, leveraging product usage data is reasoned in the increasing importance of customers and users as source of product innovations (R1.1). Second, the resource-intensive back-loaded physical testing and feedback from the field drives the exploitation of product usage data (R1.2). Third, another motive for leveraging product usage data is the demand for data- and information-driven decision making (R1.3). Finally, in addition to those three pull factors, also a push factor was identified: Products get augmented with intelligent properties upon other reasons, for example to monitor their status or to ensure machine operator safety. Hence, ubiquitous data from secondary sources make their way into the product development departments (R1.4).

4.2 Opportunities

Addressing research question 2, we identified opportunities that emerge from the exploitation of product usage data from intelligent products for product development. Drawing on the established framework by Eigner and Stelzer (2008) who provide a more detailed product lifecycle model, four opportunities were carved out: First, product usage data enable the specification of requirements (R2.1). Second, product usage data support the creation of a customer- and user-centric product portfolio (R2.2). Furthermore, by the aid of product usage data, products can be designed and planned for usage overcoming assumption- and experience-based development processes (R2.3). Finally, product usage data have the potential to shorten and replace physical prototyping and field testing (R2.4).

4.3 Conditions

Addressing research question 3, we identified conditions that support the exploitation of product usage data from intelligent products for product development. First, products which exhibit long and individual operations that determine lifecycle costs seem particularly valuable (R3.1). Second, products with self-contained systems such as product platforms and product families featuring high transferability are qualified (R3.2). Third, products with a notably high share of intelligent components tend to be suitable as those offer additional information consuming solely minimal additional resources (R3.3). Finally, another suitable context factor are homogeneous and standardized ecosystems as such a setting facilitates data and information exchange (R3.4).

4.4 Obstacles

Addressing research question 4, we identified obstacles that impede the exploitation of product usage data from intelligent products for product development. First, from a technical perspective, products and accordingly their development projects are often characterized as highly individual and complex without the security of transferability of insights (R4.1). Second, another technical issue refers to uncertainties along the chain of identification, collection, storage, analysis, and application of product usage data (R4.2). Third, from an economic perspective, the insecure quantification of costs and benefits for an investment decision in product (retro-) fit, IT infrastructure, and human resources was considered as a hindering factor (R4.3). Finally, the preservation of the ecosystem stakeholders` interests such as know-how protection (external view) or inordinate transparency (internal view) became apparent as critical factor for a seamless and multi-directional information flow (R4.4).

5 Discussion

The manufacturers` motive to leverage product usage data from intelligent products for product development to support customer- and user-centric innovation goes in line with existing approaches in literature of democratizing the innovation process from producer to customer and user (von Hippel, 2005; Chesbrough et al., 2009). Furthermore, the rationale to overcome back-loaded physical testing and feedback from field can be interpreted as a continuation of other measures applied to frontload engineering activities, such as modelling and simulation (Eigner & Roubanov, 2014). The goal to archive data- and information-driven decision making is familiar from related efforts summarized as *business intelligence and analytics* (Chen et al., 2012). Lastly, the rationale of ubiquitous available data can be discussed in the light of the *generativity* concept (Zittrain, 2009). Intelligent properties are added for a special primary purpose, but enable unanticipated, secondary purposes through contributions from broad and varied audience (Zittrain, 2009). Findings indicate that product usage data can be harnessed for all sub-stages of the product development process in a value-adding manner. Hence, this result contradicts the fact that current research on product usage data predominantly addresses the operations phase (Shin et al., 2009; Shin et al., 2014). As one study participant (BETA, interviewee [I]) stated: "It is smarter to leverage product usage data to design a product without failure than to employ product usage data to predict it`s failure." Whereas emerging opportunities to support product development in early stages (e.g., specification of requirements) can be advocated, the benefits of shortening and replacing physical prototyping and field testing have to discussed critically in view of the customer`s safety. Furthermore, existing literature (Kiritsis et al., 2008; Kiritsis, 2011) suggests that closed-loop PLM is valuable for various kinds of products. This study is conform, however, our research proposes that the expected benefits are dependent of variables such as product type and industry ecosystem. In this context, two phenomena need to be debated: On the one hand, the identified suitability for products with long lifecycles contradicts the opportunity of short-cyclical iterative product improvements. On the other hand, the eligibility for usage data-driven product improvement may decrease within the general trend of shortening lifecycles. The identified obstacles refer to challenges at a technical, economic, and social level. Accordingly, obstacles at various dimensions need to be overcome to successfully exploit the whole potential of intelligent products.

6 Conclusion

The paper at hand aims to explore the role of product usage data for product development enabled by intelligent properties. Our research is located in the field of closed-loop PLM. Grounded on empirical data from three distinct manufacturing branches, we identified rationales, opportunities, conditions, and obstacles. Our findings indicate that (1) heterogeneous motives drive the exploitation, (2) a positive impact on every product development stage is perceivable, (3) some products and industry ecosystems are more suitable than others, and (4) technical, economic, and social obstacles challenge the exploitation. We contribute to the body of knowledge as follows: As closed-loop PLM is a key enabler for a less resource intensive society and a more competitive industry (Terzi et al., 2010), our work presents a first step to understand the role of closed-loop PLM.

From a practitioners' perspective, we would like to encourage producers for a more comprehensive and overarching lifecycle thinking. Product designers and manufacturers should assess and leverage these new opportunities. However, our study should be regarded in the light of some limitations. Although we tried to cover the spectrum of manufacturing industries as a continuum, we had to focus on three discrete industries. This implies that our findings are on the one hand not representative and on the other hand bound to specific branches, companies, and products. Given the interpretative nature of our analysis, other teams of researchers might have identified other factors. Furthermore, due to the exploratory nature of our research, we cannot guarantee completeness. In the narrower sense, future work for scholars might encompass further empirical validation of the identified factors, for example on the basis of a quantitative survey. In a broader sense, remaining lifecycle information flows may represent a fertile field for further research.

References

Acatech. (2011). Cyber-Physical Systems: Innovationsmotor für Mobilität, Gesundheit, Energie und Produktion. Berlin/Heidelberg: Springer.

Alam, I. (2005). Fieldwork and Data Collection in Qualitative Marketing Research. Qualitative Market Research: An International Journal. 8(1), pp. 97-112. DOI: 10.1108/13522750510575462.

Ameri, F. & Dutta, D. (2005). Product Lifecycle Management: Closing the Knowledge Loops. Computer-Aided Design & Applications. 2(5), pp. 577-590. DOI: 10.1080/16864360.2005.10738322.

Andreasen, M. M. & Hein, L. (1987). Integrated Product Development. Bedford: IFS.

Cao, H., Folan, P., Potter, D. & Browne, J. (2011). Knowledge-Enriched Shop Floor Control in End-of-Life Business. Production Planning & Control. 22(2), pp. 174-193. DOI: 10.1080/09537281003769980.

Carlson, J. & Murphy, R. R. (2003). Reliability Analysis of Mobile Robots. In Proceedings of the IEEE International Conference on Robotics and Automation, 2003. Taipei, Taiwan: IEEE.

Chen H., Chiang, R. H. & Storey, V. C. (2012). Business Intelligence and Analytics: From Big Data to Big Impact. MIS Quarterly. 36(4), pp. 1165-1188.

Chesbrough, H., Vanhaverbeke, W. & West, J. (2006). Open Innovation: Researching a New Paradigm. New York: Oxford University Press.

Eigner, M. & Stelzer, R. (2008). Product Lifecycle Management - Ein Leitfaden für Product Development und Life Cycle Management. Berlin/Heidelberg: Springer.

Eigner, M. & Roubanov, D. (2014). Modellbasierte virtuelle Produktentwicklung. Berlin/Heidelberg: Springer.

Eisenhardt, K. M. (1989). Building Theories from Case Study Research. The Academy of Management Review. 14(4), pp. 532-550. DOI: 10.5465/AMR.1989.4308385.

Jun, H.-B. & Kiritsis, D. (2012). Several Aspects of Information Flows in PLM. In Proceedings of the 9th IFIP WG 5.1 International Conference on PLM, 2012. Montreal, Canada: Springer.

Jun, H.-B., Kiritsis, D. & Xirouchakis, P. (2007). Research issues on closed-loop PLM. Computers in Industry. 58(8/9), pp. 855-868. DOI: 10.1016/j.compind.2007.04.001.

Kiritsis D. (2011). Closed-loop PLM for intelligent products in the era of the Internet of things. Computer-Aided Design. 43(5), pp. 479-501. DOI: 10.1016/j.cad.2010.03.002.

Kiritsis, D., Bufardi, A. & Xirouchakis, P. (2003). Research issues on product lifecycle management and information tracking using smart embedded systems. Advanced Engineering Informatics. 17(3/4), pp. 189-202. DOI: 10.1016/j.aei.2004.09.005.

Kiritsis, D., Nguyen, V. K. & Stark, J. (2008). How closed-loop PLM improves Knowledge Management over the complete product lifecycle and enables the factory of the future. International Journal of Product Lifecycle Management. 3(1), pp. 54-77. DOI: 10.1504/IJPLM.2008.019970.

Klein, H. K. & Myers, M. D. (1999). A Set of Principles for Conducting and Evaluating Interpretive Field Studies in Information Systems. MIS Quarterly. 23(1), pp. 67-94.

Kortuem, G., Kawsar, F., Fitton, D. & Sundramoorthy, V. (2010). Smart Objects as Building Blocks for the Internet of Things. IEEE Internet Computing. 14(1), pp. 44-51. DOI: 10.1109/MIC.2009.143.

Lehmhus, D., Wuest, T., Wellsandt, S., Bosse, S., Kaihara, T., Thoben, K.-D. & Busse, M. (2015). Cloud-Based Automated Design and Additive Manufacturing: A Usage Data-Enabled Paradigm Shift. Sensors. 15, pp. 32079-32122. DOI: 10.3390/s151229905.

Lee, E. A. (2008). Cyber Physical Systems: Design Challenges. In Proceedings of the 11th International Symposium on Object Oriented Real-Time Distributed Computing, 2008. Orlando, Florida: IEEE.

Lee, J., Ni, J., Djurdjanovic, D., Qiu, H. & Liao, H. (2006). Intelligent Prognostics Tools and E-Maintenance. Computers in Industry. 57(6), pp. 476-489. DOI: 10.1016/j.compind.2006.02.014.

Lincoln, Y. S. & Guba, E. G. (1989). Fourth Generation Evaluation. Newbury Park: Sage.

López, T. S., Ranasinghe, D. C., Patkai, B. & McFarlane, D. (2011). Taxonomy, Technology and Applications of Smart Objects. Information Systems Frontiers. 13(2), pp. 281-300. DOI: 10.1007/s10796-009-9218-4.

McKinsey & Company. (2015). Internet of things: Mapping the value beyond the hype. McKinsey Global Institute.

Meyer, G. G., Främling, K. & Holmström, J. (2009). Intelligent Products: a survey. Computers in Industry. 60(3), pp. 137-148. DOI: 10.1016/j.compind.2008.12.005.

Myers, M. D. (2013). Qualitative Research In Business And Management. Thousand Oaks: Sage.

Park, K.-J., Zheng, R. & Liu, X. (2012). Cyber-physical systems: Milestones and research challenges. Computer Communications. 36, pp. 1-7. DOI: 10.1016/j.comcom.2012.09.006.

Parlikad, A. K., McFarlane, D., Fleisch, E. & Gross, S. (2003). The Role of Product Identity in End-of-Life Decision Making. Cambridge, United Kingdom: University of Cambridge.

Porter, M. E. & Heppelmann, J. E. (2014). How Smart, Connected Products Are Transforming Competition. Harvard Business Review. 92(11), pp. 64-86.

Porter, M. E. & Heppelmann, J. E. (2015). How Smart, Connected Products Are Transforming Companies. Harvard Business Review. 93(10), pp. 96-114.

Schultze, U. & Avital, M. (2011). Designing Interviews to Generate Rich Data for Information Systems Research. Information and Organization. 21(1), pp. 1-16. DOI: 10.1016/j.infoandorg.2010.11.001.

Shin, J.-H., Jun, H.-B., Kiritsis, D. & Xirouchakis, P. (2009). Function performance evaluation and its application for design modification based on product usage data. International Journal of Product Lifecycle Management. 4(1/2/3), pp. 84-113. DOI: 10.1504/IJPLM.2009.031668.

Shin, J.-H., Kiritsis, D. & Xirouchakis, P. (2014). Design modification supporting method based on product usage data in closed-loop PLM. International Journal of Computer Integrated Manufacturing. 28(6), pp. 551-568. DOI: 10.1080/0951192X.2014.900866.

Sinkovics, R., Penz, E. & Ghauri, P. N. (2005). Analysing Textual Data in International Marketing Research. Qualitative Market Research: An International Journal. 8(1), pp. 9-38. DOI: 10.1108/13522750510575426.

Stark, J. (2011). Product Lifecycle Management: 21st Century Paradigm for Product Realisation. London: Springer.

Stone, R., Tumer, I. & Stock, M. (2005). Linking Product Functionality to Historic Failures to Improve Failure Analysis in Design. Research in Engineering Design. 16(1/2), pp.96-108. DOI: 10.1007/s00163-005-0005-z.

Strauss, A. & Corbin, J. M. (1997). Grounded Theory in Practice. Thousand Oaks: Sage.

Terzi, S., Bouras, A., Dutta, D. & Garetti, M. (2010). Product lifecycle management - From its history to its new role. International Journal of Product Lifecycle Management. 4(4), pp. 360-389. DOI: 10.1504/IJPLM.2010.036489.

Ulrich, K. T. & Eppinger, S. D. (2008). Product Design and Development. Boston: McGraw-Hill.

Vichare, N., Rodgers, P., Eveloy, V. & Pecht, M. (2007). Environment and Usage Monitoring of Electronic Products for Health Assessment and Product Design. Quality Technology & Quantitative Management. 4(2), pp. 235-250.

Von Hippel, E. (2005). Democratizing Innovation. Cambridge, Massachusetts: MIT Press.

Wellsandt, S., Hribernik, K. & Thoben, K.-D. (2015). Content analysis of product usage information from embedded sensors and web 2.0 sources. In Proceedings of the 21st ICE/IEEE International Technology Management Conference, 2015. Belfast, Ireland: ICE/IEEE.

Wellsandt, S., Hribernik, K. & Thoben, K.-D. (2015). Sources and Characteristics of Information about Product Use. Procedia CIRP. 36, pp. 242-247. DOI: 10.1016/j.procir.2015.01.060.

Yin, R. K. (2009). Case Study Research - Design and Methods. London: Sage.

Yoo, Y., Boland, R. J., Lyytinen, K. & Majchrzak, A. (2012). Organizing for Innovation in the Digitized World. Organization Science. 23(5), pp. 1398-1408. DOI: 10.1287/orsc.1120.0771.

Yoo, Y., Henfridsson, O. & Lyytinen, K. (2010). The New Organizing Logic of Digital Innovation: An Agenda for Information Systems Research. Information Systems Research. 21(4), pp. 724-735. DOI: 10.1287/isre.1100.0322.

Zittrain, J. (2008). The Future of the Internet and How to Stop it. New Haven: Yale University Press.

29th Bled eConference

Digital Economy

June 19 - 22, 2016; Bled, Slovenia

Service-based Production Planning and Control of Cyber-Physical Production Systems

Christoph Berger

Fraunhofer Institute for Machine Tools and Forming Technology (IWU), Germany

Christoph.Berger@iwu.fraunhofer.de

Joachim Berlak

FOM University and software4production GmbH, Germany

Joachim.Berlak@software4production.de

Gunther Reinhart

Fraunhofer Institute for Machine Tools and Forming Technology (IWU), Germany

Gunther.Reinhart@iwu.fraunhofer.de

Abstract

Industrial production is facing major challenges with regard to flexibility and productivity during the manufacturing process. Due to the dynamic of product lifecycles, the number of product variants manufactured in the same production environment is continuously increasing. This paper explains the principles and the necessity for service-based planning and control of cyber-physical production systems (CPS) within a dynamic I4.0 environment. Furthermore, the paper presents the results of a public research project and describes the architecture and functionality of a derived CPS scheduling service. The service has been tested in real-life production in a lens manufacturing and show the monetary benefit of a CPS scheduling.

Keywords: Production scheduling, Cyber-Physical Production Systems, Service-based

1 Introduction

In August 2015, nearly 5.4 million of 42.89 million German employees worked in manufacturing companies, which are in essence small and medium-sized enterprises with less than 250 employees and 50 Mio. EUR turnover (Statistisches Bundesamt, 2015). After a GDP growth up to 3,75% in the years from 2000-2008, the economic turbulences between 2008-2010 and the resulting down-/up-swing, economic turbulences as well as home-made challenges will lead to major challenges in the upcoming years (Spath et. Al., 2013). The German manufacturing focus is clearly set on high-end premium products instead of low and medium-cost goods (Brecher, 2012). However, this interferes with the pressure on prices, costs and delivery times by global markets combined with unpredictable dynamics in all business areas (Jeschke, 2014). In order to compete in these conditions, manufacturing companies have to become more efficient, flexible and responsive to market changes (Abele & Reinhart, 2011). Politicians in Germany became aware of these challenges and funded research in this area five years ago. As a result, the key to meet these challenges is regarded in the use of information and communication technologies (ICT) within the manufacturing domain (Kagermann, 2013). With new technologies like the “Internet of Things” (IOT) and services in general (Kopetz, 2011), a paradigm change has started in the manufacturing industry and the German term “Industrie 4.0” or “Industry 4.0” (I4.0) became popular. This paper focuses on production planning and control within the I4.0 environment and its impact on the way of scheduling manufacturing environments.

2 Industry 4.0 and cyber-physical systems

I4.0 is a combination of the Computer Integrated Manufacturing (CIM) and Lean Management, trying to combine the benefits of both (Broy, 2010), (Schuh & Stich, 2014). From a technology perspective, the Internet of Things is the main driver of I4.0. IoT describes a vision, in which each device has its own IP address (Bauernhansl, 2015). These devices become smarter and are able connect with their surrounding environment. Therefore, these systems are able to communicate with humans, machines and any other compatible devices. Consequently, IoT benefits could be the reduction of energy costs, more comfort, healthcare support and higher flexibility (Bullinger & Hompel, 2007).

The technology for IoT is already available, cheap and powerful (Atzori & Iera & Morabito, 2010) similar to the development of smartphones. Hence, IoT is getting more and more interesting for manufacturing companies (Yang et. al., 2014). Modern plants consist of various machines and industrial manufacturing equipment like turning or milling machines, assembly lines etc., which are more or less smart. I4.0, respectively IoT, tries to integrate their environment vertically as well as in a horizontal way in order to exchange information. These devices, so-called cyber-physical systems (CPS), are main enablers for flexibility and productivity in the I4.0 manufacturing environment (El Kadiri, 2015). CPS consists of embedded systems with the ability to communicate, preferably via internet technologies like web services (Schuh et. Al., 2014). Hence, CPS are more than just an interface due to their ability to represent relevant knowledge about their physical reality and autonomous computing capacity for analysis and interpretation of the data (Reinhart et. Al., 2015). Moreover, a CPS can interact with another CPS beyond their own system boundaries. Therefore, CPS must be designed for cross-linking (Lee, 2008). This attribute requires broad networking abilities, which are presently unavailable.

This paper focuses on I4.0 CPS manufacturing in the context of I4.0 production scheduling and controlHence, the focus is not set on topics like vertical and horizontal integration and impacts of I4.0 on business models or production systems.

Following these assumptions, the question arises how scheduling software must operate to fulfil these demands. Due to the new technologies, the production planning and control software has to work in real-time in order to deal with CPS equipment reporting the own condition at any time.

3 Call for action

Due to the outlined changes in terms of dynamics, real-time data and complexity, current software for production planning and control has limited applicability within I4.0 environment (Klein et. Al., 2014). The major challenges can be summarized as following:

1. Rigid, respective not service-based, architectures and therefore lack of adaptability, versatility and scalability of these mostly proprietary systems
2. Time, cycle- and event-driven operations with focus on the support of manual production planning and control activities
3. Insufficient real-time capabilities which results in hourly or daily based scheduling batch runs
4. Scheduling of only one resource (e.g. machine, work place or employee) instead of a simultaneous scheduling of multiple resources

In contrast to the background of the I4.0 conditions of real-time production planning and control, the following requirements apply to appropriate CPS scheduling software:

1. Service-based architecture with high adaptability and scalability
2. Service-driven operations
3. Real-time production planning and control
4. Simultaneous backlog-free, multi-resource scheduling for machine, work place or employee, tool, material, etc.

Based on these requirements, a service-based multi-resource production planning and control software for I4.0 environments has been designed, developed, prototypical applied and validated in real-world cyber-physical production environments.

4 CPS scheduling service

The following chapters describe the structure and functionality of a CPS scheduler. The concept and prototype was derived in the 2012-2015 carried out research project CyProS funded by the German Federal Ministry of Research and Technology (BMBF) encompassing 19 industrial enterprises and research institutes (BMBF Industrie 4.0, 2015). Main aim of CyProS was the development of different CPS and the methodology of using them in real life production environments. Here, one of the scopes was to evaluate the benefits of CPS regarding the enhancement of productivity and flexibility.

4.1 Data and interfaces

All production planning and control system use more or less static master data and more or less highly dynamic data like e.g. production orders or shopfloor bookings (Kropp, 2014). That is similar in the I4.0 context of CPS scheduling and capacity planning, where the following data is mandatory:

1. Master data
   - Users, rights and roles for users of the CPS scheduling service
   - Resource master data for work places, machines or employees like ID, name etc.
   - Scheduling parameters like scheduling type, frozen zones etc.
2. Dynamic data
   - Customer orders, order confirmations or demands
   - Procurement orders or demands
   - Manufacturing orders
   - Working plans per manufacturing order with operations, standard times, allocated resources etc.
   - Real data with reference to an operation via e.g. manual shopfloor data collection
   - Real data with reference to a resource via e.g. machine data collection per time and attendance collection
   - Material availabilities, stock levels, bill-of-materials for stock articles etc.
   - Shifts, shift models or capacities per resource

The CPS scheduling services was designed to manage the depicted data stand-alone and/or by horizontal and/or vertical integrations to surrounding IT systems. Hence, the CPS scheduling service can be implemented in heterogeneous environments, which is often the case, especially in small and medium-sized enterprises. On the other hand, big companies can easily integrate their existing ERP or MRP and special purpose IT systems by using the pre-defined interface(s) for horizontally and vertically integrated data flows on the basis of:

1. File-based interfaces with ASCII, CSV, XML or IDoc files
2. SQL-based interfaces with transfer databases
3. Web service using REST or SOAP technology
4. OPC UA

The interfaces 1 and 2 are used more often to connect legacy systems. However, communication via web services has become a major precondition in I4.0 CPS environment (Berlak, 2015), (Franke et. al., 2014). Based on these four interfacing technologies, almost every actual or future IT system can be integrated with the CPS scheduling service (Reinhart, 2013)

4.2 Architecture for the scheduling service

Based on the derived call for action presented in chapter 3, the main conceptual approach was to derive a service-based architecture with high adaptability and scalability in order to enable real-time production planning and control with simultaneous backlog-free multi-resource scheduling. Hence, the IT architecture consists of different layers and technologies. The CPS scheduling service has been designed and implemented in Java EJB. The underlying service-oriented (SaaS) client-server architecture bases on the JBoss Application Server. Using the Hibernate framework, almost any SQL database can be used for storing the scheduling data. Evaluations or printable reports for users of the CPS scheduling service are created using open-source Jaspersoft iReports. Thanks to Java and the derived architecture, any JRE supported hardware, e.g. PC, IndustrielPC, Rasperry Pie, mobile device etc. or operating system, e.g. MS Windows, Linux, etc., can be used for running the CPS scheduling service. By iterative development applying the Rational Unified Process (RUP), permanent testing and the Java EJB technology, the CPS scheduling service has been implemented very effectively and efficiently. In summary, the CPS scheduling service architecture is versatile, future-proof, service-oriented and scalable (Broy, 2013). The main functions, relations and interfaces of the CPS scheduling service architecture between the shopfloor and office level are depicted in Figure 1.

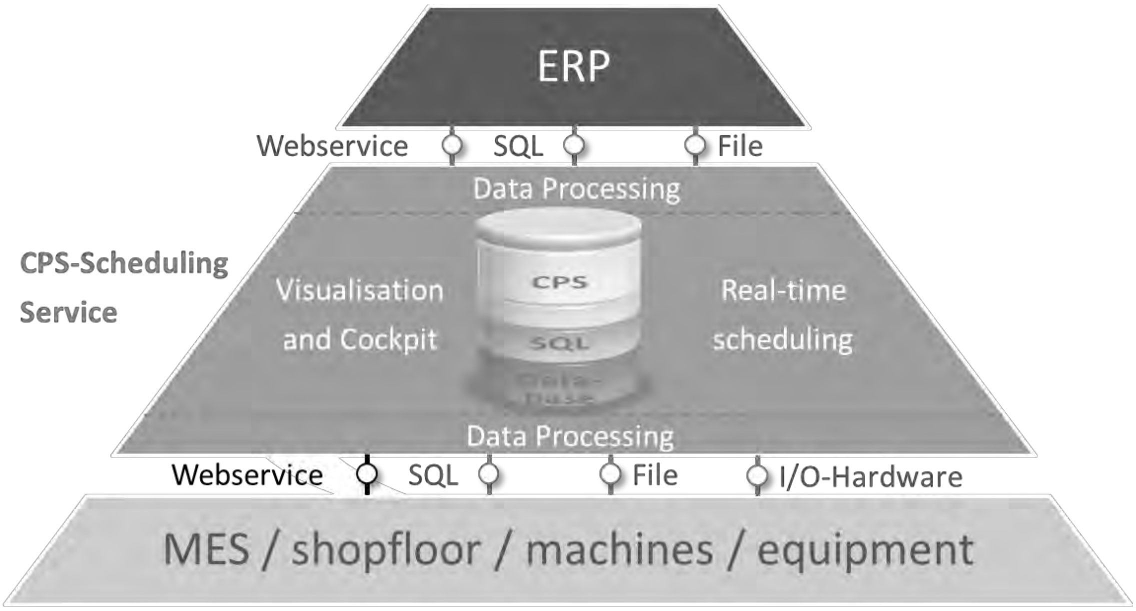


Figure 1: Architecture of the CPS scheduling services and its environment (Reinhart, 2015)

Based on Figure 1, the necessary scheduling data, as well as the interface between shopfloor and ERP level, are describe within the next chapter.

4.3 CPS scheduling service

The CPS scheduling service consists of three components (see Figure 1):

1. The data processing service
2. The real-time scheduler
3. A graphical user interface

The real-time scheduler is based on a backlog-free planning algorithm for scheduling customer and manufacturing orders with finite capacities. In contrast to today's ERP and MRP system scheduling with infinite capacities backward or forward, backlog-free means that the scheduler cannot schedule in the past. Instead, the actual point in time is the earliest possible start date for an operation. This enables realistic schedules, which is also a benefit of I4.0 CPS environments. Furthermore, the term "finite capacities" means that all scheduled resource like e.g. employees, machines, workplaces or tools have at least one valid shift allocated at all times (e.g. night shift 22:00-06:00 with pause from 01:00-01:30). Shifts and shift models can either be imported via interface or manually administered in a calendar.

Derived as need for action (see chapter 3), a scheduler for I4.0 CPS should run event-triggered as a service, rather than manually provoked or on a scheduled basis (e.g. every day or hour). This means that the scheduler reacts dynamically on changes and adjusted to the real situation. When a machine brakes down for example, it sends this information via web service interface (see chapter 4.2). The scheduler changes its capacity to "not available" and re-schedules all orders and operations automatically. However, in order to meet the challenges of industrial practice, a manual intervention of a human scheduler was built in the graphical user interface.

On opening the graphical planning board, all relevant master and dynamic data are processed in-memory in order to derive a realistic view on the production. The human scheduler can see deviations for orders immediately based on traffic light visualization. Furthermore, planned throughput times, problems and bottlenecks are presented as well. On that basis, the human scheduler can make changes to the plans by what-if-scenarios. Either manually per drag and drop movement of orders and operations or automatic optimization algorithms. These changes are not directly processed to the ERP and MRP system. The submission of scheduled start and end dates is released by saving the actual plan. In case that the plan is not sufficient for the human scheduler, he can undo the changes.

The graphical user interface (GUI) of the CPS-scheduler is depicted in Figure 2. It is separated in two areas: The upper area consists of tables for customer and manufacturing orders and operations. The bottom area shows a graphical Gantt chart graphical.

Figure 2: Graphical user interface of the CPS-scheduler

The main functions and items of the scheduler are depicted as follows:

1. Tables with customer or manufacturing orders, operations and resources:

The tables, respectively the columns, can be sorted, moved and filtered upon customer's request including a full-text search. The tables are updated in real-time, e.g. the status information according to as-is data from the shopfloor.

2. Flow of an order through production:

The sequence of a single order or an n-tier order tree is shown in the Gantt chart by double-clicking one of the table entries. Here, the sequences of operations and allocated resources as well as dependencies are clearly represented: every row represents a resource and the highlighted white box shows the associated operation of a selected order.

3. Capacity proposal:

The available capacity according to the assigned shifts and shift models is presented as coloured boxes. Lime represents available capacity and white/yellow unavailable (e.g. Saturday or Sunday).

4. Variation in time:

The Y-axis represents the time, the scale can be adjusted by sliders or mouse wheel.

5. Resource hierarchy:

Using grouping functions, types and capabilities, various organization structures within the CPS can be defined. When required, the structures can be scaled down or upwards.

6. Adherence to delivery dates and impact visualization:

In industrial manufacturing, the adherence to promised delivery dates is one of the major competitive advantages. In order to recognize delayed orders at an early stage, the CPS scheduler calculates the deviation between delivery date and scheduled end date and depicts the result with a customizable coloured traffic light: red means too late for various days, green means right on time and yellow represents too early. This list represents a to-do list for the human scheduler to take countermeasures like external processing of orders or operations, re-scheduling operations to another resource or talking to the customer and changing delivery dates. Please note that the result is strongly related to the type of scheduling: forward scheduling tries to start orders respectively operations as soon as possible with the effect that orders can be finished before the confirmed delivery date (yellow deviance). Whereas backward scheduling plans just-in-time to the delivery date (green deviance) with the effect that capacities could be idle or suboptimal utilized. Manual or automatic schedules always change the plans. In order to visualize the effect of a new schedule, a coloured up-/downward arrow appears: red means decline about various days, green represents improvement. Hence, the effect of schedules can be judged, which is very important for what-if-scenarios.

7. Simulation of dissent capacity scenarios:

An inherent question in production scheduling is, whether an additional shift or capacity is suitable for delivering orders right on-time and whether the cost-benefit ratio is appropriate for doing so. These challenges can be answered (ether: faced) by manual or automatic capacity adjusting and the effect will be visualized (see 6).

8. Save and undo function:

As long as the actual schedule is not saved, the manual schedules and what-if-scenarios can be reverted by the undo function, loading the last saved state. However, these plan are aligned with the actual situation within the CPS according to the as-is data.

9. Notes:

With the note feature, human schedulers can comment e.g. planning situations, orders and decisions. This makes it easier to track and communicate plans.

10. Operation queue:

The main scheduling result is a plan which can be viewed in the Gantt chart. However, a table view is more suitable and processible e.g. for shopfloor employees as well as machines. This list contains the orders or operations of a resource, sorted by the scheduled start and end dates.

Furthermore scheduling functions encompass the release of orders to the scheduler, splitting of orders and/or operations, fixation of orders and/or operations and a frozen-zone.

5 Application and validation

The CPS scheduling services has been tested in real-life production environments in order to judge its suitability and benefits for I4.0 CPS environments. The following application for lens manufacturing at Satisloh AG in a unique manufacture-to-order environment is described here as a showcase.

Figure 3: Validation of the CPS-planning service in lens manufacturing

Satisloh AG is a Swiss-based machine and equipment manufacturer for ophthalmic and precision optics manufacturing. There is a so-called demo-lab located at their site in Wetzlar (Germany). This demo-lab is a real manufacturing site with all necessary equipment to produce lenses in industrial conditions as showcase for customers and for the Satisloh internal lens production. Here, up to twelve process steps like generating, edging, coating etc. are carried out by machines linked together by conveyor belts with a throughput time of 2-4 hours. Hence, this is the ideal environment to test the CPS scheduler under real-world conditions according to the following scenario.

To validate the CPS-planning services in practice, the following scenario was developed. The demonstration lab for spectacle lens manufacturing (Figure 3) includes three production steps. It starts with glass blanks on a tray with each having a unique order number in form of a barcode.

The process starts by inserting the trays in the transfer device, the conveyor belt transports the trays to the appropriate machines. Every machine reads the barcode and receives the order number from a central Lab Management System (LMS). The LMS sends the machining programs and process parameters to the particular machine. The CPS-planning service receives the information about the machine status, the job number as well as the actual process from the spectacle lens machines via REST web services. The web service is on the same server as the Lab Management System (LMS) located and communicates also with it via REST web service in real time.

The following sequence from the communication shows, which information are transmitted in the CPS test scenario:

At first, the transfer of ten orders with the reference data from the LMS and a concurrent processing of the corresponding processes within the CPS-planning service need to be started. The second step is to receive actual feedback from the machinery and equipment, which order process starts/ends, the equipment status and process data. Ultimately, a disturbance of machinery for 120 second will be simulated Hence, redundant machinery is necessary for the meaningful implementation of the rescheduling in CPS-planning service.

Requirements, which the CPS-planning service needs to meet, are the following: detecting of machine malfunctions in real-time, rescheduling of the following orders or processes to the second machine and re-use of the disturbed machine.

The scenario described above was carried out in the demonstration lab over 50 times and has been tested at the customer day in live operations. The evaluation of the test scenarios revealed a response in almost real time to a machine disturbance. On average, the processing speed from the beginning of the disturbance to the processing in the database is smaller than 0.5-1 second. A threshold of 10 seconds avoids rescheduling of errors caused by short-time process and machine disturbances. The automatic rescheduling of CPS-planning services and the dissemination of the "command" over a REST web service to the conveyor belt lasted approximately two seconds. It could be determined, that the CPS-planning service can act in a time range of 2-4 seconds by rescheduling.

The monetary benefits can be shown in the following opportunity cost calculation: Without a CPS-planning service, costs arise by an hourly rate of 100 EUR by the waiting time of 3.33 EUR per disturbance. With a CPS-planning service, the waiting time is significantly reduced with the rescheduling after a 10 seconds threshold time. In consequence, the manufacturing cost saving accounts for 65.384 EUR, under the assumption of ten errors per shift and 220 working days.

6 Conclusion and discussion

It can be stated that the real-time CPS scheduling service is rather different to a conventional production planning system. The major difference is the event driven rescheduling of the production planning. This approach is possible with the straight-lined architecture, fitting interfaces between the shop floor levels and the production data.

7 Summary and outlook

The identification of unforeseen events in the production and the timely reaction on those is becoming increasingly important for companies. The real-time scheduling service for the planning and control of cyber-physical systems is an enabler for more flexibility in the manufacturing. Therefor essential is a multiple resources scheduling and a service-based real-time architectures. To develop the necessary production data and interfaces for production control is a basis for the use of service-based production planning in context of discrete manufacturing, in this article an approach to develop the basic components of the architecture is presented. So, compared to existing applications production planning in the context of service based architectures, the level of abstraction is concrete and a practical way. The core of the solution includes requirements of the scheduling and combines them with the new possibility of the cyber-physical production systems in the architecture. Its example application within in real-live lens manufacturing demonstrates that scheduling services can contribute to cost savings by reactive planning.

Acknowledgement

The research and development project CyProS is funded by the German Federal Ministry of Education and Research (BMBF) within the Framework Concept "Research for Tomorrow's Production" and managed by the Project Management Agency Karlsruhe (PTKA).

References

Statistisches Bundesamt (2015). Statistisches Jahrbuch Deutschland 2015 (pp. 343-362), 1., Auflage. Statistisches Bundesamt. Wiesbaden

Spath, D., Ganschar, O., Gerlach, S., et al. (2013). Produktionsarbeit der Zukunft - Industrie 4.0. Fraunhofer. Stuttgart: Fraunhofer

Brecher, C. (2012). Integrative production technology for high-wage countries. Berlin: Springer

Jeschke, S. (2014.) Automation, communication and cybernetics in science and engineering, Berlin: Springer

Abele, E, Reinhart, G. (2011). Zukunft der Produktion: Herausforderungen, Forschungsfelder, Chancen (pp. 121-147). München : Carl Hanser.

Kagermann, H., Wahlster, W. (2013). Umsetzungsempfehlungen für das ZukunftsprojektIndustrie 4.0 (pp. 22-29). acatech – Deutsche Akademie der Technikwissenschaften e.V.

Kopetz, H. (2011). Real-time systems: Design principles for distributed embedded applications, Real-time systems series. New York: Springer.

Broy, M. (2010). Cyber-Physical Systems: Innovation durch Software-Intensive Eingebettete Systeme (pp. 17-24). Heidelberg: Springer.

Schuh G., Stich V. (2014.: Enterprise -Integration: Auf dem Weg zum kollaborativen Unternehmen (pp. 23-35). Berlin: Springer.

Bauernhansl, T. (2014). Industrie 4.0 in Produktion, Automatisierung und Logistik: Anwendung, Technologien und Migration (pp. 38-120). Wiesbaden: Springer Vieweg.

Bullinger, H., Hompel, Mt. (2007) Internet der Dinge (pp. 315–329). Berlin: VDI. Springer.

Atzori, L., Iera, A., Morabito, G.(2010). The Internet of Things: A survey (pp. 2787-2805). Computer Networks.

Yang, D., Xue, G., Fang, X., et al. (2014). Crowdsourcing to smartphones p. 173. In: Akan ÖB, Ekici E, Qiu L et al. (eds) the 18th annual international conference.

El Kadiri, S., Grabot, B., Thoben, K., et al. (2015). Current trends on ICT technologies for enterprise information systems. Computers in Industry.

Schuh, G., Potente, T., Wesch-Potente C et al. (2014). Collaboration Mechanisms to Increase Productivity in the Context of Industrie 4.0 (pp. 51–56). Procedia CIRP.

Reinhart, G., Wittenstein, M., Scholz-Reiter, B. et al. (2015) Intelligente Vernetzung in der Fabrik: Industrie 4.0 Umsetzungsbeispiele für die Praxis (pp. 131-164). Stuttgart: Fraunhofer.

Lee, E. (2008). Cyber Physical Systems: Design Challenges (pp. 363-369) 11th IEEE International Symposium on. Los Alamitos: IEEE Computer Society.

Klein, K., Franke, M., Hribernik, K., et al. (2014). Potentials of Future Internet technologies for Digital Factories (pp. 734–741). In: 2014 IEEE/ACS 11th International Conference on Computer Systems and Applications (AICCSA).

BMBF Industrie 4.0 (2015). Innovationen für die Produktion von morgen.

Kropp, S., Schuh, G. (2014). Event-Driven Production Control based on Sensor Events. In: European Conference on Smart Objects, Systems and Technologien 2014 in Dortmund. Berlin: VDE-Verlag.

Broy, M. (2013). Engineering Cyber-Physical Systems: Challenges and Foundations (pp. 1–13). Berlin: Springer.

Berlak, J., Lutz, D. (2015). Schlanker Materialfluss: Mit Lean Production, Kanban und Innovationen.

Franke, M., Klein, K., Hribernik, K., et al. (2014). Semantic Web Service Wrappers as a Foundation for Interoperability in Closed-loop Product Lifecycle Management (pp. 225-230). 3rd International Conference in Through-life Engineering Services.

Reinhart, G., Wahlster, W., Scholz-Reiter, B., et al. (2013). Cyber-Physische Produktionssysteme: Produktivitäts- und Flexibilitätssteigerung durch die Vernetzung intelligenter Systeme in der Fabrik (pp. 84-89). wt Werkstattstechnik online.

29th Bled eConference

Digital Economy

June 19 - 22, 2016; Bled, Slovenia

Forecasting terminal call rate with machine learning methods

Davorin Kofjač

University of Maribor, Faculty of Organizational Sciences, Slovenia

davorin.kofjac@fov.uni-mb.si

Andrej Škraba

University of Maribor, Faculty of Organizational Sciences, Slovenia

andrej.skraba@fov.uni-mb.si

Amira Mujanović

University of Maribor, Faculty of Organizational Sciences, Slovenia

amira.mujanovic@student.um.si

Aleš Brglez

Gorenje gospodinjski aparati d.d., Slovenia

ales.brglez@gorenje.com

Abstract

This paper deals with the development of a model to predict the products' terminal call rate (TCR) during the warranty period. TCR represents a key information for a quality management department to reserve the necessary funds for product repair during the warranty period. TCR prediction is often carried out by parametric models such as Poisson processes, ARIMA models and maximum likelihood estimation. Little research has been done with machine learning methods (MLM). Therefore, this paper addresses the utilization of machine learning methods (MLM), such as regression trees, ensembles of regression trees and neural networks in order to estimate the parameters of different models for TCR prediction. MLM were tested on exponential and logistic non-linear models, which best describe the shape of the cumulative density function of the failed products. The estimated cumulative density function was used to predict the TCR. The results have shown the ensembles of regression trees yield the smallest TCR prediction error among the tested MLM methods.

Keywords: product failure, prediction, machine learning, regression trees, neural networks, ensembles

1 Introduction

All production companies are faced with the problem of failure of products and the provision of opportunities to repair those products within the warranty period. The warranty provides security to customers in the event of early products' failure that occur during the warranty period and represents a contract between the buyer and the manufacturer, which comes into effect when a customer has purchased the product. The purpose of the warranty is basically to ensure accountability in the case of premature failure of the product, where the failure is considered as the inability of the product to perform its function (Kim et al., 2004). Offering warranty causes additional costs to the manufacturer. As a result, the manufacturer wants to minimize that cost (Blischke and Murthy, 1994; Zuo et al., 2000). Therefore, predicting the proportion of products' failures during the warranty period is crucial for determining this cost.

In order to minimize the aforementioned cost, the manufacturers have different ways of predicting failure of products, such as lifetime distributions, stochastic processes, artificial neural networks, Kalman filters and time series models (Wu, 2012). Nonparametric approaches, such as neural networks, have also been applied to predict product failures. Wasserman and Sudjianto (1992, 1996) have implemented a neural network (multilayer perceptron, MLP) to predict warranty claims, which is able to accommodate non-linearities in the data when it cannot be adequately fitted with a low-order polynomial. Rai and Singh (2005) used a special type of neural network, i.e. radial basis function (RBF), in order to research the forecast warranty performance in the presence of the maturing data. Grabert et al. (2005) developed an early detection system using neural networks and probability distribution estimation. However, those approaches do not consider the fact that warranty claims reported in the recent months might be more important in forecasting future warranty claims than those reported in the earlier months, and they are developed on the basis of repair rates, which can cause information loss through such an arithmetic-mean operation (Wu, 2012). Therefore, Wu and Akbarov (2011) have proposed a weighted support vector regression (SVR) model and a weighted SVR-based time series model, which show a better performance compared with that of MLP and RBF as well as with ordinary SVR models.

By examining the literature, we can conclude that machine learning methods (MLM) have been used scarcely in the area of product failure prediction. Therefore, our goal was to investigate, whether it is possible to use the MLM to make a quality prediction of non-linear model parameters, which describe the cumulative failure rate of a product batch in a form of a cumulative density function (CDF). The CDF is then used to predict the terminal call rate (TCR). Such approach presents a novelty in this research area.

The rest of the paper is structured as follows. In Section 2 the literature review is provided as well as the methodology used to predict the product failures. Section 3 presents the machine learning prediction results. Finally, Section 4 gives the conclusions and the guidelines for future research.

2 Problem formulation and methodology

Manufacturer produces products in batches. Usually, batches are a monthly aggregate of a production of a certain product or a product family. When the failed product can be traced back to a specific production batch, we are able to convert such data into a so-called layer cake format. This format combines produced and failed products on a monthly basis, as presented in Table 1. The data are aggregated as an upper triangular matrix with diagonal. Such a data representation allows for the implementation of best-fit approaches (Kleyner & Sandborn, 2005). The data in Table 1 shows that we can collect 6 data points about the failures, which can be used as an input for prediction models.

Month	Num. of produced products	Number of failures per month		
		Month 1	Month 2	Month 3
1	3256	43	87	120
2	3590		78	101
3	3478			66

Table 1: An example of a layer cake

The failure process is usually described with the following well-known distributions: Weibull, exponential, normal, and log-normal (Kleyner & Sandborn, 2005; Hall & Strut, 2003, Xie & Lai, 1995). In our case, the time of production of a certain batch is known as well as the time of product failure. Hence, we can model this process with the following probability density function (PDF, right axis) and its resulting cumulative density function (CDF, left axis), as presented in Figure 1.

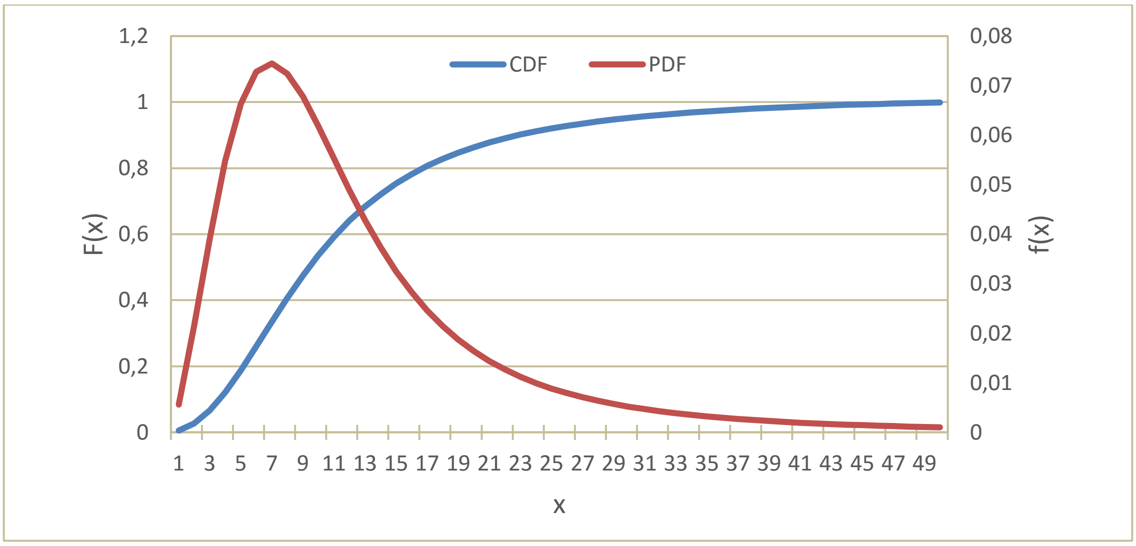


Figure 1: An example probability and cumulative density functions

An expected maximum value of the failed products within the warranty period is called the terminal call rate (TCR). To estimate the TCR, a cumulative failure rate over a specific period of time, e.g. a month, for a specific product batch must be known (Kofjač et al., 2014).

2.1 Curve fitting

In order to predict the TCR for a specific batch, its CDF must be determined. Hence, our goal is to estimate a real-valued variable $y \in \mathbb{R}$ given a pattern x (Smola and Vishwanathan, 2008).

The example is presented in Figure 2, where we are given a number of observations (presented by black dots) and we would like to estimate the function f which maps the observations X to □ such that $f(x)$ is as close to the observed values as possible.

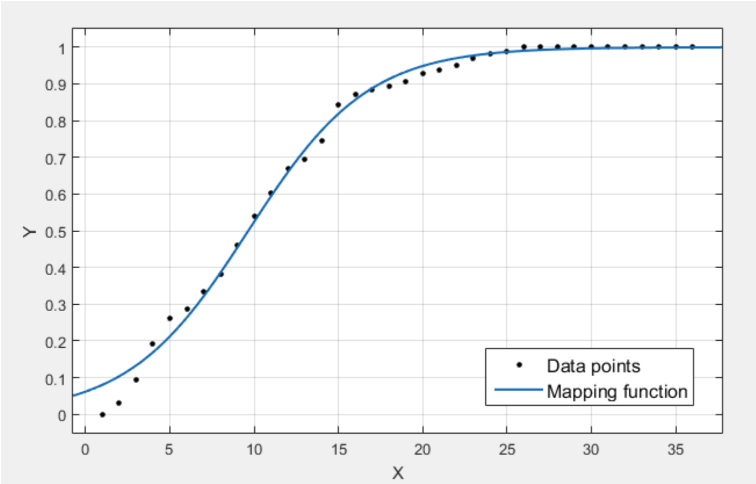


Figure 2: An example of regression estimation

The example in Figure 2 represents the CDF of a product batch failure rate (marked with dependent variable Y) over time in months (marked with independent variable X), normalized to the interval [0, 1]. Such a CDF can be estimated by using non-linear models, such as exponential and logistic. The logistic model is generally given by:

$$f(x) = \frac{a}{1 + be^{-cx}} \tag{1}$$

while the exponential model is generally given by:

$$f(x) = e^{a + \frac{b}{x}} \tag{2}$$

To evaluate the goodness of fit of the abovementioned non-linear models, we have used standard error of the estimate (SEE), which measures the average distance of a non-linear model from the observations, and is given by:

$$SEE = \sqrt{\frac{\sum (f(i) - f(i))^2}{n - p}} \tag{3}$$

where $f(i)$ are the observations, $f(i)$ the predictions, n the number of observations and p the number of parameters (independent variables) in the non-linear model. Although R^2 and R^2_{adj} are frequently used in evaluation of non-linear regression models, Spies and Neumeyer (2010) argue that these measures do not adequately reflect the goodness of fit. Therefore, those measures were not used in our research.

Finally, the TCR prediction accuracy is measured by mean absolute percentage error, which is given by:

$$MAPE = \frac{1}{n}\sum_{i=1}^{n}\frac{\left|f(i)-f(i)\right|}{f(i)} \tag{3}$$

Manufacturer has provided us with a database of 313 product batches (instances). The database contained the produced batch quantities and their respective number of failures per month. On this basis we were able to calculate the 313 CDFs of product failures and normalize them to the interval [0,1]. An example of three CDFs is shown in Figure 3. In the next step, we have used the Matlab Curve Fitting Toolbox to obtain the values for parameters a, b, and c for the logistic model (Eq. 1) and the values for parameters a and b for the exponential model (Eq. 2). The parameter values were obtained for each instance. An example of the obtained parameters for both non-linear models is presented in Table 2.

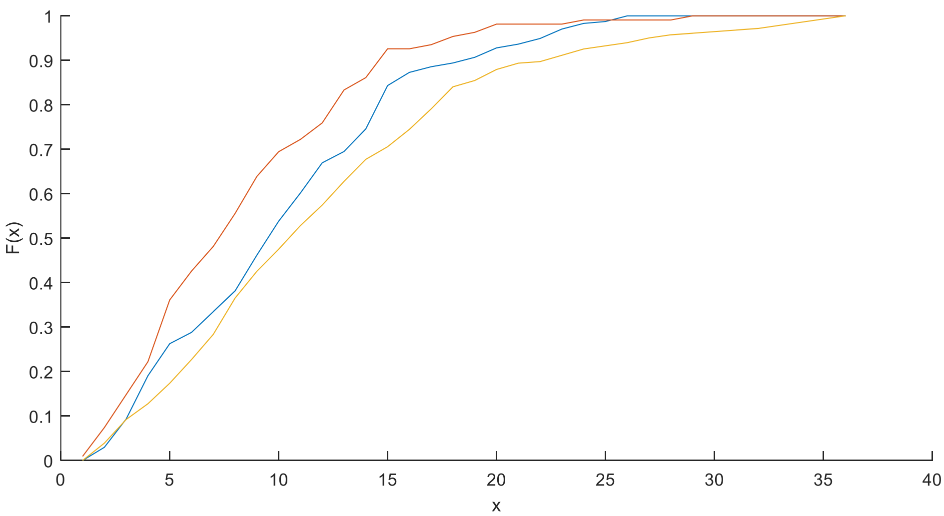


Figure 3: Examples of three different cumulative density functions, which represent a cumulative failure rate of three different product batches

Instance	Logistic model			Exponential model	
	a	b	c	a	b
1	1.309	0.839	0.092	0.304	-8.559
2	1.274	0.850	0.091	0.285	-8.438
3	1.318	0.827	0.092	0.312	-8.914
4	1.358	0.817	0.086	0.338	-9.741
5	1.323	0.827	0.088	0.316	-9.272
…	…	…	…	…	…

Table 2: An example of the obtained parameters per instance for both non-linear models

Next, the parameters obtained in the previous step were used to simulate 313 CDFs with both, the logistic and the exponential model. The simulated CDFs were compared them to the actual CDFs. The result of this modelling process was the evaluation measure SEE, for all instances and for both non-linear models. The average, minimum and maximum values and standard deviation for SEE are presented in Table 3. We can observe low average *SEE* values (with regard to the interval [0,1]), indicating that both non-linear models provide a quality fit. However, the logistic model provides better results with respect to the exponential model. It yields lower average, minimum and maximum values than the exponential model. Further, by observing the histogram of SEE values in Figure 4, one can notice that logistic model SEE values are less dispersed, indicating a more robust model.

Measure	Non-linear model	
	Exponential	**Logistic**
Avg SEE	0.036	0.024
St.dev. SEE	0.015	0.010
Min SEE	0.012	0.008
Max SEE	0.140	0.123

Table 3: Initial goodness of fit evaluation for the exponential and the logistic models

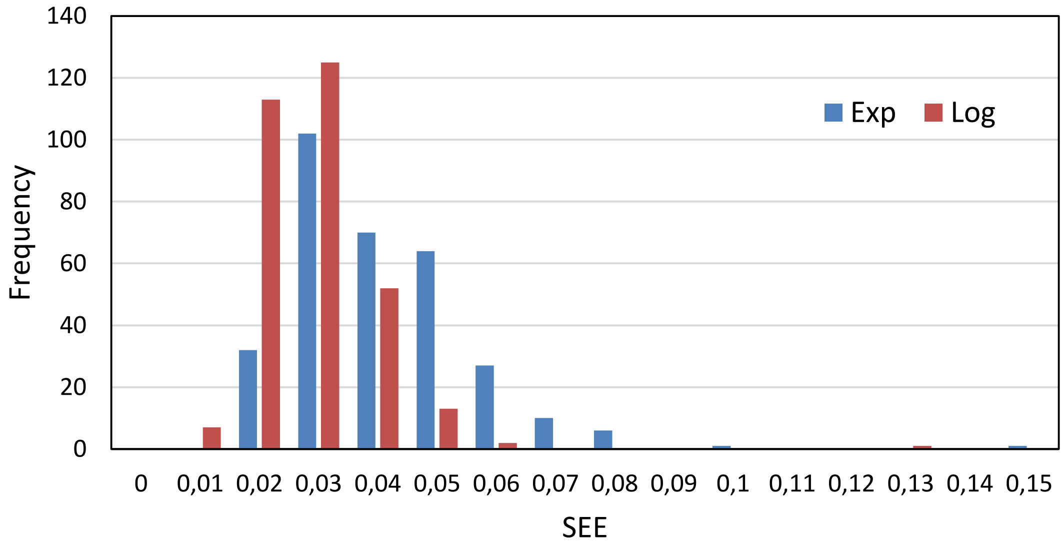


Figure 4: A histogram of SEE values in the initial goodness of fit evaluation for both non-linear models

2.2 Machine learning

By determining the parameter values for non-linear models we have obtained the instances, which can be used with MLM. Machine learning is a branch of artificial intelligence dealing with the development of techniques and methods that allow the learning of machines. Machine learning is used due to the two major reasons: some tasks are too complex to program and the need for adaptivity. First, several tasks are performed by humans routinely, yet we do not know how to sufficiently elaborate them to make an algorithm, such as driving, speech recognition, etc. Second, many tasks change over time or from one user to another. Therefore, it would be hard and inefficient to constantly change the algorithm "by hand" (Shalev-Schwartz and Ben-David, 2014).

Machine learning can tackle many problems, such as binary classification, multiclass classification, structured estimation, regression, novelty detection, etc. (Smola and

Vishwanathan, 2008). In our case, we use the regression estimation, where the goal is to estimate a real-valued variable TCR given an input pattern of cumulative failure rates.

Machine learning methods must be trained (taught) in order to be used effectively. They are able to learn in several ways. The most common classification of learning techniques is the supervised and unsupervised learning (Shalev-Schwartz and Ben-David, 2014). In supervised learning, it is assumed that the learning output is known in advance, while in unsupervised learning this is not the case. Supervised learning usually includes neural networks, decision trees, etc., while unsupervised learning includes different types of clustering, self-organizing maps, etc. (Smola and Vishwanathan, 2008).

In our case, the output is known in advance; we have obtained the values for parameters a, b (and c), which represent the desired MLM output values. Hence, we are able to use the supervised learning to train the MLM.

2.3 TCR prediction model and training

In this section we will present the TCR prediction model shown in Figure 5. The input into the model are the values r_1, r_2, ..., r_n, which represent the cumulative failure rates for the first n consecutive months since the production of a batch. The selected MLM then estimates the parameters a, b (and c). These parameters are used to calculate the CDF, which should adequately represent the cumulative failure rate of the selected batch. Finally, on the basis of the calculated CDF, we are able to predict the TCR.

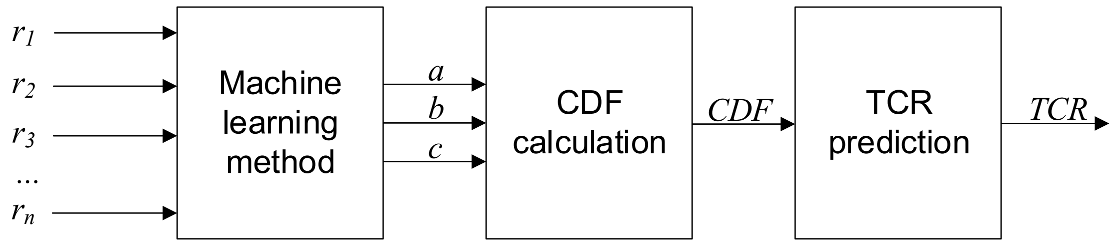


Figure 5: TCR prediction model

In order to train the MLM with supervised learning, we have to provide them with the inputs and the desired outputs. The input into the MLM are the partial CDFs, for example, the cumulative product failure rates for the first n months since the end of production of a particular product batch, where $n \in \{3,6,9,12,15,18,21,24,27,30,33,36\}$. For example, if $n = 3$ then the input into the MLM are the three values $\{0,\ 0.029,\ 0.093\}$. The desired output for the supervised learning are the estimated parameters a, b and c, which were obtained in the previous step, for example $\{1.309,\ 0.839,\ 0.092\}$. An example of this input-output mapping is presented in Table 4, where the partial cumulative product failure rates for the first 3 months (Mx denotes the month x) were taken as the input, while the parameters a, b and c were estimated for the logistic model.

	Input			Desired output		
Instance	M1	M2	M3	a	b	c
1	0	0.029	0.093	1.309	0.839	0.092

2	0	0.047	0.129	1.274	0.850	0.091
3	0.013	0.049	0.101	1.318	0.827	0.092
4	0	0.017	0.046	1.358	0.817	0.086
5	0	0.025	0.075	1.323	0.827	0.088
…	…	…	…	…	…	…

Table 4: Input and desired output data for machine learning methods

3 Results

To estimate the parameters for non-linear models, we have used regression tree, feedforward neural network and ensemble of regression trees. The MLM were tested in Matlab environment with the setup presented in Table 5. This setup has yielded the best fitting results in the preliminary study.

Regression tree	Type of tree: Binary Split criterion: MSE Number of folds in cross-validation: 10. Minimum instances in a leaf: 3 Minimum number of instances in a parent: 10
Neural network	Learning method: Levenberg-Marquardt backpropagation Max. number of epochs: 1000 Error goal: 0 Minimum gradient: 1e-7 Initial combination parameter μ value: 0.001 Decrease factor of μ: 0.1 Increase factor of μ: 10 Maximum μ value: 1e10 1 hidden layer with different number of neurons: 1, 5 and 10
Regression tree ensemble	The same parameters as with Regression tree. We have tested three different ensembles with 10, 50 and 100 trees, by using Tree Bagging.

Table 5: Experiment setup for machine learning methods

To train the MLM we have used the method of repeated random sub - sampling validation (RRSSV), also known as Monte Carlo cross-validation (MCCV) (Remesan and Mathew, 2015). We have run 10 iterations of MMCV. During each run the instances were divided into the training set (70%) and the test set (30%).

The results of testing the MLM are presented in Table 6. With obtained parameters a, b (and c) we have calculated the logistic or exponential CDFs for each instance in the test set and then evaluated the goodness of fit with the actual data by the SEE. The values in Table 6 represent the mean value and standard deviation across the 10 iterations of the MMCV method and $n \in \{3,6,9,12,15,18,21,24,27,30,33,36\}$.

Method's name in Table 6 consists of the following parts, separated by a comma:

- Type of machine learning method (NN – neural network, RT – regression tree, Ensemble – ensemble of regression trees).

- Model (Exp – exponential, Log – logistic).
- The parameter specific for the machine learning method - number of regression trees in an ensemble or the number of neurons in a hidden layer for neural network.

The results in Table 6 are sorted by the mean value of SEE in an ascending order. The best CDF fit results yielded ensembles of regression trees with exponential model, by achieving the lowest SEE values (0.04) and the lowest SEE standard deviation (0.01), indicating a robust production model. The worst SEE score was achieved by a regression tree with logistic model with the mean value of 0.06.

Method	Mean	SD
Ensemble, Exp, 100	0.04	0.01
Ensemble, Exp, 50	0.04	0.01
Ensemble, Exp, 10	0.04	0.01
NN, Exp, 5	0.04	0.01
NN, Exp, 10	0.05	0.02
Ensemble, Log, 50	0.05	0.01
NN, Log, 10	0.05	0.01
Ensemble, Log, 100	0.05	0.01
RT, Exp	0.05	0.01
NN, Log, 5	0.05	0.01
Ensemble, Log, 10	0.05	0.01
NN, Exp, 1	0.05	0.02
RT, Log	0.06	0.01

Table 6: Mean values and standard deviation for SEE per machine learning method

We have conducted further research on how the number of input data into the ML method affects SEE. For this test, we have selected only ensembles of regression trees with exponential model which have yielded the best results in the previous step. The test was performed with ensembles containing 10, 50 and 100 trees. The results are presented in Figure 6. As expected, one can notice that the SEE decreases for all ensembles with the increased number of input data. Obviously, the more input data you provide, the better the prediction result. Second, ensembles with higher number of trees yield better SEE values. The largest difference, approximately 0.005 among ensembles is with the lowest number of inputs. The more input data we provide, the lesser this difference, approximately 0.001, which is almost negligible.

In the final test, we have researched the TCR prediction accuracy of the ensembles of trees. The results are shown in Figure 7. Similar to the experiment setup in the previous step, the test was performed with ensembles of regression trees, containing 10, 50 and 100 trees, together with the exponential model. The TCR prediction accuracy was measured with mean absolute percentage error ($MAPE$) against the actual TCR. The average $MAPE$ values for (Exp, 10), (Exp, 50) and (Exp, 100) models are 2.46%, 2.34% and 2.31%, respectively. As expected, (Exp, 100) model yielded the lowest $MAPE$ values, therefore being the most suitable for TCR prediction.

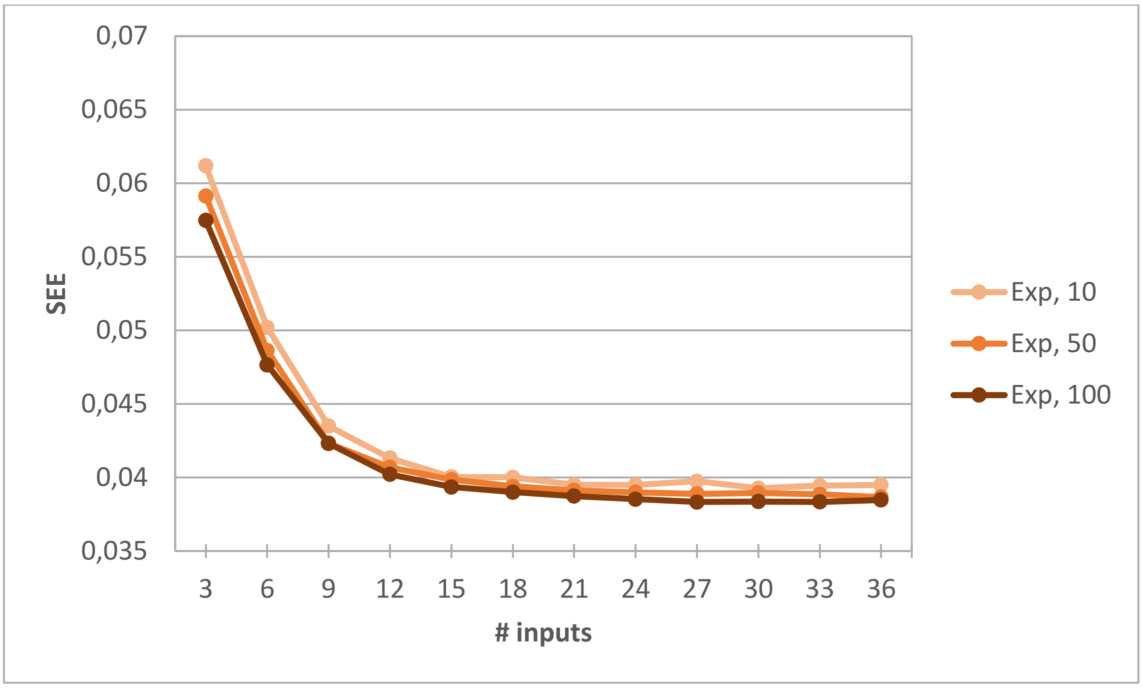


Figure 6: A comparison of ensembles with exponential model containing 10, 50 and 300 trees with regard to the different number of input data for *SEE*

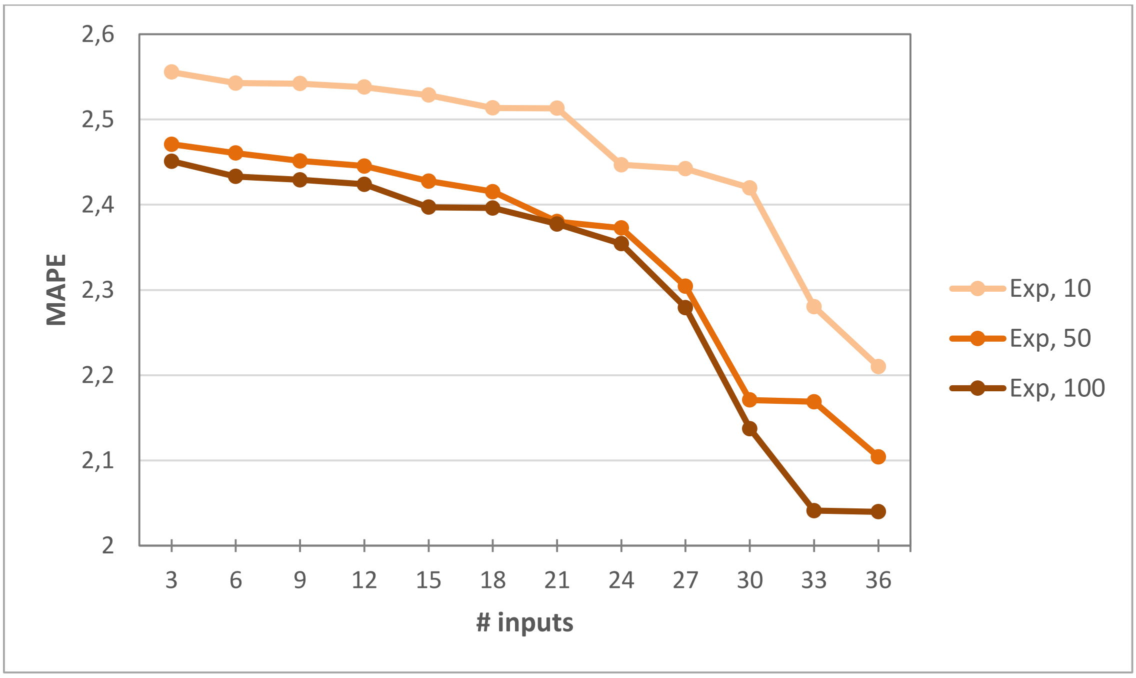


Figure 7: A comparison of ensembles with exponential model containing 10, 50 and 300 trees with regard to the different number of input data for *MAPE*

4 Conclusion

In the scope of this paper we have investigated the estimation of cumulative density function with MLM and its impact on the TCR prediction accuracy. The cumulative density functions were modelled with exponential and logistic models and their parameters were estimated with MLM, such as regression trees, neural networks and ensembles of regression trees.

In order to evaluate the goodness of fit of cumulative density functions to the actual data, we have used the SEE measure. Generally, the best fit results were achieved by ensembles of regression trees with *SEE* as low as 0.04. As expected, it was also shown that the more input data you provide, the more accurate estimation you get. With only 3 months of input data for ensemble with exponential model and 100 trees, the SEE value is 0.0575. On the contrary, if you provide the same ensemble with 12 or 36 months of input data, the SEE drops significantly to 0.04 or 0.038, respectively. Finally, cumulative density functions were used to predict the TCR. The TCR prediction accuracy was measured with $MAPE$ against the actual TCR. Ensembles of 100 regression trees yielded the highest prediction accuracy, with the average $MAPE$ value of 2.31%. Aforementioned results offer a possibility to use the developed TCR prediction model in practice. Such low $MAPE$ results could substantially improve the existing TCR prediction methods. A possible consequence of using the developed methodology are the substantially lower funds needed to be reserved for repairs during the warranty period.

The results achieved during this research phase reflect only the fundamental research in prediction of TCR with MLM. In the future, to improve the prediction accuracy, we intend to investigate the impact of other attributes, such as mean time to failure (MTTF), seasonality, market, etc. Further, ML methods setup also plays an important role in achieving greater prediction accuracy. Therefore, we will also investigate the optimization of ML methods attributes, for example, number of instances in leaves for regression trees.

Acknowledgement

This work was partially supported by the Ministry of Higher Education, Science and Technology of the Republic of Slovenia; Program No. P5-0018.

References

Blischke, W.R. & Murthy, D.N.P. (1994). Warranty cost analysis. New York: Marcel Dekker.

Grabert, M., Prechtel, M., Hrycej, T. & Günther, W. (2004). An early warning system for vehicle related quality data. Lecture Notes in Artificial Intelligence. 3275, 88–95.

Hall, P. & Strutt, J. (2003). Probabilistic physics-of-failure models for component reliability using Monte Carlo simulation and Weibull analysis: a parametric study. Reliability Engineering and System Safety. 80, 233–242.

Kim, C.S., Djamaludin, I. & Murthy, D.N.P., (2004). Warranty and discrete preventive maintenance. Reliability Engineering and System Safety. 84, 301–309. DOI: 10.1016/j.ress.2003.12.001.

Kofjač, D., Škraba, A. & Brglez, A. (2014). Warranty claims prediction with a combined model of market absorption and failure process. International journal of computing anticipatory systems. 30, 81-91.

Rai, B. & Singh, N. (2005). Forecasting warranty performance in the presence of the 'maturing data' phenomenon. International Journal of Systems Science. 36, 381–394.

Remesan, R., & Mathew, J. (2015). Machine Learning and Artificial Intelligence-Based Approaches. In Remesan, R. & Mathew, J. (eds), Hydrological Data Driven Modelling: A Case Study Approach (71-110). Switzerland: Springer International Publishing.

Shalev-Shwartz, S. & Ben-David, S. (2014). Understanding Machine Learning: From Theory to Algorithms. Cambridge University Press, New York, USA.

Smola, A. & VIshwanathan, S.V.N. (2008). Introduction to Machine Learning. Cambridge: Cambridge University Press.

Spiess, A.-N. & Neumeyer, N. (2010). An evaluation of R2 as an inadequate measure for nonlinear models in pharmacological and biochemical research: A Monte Carlo approach. BMC pharmacology. 10(6). DOI: 10.1186/1471-2210-10-6.

Wasserman, G. S. & Sudjianto, A. (1992). Neural networks for forecasting warranty claims. In C. H. Dagli, L. I. Burke, & Y. C. Shin (Eds.), Intelligent Engineering Systems Through Artificial Neural Networks. (2, 901-906). Fairfield, NJ, United States: ASME.

Wasserman, G. S. & Sudjianto, A. (1996). A comparison of three strategies for forecasting warranty claims. IIE Transactions. 28, 967–977.

Wu, S. (2012). Warranty data analysis: A review. Quality and Reliability Engineering International. 28, 795-805. DOI: 0.1002/qre.1282.

Wu, S. & Akbarov, A. (2011). Support vector regression for warranty claim forecasting. European Journal of Operational Research. 213(1), 196-204.

Xie, M. & Lai, C.D. (1995). Reliability analysis using an additive Weibull model with bathtub-shaped failure rate function. Reliability Engineering and System Safety. 52, 87–93.

Zuo, M.J., Liu, B., Murthy, D.N.P. (2000). Replacement-repair policy for multistate deteriorating products under warranty. European Journal of Operational Research. 123(3), 519–530. DOI: 10.1016/S0377-2217(99)00107-1.

29th Bled eConference

Digital Economy

June 19 - 22, 2016; Bled, Slovenia

Running While Standing Still: Rethinking ICT Business Model Decisions for the New Cloud Economy

Trevor Clohessy
J.E. Cairnes School of Business & Economics, National University of Ireland Galway,
trevor.clohessy@nuigalway.ie

Thomas Acton
J.E. Cairnes School of Business & Economics, National University of Ireland Galway,
thomas.acton@nuigalway.ie

Lorraine Morgan
Maynooth University, Lero: The Irish Software Research Centre,
lorraine.morgan@nuim.ie

Abstract

Cloud computing has underpinned an accelerated business model evolution for delivering ICT solutions. However, some established business model mature ICT providers are experiencing substantial difficulties related to the formulation of effective business models. Currently, there is dearth of IS research relating to deciphering how large business model mature ICT providers can effectively formalise and sustain competitive cloud enabled business model decisions. Thus, in order to extend the extant research, we derive a conceptual framework as a reference model which is based on business model and decision making theory. We then apply our framework to an in-depth case study of an established large ICT provider (Alpha) who have been provisioning cloud services for the past five years. Our findings reveal how the case organisation are executing their core business model decisions along increasingly specific decision making levels in order to effectively sustain their competitiveness. Our analysis provides new insight into the role of using the business model as a focusing device for enabling the effective provision of cloud technology.

Keywords: Cloud Computing, Business Model, Decision Making, Large ICT Provider

> *"All of our cloud business model decision-making strategies are founded on agility. The company are focused on making new or improved services faster than they did in the past. All new software offerings must be cloud-based in order to be provisioned at low cost."* Cloud R&D Leader, Alpha

1. Introduction

Cloud computing encompasses a recombination of existing and new technologies, and has built its foundations "on decades of research in virtualisation, distributed computing, utility computing, networking and more recently web and software services" (Vouk, 2008). Cloud computing enables information technology services providers to virtualise their computational resources and concurrently provision them, via a service orchestration process, typically in the form of Software-as-a-Service (SaaS), or Platform-as-a-Service (PaaS) or Infrastructure-as-a-Service (IaaS) (Mell and Grance, 2011). An organisation's ability to successfully commercialise early-stage information and communication technologies (ICT), while concurrently differentiating themselves from competitors in order to achieve sustainable competitive advantage, is largely dependent on their ability to repeatedly execute tactical business model decisions in the face of changing digital market landscapes (Porter, 1996; Linder and Cantrell, 2000; Teece, 2010). In the context of provisioning cloud computing, this ability is crucial as ICT providers' business model arrangements are in a constant state of flux due to the evolving cloud technology landscape (Ojala and Tyrvainen, 2011). This is also compounded by an increasingly overcrowded marketplace and the customer-oriented nature of provisioning cloud technology (Iyer and Henderson, 2010; Marston et al, 2011). ICT providers are currently experiencing substantial difficulties in their attempts to effectively leverage the transformational business capabilities afforded by cloud computing (Conboy and Morgan, 2012; Linthicum, 2012; Da Silva, Trkman, Desouza and Lindič, 2013). Recent international surveys of ICT providers have identified that lack of business model innovation and differentiation (CSA and ISACA, 2012) compounded by an inability to produce compelling business cases for customers (KPMG, 2012) represented salient challenges which are currently stagnating customer uptake of cloud technologies. According to Linthicum (2012) "the core problem is that most cloud technology providers believe what they do is innovative. To them, that means adopting the strategies of the market leaders, replicating their features and APIs (call for call), and hyping the market". The author argues that while such as a "fast follower" ethos may have worked effectively in the past, modern technological savvy business customers require concrete assurances pertaining to the business value of adopting a cloud computing solution. The IS literature's understanding of organisational business models and its relationship with cloud computing is still limited (Ehrenhofer and Kreuzer, 2012; Khanagha, Volberda and Oshri, 2014). Recently, there has been an increased focus by IS researchers on the business value afforded by cloud computing (Marston et al., 2011; Iyer and Henderson, 2012). While extant research has explored the impact of cloud computing on small and medium born on the cloud ICT providers' business models (Chang, Walters and Wills, 2013; Morgan and Conboy, 2013; Clohessy, Acton and Morgan, 2016), to the best of our knowledge no research exists which has explored this impact from a large business model mature (e.g. extant pre-cloud business models) ICT providers' multi-level decision-making perspective. Additonally, the cloud computing paradigm has reached a level of maturity which lays the foundation for information systems (IS) researchers to investigate how ICT providers have moulded and sustained their cloud computing business arrangements over time (Iyer and Henderson, 2012). Thus, the objective of this research is to:

Explore how a large business model mature ICT provider formalises cloud-enabled business model decisions in order to sustain their competitiveness.

Specifically, we present a decision-making focused research model which we subsequently use in an exploratory case study of a globally recognised ICT provider in order to shed light on our research objective. In lieu of the difficulties currently being experienced by ICT providers, and given the dearth of existing discussion in the IS literature, the study outlined here will serve as an initial step of a future larger empirical study. The remainder of the paper is structured as follows: The next section builds the theoretical foundation for the study. Then, we present our research model which is subsequently followed by an elucidation of our research method. Next, the case study results are presented and discussed. Finally, we conclude with some limitations of the study and a delineation of the next steps to be taken in order to complete the study.

2. The Business Model Research Lens

For the past 25 years, the business model concept has been used extensively in IS research to examine how organisatons can create and capture value with new ICT (e.g. the internet, ecommerce applications, mobile applications, and so on). Driving factors such as the emerging knowledge economy, the restructuring of global financial services, increased outsourcing of business processes and IS, rapid advancements in ICT and the repeated failure of organisations to capitalise on the capabilities afforded by these ICTs have catapulted the business model concept back into the public arena (Teece, 2010; Zott, Amit and Massa, 2011). The IS literature is in general consensus that the business model is a multi-faceted concept. Business models can (i) serve as a holistic, system-level approach at characterising how an organisation does business, the concepts of value creation and capture and the activities that take place between the focal organisation and its partners (Teece, 2010, Zott et al., 2011), (ii) represent an “architectural blueprint” for the formation and execution of an organisation’s IT strategic objectives (Rajala, Rossi and Tuunainen, 2003; Patelli and Giagls, 2003; Richardson 2008; Zott and Amit, 2008; Casadesus and Ricart, 2011), (iii) serve as a “conceptual tool of alignment” to fill the gap between corporate strategy and business processes in order to provide a crucial harmonisation among these organisational layers (Al-Debei and Avison, 2010; Osterwalder and Pigneur, 2010), and (iv) assist organisation’s to successfully leverage and commercialise early stage promising ICT in order to achieve sustainable competitive advantage (Chesbrough and Rosenbloom, 2002; Rajala and Westerlund, 2007).

For the purpose of this study, we have adapted an existing business model framework (Morris, Schindehutte and Allen, 2005), as a basis for our research model (See Figure 1). This model is appropriate for conceptualising how established ICT providers have crafted their business model decisions, for the following reasons. First, the framework is comprehensive, coherent and comprises constructs which are similar to other widely cited business models frameworks such as the business model canvas (Osterwalder and Pigneur, 2010). Second, a core element which differentiates this framework from other existing theoretical approaches, which merely provide a static snapshot of an organisation’s business activities at a given moment in time, are three increasingly specific levels of decision-making (foundation, proprietary and rules). These three levels can serve as a customisable iterative tool for executing the six business model decision variables in the pursuit of creating sustainable competitive advantage.

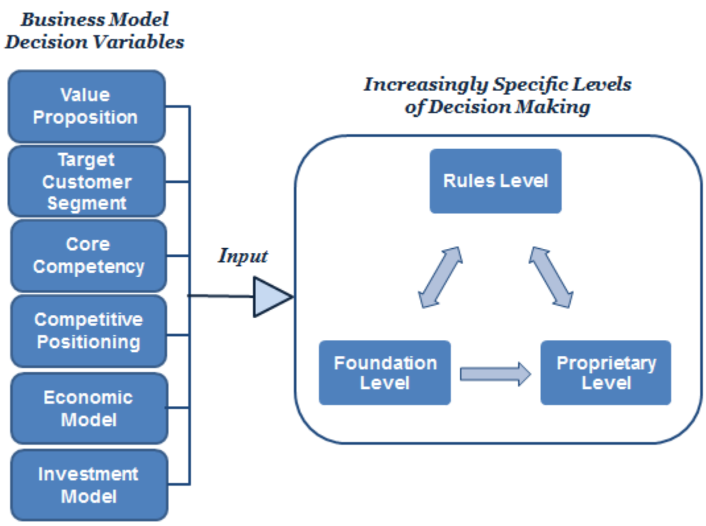


Figure 1: Research Model (adapted from Morris et al., 2005)

The first business model decision variable addresses the value proposition (how an organisation creates value). Organisations operating in voracious business environments are constantly striving to meet customer's multifarious demands by developing unique innovative value propositions in their endeavours to yield a profit. A value proposition constitutes an aggregation, or bundling, of products or services that create value for a particular customer segment (Osterwalder and Pigneur, 2010). Value propositions may be quantitative (service speed, price) or qualitative (offering design, customer experience).The second decision variable addresses target customer segments (for whom the organisation will create value). This question addresses defining the market in which the organisation intends to sell their offering and their positioning in a value chain. The third decision is concerned with the economic model (how the organisation generates revenue). An organisations long-term success and longevity is dependent on the successful implementation of "commercially viable architectures for revenues and costs" (Teece, 2010). Two closely related decision variables include core competency (internal capabilities or skillset which differentiates an organisation from others) and competitive positioning (how the organisation intends to position itself in the market). Competitive positioning can be achieved through operational effectiveness or strategic positioning. Operational effectiveness involves an organisation utilising superior technologies, superior raw materials, superior management structures, and highly trained staff in order to differentiate themselves from competitors. Strategic positioning involves organisations producing unique value to customers by adopting a novel approach to other competitors. This novel approach may take the form of different logistical arrangements, provisioning distinctive features, provisioning distinctive catalogue of services and so on. The final decision area addresses the investment model (organisation time, scope and size ambitions). Examples of investment models include subsistence, income, growth and speculative models. These business model decision variables can serve as input for execution at three increasingly specific levels of decision-making. At the foundation level, basic decisions concerning the general characteristics of what the business is and what the business is not are addressed. The proprietary level applies unique combinations of business model decision variables in order to achieve a competitive advantage. This level can serve as a customisable tool, which enables organisations to focus on means of creating and capturing unique value in each of the six business model decision areas. Whereas the foundation level can be easily replicated by competitors, the proprietary level cannot due to the interaction of the individual business model components entrenched within that level. Finally, the rules level enables the alignment of operative rules with the foundation and proprietary levels to ensure long-term success (e.g. delineates governing principles regarding decisions executed at the foundation and proprietary levels).

3. Methodology

The central objective of the following study is to determine how a large business model mature ICT provider formalises business model decisions in order to sustain their competitiveness. Due to the dearth of existing research into the focal research phenomena, this study adopts an exploratory qualitative stance (Saunder et al., 2011) Due to the nuances of the focal phenomena under scrutiny in conjunction with the dearth of previous IS research, a process of theoretical sampling was used in order to determine the appropriate study sample size (Myers, 2013). Data was collected until no major new insights were being gained (Cassell and Symon, 2007), at which point theoretical saturation was have deemed to have been reached (Corbin and Strauss, 2008). An interview protocol was prepared based on all of the elements encompassed within the research model depicted in Figure 1. The interview protocol was designed to primarily focus on eliciting contextual knowledge from the interviewees in order to clarify and deliberate about the focal phenomena. For example, while the observation of how cloud technology works is important, knowledge of detailed narratives and concrete examples of why a cloud technology is being used or not being used facilitated the elucidation of salient insight. A pre-test was carried out with several members of the target population. This enabled the researchers to detect any ambiguities the participants had in answering the questions. Based on the results, the protocol was adapted iteratively. Following the fourth iteration, no further revisions occurred. The research interview sampling was directed by evolving theoretical concepts, whereby the researchers identified a ICT provider and interviewees from which we expected to elicit the majority of insights into the phenomena of interest (Strauss and Corbin, 1998). Data collection took place between January 2015 and August 2015. The study followed the standard practice of involving senior management as data sources for cloud computing IS research (Iyer and Henderson, 2012; Morgan and Conboy, 2013). As such, the interviewees were selected based on the following criteria: first, the person should have experience working with cloud technology. Second, the person should hold a managerial position which would enable them to have an in-depth knowledge of the business model intricacies of their cloud operations. Third, the person should preferably have responsibility for overseeing their organisation's business model. Each interview was recorded (pending permission) and annotated. In order to improve the credibility of the data and provide cross and complementary perspectives on emerging elements, supplementary evidence in the form of archival documents and published materials sourced from the ICT providers' websites (e.g. white papers, specific case studies, brochures, reports) was also analysed. This form of document analysis constitutes natural occurring evidence and serves as a cogent complement to interviews (Silvermann, 1993). Moreover, using several data sources and measures of phenomena provide cross-checks on data accuracy (Denzin, 2012) and enrichment of the conclusions presented by the researchers (Harrigan, 1983). While the study did not undertake a grounded theory approach, in analysing the data, the researcher used an analytical hierarchical data analysis process adopted from Ritchie, Spencer and O'Connor (2003) incorporating open and axial coding techniques based upon the recommendations of Strauss and Corbin (1998).

3.1 Case Study Background

The case study served to (i) illuminate the study's central research objective, (ii) identify ambiguities contained within the research instrument, and (iii) identify issues which point to salient variables for further investigation. The case is an established large (>10,000 employees) multi-national business model mature ICT service provider who has been at the forefront of the advancement and provision of cloud computing technologies for the past five years. For company confidentiality, we will pseudonymously refer to the company as "Alpha". Alpha's business model has sustained company technological growth for the past thirty years and the company have consistently featured in Gartner's magic quadrant for provisioning cloud technology. Thus, the organisation is very suitable for operationalising our research model as a means of exploring our research objective. Data was collected on site through eight semi-structured, face to face and video conference interviews with senior managers (Table 1). The participating interviewees were employed by the firm for an average of ten years and had an average of 20 years IT service experience. Interviews were recorded in instances where permission was granted by the interviewee. The interviews ranged in duration from 60 to 120 minutes. Extensive field notes and observations were compiled immediately following each interview. The interviews were then later transcribed.

Interviewee Role	Interview Duration	Type
Senior Cloud Architect	62 mins	Face to Face
Cloud Product Manager	75 mins	Video Conference
Cloud R&D Director	87 mins	Face to Face
Cloud Strategy Leader	120 mins	Face to Face
Cloud Technology Officer	92 mins	Face to Face
Cloud Datacentre Manager	60 mins	Face to Face
Senior Cloud Engineer	77 mins	Video Conference
Cloud EMEA Leader	83 mins	Video Conference

Table 1: Overview of Interviews

4. Findings

In this section, we report the empirical results obtained during the analysis of the semi-structured interviews (denoted as sanitised quotes), archival documentation and published materials. Figure 2 depicts alpha's business model transformation since the organisation first commenced provisioning cloud services in 2010. Table 2 portrays how Alpha is strategically operationalising their business model decision variables (DV) along the *foundation, proprietary and rules* decision-making levels (DML).

4.1 Foundation Level

At the foundation level, the focus is centred on defining the six core business model decision variables which all enterprises must address. This level defines what the organisation is doing, as opposed to how it is doing it. Thus, it enables the generalisation across ICT providers in order to capture the essence of their cloud business models. The main danger for early stage cloud providers is "*that they have this rough implicit idea of what their business model is".* However, by constantly *"pushing similar value propositions and pricing mechanisms to other service providers",* they fall short of ever evolving their basic business model beyond the foundation level. When the company first started provisioning cloud technology, it "*afforded the organisation a brief period of success, it was clear that, prior to jumping in the deep end of the cloud ocean*", the company would have "*to innovate their business model in a way which would be hard to replicate by competitors*". Prior to adopting cloud technology, Alpha's business models gravitated towards the development of consumer technologies and the provision of professional business services such as IT consulting. Alpha have has specifically focused on business markets, in particular, larger enterprises clients, which encompass high margins and low growth levels. The study particpants revealed that the primary reason for the company deciding to provision cloud technologies was motivated by fundamental changes that were occurring across the technological industry landscape. "*Around 2010, the strategy of the organisation was to re-orientate itself towards provisioning technology as a consumable service e.g. IT as a service (ITaaS) as there were indicators this was the way the industry was going. The company were witnessing a growing need for scalable elastic computational resources based services*". Cloud computing has rendered Alpha's traditional method of technology service provisioning obsolete. The analysis reveals that in the past five years, Alpha have undergone a large scale transformation. They are currently restructuring the company so that cloud technology touches on every element of their business practices.The analysis also reveals that the increasing demand from customers for customisable cloud services has resulted in both organisations having to transform from their 'ivory tower' service centric mentality to a 'customer-facing' service centric philosophy. The participants acknowledged how this transformation has coincided with the increasingly interoperable and service-orientated nature of cloud services and the popularity of hybrid cloud deployment models. Alpha's traditional business models encompassed stable, predictable revenue arrangements and growth levels. However, the company have had to develop innovative means of coping with the unstable and uncertain revenue arrangements and growth levels encompassed within their cloud computing business models. In order to migrate to the next proprietary level Alpha have had to evaluate consistencies and trade-offs between the business model decisions.

4.2 Proprietary Level

Next, the proprietary level reflects the manner with which Alpha has applied unique innovative configurations to the foundation level components in order to differentiate itself from competitors and sustain their competitive advantage in the cloud market. Whereas the *foundation level* is generic, the *proprietary level* is strategy specific. Specifically, the *proprietary level* focuses on Alpha's core competencies and competitive positioning decision variables which make possible a range of unique value propositions (e.g. breadth and depth of cloud portfolio services/API and service customization capabilities and so on). For decades "*Alpha have been first to the market with technologies which are robust, scalable, highly available and secure, that is the route of our software heritage, ultimately it is what differentiates us from our competitors. The depth and breadth of Alpha's cloud offerings really distinguish the company from other ICT providers."* Alpha possess "*a lot of core expertise to call upon in order to develop state of the art cloud offerings. They strategically develop teams to ensure that they are competent in cloud, mobile and analytics. As every business case is different, the learning process with cloud technologies is a constantly evolving one."* Alpha "*are investing vast amounts into the configurability of their cloud services. Customers must be able to configure and customise cloud modules as they see fit."* While the provision of cloud technologies constitutes one of the company's core competency areas, *"as the company continue to sell cloud products they are learning and evolving organically based on those experiences."*

Alpha's business partners constitute key differentiators that provide cogent value to their business model stating, *"the business partners have always played a very valuable role in making large companies work for smaller companies."* The company have also recently partnered with a number of competitor service providers. These strategic partnerships, which would have been unthinkable in the past, are necessitated due to the interoperable nature of cloud technology. These partnerships "*are a necessary evil, the company must evolve or perish*". Alpha have also acquired a number of established ICT providers in an effort to maximise their market penetration. The company's recent acquisition of an already established and highly successful IaaS ICT providers has enabled the company *"to rapidly innovate our SaaS and PaaS offerings and also enable the company to rapidly gain a strong foothold in the cloud market."* When the company first commenced provisioning cloud computing services, their business models experienced an accelerated rate of change.

Traditionally the company have sold ICT products at a high cost (e.g. multimillion dollar, multiyear deals) to the customer. These products also encompassed long implementation phases. Thus, because of these cost and time limitations the company's traditional customer segment was relatively small. Cloud technologies have enabled Alpha to dramatically extend their target market reach. The company can *"now target SMEs, non-profit organisations and individual customers."* The transition from the manufacturing of hardware and software which was then sold to globally located distributors to the provisioning of cloud services was facilitated through their ability to successfully experiment and iterate their business models. Prior to provisioning new cloud services or applications, Alpha experiments with cloud technologies in sandbox environments encompassed within their R&D laboratories. The case study has clearly demonstrated that from a ICT provider perspective, considerable scope for innovation exists within each decision variable when operationalised at the *proprietary level*.

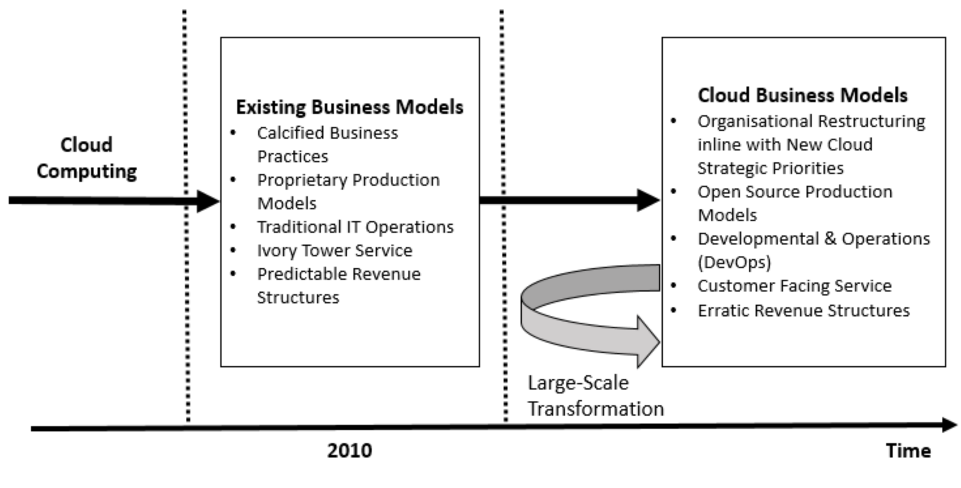


Figure 2: Alpha's Business Models Transformation

DML / DV	Foundation Level	Proprietary Level	Rules Level
Value Proposition	Scalability; Disaster Recovery; Transparency; Remote Access; Agility; Direct rapid provision; Business competitive advantage and innovation; CAPEX to OPEX.	Enterprise grade security, elasticity and availability. Self-service and fully managed cloud offerings. Breadth and depth of cloud services portfolio and API's. Offer SLA's with 99.9% uptime guarantees. Provision of customised ROI and migration strategies. Security assessment and strategy roadmap. Offer a 30 day trial period; Service customisation. Customers can build their own private and hybrid clouds – it's the cloud the way you want it. Open source standards and platforms. Provision sandbox platforms enable CSU to experiment with cloud technologies.	Combine existing legacy product and service offerings with new cloud enabled ones to create unique value propositions for customers. Emphasise customized nature of cloudofferings. Onboard new cloud customers in less than _ hrs/days. Maximum cost of onboarding customers should not exceed Eur €__.
Target Customer Segments	Broad Market; B2C, B2B and B2G (Sell to consumers, SME's, non- profit, large multinationals and governments)	Managed evolution from a leading traditional hardware and software manufacturer to a leading international ICT provider. Targeted focus on SME's and large multi nationals. Careful selection of business partners to expand. Strategically acquire cloud companies to facilitate the targeting of new markets.	Specific guidelines for selecting business partners. Specific guidelines for acquiring cloud companies. Achieve at least __ customers per day/month/year. Retain at least __ customers per month/year.
Core Competency	Technology; R&D capability; Innovation; Operational excellence.	Departments specifically tasked with migrating legacy software applications to SaaS. R&D labs specifically tasked with experimenting with cloud based technologies. Invest in new global datacentres. Use of existing hardware and software Infrastructure – data centres and legacy software applications. Careful selection of business partners to innovate and mitigate risks. The company has buttressed its core competencies via a number of recent strategic acquisitions.	New software offerings must be developed as SaaS only. Specific guidelines for acquiring cloud companies. Develop __ new SaaS offerings per /month/year. Migrate __ existing software applications to SaaS per /month/year. Test __ cloud specific technologies per month/year.
Competitive Positioning	Image of operational excellence; Software heritage; Industry experience; Service quality - consistency, security and dependability.	Differentiation is achieved by stressing that the Alpha's heritage and operational excellence enables them to be first to the market with cloud technologies which are robust, scalable, highly available and secure. The company has strengthened its competitive positioning in the cloud market via a number of recent strategic acquisitions.	Become the world's most essential cloud company. Emphasise company heritage and experience. Specific guidelines for acquiring cloud companies.
Economic Model	Multiple revenue sources; Monthly billing; Licensing fees;	Targeted focus on business process outsourcing, IT services management and consulting services revenues. Cloud financing option to enable CSU spread the up-front costs of cloud services over time.	Maintain costs per customer below Eur €__
Investment Model	Growth model	Emphasis on growth opportunities that are consistent with strategy	Managed rate of growth

Table 2: Characterising Alpha's Business Model Decision-Making

4.3 Rules Level

Finally, the establishment of operative rules not only reinforces and embeds Alpha's overall cloud objective in the consciousness of their employees but also enables management to avoid decision-making manoeuvres which may be incompatible with their business model decision variables. The ethos behind Alpha's specific rules level is that that their "*cloud business model decision-making strategies are all founded on agility. The company are focused on making new or improved services faster than they did in the past. All new software offerings must be cloud based and be able to be provisioned at low cost.*" The company are currently in the process of implementing a new breed of agile software development within the company called DevOps. The emergence of DevOps has *"enabled the company to respond more effectively to customer requirements and facilitates an accelerated time to market".* The analysis also reveals that DevOps methodologies were currently being driven by market forces and were pivotal for the company with regards to developing, deploying and maintaining state of the art cloud technologies. Traditional IT operations philosophies were ineffectual in enabling both the provider and the customer to derive 'continuous' value from cloud computing services. For example, the organisation's traditional IT operations which encompassed agile and or waterfall methodologies worked well with regards "big bang" feature releases whereby upgraded or new versions of their product offering were released on a quarterly or annual basis. However, provisioning cloud service offerings dictates that IT providers must be efficient at transporting cloud source code speedily from the software developers to the customers and be capable of reacting to the continuous feedback received. The company have also invested heavily in OpenStack cloud software development and are currently investigating the merits of releasing their own distribution of OpenStack in order to facilitate the on-boarding of customers in an accelerated manner. Alpha utilise an indigenous business modelling component technique to design governing principles so as to assist with the execution of decisions at the foundation and proprietary levels. This technique decomposes the company into strategic, operational and tactical segments in order to concurrently identify components which bring business value to the company and those that do not. This case study has demonstrated that Alpha have developed cogent operative rules which the enabled the company to gain a strong foothold in a rapidly evolving cloud market.

5. Contributions and Limitations

This study is motivated by the increasing complexity of developing and sustaining effective business models for the new cloud economy. There is evidence to suggest that these complexities have resulted in significant challenges for large business model mature ICT providers. History has shown that with the emergence of any new IS/IT, the inability to operationalise effective business models can threaten the longevity of even the most nascent IS/IT advancements. While extant research has examined the impact of cloud technology on providers' business models, to date, little research exists which has explored how ICT providers can effectively formalise business model decisions in order to sustain their competitiveness in a rapidly evolving digital ecosystem. Taking a post-provision perspective, our findings to date have illustrated how a leading large business model mature ICT provider has strategically executed their business model decisions over a period of five years in order to effectively align with the novel propitious characteristics afforded by cloud computing. The following research is valuable both from the theoretical and practical point of view. On the theory side, we make important contributions to the cloud computing literature. First, rather than taking a conventional static business model lens (e.g. business model canvas etc.) to explore the impact of cloud computing on ICT providers' value creation and value capture processes, we have taken the nuanced step of proposing a new business model decision-making perspective. This nuanced perspective provides new salient insights into how an established large business model mature ICT provider has strategically configured their individual business model components across several increasingly specific levels of decision making. While this study explored the impact of cloud computing provision on an established ICT provider, this new business model perspective could also be used to assist organisations across a range of industry settings to craft competitive and sustainable IS/ICT enabled business models. Second, this study extends the current dearth of research which has explored the long term impact of cloud technology on organisation's business models. We have illustrated how a successful large ICT providers' business models have transformed and evolved over time (e.g. five years post-provision) as a result of cloud computing technology. The study has identified that provisioning cloud services encourage business models which encompass open, devops and customer innovation led practices. Akin to the 'slow train coming' analogy provided by Wilcoks, Venters and Whitley (2013), this study has also identified that even though the concept of cloud computing has been in existence for the past decade, the cloud technological landscape is is still maturing and is currently exhibiting a rapid level of dynamism. This study has demonstrated that the impact of this technological dynamism can be minimised by operationaling effective proprietary and rule level decision making strategies. On the applicative side, some tentative practical implications may be suggested. We have identified how a leading ICT provider has (1) evolved their basic foundational business model decisions to the next proprietary level in order to compete effectively and (2) designed effective operative rules in order to sustain their competitiveness over the past five years. ICT providers should consider exploring their business models using the new perspective operationalised in this study in order to scrutinise their decision-making methods.

The study has a number of limitations. First, given that the findings are based on a single organisation, this study is naturally limited in terms of it generalisability. However, we took care in relating the idiographic details of the study findings to theoretical concepts. Additionally the primary aim of this case study, which forms part of a larger study, is to inform the next phase of our research. Second, given the complexity and rapidly evolving nature of the business model and cloud computing concepts, the evolution of how ICT providers have arrived at their current mode of operating may be best observed as part of a longitudinal study. However, as an explorative study of complex topics, our central objective in this work is to explore the dynamics of their relationships. Finally, while interviewing senior management has a number of strengths, it can also result in the manifestation of elite bias. Elite bias occurs when a researcher fails to gain a comprehensive understanding of the broader context by overweighting the data elicited from elite study participants. In order to minimize the impact of elite bias, we deployed a number of prescribed tactics in order to ensure the validity and reliability of the research design (e.g. triangulation, multiple interviews and cross-case analysis). We also trust that this study will serve as a basis for future qualitative and quantitative research that can be undertaken to confirm and extend our study. For example, future research could explore tensions encompassed within ICT providers' foundation, proprietary and rules levels which are currently inhibiting the organisations from executing effective business model decisions. Also, while this study focused on the provider perspective, furture research could also provide important insights from the customer perspective.

Acknowledgement

This work was supported, in part, by Science Foundation Ireland grant 10/CE/I1855 to Lero - the Irish Software Research Centre (www.lero.ie).

References

Al-Debei, M. M., & Avison, D. (2010). Developing a unified framework of the business model concept. *European Journal of Information Systems, 19*(3), 359-376.

Casadesus-Masanell, R., and Zhu, F. (2013). Business model innovation and competitive imitation: The case of sponsor-based business models. *Strategic management journal*, *34*(4), 464-482.

Chang, V., Walters, R. J., and Wills, G. (2013). The development that leads to the Cloud Computing Business Framework. *International Journal of Information Management, 33*(3), 524-538.

Chesbrough, H., & Rosenbloom, R. (2002). The role of the business model in capturing value from innovation: evidence from the Xerox Corporation's technology spin-off companies. Industrial and Corporate Change, 11(3): 529-555.

Clohessy, T., Acton, T., and Morgan, L. (2016). The Impact of Cloud Computing on IT Service Providers' Business Models, National University of Ireland Galway PhD Disseration, March, 2016.

Conboy, K. & Morgan, L. (2012). Assimilation of the Cloud: Challenges to Acceptance, Routinisation and Infusion of Cloud Computer, Proceedings of the 33rd I*nternational Conference on Information Systems* (ICIS,2012) Florida, December

CSA and ISACA (2012). Cloud Computing Market Maturity. Available from https://cloudsecurityalliance.org/media/news/cloud-maturity-study-reveals-top-issues/

DaSilva, C. M., Trkman, P., Desouza, K., & Lindič, J. (2013). Disruptive technologies: a business model perspective on cloud computing. *Technology Analysis & Strategic Management*, *25*(10), 1161-1173.

Denzin, N. K. (2012). Triangulation 2.0. *Journal of Mixed Methods Research*,*6*(2), 80-88.

Ehrenhofer, C., and Kreuzer, E. (2012). *The Role of Business Model Design in the Service Engineering Process: A Comparative Case Study in the Field of Cloud Computing to Join Service Engineering with Business Model Design.* Paper presented at the SRII Global Conference.

Harrigan, K. (1983). Research Methodologies for Contingency Approaches to Business Strategy. Academy Of Management Review, 8(3), 398-405.

HBR and Verizon (2014) Business Agility in the Cloud. Available from http://www.verizonenterprise.com/news/2014/07/cloud-computing-survey-business-agility

Iyer, B., and Henderson, J. (2010). Preparing For The Future: Understanding The Seven Capabilities Of Cloud Computing. *MIS Quarterly Executive, 9*(2), 117-131.

Iyer, B., and Henderson, J. (2012). Business Value From Clouds: Learning From Users. *MIS Quarterly Executive, 11*(1), 51-60.

Khanagha, S., Volberda, H., and Oshri, I. (2014). Business model renewal and ambidexterity: structural alteration and strategy formation process during transition to a Cloud business model. *RandD Management*, *44*(3), 322-340.

Leimeister, S., Böhm, M., Riedl, C., & Krcmar, H. (2010). The business perspective of cloud computing: Actors, roles and value networks. *In: 18th European Conference on Information Systems (ECIS), Pretoria, South Africa.*

Linthicum, D. (2012). Buyers Say The Cloud Is Already Tired Out. Available from http://www.infoworld.com/d/cloud-computing/buyers-say-the-cloud-already-tired-out-203760

Liu, F., Tong, J., Mao, J., Bohn, R., Messina, J., Badger, L., & Leaf, D. (2011). NIST cloud computing reference architecture. *NIST Special Publication, 500*, 292.

Luftman, J., Zadeh, H. S., Derksen, B., Santana, M., Rigoni, E. H., & Huang, Z. D. (2013). Key information technology and management issues 2012–2013: an international study. *Journal of Information Technology*, *28*(4), 354-366.

Marston, S., Li, Z., Bandyopadhyay, S., Zhang, J., & Ghalsasi, A. (2011). Cloud computing - The business perspective. *Decision Support Systems, 51*(1), 176-189.

Morgan, L., and Conboy, K. (2013). Value Creation in the Cloud: Understanding Business Model Factors Affecting Value of Cloud Computing. In: AMCIS, Chicago, USA.

Morris, M., Schindehutte, M., and Allen, J. (2005). The entrepreneur's business model: toward a unified perspective. *Journal of business research, 58*(6), 726-735.

Ojala, A, & Tyrvainen, P. (2011). Developing Cloud Business Models: A Case Study on Cloud Gaming. *IEEE software,* 28(4).

Osterwalder, A., and Pigneur, Y. (2010). *Business model generation: a handbook for visionaries, game changers, and challengers*: Wiley.

Pateli, A., & Giaglis, G. (2003). *A framework for understanding and analysing e-business models.* Paper presented at the Bled Electronic Commerce Conference.

Porter, M. E. (1996). What is Strategy? *Harvard Business Review*, 74(6), 61-78.

Rajala, R., Rossi, M., and Tuunainen, V. K. (2003). A framework for analyzing software business models. Paper presented at the Proceedings of 11th *European Conference on Information Systems*, New Paradigms in Organisations, Markets and Society.

Rajala, R., and Westerlund, M. (2007). Business models a new perspective on firms' assets and capabilities: observations from the Finnish software industry. *The International Journal of Entrepreneurship and Innovation, 8*(2), 115-126.

Richardson, J. (2008). The business model: an integrative framework for strategy execution. *Strategic Change*, *17*(5-6), 133-144.

Ritchie, J., Spencer, L., & O'Connor, W. (2003). Carrying out qualitative analysis. *Qualitative research practice: A guide for social science students and researchers*, 219-262.

Silvermann, D. (1993). *Interpreting qualitative data*. Sage Publications, London, UK.

Strauss, A., & Corbin, J. (1998). Basics of qualitative research: Procedures and techniques for developing grounded theory. *ed: Thousand Oaks, CA: Sage*.

Teece, D. (2010). Business Models, Business Strategy and Innovation. *Long Range Planning, 43*, 172-194.

Vouk, M. (2008). Cloud computing issues, research and implementations. *Journal of Computing and Information Technology*, *16*(4), 235-246.

Weinhardt, C., Anandasivam, A., Blau, B., Borissov, N., Meinl, T., Michalk, W., & Stosser, J. (2009). Cloud Computing - A Classification, Business Models, and Research Directions. *Business & Information Systems Engineering, 1*(5), 391-399.

Willcocks, L. P., Venters, W., & Whitley, E. A. (2013). Cloud sourcing and innovation: slow train coming? A composite research study. *Strategic Outsourcing: An International Journal*, *6*(2), 184-202.

Zott, C., and Amit, R. (2008). The fit between product market strategy and business model: Implications for firm performance. *Strategic Management Journal, 29*(1), 1-26.

Zott, C., Amit, R., and Massa, L. (2011). The business model: recent developments and future research. *Journal of Management, 37*(4), 1019-1042.

29th Bled eConference

Digital Economy

June 19 - 22, 2016; Bled, Slovenia

Business Model Innovation in European SMEs: some preliminary findings

Harry Bouwman

Delft University of Technology, The Netherlands

W.A.G.A.Bouwman@tudelft.nl

Francisco-Jose Molina-Castillo

University of Murcia, Spain

fjmolina@um.es

Mark de Reuver

Delft University of Technology, The Netherlands

G.A.deReuver@tudelft.nl

Abstract

Business Models have been on the research agenda since the emergence of ecommerce and ebusiness in late last century. Although a lot of attention has been paid to the concept, ontologies, taxonomies and approach in the field of strategic management, information systems, digital business and high-tech entrepreneurship research, empirical research either in the form of cases studies or quantitative research is largely missing or based on research that is not preliminary designed to understand BMs and their impact. This is even more the case for BM Innovation and BM research for Small and Medium Enterprises (SMEs). In this paper we present our very first results of a sample of European SMEs and how they deal with BM Innovation. Our research shows that 35% of the SMEs in our sample are involved in BMI. The research also show that changes in BMs most of the time are related to a combination of multiple innovations at the same time like entering a new market, changing their eco-system, change pricing strategy, or dealing with changes in IT.

Keywords: Business model, innovation, SMEs

1 Introduction

Business models has been on the agenda of business and science for a long time. Some say the first time Business Models were mentioned in academic literature goes back to 1975, when Business models were mentioned in Process and Data modelling / Information management literature. Till 1990 seven publications can be found in the ABI/Inform database, mainly in computer information science literature. Since then, mainly due to the emergence of WWW, ecommerce and e-business the number of papers in both academic and non-academic literature has exploded. Topics of attention has been the definition of the concepts, taxonomies, BM approaches, design of BMs, in diverse fields ranging from strategic and innovation management, entrepreneurship research, information systems and literature related to ecommerce, mobile of digital business. Currently Business Models for sustainability adhering to principals of the circular economy draw more and more attention.

Not only form an academic point of view BMs attracted a lot of attention, also from start-up and vested business as well as policy makers (EU and OECD) a fair share of attention was and is dedicated on the role of BM in generic innovation policy and economic performance. However empirical research, both case study research as well as large scale cross-sectionals research, is largely missing. Case studies that are available are often design cases but less focussed on the question what make BMs firms to perform better, to be more innovative on either a micro- or a macro-economic level. In the early days there were many case studies on how large companies adapted their BM to the emerging Internet, or to start-up companies that took advantage from the new opportunities.

Although a lot is written on Business Models and Business Model Innovation, empirical research is scarce, case study research is largely anecdotal, and the empirical research that is available is rather divers, scattered over different disciplines and research domains, and in some cases based on secondary analyses of data as collected via the Community Innovation Surveys (CIS). The CIS studies however where never designed to be focussed on Business models or Business Model Innovation. We define Business Model Innovation as a change in company's BM that is new to the firm and results in observable changes in the firm's practices towards its customers and partners. BM are defined as the business logic how a company creates, distribute and captures value. We clearly want to distinguish BM Innovation from product, organizational, or process innovation, by postulating that the core logic of value creation and capturing have to be at stake. Research on BM and BM innovation is mainly focussed on large and start-up businesses, but seldom on SMEs. SMEs are in many countries the driving force behind the economy and de facto employ the most people.

So, how SMEs struggled with Business Model Innovation is under researched. To fill this void, we will present the first original empirical results with regard to BMI and SMEs in Europe, and relevant methodological and other issues at stake. To frame the results, we will provide background literature, mainly with regard to what empirical cross-sectional research has been done with regard to BM Innovation until now. We will refrain from sketching the bigger pictures, as done by many others (Bouwman et al, 2008; Hedman & Kalling, 2003; Magretta, 2002; Osterwalder et al, 2005;Teece, 2010; Veitt et al, 2014; Wirtz el al., forthcoming; Zott et al. 2011;) and as we have done so in many of our earlier publications (NN). Since the current paper present the first results, and data collection is at the moment of writing still underway, the results are mainly discussing methodological issues, and giving some insights at stake researching BM Innovation. Specifically, this research paper focus on how business models changes are understood by European SMEs

2 Literature review

There is a number of papers that empirical research BM Innovation in relation to performance (see table 1). We looked for articles published and available in academic computer databases, like Scopus, Web of Science and Scholar Google, using keywords related to Business Model Innovation, SMEs and Empirical research related concepts. In general, the definition of SMEs doesn't follow the EU definition.

In some studies, (see table 1) companies with the size of 100 to 500 are analysed as mid-sized companies. Hartmann et al (2013) find that large business is better equipped to exploit BM Innovation. Some of the papers are rather vague on how BMs are defined (i.e. Aspara et al, 2010; Aziz & Mahmood, 201; Clausen & Rasmussen, 2013; Huang, et al., 2012), what the core characteristics, components or relevant (sic) concepts are (Hartmann et al, 2014; Souto, 2015), sometimes even merely discussing revenue models (Aspara et al, 2010; Aziz & Mahmood, 2011; Brettel et al, 2012). Zott & Amit relate BM to design of content, structure and governance of transactions., with a focus on innovation and efficiency in value creation and capturing. Typically Hartmann et al. (2014) have a rather arbitrary list of components that are unrelated to components as used in BM ontologies, like CANVAS (Osterwalder et al, 2005), STOF (Bouwman et al, 2008) or Visor (El Sawy & Perreira,).

In the same grain Velu (2015) consider diversification/product launch and external funding as two indicators for BM Innovation. Other studies just label BM as consulting BM, technology BM, software BM, etc. and use this as a dummy variable (Clausen & Rasmussen, 2013. Kim and Min (2015) really simplify BM Innovation to adding online retail activities or not. Some studies are vague on how concepts are measured (Aziz & Mahmood, 2011), rather vague unspecified two item-based scales (Souto, 2015), or have a rather random list of components that are used as BM Innovation indicators (Huang et al, 2012).

While some studies are making use of secondary, CIS data as a proxy to BM innovation (Barjak et al 2014, European Union 2014) or data from existing databases (Cucculelli and Bettinelli, 2015; Hartmann et al, 2013; Kim and Min, 2015). In general performance is the key dependent variable, and most of the time linear regression analyses are used. Some studies apply SEM. The study by Cortimiglia et al (2015) confirms empirically that BM Innovation is mainly about strategy implementation, as was also proposed by Al-Debei, and Avison (2010), while Cucculelli and Bettinelli (2015) argue that BM Innovation is functional to corporate strategic entrepreneurship. Strangely enough they relate corporate entrepreneurship to network activities, while we would argue that value network are a component of a BM. Clauss (2016) valuable paper is on developing a scale for BM Innovation. In general the empirical studies are divers, mainly based on a strategic management perspectives and linear econometric data analysis approaches (e.g. Cucculelli and Bettinelli, 2015; Hartmann et al, 2013; Kim and Min, 2015; Zott & Amit, 2007), and less on IS research in which the focus on ontologies offer more in depth information. Research is in a number of papers not driven by clear hypotheses or models. Nice alternatives of in-depth analyses making use of clear conceptualization of BM Innovation and more advanced model testing beyond ordinary econometric analyses are Brettel et al, 2012 and Clauss (2016).

Table 1: Review of empirical papers on Business Model Innovation

Reference	Key concepts included	Research subjects	Sample	Main Analysis
Aspara, et al. (2010)	business model innovation, strategic marketing, replication of BMs (components), and financial performance	Finnish large and small firms (unclear how defined in terms of size and turn over, median split is used)	545	
Aziz & Mahmood (2011)	business model, performance related to BM components like Stakeholders, competencies, value creation, and value capturing	Malaysian SMEs	202	Regression analysis
Barjak et al (2014)	business model innovation based on CIS, descriptive analysis	European SMEs	No info	
Brettel et al. (2012)	business model efficiency and novelty design, relation specific investments, performance	German, Austrian and Swiss SMEs	234	Confirmatory Factor Analysis and Regression analysis
Clausen, T. H., & Rasmussen, E. (2012)	Specific type of business model, number of BMs, technology domain, and innovativeness	Norwegian start-up companies	82	Regression analysis
Clauss (2016)	BM Innovation scale development Two studies	Small (<50) and midsized (50> <500) German companies, as well as large (>500)	126 232	Confirmatory Factor Analysis
Cheng, et al. (2014)	(service) business model, business model efficiency and novelty design , service innovativeness; market turbulence and competitive intensity	Large Taiwanese firms (> 304; < 8.300)	211	Confirmatory Factor Analysis and Regression analysis
Cortimiglia, M., A, Ghezzi, & A. Frank (2015)	Business Model Innovation, strategy process, CANVAS, BM design and improvement (when and how BMI in Strategy Making process)	Small but mainly large Italian firms : majority of sample is 100+	138	
Cucculelli, M. & C. Bettinelli (2015).	Levels of business model innovation/adaptation, corporate entrepreneurship, investment in intangibles, performance	Italian clothing SMEs, size between 10 and 500	376	Regression analysis
European Comission (2014)	Business Model Innovation per EU country	European SMEs < 250 employees	CIS samples	
Hartmann, et al.. (2013)	"Performance effect", "business model innovation", "empirical analysis"	Large Australian Firms in Financial industry	64	Regression analysis
Huang, et al. (2012)	Target costing system, business model innovation, performance	Large Firms and SMEs in China's electronics and information industry	189	Regression analysis
Kim, S.K. & S. Min (2015)?	Original and Imitative BM Innovation, sales revenues	Large incumbent publicly traded store based retailers in the US	131	Regression analysis

Souto (2015)	business model innovation, performance	SMEs and large firms in Hospitality Industry in Spain.	124	SEM
Velu (2015)	business model, survival of firm and the role of partnering with 3rd parties with complementary assets	Start up f in the US electronic trading platform firms in the bond market	129	Regression analysis
Zott, C., & Amit (2007)	Novelty centred and efficiency centred business model design, resource munificence, performance	Early phase entrepreneurial firms in Europe and the US	190	Regression analysis
Zott, C., & Amit (2008)	Product market strategy, (novelty and efficiency centred) business model, and performance	Large Firms and SMEs	161	Regression analysis

In general, it can be concluded that research is rather scattered and sometimes lacks depth in understanding what Business Model Innovation implies, what antecedents are and how BM Innovation affects performance and innovativeness of firms. We see a clear gap and a lack of depth where BM ontologies and approaches can contribute to theory development as well as practical implications. Current research in progress tries to fill this void.

3 Methodology

3.1 Data collection

Data collection for this part of the H20202 Envision project, is at the time of writing still going on. Envision, next to building a knowledge platform and providing tooling to SMEs, focus on a large empirical quantitative and qualitative research on Business Model Innovation by European SMEs. Data for the quantitative study is collected by a professional, The Netherlands based research agency with experience in data-collection in multiple countries at the same time by making use of native speakers and Computer Assisted Telephone Inquiry. The data as reported in this paper is based on data as collected half-way during the first wave of the panel research in which companies will be followed for three years. Cross sectional data on BM Innovation behaviour of SMEs in 13 European countries will be used. The countries are spread over Europe and contain for all the European regions a large country with a large number of SMEs in large and a small country (see table 2). Quota for micro-enterprises, small and medium enterprise are established (33%-33% - 33%). There are no quota defined for industry sectors. Agriculture, public administration, and non-market activities of households are excluded. Although family businesses and female entrepreneurship deserve special attention seen the costly way of collecting the data these concepts are only included as background variables.

The sample was based on Dun & Bradstreet. Dun & Bradstreet collect data on companies, their executives, industry classification and contact information on a regular basis from Chambers of Commerce and other organizations. Based on disproportional quota sampling companies were randomly selected and key respondents (owner or –BMI- manager) were approached to collect data in each organization. The respondent was identified and registered by the research agency so that data as collected, can be used in the following years to approach the same respondent. This identification data is not known to the researchers.

3.2 Questionnaire

The questionnaire contains several concepts related to business model and business model innovation, as introduced in the theoretical part, in order to obtain a clear picture of this phenomenon in the firms. The questionnaire contains a generic selection question on the company understudy has changed its business model in the last 24 months and four specific selection question given an example of BM Innovation related to value propositions and market, eco-system, information technology or use of social media and/or big data and pricing and related financial issues. Next question with regard to size and industry sector were asked to confirm if the company was actual an SME and if it fits the industry sectors included in the research. Next all kind of mainly Likert like statements, based on well-known studies from literature on innovation, entrepreneurship, strategic management and so on, with regard to the BM of the firm were used. For instance, data on internal and external drivers, type of innovations, how BM change is managed, the BM-changes made, familiarity with and use of BM ontologies and tools, and performance and background characteristics were collected.

The questionnaire was iterated several times and pre-tested, based on reading out aloud, with managers and academics to improve understanding of the different questions. The questionnaire was developed in English and next translated into eleven languages, e.g. Dutch, France, Finnish, German, Italian, Lithuania, Polish, Portuguese, Slovenian, Spanish, and Swedish. The German questionnaire was also used in Austria. In order to detect problems and cultural issues a back translation process was then used to assure that translation did not introduce any bias in the measures. Moreover, a final check was done on translations and consistency between translation by the research agency. The questionnaire was next pre-tested for every single country.

The preliminary results as reported in this paper are based on 395 responses collected until now, even though incidence rate is based on 413 responses per February 16. The incidence rate provides the hit rate, e.g. the number of times accompany is asked if they are involved in BMI before an actual company is found that fulfils this requirement. The data in this paper are from the same day (February 16) but from different time moments, as a result there are small differences between information on the incidence rate for instance and the answers on the questionnaire. A full discussion on response and incidence rates can only be offered when the research is concluded.

4 Results

As a first approach to business model changes, we analysed the incidence rate. According to table 2, there was an overall incidence rate of 37% (N =413). This implies that of the 100 firms approached for this research 37 are actually involved in BM Innovation. In an small preliminary trial we found a lower rate of about 10%. So there is a surprising high number of SMEs that are involve in Business Model innovation. There are striking differences between countries as some countries such as Italy, a country with many SMEs, shows an incidence rate of 61% and so differs substantially from countries such as Netherlands with 21% incidence rate.

Similarly, if we analyse table 3, this results is in line with the question of whether or not companies have changed their business model during the last 24 months, we find similar patterns between countries. This could be due to the still small samples on a country level or to cultural bias among countries.

In order to get a better understanding of the incidence rate, we asked firms four main questions regarding which kind of business model changes were undertaken in the last 24 months (table 4). Changes in the value proposition have been made by 22% of the firms of the respondent. Changes in the eco-system: new partners, new client groups are made by 66% in the last two years. Changes in financial arrangements are made by 47%, and changes related to the use of It, including social media channels of Big Data are made by 58%. More detailed results on country level are presented in Table 5 to Table 8. Table 4 also shows firms in each country that have earned money by renting products or bundling the offer with services. In this case, an average of 77,5% of companies responded no. However, if we move forward to table 5, that analyse whether a company enter a new market of start working with new type of partners, we observe important differences among countries. In average, 66% responded yes. But if we look in detail we see that firms in countries such as France with 35,7% or United Kingdom with 56,8% differ substantially with firms in countries like Austria with 84,4%. In table 4, that also analyses the pricing strategy that goes beyond regular price adaptions, we obtained mixed results as in some countries such as Spain with 52,9% or United Kingdom with 56,8% this was a common strategy whereas in Germany only 25% answered yes. Finally, our last question analysed the incorporation of IT for business purposes like for example using social media or big data. In this case, as can also be observed in Table 4, on average 58,2% incorporate this type of technology but countries like Portugal with 60,9% or Spain with 70,6% have a higher value.

However, to know more about this, we created a new variable. The variable summarize if one, two, three or four questions with regard to BM Innovation were answered positively (see table 5). So if a company only confirmed that the BM change was related to It their score is 'one', while if there was also a change in network partners or market groups than the score will be 'two'. If all the four selection scores were answered positively than the score would be 'four'. The obtained scores can be observed in table 8. Surprisingly in several countries such as France, Germany, Portugal, Spain or Sweden we observed that changes were rather limited i.e. only one component for Business Model Innovation was addressed. The opposite was true for other countries like Austria with 9,4%, Finland with 14,6%, Italy with 2,4%, Lithuania with 5,4%, Netherlands with 4,3%, Poland with 10,7%, Slovenia with 8% or United Kingdom with 6,8%, which illustrates that Business Model Innovation happened in multiple components at the same time.

Next we focus on how BM Innovation was supported by methods and tools. Companies are familiar with BM methods like CANVAS, STOF, Visor or BM Cube, at least 15% confirms so. Most well-known are CANVAS (7%) and Lean CANVAS (2%). Methods spontaneously mentioned are amongst others Agile Scrum, Data Analytics, combinations of strategic approaches, SWOT and Prestel, and some consultancy tools, as well as market segmentation approaches. Tools used are rather divers and can be computer based (80%) as well as paper and pencil (62%), spreadsheets (82%), sticky notes

(51%), or board games (7%). Tools spontaneously mentioned are brainstorm sessions, gamification, Mind-maps, Business Intelligence tools, questionnaires, as well as Social Media.

5 Discussion

This paper presents the first descriptive empirical results on Business Model Innovation. Since the almost negligence of existing research it is impossible to compare our studies with other studies. The results are based on the data as collected in the period January – early February 2016. At the moment of the writing data collection is not yet concluded but based on a reasonable sample we present some initial insights. We hope to have more data in the next iteration of this paper. Compared with Barjak et al. (2014) CIS based data on BM Innovation In European country we get higher levels of companies innovating their BM. Whereas Portugal and Italy reached levels of about 10% of the companies to be involved in BM Innovation we see levels for these two countries 47% and 61%. For Germany this is 6% versus 25% and France 6% and 22%. The difference between Lithuania data based on CIS and our data is rather big 5% versus 53%. The same goes for Slovenia 6% versus 51%. Overall we find higher levels than based on CIS data. This might be due to the fact that we asked firms if they were engaged in Business Models Innovation in a generic way, as well as in a specific way by giving examples as discussed in the results (tables 3 to 7). In our view many SMEs are not aware that they are engaged in Business Model Innovation because they will not label this themselves in this way. At the other hand our way of selecting might have lead to false positives. Striking is that only a minority of SMEs are familiar with BM ontologies and with tooling. So there is tremendous space for promoting BM Innovation and tooling.

6 Conclusion

Pan European research is not without problems. Cultural and language problems can influence the results. Also institutional differences, differences in economy structure, market behaviour and performance, affect the results. Moreover, awareness of BM Innovation and what it actual implies might differ between countries. A next complication comes from the heterogeneous nature of SMEs. Micro-enterprises, small firms and even mid-size firms differ in core characteristics from industry to industry, and from country to country. Nevertheless, our research leads to some interesting conclusions first of all that a lot of SMEs practice BM Innovation, that there is still a lack of awareness with regard to BM Innovation and existing ontologies and tooling. Positive is that in practice all most all firms use computer and information technology when dealing with reflection on business model innovation.

7 Acknowledgement

The work leading to these results has received funding from the European Community's Horizon 2020 Programme (2014–2020) under grant agreement 645791. The content herein reflects only the authors' view. The European Commission is not responsible for any use that may be made of the information it contains.

8 References

Bold references are empirical studies as mentioned in Table 1.

Al-Debei, M.M., & Avison, D. (2010) Developing a unified framework of the business model concept, *European Journal of Information Systems*, **19**(3), 359–376.

Aspara, J., Hietanen, J., & Tikkanen, H. (2010). Business model innovation vs replication: financial performance implications of strategic emphases. *Journal of Strategic Marketing*. doi:10.1080/09652540903511290

Aziz, S. A., & R. Mahmood (2011). The relationship between Business Models and performance of manufacturing smal and Medium enterprsies in Malaysia, African Journal of Business Mnagement, Vol. 5 (22). Pp. 8918-8932

Barjak, F., Bill, M., & Perrett, P. (2014). Paving the way for a new composite indicator on business model innovations. In *DRUID Society Conference 2014* (pp. 1–25).

Bouwman, H., De Vos, H., & Haaker, T. (2008) Mobile Service Innovation and Business Models. Springer-Verlag, Berlin, Heidelberg.

Brettel, M., Strese, S., & Flatten, T. C. (2012). Improving the performance of business models with relationship marketing efforts–An entrepreneurial perspective. European Management Journal, 30(2), 85-98.

Cheng, C. C. J., Shiu, E. C. C., & Dawson, J. A. (2014). Service Business Model and Service Innovativeness. *International Journal of Innovation Management*, *18*(2), 1–22. doi:10.1142/S1363919614500133

Clausen, T. H., & E. Rasmussen (2012) Parallel business models and the innovativeness of research-based spin-off ventures

Cucculelli, M., & Bettinelli, C. (2015). Business models, intangibles and firm performance: evidence on corporate entrepreneurship from Italian manufacturing SMEs. *Small Business Economics*, 1–22. doi:10.1007/s11187-015-9631-7

El-Sawy, O. A., & Pereira, F. (2013) *Business Modelling in the dynamic digital space: an ecosystem approach.* Springer Heidelberg New York.

European Comission (2014, 14 May). The Need for Innovations in Business Models, Final Policy Brief (Deliverable 5), Version 2.5. Retrieved from https://ec.europa.eu/research/innovation-union/pdf/expert-groups/ERIAB-BMI_PB_new_business_models.pdf

Hartmann, M., Oriani, R., & Bateman, H. (2013) The Performance Effect of Business Model Innovation: An Empirical Analysis of Pension Funds, 35th DRUID Celebration Conference 2013, Barcelona, Spain, June 17-19.

Hedman, J., & Kalling, T. (2003) The business model concept: theoretical underpinnings and empirical illustrations, European Journal of Information Systems, 12(1), 49–59.

Huang, H.-C., Lai, M.-C., Kao, M.-C., & Chen, Y.-C. (2012). Target Costing, Business Model Innovation, and Firm Performance: An Empirical Analysis of Chinese Firms. *Canadian Journal of Administrative Sciences*, *335*, 322–335.

Kim, S. K., & Min, S. (2015). Business Model Innovation Performance: When does Adding a New Business Model Benefit an Incumbent? *Strategic Entrepreneurship Journal*, 1–24. doi:10.1002/sej.1193

Magretta, J. (2002) Why Business Models Matter, Harvard Business Review, 80(5), 86-92

Osterwalder, A., Pigneur, Y., & Tucci, C. L. (2005). Clarifying business models: Origins, present, and future of the concept. Communications of the association for Information Systems, 16(1), 1.

Teece, D.J. (2010) Business Models, Business, Strategy and Innovation, Long Range Planning, 43(2-3), 172-194.

Veit, D., Clemons, E., Benlian, A., Buxmann, P., Hess, T., Kundisch, D., Leimeister, J.M., Loos, P. and Spann, M. (2014) Business models: an information systems research agenda, Business & Information Systems Engineering, 6(1), 45-53

Velu, C. (2015). Business model innovation and third-party alliance on the survival of new firms. *Technovation*, *35*, 1–11. doi:10.1016/j.technovation.2014.09.007

Wirtz, B. W., Pistoia, A., Ullrich, S., & Göttel, V. (2015). Business models: origin, development and future research perspectives. Long Range Planning (forthcoming)

Zott, C., & Amit, R. (2007). Business Model Design and the Performance of Entrepreneurial Firms. *Organization Science*. doi:10.1287/orsc.1060.0232

Zott, C., & Amit, R. (2008). The fit between product market strategy and business model: Implications for firm performance. *Strategic Management Journal*, *29*, 1–26. doi:10.1002/smj.642

Zott, C., Amit, R., & Massa, L. (2011). The business model: recent developments and future research. Journal of Management, 37(4), 1019-1042

Table 2. Incidence rate by country														
	Austria	Finland	France	Germany	Italy	Lithuania	Netherlands	Poland	Portugal	Slovenia	Spain	Sweden	UK	total
% (and actual ##) of companies involved in BMI	54% (32)	41% (44)	22% (29)	29% (17)	61% (42)	53% (39)	21% (50)	39% (29)	47% (24)	51% (26)	47% (18)	37% (19)	40% (44)	37% (413)
N of SMEs (2012)	339.07 1	291.410	3.039.203	2.997.832	3.953.714	150.855	996.384	1.989.8 79	808.221	128.088	3.012. 443	736.112	2.054. 940	25.642. 461
% of SMEs EU 28	1,4%	1,2%	12,1%	12,0%	15,8%	0,6%	4,0%	7,9%	3,2%	0,5%	12,0%	2,9%	8,2%	
Source: Report base on 413 responses of SMEs in Europe, and data from http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=tin00170&plugin=1														

Table 3. Did your Company change its business model during the last 24 months														
	Austria	Finland	France	Germany	Italy	Lithuania	Netherlands	Poland	Portugal	Slovenia	Spain	Sweden	UK	total
Yes	21,9%	58,5%	14,3%	25%	61%	29,7%	36,2%	28,6%	39,1%	24%	35,3%	25,%	34,1%	35,4%
No	75%	41,5%	85,7%	75%	39%	70,3%	63,8%	71,4%	60,9%	76%	64,7%	75%	65,9%	64,3%

Table 4 Different instantiations of BM Innovation

	Austria	Finland	France	Germany	Italy	Lithuania	Netherlands	Poland	Portugal	Slovenia	Spain	Sweden	UK	total
A company no longer wants to sell products but earn money by renting them out, or make money by bundling the product with services. Did your company make this type of change during the last 24 months?														
Yes	28,1%	26,8%	10,7%	0	26,8%	13,5%	29,8%	35,7%	13,%	44,%	11,8%	18,8%	15,9%	22,5%
No	71,9%	73,2%	89,3%	100%	73,2%	86,5%	70,2%	64,3%	87%	56%	88,2%	81,3%	84,1%	77,5%
A company enters a new market or starts working with new type of partners. Did your company make this type of change during the last 24 months?														
Yes	84,4%	70,7%	35,7%	68,8%	63,4%	73%	66%	71,4%	69,6%	72%	76,5%	62,5%	56,8%	66,6%
No	15,6%	29,3%	64,3%	31,3%	36,6%	27%	34%	28,6%	30,4%	28%	23,5%	37,5%	43,2%	33,4%
Change the pricing strategy, that goes beyond the regular price adaptations. Did your company make this change during the last 24 months?														
Yes	31,3%	51,2%	32,1%	25%	63,4%	48,6%	42,6%	67,9%	52,2%	44%	52,9%	12,5%	56,8%	47,1%
No	68,8%	48,8%	67,9%	75%	36,6%	51,4%	57,4%	32,1%	47,8%	56%	47,1%	87,5%	43,2%	52,9%
Incorporation of IT for business purposes for example using social media or big data in sales channels or in marketing. Did your company make this change during the last 24 months?														
Yes	59,4%	63,4%	64,3%	62,5%	51,2%	51,4%	57,4%	39,3%	60,9%	44%	70,6%	75%	68,2%	58,2%
No	40,6%	36,6%	35,7%	37,5%	48,8%	48,6%	42,6%	60,7%	39,1%	56%	29,4%	25%	31,8%	41,8%

Source: Report base on 395 responses of SMEs in Europe

Table 5. Percentage of business model changes during the last 24 months

	Austria	Finland	France	Germany	Italy	Lithuania	Netherlands	Poland	Portugal	Slovenia	Spain	Sweden	UK	total
1	40,6	34,1	60,7	50	26,8	37,8	36,2	35,7	26,1	32	23,5	50	27,3	35,9
2	25	34,1	35,7	43,8	43,9	43,2	36,2	25	52,2	40	41,2	31,3	54,5	39,2
3	25	17,1	3,6	6,3	26,8	13,5	23,4	28,6	21,7	20	35,3	18,8	11,4	19,2
4	9,4	14,6	0	0	2,4	5,4	4,3	10,7	0	8	0	0	6,8	5,6

Source: Report base on 395 responses of SMEs in Europe

*Sum up and percentage of business model changes of activities (table 3 to table 6)

29th Bled eConference

Digital Economy

June 19 - 22, 2016; Bled, Slovenia

What drives SMEs to innovate their Business Models?
A Multiple Case Study of Slovenia

Marjeta Marolt

University of Maribor, Kranj, Slovenia

marjeta.marolt@fov.uni-mb.si

Gregor Lenart

University of Maribor, Kranj, Slovenia

gregor.lenart@fov.uni-mb.si

Damjan Maletič

University of Maribor, Kranj, Slovenia

damjan.maletic@fov.uni-mb.si

Mirjana Kljajić Borštnar

University of Maribor, Kranj, Slovenia

mirjana.kljajic@fov.uni-mb.si

Andreja Pucihar

University of Maribor, Kranj, Slovenia

andreja.pucihar@fov.uni-mb.si

Abstract

Business model innovation (BMI) has become increasingly important, especially with fast changing business environment. While large enterprises approach these changes more or less systematically, small and medium sized enterprises (SMEs) are left to their own resourcefulness. For the purpose of developing dedicated methods and tools to support different SMEs in addressing these challenges, we have conducted a multiple case study to identify drivers behind BMI. We propose an analysis framework and present the results of four Slovene SME cases analyses. The results show that all four enterprises have made changes of the business model elements, some even new value proposition. The findings revealed differences between companies regarding the drivers behind BMI and changes of the different

BMI elements. Two of four analysed companies see only opportunities while other two companies also struggles with internal or external threats. Overall, the results suggest all four SMEs, coming from different sectors, are facing BMI challenges without systematically addressing it and without using any dedicated BM ontologies or tools. The number of case studies included in the research is the major limitation of the study.

Keywords: business model, business model innovation, drivers of innovation, multiple case study

1 Introduction

Every enterprise employs a particular business model (BM), either explicitly or implicitly. To design a BM that is more than just a good logic of doing business, enterprise needs to assess internal and external factors concerned with customers, suppliers as well as the broader business environment (Teece, 2010). Even after a good BM is designed and implemented an enterprise needs to continuously re-think, re-design and develop its BM to remain competitive over time (Amit & Zott, 2012; Chesbrough, 2007; Teece, 2010; Zott, Amit, & Massa, 2011).

BM has been recognized as a valuable tool for building competitive advantages (Teece, 2010) and driving enterprise growth and profit (Casadesus-Masanell & Ricart, 2010). Only product or process innovations are according to Chesbrough (2007) insufficient for an enterprise to build and sustain long-term competitiveness. Therefore business model innovation (BMI) is becoming indispensable in practice (Amit & Zott, 2012; Casadesus-Masanell & Zhu, 2013; Chesbrough, 2007). In the past, a number of enterprises have successfully innovated their BMs (e.g. Apple, Ikea, EasyJet, etc …). However, there are still many enterprises that failed to renew or innovate their BM as well (e.g. Eastman Kodak, Encarta - Microsoft, Iridium – Motorola).

Many business leaders have difficulties with how to define and approach BMI (Giesen, Berman, Bell, & Blitz, 2007) what may lead to failure. Casadesus-Masanell & Ricart (2010) argue that business leaders are searching for insights on how to approach BMI. Furthermore, Teece (2010) argues that BMs are often poorly understood, because they are rarely analysed. Recent research has contributed greatly towards the understanding of BMI (Florén & Agostini, 2015), but the lack of empirical investigation of BMI phenomenon (Casadesus-Masanell & Zhu, 2013) and lack of systematic research on how enterprises should approach BMI (Bucherer, Eisert, & Gassmann, 2012) is acknowledged.

For a more systematic approach toward BMI several BMI frameworks were established (e.g. Bucherer et al., 2012; Florén & Agostini, 2015; Mahadevan, 2004). The frameworks can help to systematically investigate similarities and differences between BMs (Bucherer et al., 2012), but have mostly failed to establish general findings. The identified BM frameworks have been developed based on theoretical foundations and studies of BMI approaches mostly in large companies, while studies often neglected small and medium enterprises (SMEs). However, the European Union SMEs represent 99,8 % of all enterprises and are key drivers for economic growth, innovation, employment and social integration (European Commision, 2014). Many European enterprises, SMEs and also large enterprises, still lack awareness and knowledge about approaches and proper tools on how to innovate their BMs (Envison, 2015a).

The aim of this paper is to gain deeper understanding of drivers that stimulate SMEs to innovate their BMs. For that purposes we conducted case studies in 4 different SMEs in Slovenia. In particular, we investigated core elements, similarities and differences of origin, and types of BMI. Understanding of different BMI approaches in SMEs will contribute to wider knowledge base in this field, which will enable to develop proper support for BMI in SMEs.

The paper is organized as follows. After introduction, we present literature review on BMI. Next chapter presents methodology, which is followed by case analysis and findings. We end with conclusions.

2 Business model innovation

According to Morris, Schindehutte, Richardson, & Allen (2006) the term business model (BM) have received a lot of attention since the 1990s. The main factors behind its increasing popularity are the growth of internet and e-commerce, the emerging knowledge economy, the outsourcing and offshoring of many business activities (Teece, 2010). Business model concept has evolved over time from a term that refers to a way enterprise does business (e.g. Gebauer & Ginsburg, 2003) to ontologies of generic components that constitute business models (e.g. Bouwman, Faber, Haaker, Kijl, & De Reuver, 2008; Osterwalder & Pigneur, 2010). Despite the contribution towards understanding of BMI, there is a lack of clarity and definitional consistency as well as theoretical grounding in economics or in business studies (Teece, 2010). The definitions of business model are focused on value creation (Teece, 2010), customer value (Osterwalder & Pigneur, 2010), customer and the enterprise value (Bouwman et al., 2008) or on the economic value (Gordijn & Akkermans, 2001). In this paper, we use the BM definition proposed by Osterwalder & Pigneur (2010, p. 14): “a business model describes the rationale of how an organization creates, delivers, and captures value”.

A business model is not static. It has to be managed and innovated over time (Chesbrough, 2007; Hedman & Kalling, 2003). Companies must continuously evaluate, adjust and develop their business models to remain viable and sustain future growth (Amit & Zott, 2012; Teece, 2010; Zott et al., 2011). The body of knowledge in this field is still rather immature. There are many different and partially contradictory definitions that represent a potential source of confusion (Florén & Agostini, 2015). Based on the literature review we identified two directions towards the understanding of BMI. BMI can be understood as a supporter of other types of innovation or as a sustainer of BMI uniqueness (Amit & Zott, 2012; Teece, 2010). In ENVISION project the following definition of BMI was adapted (Pucihar, Kljajić Borštnar, Heikkilä, Bouwman, & De Reuver, 2015): “BMI is defined as changes in business logic, that are new to the focal firm, yet not necessarily new to the world, and have to result in observable changes in the practices of a BM”.

There are different frameworks available for analysing BMI (e.g. Bouwman, MacInnes, & De Reuver, 2006; Bucherer, Eisert, & Gassmann, 2012; Florén & Agostini, 2015; Mahadevan, 2004). These frameworks mainly include the following aspects: the foremost reasons for enterprise to engage BMI (Bucherer et al., 2012; Carayannis, Sindakis, & Walter, 2014; Mahadevan, 2004), core BM elements that can be changed (Florén & Agostini, 2015; Mahadevan, 2004) and types of BMI (Bucherer et al., 2012; Florén & Agostini, 2015). The most compiling reasons for enterprise to engage BMI are cost reduction and flexibility (Pohle & Chapman, 2006). There are also other reasons (e.g. technology development, competition, legislation) behind BMI engagement and therefore several authors generally distinguish internal and external origin of BMI (Bucherer et al., 2012; Sorescu, Frambach, Singh, Rangaswamy, & Bridges, 2011). Carayannis et al. (2014) observe that BMI seems to be driven by internal and external opportunities and threat identified by Bucherer et al. (2012). These identified drivers may influence the change of core BMI elements. These elements usually origin from the existing business model ontologies (e.g. Bouwman et al., 2008; Johnson & Christensen, C. M. Kagermann, 2008; Skarzynski & Gibson, 2008). The level of changes of core BMI elements leads to the different types of BMI. Some authors differentiate between disruptive and incremental BMI (e.g. Comes & Berniker, 2008; Markides, 2006). Others argues that BMI covers changes from incremental adjustments to more radical changes, proposing a classification that distinguishes more than two before mentioned extremes (Bucherer et al., 2012; Florén & Agostini, 2015; Schaltegger, Lüdeke-Freund, & Hansen, 2012).

2.1 Framework of analysis

For systematic analysis of cases of 4 SMEs, we combined and adapted two frameworks for BMI (Bucherer et al., 2012; Mahadevan, 2004). Framework for analysis consists of three key aspects of BMI: origin, core elements and type of BMI (Figure 1).

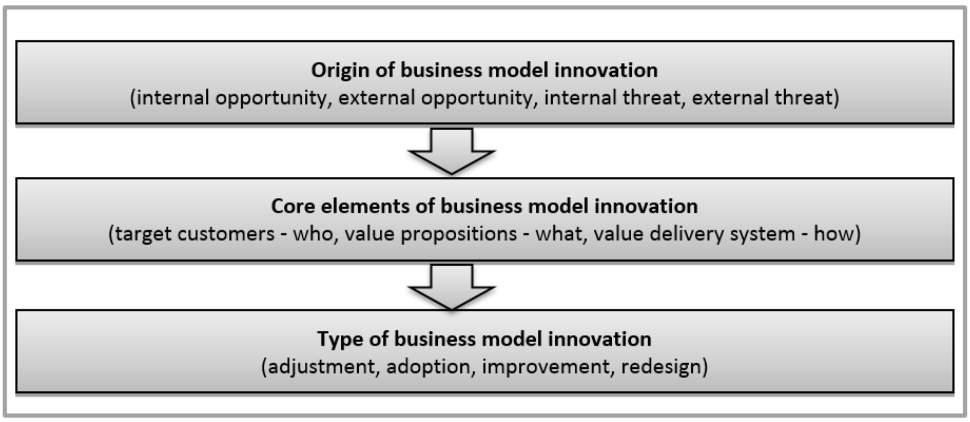


Figure 1: Framework of analysis (adapted from Bucherer et al., 2012; Mahadevan, 2004)

Origins of BMI

The innovation can be triggered in different ways. According to Bucherer et al. (2012) there are four different origins of BMI: internal opportunity (e.g. improvement of internal processes), external opportunity (e.g. changes in key technologies), internal threat (e.g. the outsourcing of certain activities or investment in new capabilities), external threat (e.g. competitive threat, market shift, legal changes). There can be only one origin of BMI or combination of more dimensions at the same time. Additionally, it is not necessary that specific origin of BMI triggers only one BMI of the enterprise. Enterprise can have multiple BMs and support multiple business logics, dependent on product/service market combinations and market segmentation (Pucihar et al., 2015). Last but not least an enterprise can perceive the specific trigger as an opportunity or as a threat. For instance, the changes in key technologies can one enterprise see as an opportunity that leads to improvement of processes or even new product/service generation, and another enterprise as a threat, because of the employee reluctance to learn and adopt novelty.

Core elements of BMI

Mahadevan (2004) argues that there are three core elements of a BMI, including “who”, “what” and “how”. The “who” element addresses the appropriate identification of customer and their needs in order to decide the value proposition (“what”) that needs to be provided to the targeted segment. When these two elements are set, the “how” element (value delivery system) can be configured. This element includes the operational aspects of the business (e.g. decisions about type of product and process technology to be adopted, asset configuration, the extent and nature of interactions with other supply chain elements) (Mahadevan, 2004).

To obtain more detail analysis, we have further divided the three core elements of BMI into sub-elements. The “who” element was divided into market area (What is the market area of the enterprise? - National and/or international) and types of markets (Which customers do the enterprise choose to serve? - business market and/or customer market and/or governmental market). The “what” element was divided into product offering and service offering. The “how” element we divided into value chain (How is enterprise configured to deliver value proposition to customer? - In-house and/or outsource), organization (How the enterprise sustains and enhances competitive advantages? - Employee deployment and/or employee development) and Information technology (IT) (How the enterprise exploits IT technology? - IT as a product/service enabler and/or IT as a promotion/sales channel). Employee deployment is understood as realignment of human resources to new work assignments or job responsibilities to meet operational needs (BC Public Service Agency, n.d.). Employee development is understood as providing learning conditions for employees to develop current skills and gain new ones (Lee & Bruvold, 2003). In the element how we did not cover revenue streams and under the technology sub-element only IT technologies were considered.

Types of BMI

The changes in the elements of BM influence the degree of BMI. In general many authors categorise BMI as radical and incremental (e.g. Zott & Amit, 2002). While the spectrum of possibilities lies across a continuum in practice (Bouwman et al., 2006) we adopted four types of BMI proposed by Schaltegger et al. (2012), that includes:

- BM adjustment refers to changes of only one business model element or a minor number of business model elements. The element of value proposition (i.e. modification of customer relationships, business infrastructure, or financial pillar alone constitute improvements) is in this stage excluded.
- BM adoption refers to changes that are made in order to match competitors' value propositions.
- BM improvement refers to changes of a major number of business model elements (e.g. customer relationship approaches, infrastructure elements), except the value proposition is not changed.
- BM redesign refers to changes that lead to a completely new value proposition, offering new products, services or product-services systems.

3 Methodology

For the purpose of this study multi-case study research, as a suitable methodology for obtaining insights into BMI approach, was used. The case study research method described by Yin (2009) was adopted. The case study research consists of design, data collection and analysis phases proposed in the Case Study protocol (CSP) of ENVISION project (Pucihar et al., 2015).

In the design phase the selection process, criteria and sampling method was determined. Sampling was purposeful; at least one of the cases has to qualify as a family business and one of them as a female business. These selection criteria were chosen because it is estimated that on average half of EU SMEs are family businesses (Mandl, 2008) and women entrepreneurs make up 29 percent of all European entrepreneurs (European Commission, 2014). An enterprise was considered as a family business, if the enterprise met the criteria proposed by Family Business Expert Group (2009). A female business was considered as a female entrepreneur which was defined by European Commission (2004) as "woman who has created a business in which she has a majority shareholding and who takes an active interest in the decision-making, risk-taking and day-today management". Based on selection criteria four Slovenian micro and small enterprises were invited to participate in the study.

Data collection methods, defined by CSP (Pucihar et al., 2015) were based on the preliminary investigation of available resources (business reports, web sites, media coverage) and semi-structured interview. The semi-structured interviews were conducted to gain a deeper understanding on BMI in selected enterprises. Different business model templates were used to encourage discussion. The interviews were recorded and transcribed. The transcription and other information gathered before and during the interview served for case study report preparation. Some additional insights were gathered through e-mail, phone call or in additional short meetings. Each case study report was sent for approval to the enterprise contact person.

4 Case Analysis and findings

The four micro and small enterprises included in the study represent different sectors of the Slovenian economy. Our analysis was focused on drivers behind the BMI, changes made in BM and the level of BMI. First, we present a brief overall description of each enterprise, following with detail comparative analysis of cases. We conclude this chapter with the aggregated findings.

4.1 General characteristics

SME A

SME A is a family business that was founded in 1993. At the beginning the enterprise was focused in building log cabins, garages, pergolas and making wooden panelling, floor, slats, etc. Later on, in 2006, the enterprise shifted their value proposition to the production of wood biomass.

SME B

SME B is a female business that was founded in 2004. It provides a variety of handmade high quality leather shoes, hand bags and accessories with hand painted details.

SME C

SME C was founded in beginning of 1990's as internet service provider and has transformed over the years into high tech IT service and solutions provider in the field of High Performance Computing (HPC). Today it offers services of supercomputer infrastructure to their clients and provides them system administration, optimization and parallelization of code, cloud computing services, web and mobile application development services and project management SaaS services.

SME D

SME D is a family business established in 1992 based on their tradition and inherited chocolate recipes from their ancestor. Today SME D produces more than 150 different kinds of confectionary (sweets) products. They also offer customized products for individual/custom orders.

4.2 Comparative analysis

Origin of BMI

The drivers behind BMI in SME A are opportunities in the wood biomass market. While the production of wood biomass is quite fragmented they see the opportunity in connecting and collaborating with other wood biomass providers in Slovenian market. On the other hand, the internal opportunities are also present. The younger generation is more risk-taking oriented and therefore they start to collaborate with their competitors and participate in the projects (e.g. establishment of a biomass district heating system for a six apartment blocks for which they received an EU grant).

SME B main driver for the innovation was internal threat related to the time management challenges. The owner wanted to dedicate more time to design and make new products, but without any help she was not able to run the store and to have sufficient number of products on the stock at the same time. The owner also noticed that the Slovenian market is too small for the unique products that she offers and she sees the potential in foreign markets (external opportunities).

SME C drivers behind BMI are a combination of internal (highly skilled experts) and external opportunity (emerging technologies which they combine together with specialized customer focused services to solve customers' problems).

SME D drivers behind BMI are also combination of internal and external opportunity and external threat. Internal opportunities are driven by joy to produce high quality products which will be successful on market. External opportunities are more related to geographic positioning of enterprise stores locations in such a way to attract high number of visits of customers in their stores. The enterprise also encounters external threat in a form of high level competition, especially when the enterprise participates in public procurement markets.

Core elements of BMI

Who

SME A has the customers not only in Slovenia, but also in neighbouring countries. They are doing business with other companies, end customers and also with public institutions. The majority of customers are companies. In Slovenia they have fewer customers but they are trying to position themselves as relying supplier for wood biomass.

SME B does not know their customers very well, because its aim is to design and create unique leather products. The store is located in Bled, one of the most popular Slovenian tourist destinations. The customers are mostly foreign tourists and local people who know the brand and/or like that kind of art.

SME C operates on both national and Central Europe market depending on type of services offered. They are primarily focused on offering services for other enterprises, only small part of their service portfolio is offered to end customers.

SME D main customers are tourists and also some local customers which are most often returning for their high quality confectionary products. The remaining share of their revenues comes from business and governmental market during high season for business gifts and presents around New Year's holidays. Time to time they get orders from abroad.

What

SME A the main goal is to offer all available wood biomass heating options in order to meet variety of customers' needs regarding wood biomass and maintain a competitive advantage. They exactly know what the trends in the production of wood biomass are and how to satisfy their customers. They are also offering log cabins, garages, pergolas, etc. but they are currently focused more on production of wood biomass.

SME B mainly relies on the creativity and the quality of the products. The added value for the customers is uniquely designed high quality products (shoes, bags, and accessories) with various hand techniques used.

SME C provides their clients end to end IT solutions for their problems. They are offering services on their own HPC platform or they guide clients for building their own HPC infrastructure. They are also offering classical IT system administration and software application development services. In addition, they are also specialized for implementation of their own cloud based project management solution; therefore they offer various services.

SME D has a large portfolio of more than 150 handmade chocolate pralines and chocolates. Their main value offering is high quality handmade chocolate confectionaries, constant quality of products and customized confectionary products for corporate customers.

How

SME A is a small enterprise with limited resources and capabilities. Without the help of their partners' network they would not be able to offer all the available wood biomass heating options. They have good connections with the companies in Austria, which is one of the leading countries in the field of wood biomass usage. The knowledge they achieve through those connections helps them to be ahead of the Slovenian competition. The director is the one who transmits the achieved knowledge to employees and encourages them to gain new skills. In 2015, because of the growth of the enterprise, they needed to reassign their employees to new assignments and even employ new employees. The enterprise is very flexible and is willing to take risks to achieve competitive advantage. All the gained profit is invested in development of the enterprise, especially in biomass technologies.

SME B is also relying on partners. In order to make high quality products, the enterprise needs to have suppliers that offer (raw) material of high quality (e.g. leather, dye). While the enterprise is more focused on design and painting, the sawing part is executed by reliable subcontractor. Enterprise needs only basic tools such as scissors, skiving knifes, brushes. Besides, the creativity a lot of time without distractions is needed. While working in the store and making the product at the same time was not very productive, hiring an assistant to help in the store was the most logical option. In the beginning the assistant only helped in the store, since recently she also helps managing the paperwork. In order to attract the customers from abroad the enterprise created an online store and is involved in social media.

SME C uses state of the art IT infrastructure to deliver new services in domains where IT have not been used before. They also partner with other R&D institution like universities and research institutes in order to keep up with rapid development in the field they are operating. They also partner with their clients for specific improvements and upgrades of their existing product and service portfolio. SME C is typical project type of organization and they would assign their employees to projects. They have weekly meetings (planning work) and monthly meetings (overview of the main activities and the status of projects) which can also result in reassignment of employees to different projects where needed.

SME D on the other side heavily rely on their own resources to deliver products to the market. They have their own independent production of their products. Sale of products heavily depends on customers visits to their stores. They typically partner with touristic service providers to include stop of touristic bus at their store location which enable tourists to buy some authentic locally produced confectionary item in theirs stores. SME D has smaller number of core employees at their production location and number of contract employees who are deployed dynamically where needed to work in stores to sell the products or in chocolate production mainly in packaging activities. They also have an online store.

Types of BMI

SME A is following good practices in the field of wood biomass and have changed value proposition (offering all available wood biomass heating options) as well as some other BM elements. First of all the SME A changed the approach towards the customers, especially the foreign companies. They connected with partners who have connections with the foreign companies who are using wood biomass. Similarly, they are trying to convince other providers of wood biomass to work together on bigger projects that individual enterprise (biomass provider) is not capable to cover. Enterprise also reassigns their employees to new assignments and bought additional technologies for the biomass production. The enterprise classifies to BM redesign type of BMI.

The owner of SME B is driven artist; she enjoys designing new products, and less running a business. She saw the change of the legal status as an enabler for other changes of BM. She was finally able to employ an assistant to help her with daily tasks. Consequently she had more time to design new products, produce more products, launch online store and be more active on social media. Furthermore she encounter some negative consequences. Before the change she did not need to run an inventory. She was also not liable to tax in a way that sole proprietorship is. While she could not afford to increase the prices of her products for 22% (general tax rate of VAT), her work became less valued. Furthermore, she has additional salary expenses (payment for her assistant). The enterprise classifies to BM improvement type of BMI.

SME C is usually upfront market trends and thus has to redesign the BMs to adjust the value proposition to the potential customers. For instance, at the beginning their idea was to lease only infrastructure for HPC, but this did not generate enough revenue to cover the high maintenance costs, let alone to create profits. Therefore they started to lease HPC along with specialized services in the cloud and focused mostly on manufacturing SMEs. The enterprise classifies to BM redesign type of BMI.

SME D has more stable BM and they only introduce incremental changes into their offering. Two years ago they renewed their website and introduced online shop. Each year they introduce a couple of new products and if they are a success on a local market, they start to sell them in all of their stores. The enterprise classifies to BM adoption type of BMI.

The aggregated findings of comparative analysis are presented in Table 1. The table was used to derive an overview of BMI key drivers, core elements of BMI and type of BMI for each of four cases. The changes are labelled as x.

Criteria based on framework of analysis				SME A	SME B	SME C	SME D
Origin of BMI			Internal opportunity	x		x	x
			External opportunity	x	x	x	x
			Internal threat		x		
			External threat			x	
Core elements of BMI	Who	Market area	National	x	x	x	x
			International	x	x	x	x
		Types of markets	business market	x		x	x
			customer market	x	x		x
			governmental market	x			x
	What	Types of offering	Product	x	x		x
			Service	x		x	x
	How	Value chain	In-house	x	x	x	x
			Outsource	x	x	x	
		Organization	Employee deployment	x	x	x	x
			Employee development	x		x	
		Technology	IT as a product /service enabler			x	
			IT as a promotion /sales channel		x		x
Types of BMI			Adjustment				
			Adoption				x
			Improvement		x		
			Redesign	x		x	

Figure 1: Aggregated findings of comparative analysis

4.3 Findings

Surprisingly, all four enterprises have made changes of the BM elements, some even new value proposition. It seems that all the interviewees mentioned only major changes because small changes are made on a daily basis and companies do not perceive them as innovation of their BMs. This assumption is made based on the interview with the SME C. The interviewee said: "We are constantly changing, facing minor as well as major changes. The major changes are planned, approached more systematically, while the minor changes are usually executed without preparation and in parallel with other daily assignments". Therefore we agree with Teece (2010) who states that minor changes in the manufacturing process usually does not require BMI.

All four cases are well established SMEs, being on the market for more than 10 years. They have encountered several major changes in the time of their existence but none of them have used any of known BM ontologies or tools. For example, one very interesting quote that interviewee from SME A has stated is: "my concerns are that, if our growth rate will continue, I will not be able to have everything in my mind and I think that some sort of simple BM tools would be of significant value for me".

The analysed companies have changed few or several core elements of BMI. While they are constantly making minor changes, the major changes are usually made every few years. The changes in the four analysed cases are not categorized as of a same type of BMI, because not all of the cases have made changes that lead to completely new value proposition. Among all four analysed companies only SME B did not consider BMI as successful. The owner said: "The changes are not considered successful so far." Perhaps because the owner is driven artist with lack of interest in running a business. Interestingly, among the three companies that considered changes in their BMI as successful, only SME A acknowledged growth in the profit. Director said that they acknowledge "approximately 300 to 400% growth in last several years".

Two of four analysed companies are offering different product or services that require different business logics. Both companies, SME A and SME C, have made major changes only in the business logic of one product or service, namely the one they are currently focused on. For example SME A changed only business logic of wood biomass, while business logic of other products remains the same. The owner has stated: "We are currently focused only in the wood biomass, because it represents 90 % of all revenue."

Last but not least, IT technology was identified as BMI driver as well as a part of BM element that was changed. IT as a BMI driver was identified only by SME C, while other three SMEs did not give considerable emphasis on IT. Nevertheless, all four analysed companies have invested into technology development, not only IT. SME A mostly invested in the development of wood biomass production technologies while the other three companies mainly in the ICT technologies. SME C has heavily invested in ICT and HPC, as IT services are their core business, while companies B and D have developed their presence on the internet (web store, social media profiles).

5 Conclusion

BMI has become a key concern for enterprises to stay competitive and successfully overcome nowadays challenges from rapid changing business environments. However, most of the enterprises, especially SMEs have little knowledge and awareness about critical importance of BMI systematic approach, and supportive methods and tools that could be used.

The present paper analysed this issue based on four case studies. Our findings were validated by theoretical insights from the field of BMI. Contributions of this paper are twofold. First, we proposed framework for BMI case study analysis, which has been developed based on prior frameworks. Second, we performed a comparative analysis between four SMEs, two of them being family and one female business. More specifically, we investigated similarities and differences of origin, core elements and types of BMI in four different SMEs in Slovenia.

The main conclusion is that the external opportunity is the main driver that influences SMEs decision to innovate their BM, but it is not the only one and is usually combined with at least one internal driver. Regardless of the drivers, one should expect that family businesses are more careful and not prepared to conduct major changes of BM. In one of the cases we showed the contrary. Perhaps the younger generations are more willing to take risk, even though they can endanger income for the whole family. Regarding the female business we can not draw any conclusions because we have only one case. Overall, all four analysed SMEs approached BMI intuitively, usually using only spreadsheets or other similar tools.

Looking at the fact that very few studies have given attention to BMI in relation to SMEs, the findings of this study provide some useful information regarding the BMI practices in SMEs. However, there are also limitations of this study. The limitation of this study is mainly concerned with the number of cases currently conducted for this study. Another limitation is that all the cases, presented in this paper are done in one country. Further research should focus on more cases, including SMEs of various sizes, from various industries and various countries. This will be done in the scope of Envision project. Further research will help us to expand the knowledge about BMI practices and needs of SMEs to provide them with proper frameworks and tooling for evaluation, redesign and innovation of their BMs. Last but not least, for more detailed analysis the proposed research framework needs further elaboration.

Acknowledgement

The work leading to these results has received funding from the European Community's Horizon 2020 Programme (2014–2020) under grant agreement 645791. The content herein reflects only the authors' view. The European Commission is not responsible for any use that may be made of the information it contains.

References

Amit, R., & Zott, C. (2012). Creating value through business model innovation. *MIT Sloan Management Review*, *53*(3), 41.

BC Public Service Agency. (n.d.). Hiring & Deployment. Retrieved March 5, 2016, from http://www2.gov.bc.ca/myhr/article.page?ContentID=42e3b62b-c4a7-b92b-3931-bc213f2c564e&PageNumber=6

Bouwman, H., Faber, E., Haaker, T., Kijl, B., & De Reuver, M. (2008). Conceptualizing the STOF Model. In H. Bouwman, H. de Vos, & T. Haaker (Eds.), *Mobile Service Innovation and Business Models* (pp. 31–70). Springer Publishing Company, Incorporated. Retrieved from http://dl.acm.org/citation.cfm?id=1951590

Bouwman, H., MacInnes, I., & De Reuver, M. (2006). Dynamic business model framework: A comparative case study analysis. In *Proceedings ITS* (pp. 1–15).

Bucherer, E., Eisert, U., & Gassmann, O. (2012). Towards Systematic Business Model Innovation: Lessons from Product Innovation Management. *Creativity and Innovation Management*, *21*(2), 183–198. http://doi.org/10.1111/j.1467-8691.2012.00637.x

Carayannis, E. G., Sindakis, S., & Walter, C. (2014). Business Model Innovation as Lever of Organizational Sustainability. *The Journal of Technology Transfer*, *40*(1), 85–104. http://doi.org/10.1007/s10961-013-9330-y

Casadesus-Masanell, R., & Ricart, J. E. (2010). From Strategy to Business Models and onto Tactics. *Long Range Planning*, *43*(2-3), 195–215. http://doi.org/10.1016/j.lrp.2010.01.004

Casadesus-Masanell, R., & Zhu, F. (2013). Business model innovation and competitive imitation: The case of sponsor-based business models. *Strategic Management Journal*, *34*(4), 464–482. http://doi.org/10.1002/smj.2022

Chesbrough, H. (2007). Business model innovation: it's not just about technology anymore. *Strategy & Leadership*, *35*(6), 12–17. http://doi.org/10.1108/10878570710833714

Comes, S., & Berniker, L. (2008). Business model innovation. In *From strategy to execution* (pp. 65–86). Springer Berlin Heidelberg.

Envison. (2015a). Envision project. Retrieved February 24, 2016, from http://www.envisionproject.eu/

Envison. (2015b). Envision project.

European Commision. (2014). *SMEs' access to public procurement markets and aggregation of demand in the EU*. Retrieved from http://ec.europa.eu/internal_market/publicprocurement/docs/modernising_rules/smes-access-and-aggregation-of-demand_en.pdf

European Commission. (2004). *Promoting entrepreneurship amongst women*. Retrieved from http://ec.europa.eu/DocsRoom/documents/1972/attachments/1/translations/en/renditions/pdf

European Commission. (2014). *Statistical data on Women entrepreneurs in Europe*. Retrieved from http://ec.europa.eu/DocsRoom/documents/7481/attachments/1/translations/en/renditions/native

Family Business Expert Group. (2009). *Final report of the expert group overview of family–business–relevant issues: research, networks, policy measures and existing studies*. Retrieved from http://ec.europa.eu/enterprise/policies/sme/promoting-entrepreneurship/family-business/family_business_expert_group_report_en.pdf

Florén, H., & Agostini, A. (2015). The Business Model Innovation Map : A Framework for Analyzing Business Model Innovation. *24th IAMOT Conference, Cape Town, South Africa, 8-11 June, 2015*. University of Pretoria & Media Chef CC. Retrieved from http://www.diva-portal.org/smash/record.jsf?pid=diva2%3A849082&dswid=-1759

Gebauer, J., & Ginsburg, M. (2003). The US Wine Industry and the Internet: An Analysis of Success factors for Online Business models. *Electronic Markets*, *13*(1), 59–66. Retrieved from http://www.tandfonline.com/doi/abs/10.1080/1019678032000039877?journalCode=rema20

Giesen, E., Berman, S. J., Bell, R., & Blitz, A. (2007). Three ways to successfully innovate your business model. *Strategy & Leadership*, *35*(6), 27–33. http://doi.org/10.1108/10878570710833732

Gordijn, J., & Akkermans, H. (2001). Designing and evaluating e-business models. *IEEE Intelligent Systems*, *16*(4), 11–17. http://doi.org/10.1109/5254.941353

Hedman, J., & Kalling, T. (2003). The business model concept: theoretical underpinnings and empirical illustrations. *European Journal of Information Systems*, *12*(1), 49–59. http://doi.org/10.1057/palgrave.ejis.3000446

Johnson, M. W., & Christensen, C. M. Kagermann, H. (2008). Reinventing Your Business Model. *Harvard Business Review*, *86*(12), 50–68.

Lambert, S. C., & Davidson, R. A. (2013). Applications of the business model in studies of enterprise success, innovation and classification: An analysis of empirical research from 1996 to 2010. *European Management Journal*, *31*(6), 668–681. http://doi.org/10.1016/j.emj.2012.07.007

Lee, C. H., & Bruvold, N. T. (2003). Creating value for employees: investment in employee development. *The International Journal of Human Resource Management*, *14*(6), 981–1000. http://doi.org/10.1080/0958519032000106173

Mahadevan, B. (2004). A framework for business model innovation. In *MRC Conference*. Retrieved from http://www.iimb.ernet.in/~mahadev/imrc2004.pdf

Mandl, I. (2008). *Overview of Family Business Relevant Issues, Final Repor*. Retrieved from https://www.google.si/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0ahUKEwjx6Ljm4f7KAhUC_XIKHc4LAVAQFggmMAA&url=http://ec.europa.eu/DocsRoom/documents/10389/attachments/1/translations/en/renditions/native&usg=AFQjCNGsrc7Rmi9QKlwRDK

Markides, C. (2006). Disruptive Innovation: In Need of Better Theory*. *Journal of Product Innovation Management*, *23*(1), 19–25. http://doi.org/10.1111/j.1540-5885.2005.00177.x

Morris, M., Schindehutte, M., Richardson, J., & Allen, J. (2006, May 20). Is the Business Model a Useful Strategic Concept? Conceptual, Theoretical, and Empirical Insights. *Journal of Small Business Strategy*. Retrieved from http://libjournals.mtsu.edu/index.php/jsbs/article/view/62

Osterwalder, A., & Pigneur, Y. (2010). *Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers*. Wiley.

Pohle, G., & Chapman, M. (2006). IBM's global CEO report 2006: business model innovation matters. *Strategy & Leadership*, *34*(5), 34–40. http://doi.org/10.1108/10878570610701531

Pucihar, A., Kljajić Borštnar, M., Heikkilä, M., Bouwman, H., & De Reuver, M. (2015). Envision Case Study Protocol. Unpublished internal document, Envision project.

Schaltegger, S., Lüdeke-Freund, F., & Hansen, E. G. (2012). Business Cases for Sustainability:

The Role of Business Model Innovation for Corporate Sustainability. Retrieved from http://papers.ssrn.com/abstract=2010510

Skarzynski, P., & Gibson, R. (2008). Unnovation to the Core: A Blueprint for Transforming the Way Your Company Innovates. *Harvard Business Press, Boston*.

Sorescu, A., Frambach, R. T., Singh, J., Rangaswamy, A., & Bridges, C. (2011). Innovations in Retail Business Models. *Journal of Retailing*, *87*, S3–S16. http://doi.org/10.1016/j.jretai.2011.04.005

Teece, D. J. (2010). Business Models, Business Strategy and Innovation. *Long Range Planning*, *43*(2-3), 172–194. http://doi.org/10.1016/j.lrp.2009.07.003

Yin, R. K. (2009). *Case Study Research: Design and Methods (Applied Social Research Methods)*. California: SAGE Publications.

Zott, C., & Amit, R. (2002). *Measuring the performance implications of business model design: evidence from emerging growth public firms*. Fontainebleau: Insead.

Zott, C., Amit, R., & Massa, L. (2011). The Business Model: Recent Developments and Future Research. *Journal of Management*, *37*(4), 1019–1042. http://doi.org/10.1177/0149206311406265

29th Bled eConference

Digital Economy

June 19 - 22, 2016; Bled, Slovenia

Designing an ICT tooling platform to support SME business model innovation:
Results of a first design cycle

Mark de Reuver, Alexia Athanasopoulou

Delft University of Technology, The Netherlands

{g.a.dereuver;a.athanasopoulou}@tudelft.nl

Timber Haaker, Melissa Roelfsema

Innovalor, The Netherlands

{timber.haaker;melissa.roelfsema}@innovalor.nl

Angelika Riedl, Gert Breitfuss

Evolaris, Austria

{angelika.riedl;gert.breitfuss}@evolaris.net

Abstract

Business model innovation (BMI) is becoming increasingly relevant for enterprises as they are faced with profound changes like digitalization. While business model thinking in academia has advanced, practical tooling that supports business model innovation for small and medium sized enterprises (SMEs) is still lacking. In this paper, we design, implement and evaluate an online platform with ICT-enabled tooling that supports business model innovation by SMEs. Based on interviews with ten SMEs and SME helpers, we define requirements for the BMI tooling platform. The implemented platform offers downloadable tools, decision support for finding the proper tooling, and interactive features for building communities of SMEs. Evaluation through log data analysis and informal interviews shows that the platform is usable and provides a relevant overview of BMI tooling, although several improvements are still suggested. As next steps, we will (1) create prefilled tools and templates to speed up the process of BMI; (2) create educational videos on how to use the tooling; (3) define paths on how to move from one tool to another; and (4) enhance the community features on the *platform. The paper contributes to understanding how academic conceptualizations of BMI can be transferred into practically valuable artefacts for SMEs.*

Keywords: Business Model Innovation, SME, Digital Platform, Design Science Research, ICT Tooling

1 Introduction

The topic of business model innovation (BMI) is gaining considerable attention in information systems (e.g., Osterwalder & Pigneur 2013) and management literature (e.g, Zott et al 2011). The construct of business models is typically considered as a means to explicate the value of (digital) innovations (Baden-Fuller & Haefliger, 2013; Al-Debei & Avison, 2010). While most business model research focuses on large firms, small businesses are hardly aware of BMI (Kesting & Gunzel-Jensen 2015). However, SMEs in all kinds of industries will increasingly be forced to change their business models when faced with trends like servitization, digitization and Internet-of-things or simply changing customer demands and competitive pressure.

Within Information Systems (IS), a specific area of interest is tooling to support BMI. In the community of organizational modelling, extensive ontologies, metamodels and associated tools have been developed (e.g. Roelens & Poels, 2015). However, this stream of literature is hardly concerned with how to use those tools in practice. More hands-on tooling approaches are also emerging, for instance in the work of Fritscher & Pigneur (2014). In the practitioner area, tools are being developed ranging from highly advanced (e.g. VDMBee) towards simple click-and-fill-out tools (e.g. Canvanizer). However, existing BMI tools are either limited to brainstorming tools or incomprehensible for most SMEs.

BMI tools especially designed for Small and Medium Enterprises (SMEs) are not about advanced, complexed or costly supporting environments, but about 'light', simple and easy-to-use tools. More specifically, designing BMI tools that are to be adopted by SMEs poses at least three challenges. First, since SMEs have less complex management structures, BMI tools should do more than codify and communicate strategic ideas (cf., Pateli & Giaglis 2004). Second, SMEs are typically not aware of BMI and might be reluctant to change their business logic (Kesting & Gunzel-Jenssen 2015). Third, SME managers are often less highly educated than managers in large corporations, which implies that BMI tooling has to be simple and intuitive.

Our research objective is to design and evaluate a digital self-service platform for BMI tooling aimed at SMEs. We define BMI as systemic changes in business logic of a company (or network of companies) when creating and capturing value. We conduct design science research (DSR) combined with an agile development approach in order to develop a minimum viable version of the platform as soon as possible. This paper provides the results of a first design cycle. The artefact is evaluated through interviews with SMEs and other users of the platform. The paper is based on work done in the European Horizon2020-project ENVISION, which aims to bring BMI tooling to 200,000 European SME owners by 2018.

We follow the approach described by Verschuren and Hartog (2005) for design-oriented research. We develop requirements and specifications based on user stories that were elicited in interviews with SMEs . We develop a prototype of the artefact, and subsequently evaluate the artefact through log data analysis and informal open-end interviews. The paper is structured as follows. Section 2 provides a background on business model innovation theory as well as related work on BMI tooling in academia and practice. Section 3 develops the requirements for the BMI tooling, the platform and tooling based on interviews with ten SMEs and SME helpers (i.e. actors that advice SMEs on how to conduct BMI, such as consultants or researchers). Section 4 describes the artefact as it has been designed based on the requirements. Section 5 provides the results of the evaluation through log data analysis and informal interviews with SME helpers. Section 6 concludes the paper by discussing findings and suggesting next steps.

2 Background

Business Models (BM) as a concept are typically used to explicate how companies create and capture value from technological innovation (Chesbrough & Rosenbloom, 2002). BM has been investigated and used by many scholars and practitioners from various disciplines and contexts from IS and management to computer science and strategy (DaSilva and Trkman, 2014. This results in a wide variety of definitions (e.g., an overview is provided by Osterwalder et al, 2005; Pateli & Giaglis, 2004; Zott et al, 2011; DaSilva & Trkman, 2014). Generally speaking, the term BM refers to a description or model that represents a firm's logic to create, provide and capture value from and for its stakeholders (e.g., Bouwman et al, 2008; Chesbrough & Rosenbloom, 2002; Gordijn & Akkermans, 2001; Linder & Cantrell, 2000; Magretta, 2002). Specific models have been presented including BM Canvas (Osterwalder, 2004), the STOF model (Bouwman et al, 2008), and VISOR (ElSawy & Pereira, 2013).

More recently, scholars and practitioners acknowledge the need to shift the focus from conceptualization towards BMI and implementation, aiming to develop approaches to analyse BM viability and feasibility (Al-Debei & Avison, 2010; Bouwman et al, 2008; El-Sawy & Pereira, 2013; Teece, 2010). By Business Model Innovation (BMI) we refer to the ways organisations change their business logic from the moment that an idea is created, analysed, tested and in the end adapted to form their business model (Heikkilä et al, 2010) in parallel with technological, social, product or service innovation (Bouwman et al., 2014). Mitchell and Coles

(2004) looked at BMI best practices by interviewing several business model innovators and came up with several type of business model breakthroughs. Based on a case study, Bucherer et al. (2012) found strong similarities between product innovation and BMI suggesting that BMI research would benefit from building on the product innovation management literature.

Although scholars often argue that BMI increases performance or innovativeness of a firm, only few quantitative studies provide evidence of this link. Chesbrough (2007) argues that business model innovation can lead to sustained competitive advantage, assuming that other firms cannot replicate the business model. Zott and Amit (2007) find that SMEs can increase their market share by adopting new business models that allow recombining resources of the SME and its partners. Firms that focus on BMI have been shown to exhibit higher profit rates (Giesen et al, 2007). Aspara et al (2010) find that both developing radically new and replicating existing business models positively affects profit growth.

Several websites already offer BMI or strategy-making tools. As a starting point for the design, we developed a structured repository of over 100 online tools. For instance, fifteen websites were found that provide web-based support for developing a business model canvas. Several websites already exist that offer a collection of tools for BMI and Innovation management, e.g. DIYtoolkit or Tuzzit's Canvas library. Overall, existing tools can be categorized into five different purposes: explore new BM opportunities, design a new BM, test a new BM, plan implementation of the BM in practice, and grow an existing BM.

3 Requirements elicitation

3.1 Method

Requirements for the tooling as well as platform are derived from interviews with potential users. We interviewed SMEs with different levels of experience in BMI and BMI tooling, since this is the primary target group of the platform. As SMEs are often supported by consultants and advisors on BMI, we also interview these `SME helpers' as they possess knowledge on current practices and problems with BMI and BMI tooling. Typical SME helpers work at consultancy firms, chambers of commerce or university incubators. As we aim for a pan-European platform, we conduct interviews in Austria, Netherlands and Finland. Interviewees were sourced through the personal networks of the researchers involved (i.e. convenience sampling); however, we did strive for diversity and only included those interviews with `weak ties' to the researchers. See Table 1 for an overview.

	Organization type	Country	Role description

SME 1	Animal care provider	Austria	Innovation manager
SME 2	Coffee bar	Austria	Business manager
SME 3	Coffee bar	Austria	Business manager
SME 4	Retail firm	Netherlands	Business manager
SME helper 1	Start-up support and consultancy	Austria	Member advisory board
SME helper 2	Consultancy	Finland	Consultant to SMEs
SME helper 3	University	Netherlands	Gives BM canvas workshops to SMEs
SME helper 4	Innovation accelerator campus	Netherlands	Consultant to SMEs Manager investor funds
SME helper 5	Chamber of Commerce	Netherlands	Advisor for entrepreneurs
SME helper 6	Consultancy	Netherlands	Co-owner

Table 1: Interviewees for requirements elicitation

Given the diversity of interviewees and lack of scientific knowledge on BMI by SMEs, interviews were semi-structured. The interview protocol contained items on (1) background of interviewee; (2) past experiences and challenges with BMI and BMI tooling; and (3) expectations and desires for new BMI tooling. Interview summaries were created and fed back to interviewees for validation.

Interview analysis focused on creating user stories. User stories are often used in agile software development as a lightweight method to document expectations from users of a system. User stories typically follow the structure `*As a <type of user>, I want <some goal> so that <some reason>'.* The advantage of deriving user stories is to force designers to think from the user perspective, which is useful in our project given the highly complex and ill-understood needs of SMEs. Based on these user stories, we derive more high-level requirements for the BMI tooling and platform, which is reported in Section 3.2 and 3.3 respectively.

3.2 Requirements for BMI tooling

Interview results indicate that SMEs and SME helpers mainly use business model canvas and SWOT analysis methods as these are easy to use, conceptually simple and suitable for group brainstorming. Less frequently mentioned tools are Blue Ocean, Business capability modelling, Designtoolkit.org, Excel, Five forces, HCI Canvas, IDO toolkit, Innovation Action Plan, Lean scientist toolkit, Powerpoint, and the STOF method. Interviewees mainly use these tools to formulate strategy, design business models and derive concrete actions.

Several interviewees do not use any BMI tooling at all as they prefer working intuitively, with an implicit understanding of the market and customer environment. Some interviewees are outright sceptical about the use of tooling, especially if web-based, as they prefer sitting down with an SME helper to ask challenging questions directly. These sceptics also argue that domain-specific knowledge about the market of the SME is crucial to giving advice, which is difficult to incorporate into generic BMI tooling.

Interview summaries were drafted and coded into user stories. Analysis of the user stories elicits the following functional requirements. BMI tools for SMEs should:

- support a structured problem analysis, market analysis and stakeholder analysis,
- be modular, applicable in a phased process, and usable in different order (instead of strictly linear),
- preferably include domain knowledge as this is at the heart of good advice,
- lead to actions, taking into account the fact that SMEs like to do things,
- provide 'prefilled' content not just empty canvasses,
- support communication, sharing and collaboration between SME and helpers at a distance,
- allow to test ideas against strategy,
- allow to do some ballpark calculations on the business case

We elicit the following non-functional requirements:

- be visual and provide structure,
- stimulate the user to explore the tool and fit with his/her ability,
- be adapted to what the user can handle,
- have very low entry barriers,
- be simple, concrete and with clear added value,
- be easy and fast to use and provide a concrete result,
- be enjoyable and pleasant, playful, game like,
- provide an easy to use front-end, (intelligence should be in the back-end)
- provide well-known tools and methods but with additional smartness (reference models, patterns, etc.) that accelerate their use and adoption,

3.3 Requirements for a BMI platform

According to the interviewees, the BMI platform should primarily help finding the proper BMI tool for a specific context. Which BMI tool to use may depend on (1) the phase of a BMI process (i.e. exploring opportunities, designing a BM, testing a BM, implementing a BM or letting an existing BM grow); (2) the complexity and time investment a user can handle; and (3) the level of experience of a user with BMI. Based on these three dimensions, three personas were defined: Anja (low experience with BMI, established firm); Tom (low experience with

BMI, start-up firm) and Liz (high experience with BMI, established firm). The goal of being able to find appropriate tooling is defined in the following requirements. The platform should allow SMEs to:

- find more information on BMI tools, i.e. a description, background, benefits, links with more information about a tool
- download information on BMI tools
- view BMI tools through search, browsing, choosing a persona or advice tailored to the SME context
- provide feedback on a BMI tool, including recommending the tool to others

As it became clear in the interviews, interaction and discussion is highly important in the process of BMI. To facilitate such interaction, a secondary aim of the BMI platform is to create an interactive community of SMEs that help each other with BMI challenges. Such interaction is also important for engaging with users, ensuring stickiness of the platform and gathering feedback on the platform and tooling. The goal of fostering interactivity and a community of SMEs is defined in the following set of requirements. The platform should allow SMEs to:

- participate in a challenge on BMI, including finding, viewing, participating in, submitting to and sharing challenges with others
- leave comments for a challenge and view comments of others
- view the location of other users
- join communities on BMI topics and network with other users
- create a log-in account through social media or dedicated login

4 Artefact description

As explained in Section 2, academic knowledge on how SMEs and BMI tooling is largely lacking. Section 3 indicated a wide range of requirements and expectations on BMI tooling, as well as a degree of scepticism about online BMI tooling in general. For these reasons, in the first design cycle we aim to develop a minimum viable product version of the artefact as soon as possible, in order to allow early testing of our requirements. To avoid spending development effort on features with uncertain added value, the first design cycle reuses existing BMI tooling and platform components as much as possible.

The artefact has been developed and implemented and can be retrieved through www.businessmakeover.eu.

4.1 BMI tooling

On the platform, fourteen tools are implemented that required the least development effort, while covering the five phases of BMI elicited in Section 2, see Table 2.

BMI phase	Purpose	Tools instantiated
Explore	Providing new insights on business and context to discover new BM opportunities	SWOT Customer analysis Porter's five forces Wheel of skills
Design	Define or redefine how business creates, captures and delivers value	Business model canvas STOF business model Business model patterns
Test	Verify and validate current or new BM	Business model stress test Business case Success factors
Implementation	Realize BM design in practice	Business plan Marketing mix
Grow	Plan how to grow business through innovation actions	Cash flow analysis Balanced scorecard

Table 2: Instantiated tools

In the first design cycle, to come up with a minimum viable product as soon as possible, tools are made available as downloadable and printable templates. Explanation about the tool is added as a text.

4.2 Platform

As explained in Section 3.3, the two main goals of the BMI platform is to enable SMEs to access relevant tooling and set off an interactive community of SMEs. To enable the latter goal, we reuse existing components from an open innovation platform.

To fulfil the requirement related to accessing relevant tooling, a `Tools' page is instantiated. This page advises the SME user what tool to use based on selecting a persona or one of the five phases of BMI. When clicking a tool, users can read a short description of the core functionality and purpose. Next, users can download a tool, find more background information or view a prefilled example for better understanding on how to work with the tool. A screenshot of the Tools page is provided in Figure 1.

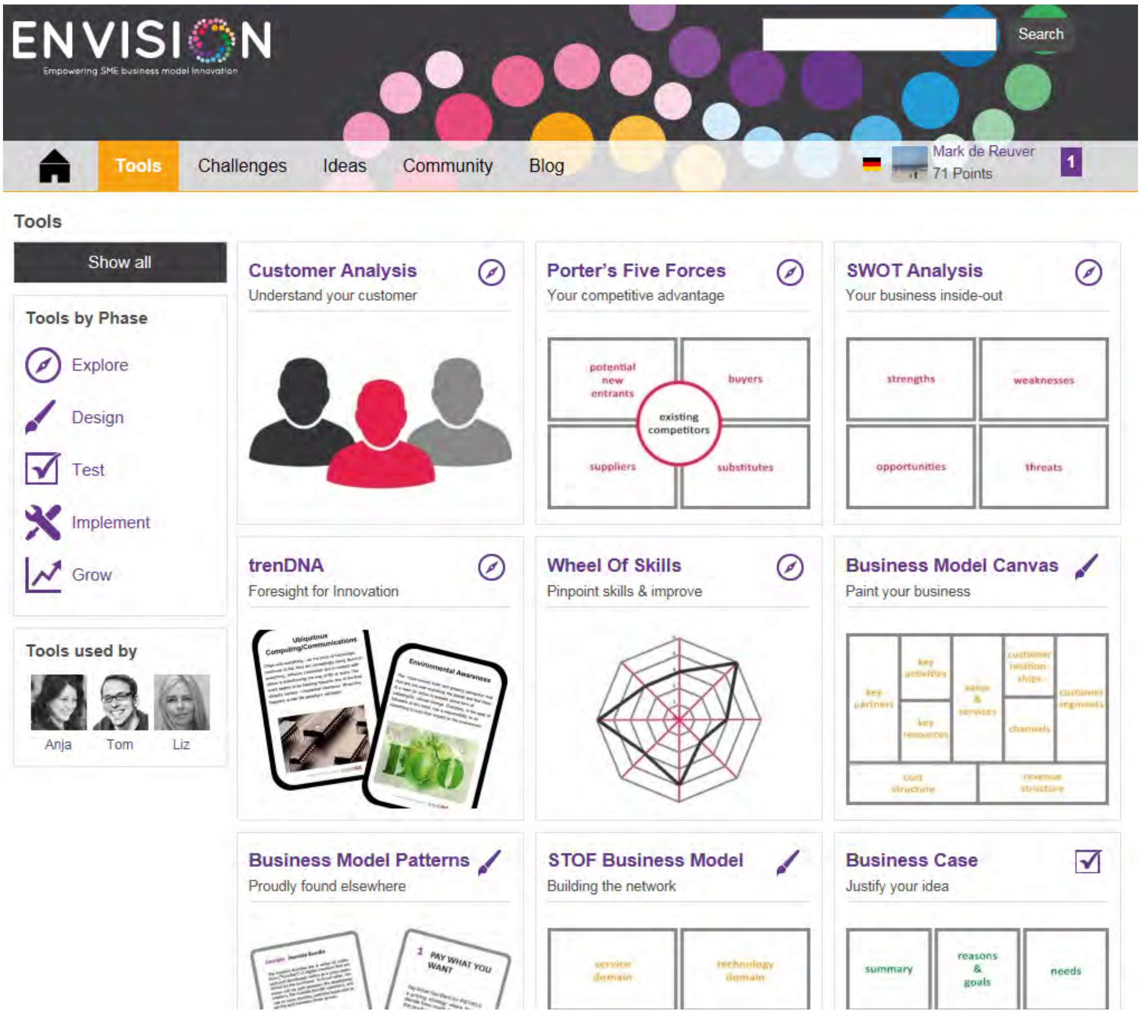


Figure 1: Screenshot of Tools page in the ENVISION platform

To fulfil the requirements related to creating an interactive community of SMEs, three pages are instantiated. On the `Challenges' page, users can find BMI problems based on actual cases, see Figure 2. Users can participate by contributing solutions to the business model problem stated in the challenge. On the `Ideas' page, users can share feedback on BMI tooling, for instance recommending what tooling they would like to use for a specific problem. On the `Community' page, users can interact with other users, find nearby users and form network ties.

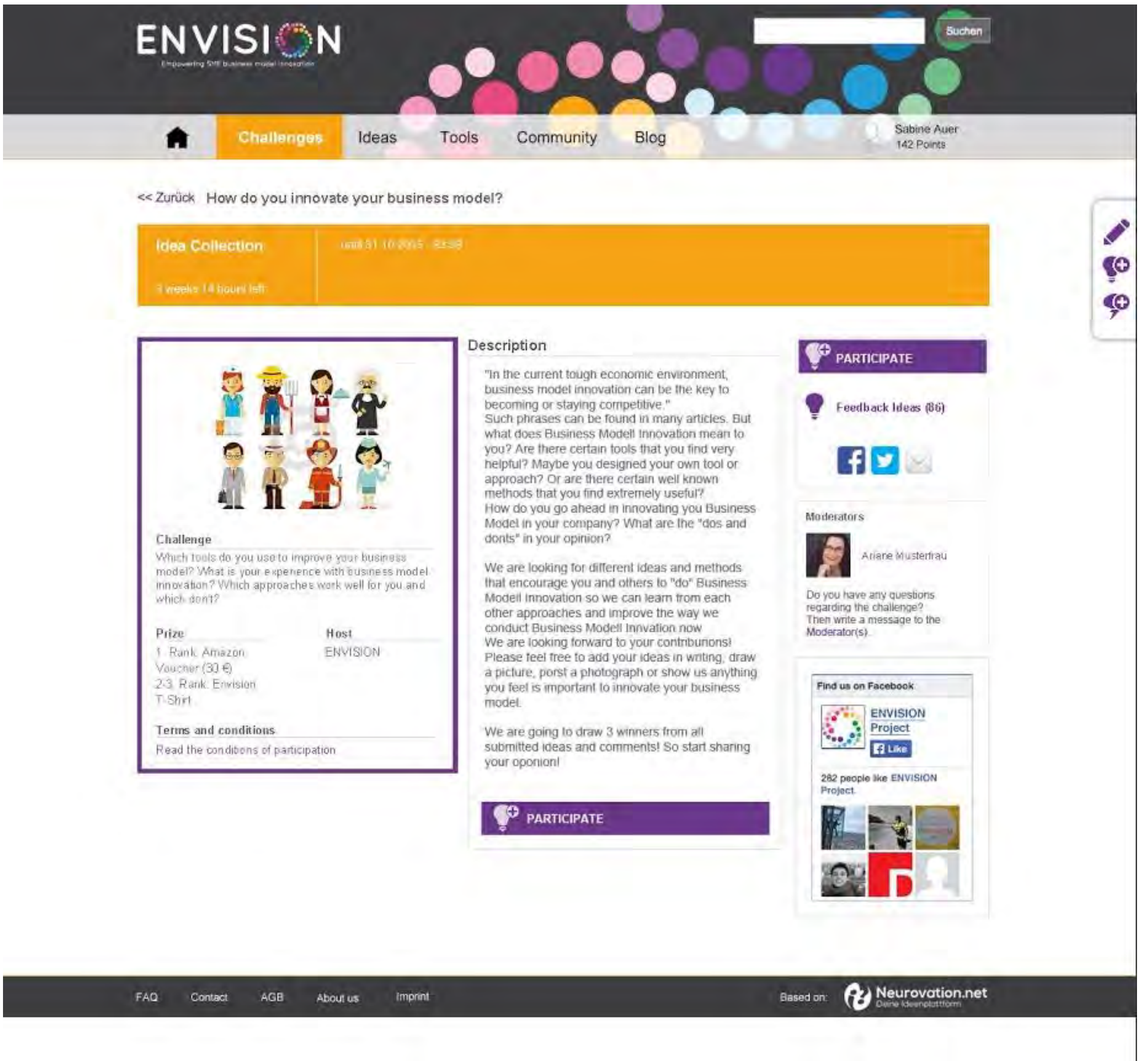


Figure 2: Screenshot of Challenges page in the ENVISION platform

Besides the core functionality, support features like "frequently asked questions", "contact", "terms of use", "about us" and "legal statement" are included. A blog page provides information on events and news which is dynamically updated. The platform offers a home page, on which users can log-in, register and select a persona that is closest to their situation. Integration with social media and other channels is included, for instance users can share challenges with friends or visit the platform's Facebook page. The platform is intended to be used on a laptop, i.e. mobile versions are not explicitly included.

5 Evaluation

The platform is evaluated through interviews with SMEs and SME helpers that have used the platform, user feedback gathered on the platform itself, and analysis of log data.

5.1 Log data analysis

The platform was launched on 10 October 2015. Between October 2015 and May 2016, 2700 unique users visited the platform with average session duration of 4 minutes and 4.6 page views per session. In total 5100 sessions were recorded, of which 47% were through a direct link, and others via Facebook, Google, a Swedish website or the project website. Visitors are largely from Austria, Netherlands, Finland and France, presumably since project participants promoted the platform to their local partners. The `Tools ‘page was visited most, followed by `Challenges’, `Ideas’ and the blog section. Strikingly, visitors hardly used the personas to navigate through the tooling. Regarding the tooling, BM canvas and BM patterns were the most popular ones.

5.2 Informal interviews

Feedback was collected from 3 SME helpers in Austria and 2 SME helpers in the Netherlands, and was sourced through informal conversations, email and telephone.

Regarding the tooling, informants appreciated the overview of tooling. A common point of advice was to explain more clearly how to use the tooling, select the most suitable tool and proceed through the five BMI phases. Multiple informants recommended short and comprehensive video tutorials. Others advised giving more real-life or best practice examples. One informant was concerned that certain tools are too complex for SMEs to use, saying that `they already have trouble maintaining their administration on a weekly basis’. One informant was sceptical about the use of BMI tooling in general. The informant argued that an intermediary is required to discuss the business activities, give advice and take away concerns of the entrepreneur.

Regarding the platform, initial impressions from SME helpers were positive. Informants suggested additional features such as saving, printing and sharing ideas and tool preferences. Multiple informants argued the platform should be more entertaining, for instance by adding gamification elements or success stories from entrepreneurs. Enriching the contents was also a common suggestion. For instance by adding industry trends to the blog, making the challenges more real-life oriented and adding details on the business problems of the personas. Other suggestions were giving feedback on ideas submitted and cooperate with other platforms to enhance visibility.

6 Discussion and conclusions

In this paper, we designed and evaluated a BMI tooling platform for SMEs. The artefact is original as existing online BMI tools are typically not tailored to SMEs, and existing academic ontologies and tools are too complex to be used by SMEs. Our artefact is a first step towards making BMI tooling available and relevant for SMEs. The functional requirements elicited in this paper inform future design science research studies on what BMI functions to focus on.

In this paper, we provide only a preliminary evaluation of the first version of the tooling and platform. The log data analysis shows which tools are frequently used, and the expert validation with SME helpers shows that the tooling platform are considered promising. As next steps, we will conduct a summative evaluation on the tooling and platform, i.e. evaluating how usage increases innovativeness and performance of the SME. To do so, we will conduct action design research case studies on the use of the developed tooling in the future. In the case studies, we will apply BMI tooling to solve the problems of actual SMEs, and observe the long-term impacts of doing so on innovativeness and performance.

While the evaluation results of the first design cycle are encouraging, we see four main challenges for improving subsequent versions of the platform. First, SMEs typically engage with consultants or advisors to conduct BMI. A fundamental concern for any BMI tool is therefore whether and how an online platform could replace such real-life interactions, for instance because deep domain knowledge on the market conditions of SMEs are crucial. We will address this challenge in subsequent design cycles by adding prefilled BMI tools. For instance, typical answer categories may be added to a BM canvas, reference models may be displayed or BM patterns may be given. Such predefined patterns will be made domain-specific for a limited number of industries. In this way, the BMI process can be sped up to boost creativity. The next version of the platform will also include thematic communities in which SMEs can help each other in solving BMI challenges, for instance by posting challenges. We will also explore how the platform can facilitate SME helpers in their online and face-to-face interactions with SMEs.

Second, the evaluation results suggest that SMEs may still struggle using our tools in practice. We are currently preparing educational packages, including tutorial videos, to teach users how to use the tools. In addition, in a separate part of the project, a repository of BMI cases is being compiled, which will generate examples on how to apply the tools in practice. These cases may also form the bases for best practice examples in the future. Through action design research with actual SMEs, we will also deepen our knowledge on if and how our tools can be used independently by SMEs, and what kind of support is still required.

Third, the evaluation shows that SMEs may still struggle to find the right tooling for their needs and context. Our approach to have personas represent archetypical user needs was hardly adopted by users. We will address this challenge by predefining subsets of the tools common to SMEs. These subsets of tools will be linked to `I want to' statements that are derived from our BMI case repository. We also defined a metamodel to link up tooling that is instrumental in doing so. For instance, a SWOT analysis may logically link up to a BM canvas which is then used as input for a business model stress-test. However, such integrative approach raises ontological as well as technical issues such as where to store customer data and how to handle security and confidentiality.

Fourth, engaging with a community of SME users is difficult in practice. In the first cycle, we experimented with several options from an open innovation approach, such as sharing ideas, responding to challenges and building communities. In subsequent design cycle, we will explore which of these options are most valuable for engaging with SMEs. Our aim in doing so is creating thematic communities where SMEs help each other. Being able to store and share filled out canvases, working together through collaboration environment and chat functions are further options we will explore.

Acknowledgement

The work leading to these results has received funding from the European Community's Horizon 2020 Programme (2014–2020) under grant agreement 645791. The content herein reflects only the authors' view. The European Commission is not responsible for any use that may be made of the information it contains.

References

Al-Debei, M. M., & Avison, D. (2010). Developing a unified framework of the business model concept. European Journal of Information Systems, 19(3), 359-376.

Aspara, J., Hietanen, J., & Tikkanen, H. (2010). Business model innovation vs replication: financial performance implications of strategic emphases. Journal of Strategic Marketing, 18(1), 39-56.

Baden-Fuller, C., & Haefliger, S. (2013). Business models and technological innovation. Long range planning, 46(6), 419-426.

Bouwman, H., de Vos, H., & Haaker, T. (Eds.). (2008). Mobile service innovation and business models. Springer Science & Business Media.

Bucherer, E., Eisert, U., & Gassmann, O. (2012). Towards systematic business model innovation: lessons from product innovation management. Creativity and Innovation Management, 21(2), 183-198.

Chesbrough, H. (2007). Business model innovation: it's not just about technology anymore. Strategy & leadership, 35(6), 12-17.

Chesbrough, H., & Rosenbloom, R. S. (2002). The role of the business model in capturing value from innovation: evidence from Xerox Corporation's technology spin-off companies. Industrial and corporate change, 11(3), 529-555.

DaSilva, C. M., & Trkman, P. (2014). Business model: what it is and what it is not. Long Range Planning, 47(6), 379-389.

El Sawy, O. A., & Pereira, F. (2013). Business modelling in the dynamic digital space: An ecosystem approach. Springer.

Fritscher, B., & Pigneur, Y. (2014, January). Computer aided business model design: analysis of key features adopted by users. In System Sciences (HICSS), 2014 47th Hawaii International Conference on (pp. 3929-3938). IEEE.

Giesen, E., Berman, S. J., Bell, R., & Blitz, A. (2007). Three ways to successfully innovate your business model. Strategy & Leadership, 35(6), 27-33.

Gordijn, J., & Akkermans, H. (2001). Designing and evaluating e-business models. IEEE intelligent Systems, (4), 11-17.

Heikkilä, J., Tyrväinen, P., & Heikkilä, M. (2010). Designing for performance-a technique for business model estimation. In EBRF 2010 conference proceedings.

Kesting, P., & Günzel-Jensen, F. (2015). SMEs and new ventures need business model sophistication. Business Horizons, 58(3), 285-293.

Linder, J., & Cantrell, S. (2000). Carved in water: Changing business models fluidly. Accenture Institute for Strategic Change Research Report, 8-10.

Magretta, J. (2002). Why business models matter. Harvard Business Review.

Mitchell, D. W., & Bruckner Coles, C. (2004). Business model innovation breakthrough moves. Journal of business strategy, 25(1), 16-26.

Osterwalder, A., & Pigneur, Y. (2013). Business model generation: a handbook for visionaries, game changers, and challengers. John Wiley & Sons.

Osterwalder, A., Pigneur, Y., & Tucci, C. L. (2005). Clarifying business models: Origins, present, and future of the concept. Communications of the association for Information Systems, 16(1), 1.

Pateli, A. G., & Giaglis, G. M. (2004). A research framework for analysing eBusiness models. European journal of information systems, 13(4), 302-314.

Roelens, B., & Poels, G. (2015). The Development and Experimental Evaluation of a Focused Business Model Representation. Business & Information Systems Engineering, 57(1), 61-71.

Teece, D. J. (2010). Business models, business strategy and innovation. Long range planning, 43(2), 172-194.

Verschuren, P., & Hartog, R. (2005). Evaluation in design-oriented research. Quality and Quantity, 39(6), 733-762.

Zott, C., & Amit, R. (2007). Business model design and the performance of entrepreneurial firms. Organization science, 18(2), 181-199.

Zott, C., Amit, R., & Massa, L. (2011). The business model: recent developments and future research. Journal of management, 37(4), 1019-1042.

29th Bled eConference
Digital Economy
June 19 - 22, 2016; Bled, Slovenia

Business Model Innovation Paths and Tools

Marikka Heikkilä
University of Turku, Finland
marikka.heikkila@utu.fi
Harry Bouwman
Technical University of Delft, the Netherlands
Åbo Akademi University, Finland
W.A.G.A.Bouwman@tudelft.nl
Jukka Heikkilä
University of Turku, Finland
jups@utu.fi
Timber Haaker
Innovalor, the Netherlands
timber.haaker@innovalor.nl
Carolina Lopez Nicolas
University of Murcia, Spain
carlopez@um.es
Angelika Riedl
Evolaris, Austria
Angelika.Riedl@evolaris.net

Abstract
There is a multitude of tools available for Business Model Innovation (BMI). However, Business models (BM) and supporting tools are not yet widely known by micro, small and medium sized companies (SMEs). In this paper, we build on analysis of 61 cases to present typical BMI paths of European SMEs. Firstly, we constructed two paths for established companies that we named as 'I want to grow' and 'I want to make my business profitable'. We also found one path for start-ups: 'I want to start a new business'. Secondly, we suggest appropriate BM toolsets for the three paths. The identified paths and related tools contribute to BMI research and practise with an aim to boost BMI in SMEs.

Keywords: Business Model Innovation, SME, tooling

1 Introduction

Business Models (BM) have drawn enormous attention in academic literature. A broad array of literature proposes differing definitions, lists of components, taxonomies and evaluation models for BMs (e.g. Timmers, 1998; Amit & Zott, 2001; Gordijn et al., 2000; Osterwalder & Pigneur, 2002; eFactors, 2002; Magretta, 2002; Faber et al., 2003; Osterwalder, 2004; Haaker et al., 2006; Lambert, 2008; DaSilva & Trkman, 2014). However, research on BM and BM Innovation (BMI), based on cases or on cross-sectional research has been rather limited. Also, the practical importance of BMI has been underlined, for instance by the EU, which has identified BMI, especially by micro, small and medium sized enterprises (SMEs), as a major source for competitive advantage, economic growth and job creation (Empirica, 2014; EASME, 2015). Unfortunately, the concept of BM or the tools to support BMI are not widely known by the SMEs. They are seldom aware that besides product development, they actually are engaged in BMI to achieve increase in performance and innovativeness in their offerings. Furthermore, often they are not aware of available tools, and if they are aware, the tools appear too academic, or too complex for SME use. To serve the 20 million SMEs in Europe in supporting BMI, we are in need of simpler tools with clear relation to the needs of SMEs in their BMI. Our study is motivated by an H2020 research project, where we work on developing an easy-to-use toolkit for SMEs to be readily available on the Internet. The toolkit is built on the basis of analyses of case studies as well as quantitative research on European SMEs' BMI behaviour.

Against this backdrop, this paper presents an empirical case study of 61 cases. The objective of our research is *to identify paths that take SMEs through BMI and to assist them on the way with a limited/minimum set of suitable tools suitable to their specific situation*. We do this by analysing first, what kind of challenges SMEs have regarding BMI. We depict paths, or sequences, of the challenges identified in the cases. Then we suggest suitable combinations of tools for analysing and finding the solution for the challenges. The latter serves also our ultimate goal of creating an easy-to-use, relevant toolkit for SMEs in BMI.

The paper is structured as follows. Section 2 provides a background on BMI theory as well as related work on BMI tooling in academia and practice. Section 3 describes the empirical study and presents the paths, or patterns found in our case companies. In Section 4 we discuss the findings and section 5 concludes the paper.

2 Business Model Innovation and tooling

Schumpeter (1943, p. 132) explained innovation as *'neue Kombinationen',* new combinations, and "*an untried technological possibility for producing a new commodity or producing an old one in a new way, by opening up a new source of supply of materials or a new outlet for products, by reorganizing an industry and so on*." His characterisation has influenced the research and definitions of innovations. For instance, a joint publication of OECD and Eurostat, *'The Oslo Manual'* (2005, p. 46) defines innovation as: *"An innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations"*. The requirements for an innovation is that it must be new (or significantly improved) to the firm; it can be a single significant change, or of a series of smaller incremental changes that together constitute a significant change - and - it must have been implemented.

'The Oslo Manual' covers primarily product, process, marketing, and organisational innovations, but it does not define explicitly innovation of BMs. Therefore, we have gathered some definitions of BMI proposed in BM literature to Table 1. Several of these define BMI as an activity, where core elements of a firm and its business logic are deliberately altered.

Table 1 Definitions of Business Model Innovation

Amit & Zott (2012).	*"The authors define a company's business model as a system of interconnected and interdependent activities that determines the way the company "does business" with its customers, partners and vendors...Business model innovation can occur in a number of ways: (1) by adding novel activities, for example, through forward or backward integration, (2) by linking activities in novel ways, or (3) by changing one or more parties that perform any of the activities."*
Björkdahl & Holmen (2013)	Business model innovation is a new integrated logic of value creation and value capture, which can comprise a new combination of new and old products or services, market position, processes and other types of changes.
Bucherer, Eisert & Gassmann (2012); Bonakdar (2015)	Business model innovation is a process that deliberately changes the core elements of a firm and its business logic.
Giesen, Berman, Bell & Blitz (2007)	Three types of business model innovation are identified, namely, industry models (innovations in industry supply chain), revenue models (innovations in how companies generate value), and enterprise models (innovations in the role the structure of an enterprise plays in new or existing value chains).
Hartmann, Oriani & Bateman (2013)	Modification or introduction of a new set of key components – internally focused or externally engaging – that enable the firm to create and appropriate value.”
IBM global CEO study by Pohle & Chapman (2006)	Business model – Innovation in the structure and/or financial model of the business
Lindgardt et al. (2009)	Innovation becomes business model innovation when two or more elements of a business model are reinvented to deliver value in a new way.
Osterwalder, Pigneur & Tucci (2005)	Specifying a set of business model elements and building blocks, as well as their relationships to one another, is like giving a business model designer a box of Lego blocks [Burgi, Victor et al. 2004]. He or she can experiment with these blocks and create completely new business models, limited only by imagination and the pieces supplied.
Taran, Boer & Lindgren (2009)	Specifying a business model innovation typology based on three dimensions: a) radicality (the extent to which and innovation departs from prior products/services, processes or business model); b) the reach of innovation (new to the company, the market or the industry); c) architectural innovation (change in any block of the business model)
Empirica (2014)	"We propose delimiting business model innovation as a composite type of innovation at the intersection of the four types of innovation defined in the Oslo Manual and implemented globally in innovation surveys, product, process, marketing and organisational innovation. In line with the literature, we consider BMI as radical or fundamental innovations rather than incremental changes."
Zott (2013)	"Design and implementation of an activity system that is either new to the market/ industry /world or new to the focal firm - new in terms of content, structure and or governance - for established firms; radical or incremental The more radical the BMI, the more wide-ranging the system-level changes"

Based on the above discussion on innovation in general, and BMI in specific, we define both BM and BMI as follows: *BM is the business logic how a company creates, distribute and captures value, and BMI is the innovation in company's BM that is new to the firm and results in observable changes in the firm's practices towards its customers and partners.*

In practise, BMI has at least following characteristics:

- Business logic describing how a single firm, or a network of firms, collaborates on a strategic (eco-system) and operational (process) level in bringing products and services (or bundles) to the market by making use of a technological platform, or an architecture that adds/captures value for both the (networked) firm(s) as well as the customer.
- BMI can be perceived, or experienced by ecosystems partners, and/or customers/end-users as a change.

Examples of BMI are, but not limited to,

- Service bundling or un-bundling; change from product to service provider (servitisation); moving upwards in the value chain, and so attracting new customer groups, or defining new markets.

- Companies transforming their processes from physical to virtual ones, by making use of capabilities of social media, IT-platforms, cloud computing, and/or big data analytics.
- Out- or insourcing of key resources and capabilities to new, or existing key partners within the constituting ecosystem (or value network). The core business is changed from an in-house producer to an orchestrator in a network.
- Changes in financial models like pricing strategies, (e.g. from pay per product to pay per use, or dynamic prizing) or monetisation and revenue models (combining advertisement with usage fees, or change to a commission model).

Many kinds of methods, frameworks and templates (here referred as *tools*) have been developed to facilitate the BMI and its implementation (Bouwman et al., 2012).

1. The most central tools for BMI are the ones building on BM ontologies like CANVAS (Osterwalder, 2002; Osterwalder et al., 2005), STOF (Bouwman et al., 2008), VISOR (El-Sawy & Pereira, 2013), BM Cube (Lindgren & Rasmussen, 2013), etc.
2. There are more specific tools for BMI, such as *stress-testing* for analysing and managing risks by combining BM ontologies like (lean) CANVAS and STOF with scenario analyses. They help the company to assess the viability of its BM already in a design phase and *road-mapping* for contingency planning and implementation (Bouwman et al., 2012). A *heat map* illustrates, which components of a BM are at risk, or need closer attention. The BMI roadmap is focussed on developing paths of transitions from current as-is BM to a to-be BM. In road-mapping, there are multiple, optional paths in achieving the desired change. These paths can consequently be more or less efficient, depending on the circumstances and the environment (De Reuver et al., 2013).
3. Market analysis and marketing tools: For example PEST-analysis and SWOT–model for analysing the environment. Marketing tools are mainly focused on formulation of a value proposition in combination with product market combinations or marketing mix. With Value proposition Canvas (strategyzer.com) the SME can make explicit how its products answer to the customer needs.
4. Financial tooling can range from simple business plan check-lists to cost-benefit analysis, cash-flow management tools and to advanced financial planning tools that make it possible to carry out value assessments, or to combine marketing research with revenue sharing models.
5. Tools to analyse the value constellation of the interacting parties with processes. VIP tools focus on value and information exchange aligned with processes. It is directed towards networked BMs, where one firm is clearly in the lead but dependent on first tier network partners (Solaimani & Bouwman, 2012; Solaimani et al., 2015; Solaimani et al., forthcoming).
6. Tools for implementing BM designs. There are attempts to directly connect BMI with EA (Fritscher & Pigneur, 2011; Iacob et al., 2012) using CANVAS, or STOF at one side for design and Archimate –notation for mapping the design with existing assets of organizations. Heikkilä et al. (2010) has developed a similar approach to connect BM to EA for boardroom use.

Alternatively, BMI-tools can also be classified along the line of exploring BM stages. Typically in an **explore** phase strategic oriented tools, like Porter’s 5-forces, or environment scanning tools, play a role. Also other companies’ BM changes, as examples or benchmarks, can stimulate creativity and propose new ideas for BMs. In the **design** phases the focus is more on the BM ontology tools. The CANVAS is commonly used, while other ontology-based tools emphasize different aspects of BMs (Bouwman et al., 2008). For instance, VISOR can illustrate well human-computer interaction on webstores (El-Sawy & Pereira, 2013), or C-SOFT can deal explicitly with market segmentation issues (Heikkilä et al., 2010), whereas BM Cube on Value Sharing between network partners (Lindgren & Rasmussen, 2013). In the **test** phase the already discussed stress-testing can play a role as well as the use of success factors, as proposed within the STOF approach. In the **implementation** phase tools that deal with process or technical implementation are relevant, but also tools that deal with scalability and agility are useful. Moreover, the tools related to roadmaps and the order in which certain steps have to be followed are relevant. In the **grow** phase specific metrics can be used to analyse the progress and to adjust the BM if required. A repository as offered in Heikkilä et al. (2015) specifies all kind of metrics specific for BMs specific domains, like the Customer Value, Service, Technology, Organizational and Finance, as well as value and information exchange and process related metrics.

Tooling suites and platforms are also abundantly available. There are more than 15 websites that offer support tooling for CANVAS (canvanizer.com; diytoolkit.org, groupmap.com or tuzzit.com, to name a few). But next to websites there are also dedicated tool suites like e-Progress (http://www.e-progress.fi) and VDMBee (vdmbee.com). e-Progress offers tooling that requires an advisor, or consultant to be involved. The tool has currently four modules, i.e. (1) strategy, that focus on competitive advantage, (2) BMs focussed on profit generation, (3) business development with a focus on growth and cost effectiveness, and (4) business action planning, mainly concerned with operations management, performance and cash flow. In the web based tool, data on several firms is combined to offer benchmark opportunities. Every e-Progress module provides several tools, such as PEST to make trend analysis in the strategy module, as well as for instance a stakeholder analysis tool. The BM module contains CANVAS and cost benefit analysis. The main limitation of the tool is that it is not a self-service tool. The VDMbee (vdmbee.com) tool is developed on the BM Cube and makes use of Value Delivery Modelling Language to support development of value propositions, business modelling and cases in networked environments. It has specific modules for risk management, decision-making and business planning.

From the above short description of tools, and from experiences from the cases, we can draw a number of conclusions:

- The tools are typically demanding to use. In the SME context it would most often take a Ph.D. degree or a consultant to run through a full BMI-cycle.
- The process leads to many branches and iterations, which calls for persistence and experience in determining 'the good enough' –design.
- In most cases, one panacea for business problems is not enough – our early analysis shows that BMI leads to changes in multiple BM elements in parallel.

The above further motivates our study: because of the iterative nature of BMI and the inherent dynamic complexities, we should cut corners for SME BMI. SMEs are typically resource constrained, striving towards agility, instead of perfection in *ex ante* - design. This calls for a contingent, decision tree type of an approach to select most suitable approaches to the situation at hand. Another important issue is how to make tooling available to SMEs in such a way that it is easy to understand, easy to use, modular and building on familiar tools of an SME entrepreneur (or consultant/advisor serving entrepreneurs).

To summarize, we postulate that simplicity of the BMI process is the key for a successful toolkit for SMEs. Therefore, it is important to recognise the underlying patterns and typical situations that SMEs are struggling with in striving for BMI. This is where our use case analyses can provide insight for toolkit development to match typical patterns.

3 Empirical Study

3.1 Method

In this article we use a multiple case study approach to analyse data from a total of 61 case studies. It is suggested that multiple case studies are well suited to building theory or constructs, because they permit replication and extension among individual cases (Yin, 1984; 2003; Cunningham, 1997; Eisenhardt & Graebner, 2007). Central to building theory from case studies is replication logic (Eisenhardt, 1989): multiple cases serve as replications, contrasts, and extensions to the emerging theory (Yin, 1984) and the researcher develops an understanding of why certain conditions did or did not occur, and then offers interpretations. Instead of relying on in-depth information about the case, there is a more general aim at using cases for illustrating and testing the soundness of concepts (Cunningham, 1997).

Our case study database consists of cases on BMI in SMEs collected by the authors and other consortium partners of our multi-national EU funded ENVISION project. The database follows a case study protocol and reporting format as used in the project. As a result the available data is well structured allowing us to make cross case analysis. The reliability of our analysis was improved by engaging the original researchers of each case study to review our analysis. The protocol is available on request.

The SME cases come from 14 European countries (Austria, Denmark, Estonia, Finland, France, Germany, Italy, Lithuania, the Netherlands, Poland, Slovenia, Spain, Switzerland, and the UK). SMEs' sizes range from micro enterprises (<10 employees, 28 firms), small (11-50, 18) to midsize (51-250, 15). The oldest SME in the sample was founded over three hundred years ago, in 1695, and the youngest are being established during the study. Fifteen, i.e., one fourth of the cases are family businesses. (The list of the cases is provided in the Appendix).

As the first step, we analysed the background, such as the characteristics of SME and its environment, the main challenges or needs described by the SME (labelled as *'I want to'*) when innovating its BM. We analysed the data in a systematic way using the qualitative data analysis approach proposed by Miles and Huberman (1994). The data analysis started with open coding of the 'I want to's of 50 SMEs. This task was concerned with naming and categorizing the needs related to BMI (Strauss and Corbin, 1998, p.223). As a result a provisional list of categories was created. The authors went through the coding several times searching for potentially missing codes or miscoded cases using *Atlas.ti* -software. The final categorisation consists of sixteen differing BMI foci.

Next, we analysed the topic more in-depth by using the additional eleven cases. We tried to detect patterns and regularities and inductively formulate tentative hypotheses in the appearance of the needs.

The last step was carried out by a group of experts that suggested suitable tools for each of the BMI foci. The group consisted of 6 persons from the H2020 -project, who all are very familiar with the available tools, and also with the challenges faced by the SMEs. Three of the experts are also authors of this paper. First it jointly listed tools that could be of help for the SMEs with specific business challenge. Then the *'I want to's'* were divided between the group members so that each expert studied and analysed 3 of them more thoroughly. After discussions, the group came up with a suggestion, where each *'I want to'* connects with specific BMI tool(s) suitable to the situation.

3.2 Results

In the first step, we collected the desires of SMEs concerning BMI (*'I want to'*). Some companies mentioned multiple areas of innovation: e.g., a 5-year old veterinary clinic in Lithuania, wants both to expand its services and to gain larger market share in local market. A family owned restaurant in the Netherlands, wants to improve its customer relationship management by using social media channels and, in the long term, franchise their BM. Some SMEs want to move their business to web, and use new channels to reach customers. Two SMEs want to improve their offering by changing from product supplier to service provider. Two of the studied 50 SMEs were hesitant to make changes in their BM[1].

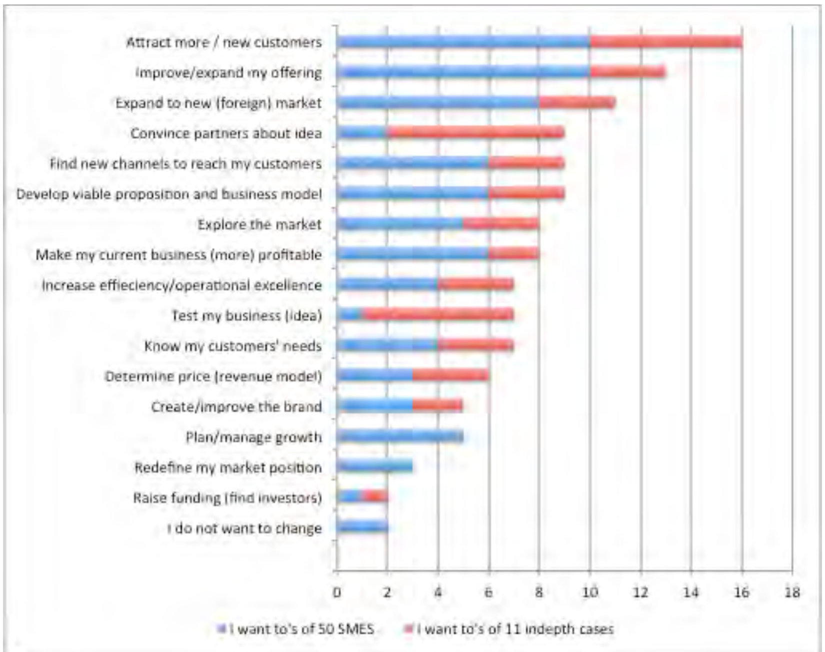


Figure 1. The aspirations of SMEs in improving their BM

1 The first SME reluctant to change their BM is a medium sized family business owning three restaurants in Spain. The family has not changed its recipes of their main dishes since it first opened in 1980's and would rather not make changes to their BM, although the 'younger' generation explores possibilities to improve the supply chain and use social media. The other case is a micro-sized travel agency in Finland arranging special tours. It is owned by a married couple. In 1991 when the company was founded, the husband drove a mini-bus and the wife was a guide for small groups of tourists. Now they have 3 additional workers. The husband is sometimes pondering whether growth is a plausible option for their firm. However, his wife is reluctant to make the extra effort and therefore they have decided to keep it as it is for the last years before retiring.

Altogether, 16 differing topics were derived from this analysis (Figure 1), in most cases more than one topic per SME. Most often the SMEs said they want to attract new customers (10 out of 50) and improve their offering (10). Many were planning to expand to new or foreign markets (8). Developing a viable value proposition and BM (6), finding new channels (6) and making their current BM more profitable (6) were also among the challenges.

The additional eleven in-depth cases seem to be somewhat different in terms of their 'want to's: They are also keen on attracting new customers (6), but they also expressed the need to convince partners about their business idea (7) as well as testing their business idea (6).

As we had more thorough information to continue our study with the in-depth analysis of 11 cases, we drew paths of each SME, depicting the needs and sequences, and finally grouped them according to the similarity of the paths. We coin them as follows (see also Figures 2-4): 1) I want to make my business profitable**,** 2) I want to grow, and 3) I want to start a new business. BMI seems to starts with a specific question that leads to more related questions and, eventually to different paths for start-ups, and for established companies.

1. ***'I want to make my business profitable':*** Three of the established SMEs wanted to improve the profitability of their business. All three started their improvements by focusing on efficiency of their key activities and use of internal resources [***Increase efficiency/operational excellence***]. A family owned Hardware Store in Finland for instance, analysed its processes and managed to cut its costs first by rearranging holidays of its employees, a critical capacity in seasonal business. Thereafter, it continued harmonising and adjusting the prices of the products in its three stores [***Determine price***], which helped to compete on price without the problem of uncontrolled discounts. A candy manufacturer in Spain wanted to start with improving its machinery and quality assurance processes **[*Increase efficiency/operational excellence*]**. Also a family owned wine trading SME, which desires to change from importing to manufacturing, wanted to start BMI by reducing its operating costs and product lines **[*Increase efficiency/operational excellence*]**. Both SMEs considered to obtain more information about their customers' needs [***Know my customers***] as the next step. Based on the knowledge about the demand, the SMEs went to analyse their offering and made adjustments in order to improve the profitability [***Redefine the offering***]. Finally, the candy manufacturer wanted to develop new distribution channels for its products [***Find new channels***], whereas the Hardware store wanted to limit and focus its supplier network [***Select partners***].
2. ***'I want to grow':*** Five SMEs, which wanted to grow their business, stated that their first desire is to attract more customers from their current market [***Attract more customers***]. Thereafter, the growth path divides into three routes: either the SME wanted to improve the offering [***Improve my offering***], to improve the brand [***Improve my brand***] or to explore the market [***Explore market***]. The third step seems to be common to all and involves selection and convincing partners [***Select and convince partners***]. Last, the SMEs expressed a need to expand to foreign markets [***Go to new/foreign markets***] or to find new channels for their products [***Find new channels***]. For example, a micro-sized SME in Austria, specialized in portable solar cells, had previously offered products where the solar panel was incorporated into shoulder bags. Now it wants to grow and extend its offering by finding new items to which solar panels can be attached. It also wants to enrich the

products with services, such as digital add-ons, to tie its customers to the offering of the SME. The production and delivery of these new offerings require that the SME can build a reliable partner network, which has the expertise that the SME does not cover itself.

3. ***'I want to start a new business':*** The path for starting up a new business seems to be more explorative in nature and includes several steps. For example, a start-up company in the Netherlands wanted to start a business with a new matchmaking platform in elderly care. First it wanted to know the market for matchmaking platforms in care [***Explore the market***], before it could develop the business proposition, explore the BM [***Develop viable proposition and BM***] and test it [***Test my BM***]. Afterwards, it wanted to find the right partners and arrangements [***Select and convince partners***], to find investors [***Raise funding***] and to select the right technology [***Analyse technology***]. Next, it wanted to determine which revenue models are viable [***Determine price***]. Finally the SME wanted to know if its BM is future proof [***Test my BM***] and to make revisions accordingly [***Develop viable proposition and BM***]. A start-up entrepreneur in Finland, which wanted to start an e-health service, was following almost exactly the same path, the difference was that he was not aiming to raise funding, mainly because his plan was to share the investment costs with well-established partners. The third start-up case shows how sometimes the SMEs might want only to take some steps in the path: a company that provides lotteries as a service for charity organizations wanted to take the path up till testing phase ***[Test my BM]***.

The final task in our empirical research was to assign the most useful BM tools to each of the *'I want to'* as suggested by the expert group. The resulting tooling paths are depicted in the following figures 2, 3 and 4. For instance, *'I want to make my business more profitable'* path consists of total six differing BM tools: cash flow analysis, customer analysis, price calculation, Value proposition Canvas, BM pattern cards and stakeholder analysis. For the paths *'I want to grow'* and *'I want to start new business'* we suggested several alternative tools from which the SME can choose - the last path consisting of nearly 30 optional tools.

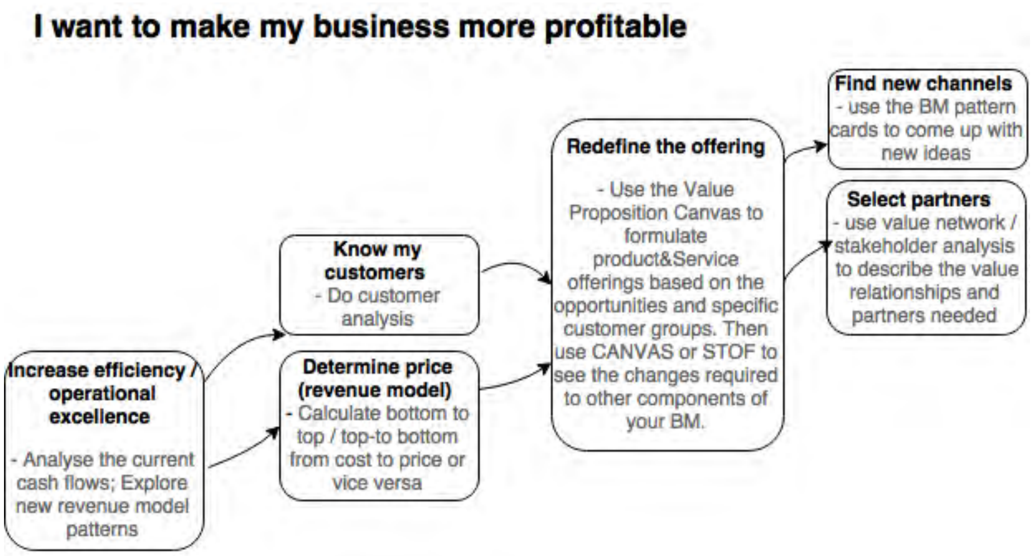


Figure 2 *'I want to make my business more profitable'* -path and tools for established SMEs

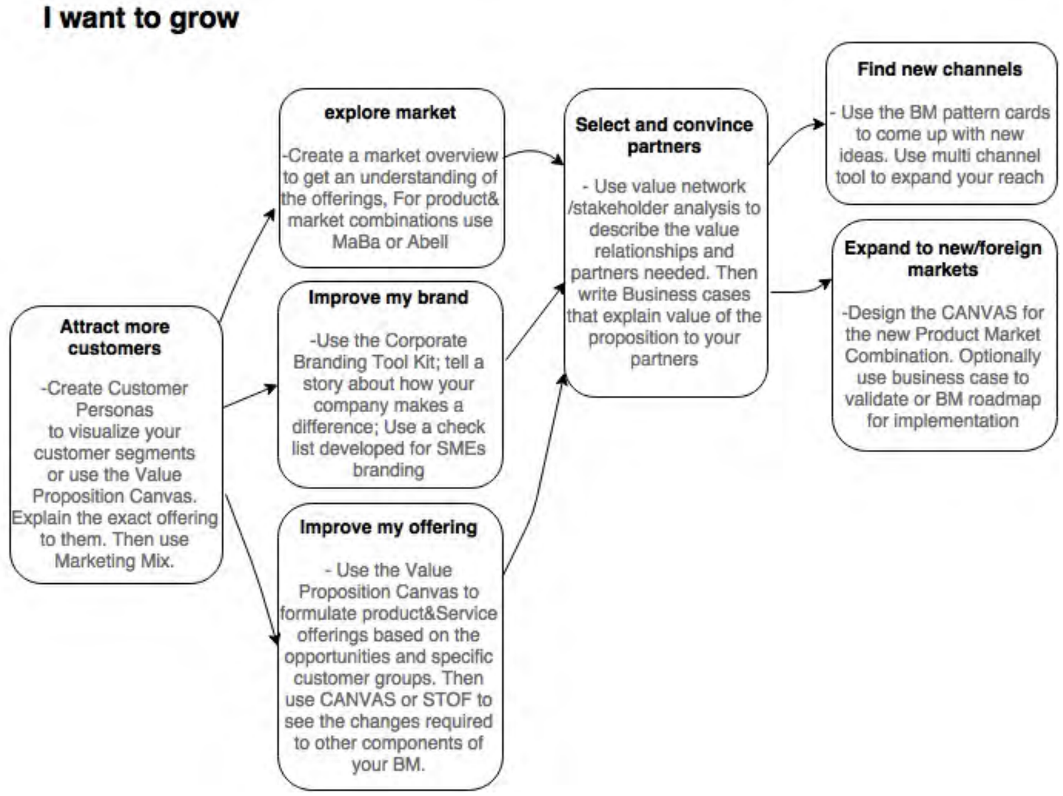


Figure 3 *'I want to grow'* -path for established SMEs

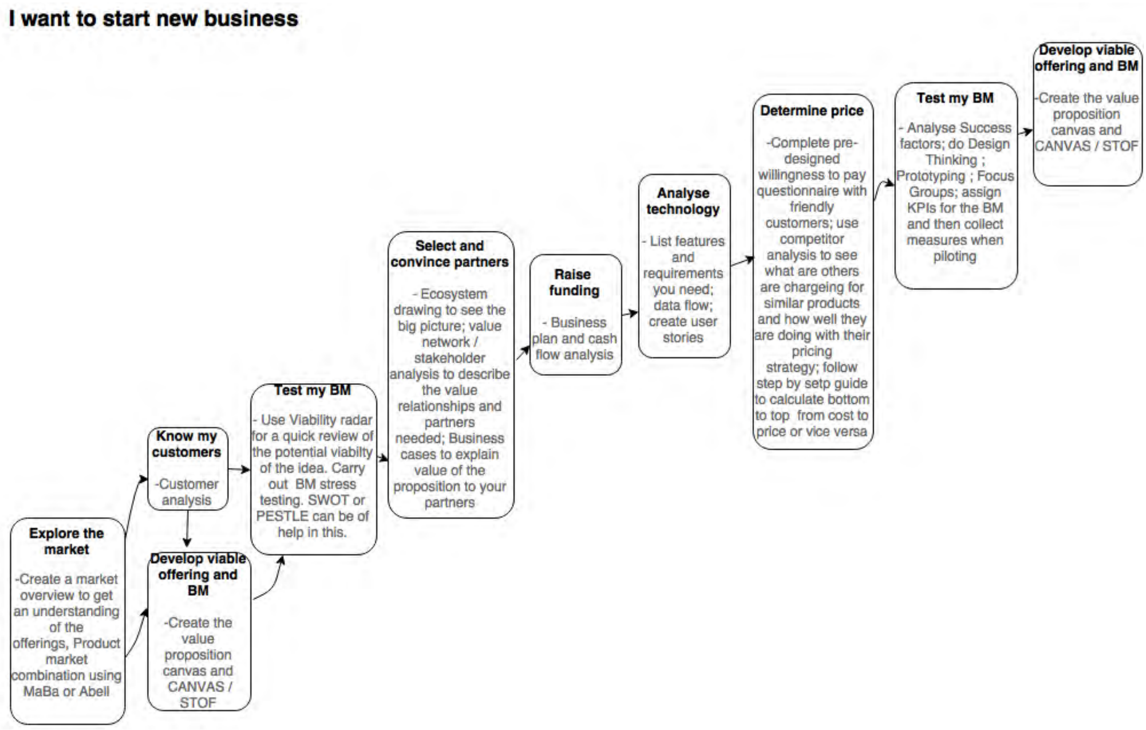


Figure 4 *'I want to start new business'* -path for start-ups.

4 Discussion

Empirical research on BMI is still sparse in the context of SMEs. Although case studies are available (Empirica, 2014), the focus is seldom on the commonality between cases, or paths of BMIs, even less so on suitable BMI tooling for SMEs. In chapter 2 we identified and summarized six types of tools for BMI with different emphasis, and based on our earlier experience in using them primarily in large company settings, we determined most BMI methods too complicated for SMEs internal use. Therefore, we analysed a set of 61 SME business change cases for what the entrepreneurs want to achieve, as some kind of proxy for their strategic intent. Thereafter, we identified the most common aspirations for improving their businesses, and selected 11 in-depth cases for closer elaboration for the paths they have taken in solving their business challenges.

We found three broader categories of paths, two for established firms 1) either want to innovate their BM to become more profitable or 2) to achieve growth. The start-up firms, in turn, are naturally searching for ways 3) to build up their BM. Then, we mapped the tools with the stages on the paths. This way we created tentative sets of tools for each of the paths, and we expect these to serve as starting points for creating the context dependent toolsets.

When reflecting upon our toolsets, it seems that the toolsets vary in each of the paths. As a consequence we got a limited collection of tools, where tools are suited at the specific challenges at hand.

The paths of the needs depicted in this paper show how the analysed SMEs are changing multiple elements in their BMs in reality. Their approach is often to tackle the needs sequentially mostly due to lack of resources. This is in contrary to our earlier findings in larger businesses, where the elements are typically changed in parallel. However, it should be remembered that BMI will most probably require changes to multiple elements in BM. In our reasoning this implies, that even though we can reduce the toolsets to solve the specific problems of SMEs, we should have (at least) a base-line BM at hand to show the interdependences of changes in one element on the other elements of BMs. The simple baseline business model with CANVAS, STOF or CSOFT should therefore be included in all paths.

Furthermore, the two common needs for the toolsets in the three paths are 1) the need to identify partners and 2) the need to articulate the offering. The tools for these are typically at the core of the networked business modelling.

The crucial question that we cannot yet answer is how these patterns and paths lead to increased performance, to the realization of set objectives, to next iterations of BMI, or disruptive BMIs that lead to total new industries. It will be clear that before we can have more predictive models, more analyses of our rich dataset is required.

5 Conclusions

This is to our knowledge the first paper that focuses on finding patterns in BMI. Our key message in this paper is that, we can reduce the toolset to three basic business challenge paths of the SMEs. However, as an integrative element, we'd always need a BM-baseline, because it is needed to articulate the offering to the customers and to identify the partners in the business change in all the three paths. This is also supported in BM literature, in BMs capacity to map the interdependencies between BM elements and the effects of changing environmental conditions. Furthermore, the differing paths share two common needs: 1) the need to identify partners and 2) the need to articulate the offering. The tools for these are typically at the core of the networked business modelling. For managers of SMEs our results provide suggestions on what BMI tools they could consider using if they are sharing some of the 'I want to's discovered in our cases. It also helps to anticipate the next steps in their path towards improved BMs.

Our results are based on an extensive database of SME cases collected within Europe, across different industries, including family and non-family businesses, start-up companies, and being in different stage of maturity. We are aware that this leads to heterogeneity. We deliberately strived for this heterogeneity, although we have not been able yet to take all the different background and exploratory variables into account. In combination with pan-European quantitative research we expect to provide deep insights into BMI patterns and paths. Based on these analyses we can help SMEs to get better access to relevant tooling via the platform that we have developed and will be revised based on the insights from our research. In future studies we need to put more focus on finding or creating tools that are not only helping to answer the 'I need to' questions by the SMEs, but also are easy-to-use and comprehend. To encourage the SMEs to start using these tools they should be accompanied with appropriate guidance and examples for instance of how other SMEs have utilised them.

The strength of this paper, the large database with heterogeneous cases, is also its weakness. We are aware that within the EU there still exist large differences in institutional, economic, cultural, and industrial differences that might affect our insights. Further data-analyses, expanding the database as well as more advanced conceptualization is necessary. Moreover BM thinking is embedded in theories from marketing, service innovation and engineering, organizational theory, platform and eco-system thinking, as well as financial models. Although in grounding of our own model we paid a lot of attention to these theories, BM thinking tends to overlook theories. Making the grounding in theory more explicit in analyses of data is highly relevant and requires researchers' attention.

6 Acknowledgement

The work leading to these results has received funding from the European Community's Horizon 2020 Programme (2014–2020) under grant agreement 645791. The content herein reflects only the authors' view. The European Commission is not responsible for any use that may be made of the information it contains.

7 References

Al-Debei, M.M., & Avison, D. (2010) Developing a unified framework of the business model concept, *European Journal of Information Systems*, **19**(3), 359–376.

Amit, R., & Zott, C. (2012). Creating value through business model innovation. *MIT Sloan Management Review*, *53*(3), 41.

Amit, R., & Zott, C. (2001). Value creation in e-business. Strategic Management Journal, 22, 493-520.

Björkdahl, J., & Holmén, M. (2013). Editorial: Business model innovation–the challenges ahead. *International Journal of Product Development*, *18*(3/4), 213-225.

Bonakdar, Amir. "Business Model Innovation" PhD diss., University of St. Gallen, 2015.

Bouwman, H., de Vos, H., Haaker, T. (2008). Mobile service innovation and business models. Springer (2008).

Bouwman, H., M. De Reuver, S. Solaimani, D. Daas, T. Haaker, W. Janssen, P. Iske & B. Walenkamp (2012). Business Models, Tooling and Research Agenda. In R. Clark, A. Pucihar * J. Gricar (eds.). The first 25 years of the Bled Conference. Kraj: Moderna organizacija.

Bucherer, E., Eisert, U., & Gassmann, O. (2012). Towards Systematic Business Model Innovation: Lessons from Product Innovation Management. Creativity and Innovation Management, 21(2), 183–198.

Cunningham, B. (1997). Case Study Principles for Different Types of Cases. Quality & Quantity, 31, 401-423.

DaSilva C.M. and Trkman, P.(2013). Business Model: What It Is and What It Is Not. *Long Range Planning,* Vol. 47, Issue 6, December 2014, p. 379–389

De Reuver, M., Bouwman, H. & Haaker, T. (2013). Business model roadmapping: A practical approach to come from an existing to a desired business model. *International Journal of Innovation Management,* 17, 1-18.

EASME (2015). Horizon 2020's SME Instrument. Retrieved from http://ec.europa.eu/easme/en/horizons-2020-sme-instrument.

eFactors (2002). E-business Model Roadmap. Deliverable 3.1. of Information SystemsTechnologies e-Factors Thematic Network Report, IST-2001

Eisenhardt, K. (1989). Building theories from case study research. Academic Management Review, 14(4), 532 –50.

Eisenhardt, K., & Graebner, M. (2007). Theory building from cases: Opportunities and challenges. Academy of Management Journal, 50(1), 25–32.

El-Sawy, O. A., & Pereira, F. (2013) *Business Modelling in the dynamic digital space: an ecosystem approach.* Springer Heidelberg New York.

Empirica (2014). The need for innovation in Business Models. Policy Brief prepared by empirica and FHNW on behalf of the European Commission. European Commission DG Research and Innovation. Version 2.5. 14th May 2014.

Faber, E., Ballon, P., Bouwman, H., Haaker, T., Rietkerk, O., & Steen, M. (2003). Designing business models for mobile ICT services. Proceedings of the 16th Bled Electronic Commerce Conference eTransformation, Bled, Slovenia.

Fritscher, B., & Y. Pigneur (2011) Business IT alignment from Business Model to enterprise architecture. In: *Proceedings of the 6th International workshop on Business/IT alignment and Interoperability.* An Ancillary workshop of CAISE. London (June), 4-15.

Giesen, E., Berman, S. J., Bell, R., & Blitz, A. (2007). Three ways to successfully innovate your business model. *Strategy & Leadership*, *35*(6), 27-33.

Gordijn, J., Akkermans, H., & Vliet H. (2000). Business Modelling is not Process Modelling. In the Proceedings of the 'ECOMO 200O. Springer-Verlag, 40-51.

Haaker, T., Faber, E., & Bouwman, H. (2006). Balancing customer and network value in business models for mobile services. International Journal of Mobile Communications, 4(6), 645- 661.

Heikkilä, M. , H. Bouwman; J. Heikkilä, S. Solaimani & W. Janssen (2015). Business Model Metrics: an open repository. *Information Systems and e-Business Management.*

Heikkilä, J., Tyrväinen, P. & Heikkilä, M. (2010). Designing for performance - a technique for business model estimation. Seppä, M., Helander, N. & Ilvonen, I.

(eds.) Proceedings of EBRF, Research Forum to Understand Business in Knowledge Society.

Iacob, M. E., Meertens, L. O., Jonkers, H., Quartel, D., Nieuwenhuis, L. J. M., & Van Sinderen, M. J. (2012) From enterprise architecture to Business Models and back. Software and System Modeling, ISSN 1619-1366.

Lambert, S. (2008). A Conceptual Framework for Business Model Research. Proceedings of the 21st Bled eConference eCollaboration: Overcoming Boundaries through Multi-Channel Interaction, Bled, Slovenia.

Lindgardt, Z., Reeves, M., Stalk, G., & Deimler, M. S. (2009). Business Model Innovation. *When the Game Gets Tough, Change the Game, The Boston Consulting Group, Boston, MA*.

Lindgren, P., & O.H. Rasmussen (2013). The Business Model Cube. Journal of Multi Business Model Innovation and Technology, Vol. 1 (3), pp. 135-182.

Magretta, J. (2002). Why business models matter. Harvard Business

Miles, M. B., & Huberman, A. M. (1994) Qualitative data analysis: an expanded sourcebook. Sage Publications, 2nd Ed.

OECD/Eurostat (2005), Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data, 3rd Edition, The Measurement of Scientific and Technological Activities, OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/9789264013100-en

Osterwalder, A. (2004). The Business Model Ontology: A Proposition in a Design Science Approach (Diss. thesis, l'Ecole des Hautes Etudes Commerciales de l'Université de Lausanne).

Osterwalder, A., & Pigneur, Y. (2002). An e-Business model ontology for modelling e-Business. In Loebbecke et al. (Eds.), The proceedings of the 15th Bled Conference on E-Commerce, Bled, Slovenia.

Osterwalder, A., Pigneur, Y., & Tucci, C. L. (2005). Clarifying business models: Origins, present, and future of the concept. *Communications of the association for Information Systems*, *16*(1), 1.

Pohle, G., & Chapman, M. (2006). IBM's global CEO report 2006: business model innovation matters. *Strategy & Leadership*, *34*(5), 34-40.

Schumpeter, J. (1943). Capitalism, Socialism and Democracy. 2003 edition published in the Taylor & Francis e-Library, 2003. Available from http://digamo.free.fr/capisoc.pdf.

Solaimani, S. & Bouwman, H. (2012) A Framework for the Alignment of Business Model and Business Processes: A Generic Model for Trans-Sector Innovation, *Journal of Business Process Management*, **18**(4), 1-17.

Solaimani, S., Itälä, T. & Bouwman, H. (2015) Networked Enterprise Business Model Alignment: a case study on Smart Living. *Information Systems Frontiers*. **17**(4), 871-887.

Solaimani, S., et al. (forthcoming). Business Model Implementation within Networked Enterprises: A case study on a Finnish pharmaceutical project.

Strauss, A., & Corbin, J. (1998) Basics of qualitative research: techniques and procedures for developing grounded theory, (2nd Ed.) Sage: Thousand Oaks, CA.

Taran, Y., Boer, H., & Lindgren, P. (2009) Towards an understanding of business model innovation processes, DRUID-DIME Academy Winter 2009 PhD Conference

Timmers, P. (1998). Business Models for Electronic Markets. Electronic Commerce in Europe. International Journal on Electronic Markets and Business Media, 8(2), 3-8.

Yin, R. (1984, 2003). Case Study Research: Design and Methods, Sage Publications.

Zott (2013). Conceptualizing Business Model Innovation. a critical discussant's view, A presentation in Expert workshop Friday, 20 October 2013, 9.30 – 16.15 hrs Brussels, Belgium

Appendix: List of SME cases

	Number of cases collected								
	61		28	18	15	15	22		
Case name	Country	Part of Europe	MICRO	SMALL	MEDIUM	Family	Female	industry	"I want to"
Audio Tours	Poland	East		1		0	0	N79 Travel agency, tour operator and other reservation service and related activities	I want to increase profitability by using my BM to provide wider array of services
Big Data analytics for SMEs	Netherlands	West		1		0	0	J63.1 Data processing, hosting and related activities; web portals	to find a feasible model to commercialize our tehnology (big data platform)
Bus tours	Finland	North	1			1	1	N79 Travel agency, tour operator and other reservation service and related activities	Analyse whether growth is worth the extra effort
Candy manufacturer	Spain	South	1			1	0	10.82-Manufacture of chocolate, cocoa and confectionery productos; 10.89-Manufacture of other food products	PATH"I want to survive in a mature sector • I want to develop new distribution channels • I want to expand range of products To reach those objectives
digital marketing agency	UK	West			1	0	0	M73.11 Advertising agencies	I want to adjust my service offering and resources to the changes in the business domain.
Educational service provider	Netherlands	West			1	0	0	J58.1 Publishing of books, periodicals and other publishing activities	establish and grow international
Electronic Boot fair	Germany	Central	1			0	0	J63.1 Data processing, hosting and related activities; web portals	expand to global markets
Electronic medicine dispenser	Netherlands	West			1	0	0	G47.74 Retail sale of medical and orthopaedic goods in specialised stores	explore the possibilities to make business with my idea
electronic receipts for bookkeeping	Finland	North	1			0	0	J62.0 Computer programming, consultancy and related activities	Reach my potential customers better to increase sales
eRecruitment	Netherlands	West	1			0	1	J63.1 Data processing, hosting and related activities; web portals	I want to build a scalable product as our current business model is not that scalable
eSpice	Germany	Central	1			0	0	G46.36 Wholesale of sugar and chocolate and sugar confectionery	I want to make our brand better known and the enhance our offering to related products.
Event Technology Services	Germany	Central	1			0	0	G47.4 Retail sale of information and communication equipment in specialised stores	To keep customers (who are always looking for WOW effects) satisfied , I want to be in the front line with the newest technology and equipment
Everyone deserves plants	Finland	North	1			0	1	A01.61 Support activities for crop production	Convince funders and pioneer customers of the product, and to design roadmap for growth and futher services & product categories
find eAdvertisement space	Netherlands	West		1		0	0	M73.11 Advertising agencies	turn my technical invention into business
FitCity	Italy	South		1		0	0	J63.9 Other information service activities	Survive - Modify my BM so that it will be viable even though big competitors
from telco to smart living services	Netherlands	West			1	0	0	J61 Telecommunications	Redefine my market position and service portfolio
Gourmet Burger	Netherlands	West		1		1	1	I56.1 Restaurants and mobile food service activities	short term: use social media to direct interaction with clients; long term: turn the business into franchise
Hamburger and BBQ restaurant	Spain	South			1	1	1	I56.1 Restaurants and mobile food service activities	I do not want to change
Hardware store	Finland	North		1		1	1	G47.5.2 Retail sale of hardware, paints and glass in specialised stores	PATH I want to cut losses and change from 3 separate stores to a chain BM: "I want to cut losses • I want to cut the employment costs (solution: Move holidays to low season) I want to Change from 3 separate stores to a chain BM • I want to harmonize my offering"" & ""I want to harmonize pricing • I want to have better information and understanding what is going on in my business • I want to share know-how within the company • I want to reduce the number of products and the number of suppliers"
Herb&Salad	Finland	North		1		1	1	A01.13 Growing of vegetables and melons, roots and tubers	Grow, serve new customer segments
High Performance Computing services	Slovenia	East		1		0	1	J63.9 Other information service activities	PATH"I want to increase sales • I want to offer new services
Incubator	Germany	Central	1			0	0	N82 Office administrative, office support and other business support activities	Have my income more balanced and recurring
Indie game developer studio	Finland	North		1		0	0	J62.01 Computer programming activities	Differentiate from the competing products
Industrial insurances	Germany	Central	1			1	0	J63.1 Data processing, hosting and related activities; web portals	Increase the market penetration and grow a larger customer base, in order to turn profitable
Integrated travel services	Spain	South		1		0	0	N79 Travel agency, tour operator and other reservation service and related activities	I want to expand to reach more customers and increase income.
IoT platform for elderly care	Netherlands	West	1			0	0	C28.9 Manufacture of other special-purpose machinery	design BM for my new invention
IT for greenhouses	Netherlands	West			1	0	0	A1.61 Support activities for crop production	increase value to customers, increase vendor lock-in, increase in revenue and increase in customer loyalty.
IT sourcing intermediary	Netherlands	West	1			0	0	J63.1 Data processing, hosting and related activities; web portals	deliver new type of IT services to the market. This can open up a new market since there are no or few players that offer this kind of service.
Liquor producer	Netherlands	West			1	1	0	C11.0.1 Distilling, rectifying and blending of spirits	I need to remain flexible and be able to (strategically) react to changes in the environment
Local Hotel	Germany	Central		1		1	0	I55.1 Hotels and similar accommodation	keep my position as the leading hotel in the area
Lottery as a service	Netherlands	West	1			0	0	Q88 Social work activities without accommodation	PATH"I want to start a new business from a service concept • I want to know there is a need for our service concept for intended customers • I want to know if my business model is future proof • I want to know about future changes in legislation that might affect our BM in a negative way"
Meal delivery service	Lithuania	East			1	0	1	I56.1 Restaurants and mobile food service activities	PATH "I want to expand my business through replicating business model • I want to identify market (country) for growth • I want to find reliable partners for BM implementation • I want to attract customers (marketing activities) • I want to expand to the new cities I the same market"
mechanical Engineering company	Netherlands	West	1			0	0	C28.99 Manufacture of other special-purpose machinery n.e.c.	I want to collaborate with other companies to create the most suitable product.
MobiFish	Finland	North	1			1	0	J61.2 Wireless telecommunications activities	move my business to mobile
Online Marketing Services	Germany	Central			1	0	1	M73.11 Advertising agencies	manage/plan growth
Online printing	Netherlands	West			1	0	1	C18 Printing and reproduction of recorded media	keep customers satisfied and serve wide variety of customer needs
Online publishing	Netherlands	West			1	0	0	J58.1 Publishing of books, periodicals and other publishing activities	I want to know how change in our BM impacts our EA

Online Showroom	Germany	Central	1			0	0	J63.1 Data processing, hosting and related activities; web portals	Short term: reach critical mass of users and establish brand; Medium term: continuous growth and internationalisation; Long term: warehousing and own product creation
OpticalFibre&Tele services	Finland	North			1	0	0	J61 Telecommunications	Refine my service portfolio for new customer segments
Plant in a bottle	Netherlands	West	1			0	0	C23.1 - Manufacture of glass and glass products	I want to move towards more easily shippable products, strengthen online sales.I want to grow my products' retailer network and expand to the United States and Hong Kong retailers.
Platform - Welfare for the elderly	Netherlands	West	1			0	1	Q88 Social work activities without accommodation	PATH "I want to start a business with a new match making platform in care • I want to know the market for match making platforms in care • I want to develop my proposition • I want to explore my business model • I want to find the right partners and arrangements • I want to find inverstors"
Portable Medical Device	Finland	North		1		0	1	G47.74 Retail sale of medical and orthopaedic goods in specialised stores	Change from product to service provider
Portable Solar Cells	Austria	Central	1			0	0	C14.19 Manufacture of other wearing apparel and accessories	PATH "I want to sustain and grow my business • I want to identify and attract new customer segments I want to establish my business • I want to survive the first 3 years as a Start-up and offer continuous employment and career perspective to my employees. I want to convince partners about my idea • I want to grow a reliable partner-network • I need partners with expertise I can not cover within my own company • I need partners for large project to receive additional funding Change from product to service provider • I want to enrich my product with services to tie my customers to my offerings • I want to address innovation-leaders as customers and need to offer them digital add-ons"
project management application	Finland	North	1			0	0	M70.2 Management consultancy activities	Create a good trusted network of key partners
Rate the club!	Netherlands	West	1			1	0	J63.1 Data processing, hosting and related activities; web portals	expand to foreign countries
Real estate management	Finland	North	1			1	1	J62.0 Computer programming, consultancy and related activities	Redefine my customer segment
Rehabilitation app	Austria	Central		1		0	0	G47.74 Retail sale of medical and orthopaedic goods in specialised stores	To keep the innovative image and stay ahead of competition we need to constantly re-invent our products and services.
SaaS for Health	Netherlands	West		1		0	0	J63.1 Data processing, hosting and related activities; web portals	Explore the market possibilities
SAP consultancy	Germany	Central		1		0	1	J63.9 Other information service activities	find out what the market needs
Sewing services	Lithuania	East	1			0	1	C14.0 Manufacture of wearing apparel	PATH"I want to establish my business
Space saving containers	Netherlands	West		1		0	0	H52.2 Support activities for transportation	PATH "I want to sustain and grow my business • I want to identify and attract new customer segments • I want to know how I can exploit our IPR"
SportEquipment_eStore	Finland	North	1			0	0	G47.64 Retail sale of sporting equipment in specialised stores	expand and reach larger customer base by eShop
Sports prescription	Finland	North	1			1	1	Q86.9 Other human health activities	PATH "I want to convince potential network partners that my business idea is good and profitable to all partners • I want to design/draw business model for network of companies (Tool: multiple BM CANVASes) • I want to analyse risks (tool: tress testing) • I want to analyse the IT requirements (tool: use cases, IT specs) • I want to make financial calculations (tool: excel) • I want to demonstrate my idea in practise (tool: a pilot with minimum viable product) • I want to analyse improvement needs (tool: select KPIs and collect measures during the pilot concerning the Business model) • I want to revise business model (Tool: multiple BM CANVASes"
Teaching platform	France	West		1		0	1	P85.6 Educational support activities	I need to go to international markets
training planner tool	Estland	East	1			0	0	J63.1 Data processing, hosting and related activities; web portals	I want to have profitable and sustainable business. The short-term goal is increasing the number of customers
Urban 3d planning	Switzerland	Central	1			0	1	M71.1 Architectural and engineering activities and related technical consultancy	roll out my exisiting product and find new customers and new product offerings
Veterinary clinic	Lithuania	East		1		1	1	M75.0 Veterinary activities	expand and gain large market share in local market
Vintage eMarketplace	Lithuania	East			1	0	1	J63.1 Data processing, hosting and related activities; web portals	I want to shift from free service to paid services (commission from each sale is charged). The strategic objective is to become a world leader (be the first the world) and to be a leading company in each country. The company has chosen the principle of „divide and rule" and has been developing its activities in Europe and the USA first. The further development of the principle will depend on the market research that is performed in a given area before entering a new market. The company's targets are to grow continentally
Web app development environment	Finland	North			1	0	0	J62.01 Computer programming activities	Grow (change in pricing strategy, change in IPR)
Wind Enegy Technology	Denmark	Central			1	1	1	C28.9 Manufacture of other special-purpose machinery	turn my technical patent into business
Wine trader	Spain	South	1			0	0		PATH "I want to reduce my product portfolio from delicatessen products to wines • I want to reduce product line breadth • I want to reduce operating costs • I want to focus on profitable product lines I want to Change my business from importing to manufacturing • I want to find to find new clients in manufacturing channels • I want to establish and promote my own brands • I want to identify distribution channel growth • I want to find the right partners and arrangements

29th Bled eConference

Digital Economy

June 19 - 22, 2016; Bled, Slovenia

Youth e-participation: Lessons Learned from an Ongoing Project in Switzerland

Hans-Dieter Zimmermann

FHS St. Gallen University of Applied Sciences, Switzerland

hansdieter.zimmermann@fhsg.ch

Abstract

E-participation describes the utilization of ICT means and social media in order to further develop citizen participation in the information society. Especially the youth is using respective applications and platforms quite naturally for communication and interaction. In an ongoing e-participation pilot project in a Swiss municipality an e-participation platform has been developed. After presenting a general overview of the topic the project including its initial situation as well as lessons learned are being presented.

Keywords: eparticipation, youth, participation, edemocracy

1 Introduction

An increasing citizen engagement is one of the major current trends in many European societies. This general trend can be understood as a form of Open Societal Innovation, which “refers to the adaptation and subsequent sustainable use of appropriate open innovation approaches from business, adapted and utilized by state and society to solve societal challenges” (von Lucke et al., 2012). Thus, citizens are involved more and more in political opinion and decision making processes, beyond elections. In democracies like in Switzerland the so called “Direct Democracy” is well established and institutionalized, many other countries have established instruments such as referendums, initiatives, plebiscites, or petitions during the last couple of years as well. In a recent study David Altman has analyzed 200 states and developed the Direct Democracy Practice Potential (DDPP) in order answer the question to what extent direct democracy has been achieved in current politics (Altman, 2015).

Already in 1969 Arnstein discussed “citizen participation” in her seminal paper; she developed the broadly cited “Ladder of Citizen Participation” (Arnstein, 1969). The different forms of (Non-) Participation have been adopted to fit into different settings since then. Teran and Drobnjak introduce further concepts of participation levels (Teran & Drobnjak, 2013).

In 1992 Hart adopted it to the needs of children and young adults; nowadays, this model of children's participation is one of the most widely used models of participation in the context of younger citizens (Hart, 1992). Hart's report has been published by the UNICEF International Child Development Centre: Through UNICEF the United Nations are fighting for the rights of children and the youth. In 1990 the "Declaration of the Rights of the Child"[1] came into force, which have been ratified by 196 countries worldwide as of today (March 2016). In Switzerland, UNICEF has launched the program "Kinderfreundliche Gemeinde" (child friendly municipality) which offers the municipalities an assessment program regarding its child related activities in different areas such as administration and politics, school, health, child and youth protection. Several Swiss municipalities received the according label of a "child and youth friendly municipality".

Participation, be it for adults or children and adolescents, utilizes a number of Offline formats depending on the level and the purpose of participation according to the participation ladder. In the information society the utilization of ICT means can be seen as an additional chance to implement participatory processes. eDemocracy and eGovernment can be understood as umbrella terms which comprise several ICT-supported activities in modern democratic societies. Meier presents a comprehensive and structured overview of respective services (Meier, 2012).

Consequently, supporting participation processes by means of ICT is referred to as e-participation: "eParticipation involves the extension and transformation of participation in societal democratic and consultative processes, mediated by information and communication technologies (ICTs)" (Sanford & Rose, 2007). It is important to mention that e-participation shall not imply that existing traditional processes have to be replaced by ICT-supported processes but that means of ICT either complement traditional Offline participation processes, transform them where applicable, or introduce new and innovative e-participation processes. Several authors have analyzed the research area of e-participation and thus provide comprehensive overviews, e.g., (Sanford & Rose, 2007) (Medaglia, 2012) (Susha & Grönlund, 2012).

In this paper we want to bring together the development of e-participation on the one and youth participation on the other side. So far the body of existing research in the area of youth e-participation is rather limited; two Swiss studies focus on youth participation (Rothenbühler, Ehrler, & Kissau, 2012; Wittwer, 2014). As a result it can be said that there are only a very few e-participation projects in Switzerland, among others, easyvote.ch, which focuses on voting, and engage.ch, focusing on youth parliaments. In both studies also an in-depth discussion of the understanding of youth (e-) participation can be found. It is also known from previous research that young people engage

[1] See http://www.unicef.org/crc/

themselves more likely in political processes of participation if they have a personal interest and if they are affected personally.

Therefore, we will introduce a concrete ongoing project in a Swiss municipality as a case study in order to demonstrate how youth e-participation might could look like and what the benefits and challenges as well as success factors are. After presenting the initial situation we will present the procedure of the project as an example including first results and preliminary lessons learned.

2 The Youth e-Participation Project

2.1 The Initial Situation

In Switzerland direct democracy has a long tradition and is – figuratively speaking – part of the Swiss society's DNA. Also the support of the youth is a highly important issue on all federal levels. In order to enable children and adolescents to participate in democratic processes even before they reach the legal age – which is 18 as in most other countries as well – the national government in 2011 passed the federal law on the Promotion of extracurricular Youth Welfare[2] which shall support and stimulate respective youth activities. Furthermore, different instruments such as so called youth parliaments or youth commissions have been introduced in many cantons as well as municipalities including bigger cities.

The municipality of Grabs is situated in the Rhine Valley and has around 7000 inhabitants[3] and thus can be considered as a medium sized municipality as the average size of Swiss municipalities is around 1500 inhabitants.

Mid 2013, the municipality's commission for youth decided to put a focus on children and adolescents participation (youth participation) (Fernandez, 2014, 3). Also in 2013, Grabs was one of ten pilot municipalities of a program in the canton of St. Gallen which promoted physical exercise in combination with securing the ways to school. (Zihlmann, 2013) In addition, Grabs participated in the Swiss UNICEF initiative „Kinderfreundliche Gemeinde" as well (Regli, 2013). As one result of the analysis it has been identified that Grabs offers structural prerequisites for youth participation – a youth commission, a special youth association - but lacks in respective processes.

Based on an input by a university the local council decided to intensify the municipality's efforts to integrate the youth more into political processes. Therefore, a project group has been established in Feb. 2014 in order to prepare a respective project. From the very beginning all concerned stakeholders have been involved in the planning process: Representatives of the youth, youth work, school administration, school teacher, local

[2] https://www.admin.ch/opc/de/classified-compilation/20092618/index.html (Kinder- und Jugendförderungsgesetz, KJFG)

[3] https://en.wikipedia.org/wiki/Grabs

council, the responsible cantonal agency, and researchers from a University (Fernandez, 2014).

2.2 The Project

In a first step the project group discussed possible formats for the planned youth e-participation. Based on five scenarios developed by the project group a questionnaire was developed. In May 2014 420 students from the local school between the 4th and the 9th grade (approx. 10 to 15 years of age) participated in the survey. As the poll was done through the school as part of the regular classes close to 100% of all students participated. The scenarios have been an idea exchange, a discussion forum, Feedback functionality, a municipality game, and an information platform. As a result, 76% of the students said that they prefer the idea exchange. Furthermore, the students were asked which device they would prefer. More than 50% voted for the Smartphone, second was PC and Notebook, fourth a tablet computer.

Based on the results the project group elaborated the scenario of the idea exchange in more detail; a detailed proposal was developed and a SWOT analysis has been applied. The cost and options of an implementation have been estimated as well.

In the following we summarize the most important basic functionalities of the planned platform.

To access the platform a user needs to have an ID. Consequently, it can be assured that only the youth living in the municipality will be able to access. The IDs are being issued through the central school administration. All content is only visible for registered users.

The basic mechanism of the idea exchange has been designed twofold: First, users should be able to post ideas as they have it anytime. Second, the municipality's administration, the local council, or the editorial team should be able to post ideas and issues. User can "Like" postings as well as comment.

It was agreed that postings shall be published "as is" without any moderation beforehand. An editorial team was set up to review the entries on a regular basis. The team members comprise youth from the municipality lead by a volunteer who is actively involved in the youth work. The editorial team is being coached and advised by a coaching team on a weekly basis lead by the youth worker responsible for the municipality. A first draft of a process model has been developed accordingly.

An organization sheet was developed in order to document the different involved stakeholders and groups including their competencies, duties, and rights. The basic and overall idea of the project was to delegate as much as possible to the youth themselves. Adults shall only intervene if absolutely necessary.

In August 2014 it was decided to develop a website targeted for the use on Smartphones. This decision was made as native Apps for several platforms would have been too costly to develop and to maintain.

This approach has been chosen based on the knowledge and experience of the project group in combination with the students' survey during class. Although the approach has been chosen pragmatically it corresponds with a study which was not yet available at that time.

In the study young people in Switzerland have been asked how they would like to participate in their municipality. First, the real social network, comprising friends and family, was mentioned (49%). Second, through school (40%), and third through a Smartphone or Tablet App (32%). The fewest would like to be active in a youth or local parliament (10% each) (HTW Chur (Hrsg.), 2014, 83). Through these findings the chosen approach has been confirmed empirically subsequently.

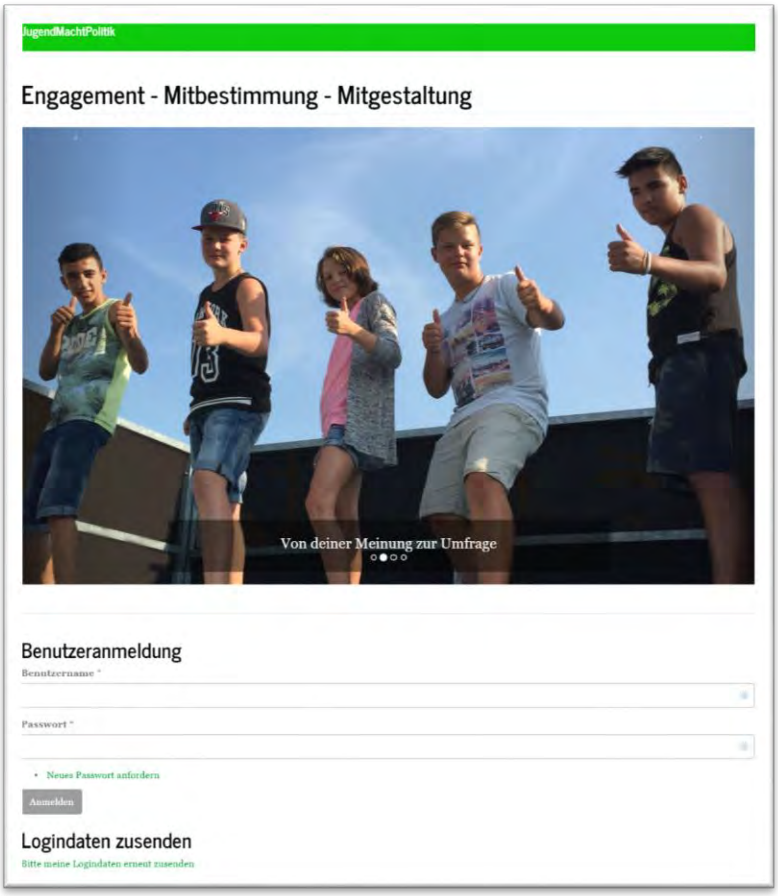


Figure 1: Screenshot of the (mobile) webpage jugendpolitikgrabs.ch

It was decided that the application shall be implemented by students of a nearby school providing vocational education ("Berufsschule"). The students of the respective class all have been in their last (fourth) year of their vocational training in the IT area. The mobile website was developed in the first quarter of 2015 as part of a regular class. The teacher joined the project group accordingly.

The mobile website was intensely tested by the members of the project group, changes have been applied by the students accordingly.

In mid-August 2015 the application was rolled out. All students from the local school from the 4th grade and up got their personal ID including an initial password through the school. The initial, first phase lasted until mid-October 2015.

To promote the platform a video was shot by the involved youth[4].

During the setup process of the project the project group decided to apply for additional funding for the project at the Federal Social Insurance Office (FSIO) based on the federal law on the promotion of extracurricular youth welfare. The project proposal was accepted in June 2015. With the additional funds, among others, especially the accompanying research will be funded.

First Results

The activities on the platform have been observed by all involved groups. Observations have been captured weekly based on an evaluation sheet provided by the accompanying researchers. The sheet comprised three areas of observations: observed activities, changes, and reasoning or possible explanation. The two researchers observed the activities on the platform as well. Intermediate results have been analyzed and discussed in November 2015 within the project group. Intermediate results also have been discussed with the Federal Social Insurance Office (FSIO) in Feb. 2016.

During the first phase of ca. eight weeks 40 ideas and topics have been captured on the platform by a total of 25 identified different authors. Entries got up to 15 feedbacks (comments) each.

Two topics have been posted by the editorial team. The very first entry addressed a planned swimming lake in the municipality. The youth was asked about their ideas. The second topic was about typical local idioms used by the youth which have been collected and voted for through the platform. The editorial team started rather slowly to moderate the discussions through inputs and questions, etc. The posted ideas can be clustered into the following groups: swimming lake/ pool, nature and environment, school, sports complex, infrastructure projects, playgrounds.

One idea addressed the issue of an increased protection of the environment. This idea was picked up already, some further actions have been initialized, for example, a workshop took place in the beginning of March 2016 in order to further discuss concrete activities.

The local idioms with the most votes have been produced as t-shirts and are being sold now in the municipality.

Based on the captured observations from the first phase as well as the course of the project in general and its discussion within the project group we will summarize some of the findings and lessons learned in the following.

---

[4] See https://youtu.be/ZKnjZgMjn4c (in German only)

As youth participation was already a topic of the local council the idea of an e-participation project was a logical next step. Without these preconditions it might be much more difficult to convince the necessary stakeholders.

It seems to be a crucial success factor that all affected stakeholders have been integrated into the project from the very beginning. For example, the editorial team feels taken seriously in terms of real participation.

To involve the school also can been seen as a crucial success factor as otherwise it might be difficult to reach all students. Addressing the issue of participation in class might stimulate participation. Furthermore, as the platform was introduced through the school also parents take it more seriously.

A clear organizational structure helps to clarify the role of each stakeholder.

It is crucial to give a feedback concerning the posted ideas and issues. Users want to know what is going to happen with their ideas. Here major challenges occur: First, only a minority of ideas can be followed up, and second, when following up on an idea through the municipality's administrative processes take their time, e.g., budgets have to be planned for the next period, etc. A respective process model has to be further developed during the further course of the project.

Furthermore, it can be seen as crucial as well that participation has to be a mix of virtual as well as physical participatory formats. Even the so called Digital Natives or Millennials like to attend face-to-face formats.

Although it was decided to post contributions "as is" without a moderation beforehand no posting had to be deleted because of offensive language, insults, or alike.

Overall evaluation after the first phase:

Strength

Strong personalities are being involved into the project. All participants are open to innovative forms of participation. The culture of a mid-sized rural municipality supports the utilization of existing social networks.

Weaknesses

The emerging complexity has to be managed carefully. The youth might have the expectations that their ideas have to be realized for sure. As the youth culture is rather fast moving compared to administrative processes sustainability might be an issue. Without a rather quick feedback the youth may lose their interest. Technical limitations of the platform might hinder youth to participate more intensely.

Opportunities

The platform offers new ways of participative processes for the youth, it raises the understanding of political processes and contributes to the education of future citizens. Clear processes and roles enable a joined development by all stakeholders.

Threats

Participation as a term sounds too abstract and high level to many stakeholders and might be even deterrent. As the idea exchange is just one platform which the youth is using it might be hard to keep their attention and interest to participate.

3 Further Steps

So far, the platform is running and is being used in its current form.

It is planned to revise the technical platform by adding and changing several functionalities based on the experiences made. Based on the second version of the platform a second phase of observations will take place.

The platform shall be become a sustainable component in the municipality’s political processes.

The involved researchers will conduct several interviews with all involved stakeholders in order to capture feedbacks systematically. Insights will be analyzed and compared with existing findings from the (scholarly) literature and existing studies. From a research point of view it will be discussed in how far ICT and social media stimulate youth participation as such.

Based on the concrete experiences of the project as well as on further findings from the literature the researchers will develop guidelines which shall enable other municipalities to implement youth e-participation.

References

Altman, D. (2015). *Measuring the Potential of Direct Democracy Around the World (1900-2014)*. Gothenburg. http://ssrn.com/abstract=2701164

Arnstein, S. R. (1969). A Ladder Of Citizen Participation. *Journal of the American Institute of Planners*, *35*(4), 216–224. http://doi.org/10.1080/01944366908977225

Fernandez, A. (2014, November). «Kinder- und Jugendpartizipation» in Grabs. *Grabser Blatt*, p. 3. Grabs. http://www.grabs.ch/dl.php/de/546c5e04d2b17/2014_11_Website.pdf

Hart, R. A. (1992). *Children’s Participation: From tokenism to citizenship*. http://www.unicef-irc.org/publications/100

HTW Chur (ed.). (2014). *«Scoop it 2.0» - Studie zur Mediennutzung und zur politischen Partizipation von Jugendlichen in der Schweiz und im Fürstentum Liechtenstein*.

Chur, Schweiz. http://www.dsj.ch/fileadmin/files/4_Projekte/140905_Scoopit_Studie_Druckboegen_jh.pdf

Medaglia, R. (2012). eParticipation research: Moving characterization forward (2006–2011). *Government Information Quarterly*, *29*(3), 346–360. http://doi.org/10.1016/j.giq.2012.02.010

Meier, A. (2012). *eDemocracy & eGovernment: Stages of a Democratic Knowledge Society*. Springer-Verlag Berlin Heidelberg. http://doi.org/10.1007/978-3-642-24494-0

Regli, P. (2013). *«GEMEINDE BEWEGT»: Strukturelle Bewegungsförderung in der Gemeinde: Grabs*. http://www.zepra.info/tl_files/content/06_programme_projekte/gemeinde_bewegt/abschlussberichte_2013/Gemeinde-Bewegt_Abschlussbericht_Grabs.pdf

Rothenbühler, M., Ehrler, F., & Kissau, K. (2012). *Politische Partizipation junger Erwachsener in der Schweiz*. Bern. http://forscenter.ch/de/forschung-publikationen-projekte/projekte/chyoupart/resultate/

Sanford, C., & Rose, J. (2007). Characterizing eParticipation. *International Journal of Information Management*, *27*(6), 406–421. http://doi.org/10.1016/j.ijinfomgt.2007.08.002

Susha, I., & Grönlund, Å. (2012). eParticipation research: Systematizing the field. *Government Information Quarterly*, *29*(3), 373–382. http://doi.org/10.1016/j.giq.2011.11.005

Teran, L., & Drobnjak, A. (2013). An Evaluation Framework for eParticipation:The VAAs Case Study. *World Academy of Science, Engineering and Technology*, (73). http://waset.org/publications/5553/an-evaluation-framework-for-participation-the-vaas-case-study

von Lucke, J., Herzberg, J., Kluge, U., vom Brocke, J., Müller, O., & Zimmermann, H.-D. (2012). Open Societal Innovation – The Alemannic Definition. https://esocietybodensee2020.wordpress.com/publikationen/open-societal-innovation-the-alemannic-definition/

Wittwer, S. (2014). *Politische Partizipation von Kindern und Jugendlichen in der Schweiz*. Bern. http://www.sajv.ch/media/medialibrary/2014/07/Partizipationsstudie.pdf

Zihlmann, I. (2013). *«GEMEINDE BEWEGT» Strukturelle Bewegungsförderung in der Gemeinde*. http://www.strukturelle-bewegungsfoerderung.ch/gemeinde_bewegt/docs/131219_Schlussbericht_SG_Endfassung.pdf

29th Bled eConference

Digital Economy

June 19 - 22, 2016; Bled, Slovenia

The disruptive impact of digitalization on the automotive ecosystem: a research agenda on business models, platforms and consumer issues

Research in progress

Alexia Athanasopoulou, Harry Bouwman, Fatemeh Nikayin, Mark de Reuver

Delft University of Technology, The Netherlands

{a.athanasopoulou; w.a.g.a.bouwman; g.a.dereuver}@tudelft.nl; fatemeh.nikayin@gmail.com

Abstract

Digital technologies are transforming the automotive industry, and disrupting traditional business models based on ownership of cars. With the emergence of connected cars, mobility services and servitization, questions arise on how these enabling technologies affect the ecosystem. In this paper, we propose a research agenda for the digitalized automotive ecosystem. In this research agenda we raise research questions on the impacts of digitalization on business models (i.e. how to move from traditional to digital business models, how do new business models transform the ecosystem and how to construct new revenue models), digital platforms (i.e. who controls data from connected cars, how to open up and govern data platforms, and how to deal with platform competition) and consumer issues (i.e. what mobility services do consumers prefer, and how to guarantee safety, security and privacy).

Keywords: Internet of things, digital technologies, automotive industry, digital platforms, research agenda

1 Introduction

Digital technologies like Internet-of-things (IoT) are about to transform the automotive industry in ways that could disrupt established players' business models (KPMG, 2014). Digital technologies enable multi-modal solutions, in which cars ownership is no longer central but the core is mobility services, appealing to trends like eco-lifestyle, personalization and sharification (Seeger & Bick, 2013). While business models in automotive industry have long focused on cars as products, competition will increasingly revolve around services created through digital platforms. Offerings will increasingly focus on transportation needs and modalities, energy efficiency, collection of data on footprints and driving behavior, Bluetooth and 5G network dedicated system integrators. Besides enabling new service offerings, digital technologies also enable new actors to enter the traditionally closed automotive industry. As a result, traditional players like car manufacturers, car dealers, leasing, and insurance companies and fuel providers will face new entrants like app providers, platform providers and specific service providers (e.g. Google Car, Apple iCar and Uber) (Hanelt et al., 2015).

From an academic point of view, automotive industry digitalization implies that cars will become a platform on which a number of services run (Mohaghegzadeh & Svahn, 2015). The digitalization of the automotive industry gives rise to many research issues that are related to (1) collaborative, changing and multi-level BMs as a result of servitzation for existing and new players, (2) the role of data platforms and platform competition, and (3) the consumer side of new ownership and payments models, security and privacy issues. In this paper, we develop a research agenda for investigating the impact of digitalization on business models, digital platforms and consumer issues. Our research agenda is based on reviewing the as-yet limited set of academic and industry papers on automotive industry, digitalization and connected cars.

The paper is organized as follows. Section 2 provides a background on automotive industry, digitalization and IoT. Section 3 discusses, based on existing literature, how these trends raise new research questions in relation to business models, data analytics, ecosystem and consumer issues. Section 4 concludes the paper.

2 The automotive industry, digitalization and IoT; setting the stage

Digital technologies have long been adopted by automotive players, ranging from back office automation to localization technologies and in-car entertainment systems (Hanelt et al. 2015). However, new digital technologies will fundamentally change the automotive industry and makes the affected participants to rethink their position in the market, and explore new opportunities improving their offerings (Viereck et al., 2015; Kavis, 2015). As objects ranging from clothes (wearables) to vehicles (e-bikes, smart cars) are being connected to the Internet, the so-called Internet of Things is emerging (Miorandi, 2012; Westerlund, Leminen & Rajahonka. 2014). IoT enables enterprises, within this new dynamic business environment, to create value by providing innovative products and complementary services (Kyriazis & Varvarigou 2013; Turber et al. 2015).

The automotive industry the mobility provider is shifting from being product to service oriented with the basic product –the car- only to be an enabler for delivering services (Vargo & Lusch, 2004). New value propositions relate to self-driving, parking and lane assistance options, based on a combination of sensor and GPS technologies, and real time data processing. Complementary services enabled by mobile and sensor technology are car diagnostics, preventive maintenance or automated emergency calls. More enhanced the car as a platform can also be related to ecommerce activities. As with many other industries, automotive industry is moving from a well-defined and structured ecosystem, with car manufacturers as central actor, to a flexible networked ecosystem with open boundaries (IBM, 2015). Consumers are co-designers for new services and new entrants are offering innovative products and services such as app driven electrical cars (BMWi3), Supplementary in-car entertainment systems (Apple CarPlay, Andorid Auto, and Google sponsored Open Automotive Alliance) like remote diagnostic, tracking and tracing systems and location based advertisement are already reailty.

So, the car is becoming a platform on which add-on services run. Connected car platforms typically have a layered model. On the lowest level the client systems are represented based on embedded sensors and other peripheral equipment. On the connection level use is made of 3G/4G/LTE networks as well of

WiFI 802.11p, and specific DSRC (dedicated short range communication) roadside communication protocols. On top we find Internet access to public, private or enterprise cloud systems. Together they provide a connected car platform (Golestan et al., 2015).

3 Research issues

Business models in a digitalized automotive industry

Digitalization in the automotive industry is disrupting existing business models (BMs) (Hanelt et al. 2015). Traditional BMs were based on a linear, mechanical value chain focused on delivering a product, i.e. a more or less sophisticated, conventionally, fuelled cars, offering after sales maintenance services via a dealer network. Core competences of car manufacturers are therefore based on engineering, design and electronics, while software components were purchased from suppliers. The automotive industry leads to a changed ecosystems in which other parties have to find their role, not only as app or technology provider, but also transaction providers and others (Hanelt et al., 2015). There has been limited prior research on BMs for digitalized automotive industry. Based on a Delphi study with nineteen experts, Piccinini & Gregory (2015) present a list of relevant BM challenges: (1) creating valuable new digital co-created products and services, (2) competing with rival (service) offerings from new entrants, and (3) designing new business models. They find that legal, regulatory, security and privacy issues are least relevant. Fleisch et al (2015) suggest BM changes based on analysing 55 IoT cases. Digitalization of automotive industry gives rise to research issues like

- *How can existing players gain the required resources and capabilities to conduct BM innovation?* As a consequence of digitalization automotive manufacturers need additional resources and capabilities, for instance know-how on software engineering, big data, social media, mobile technology and on security and privacy, either internally or on arm's length.
- *How can existing players move from their current BM to a new BM?* On a more generic level tension of working in two rather different BM concepts, i.e. the traditional automotive paradigm vis-à-vis the digital paradigm (as also confirmed by Piccinini & Gregory, 2015). Clearly this asks for an ambidextrous approach, combing exploration and exploitation.
- *What new BMs emerge and how ecosystem partners will innovate their BM? How can car automotive industry actors work together to develop new propositions and BMs?* When moving from car-as-a-product to mobility services BMs, new actors become part of the ecosystem. The system integration and governance role can be fulfilled by the automobile manufacturer or by any other party in the ecosystem, for instance a public transport provider. In the case of enhanced ecommerce services , the ecosystem changes in a different direction, for instance petrol stations can play a role in delivering services to the end consumer.
- *What are new revenue models for BMs in a digitalized automotive industry?* Changing value propositions offer new opportunities for revenue generation. For instance, congestion pricing for parking or new insurance fees based on data about driving behavior. When cars are no longer owned as a product, new pay-per-use pricing models can be offered. Other revenue models become possible as well for peripheral actors, as for instance petrol stations can ask for a commission, while transaction and/or payment provider can create revenues based on user and transaction profiles. Digitalization can also lead to cost reduction, for instance due to co-creation in the design process and plant design for a production line supported by virtualization (Hanelt et al., 2015).

Data platforms in connected cars

Connected cars generate massive amounts of data, which raises issues on how to collect, orchestrate and distribute data to service providers. Mikusz et al. (2015) discuss BMs for three specific platforms that collect, process and sell data from connected cars, i.e. Audi Connect, BMW Connect Drive and Mercedes Connect. In their analysis, data platforms are closed and access is only given to preferred partners, (e.g. Audi to Google, BMW to DoubleSlash and Mercedes to TomTom). Mohaghegzadeh & Svahn (2015) discuss how to develop open in-car platforms starting from Volvo's existing organizational and technological resources, to be made available via Google's Android platform. The project stalled because an open platform would imply that core strategic data and knowledge on drivers behavior should be made available as well. The research of Mohaghegzadeh & Svahn (2015) clearly show the trade-off companies have to make regarding platforms, i.e. giving away critical knowledge based on user data vis-à-vis offering new apps via an open platform.

We suggest the following research questions due to platformization in the automotive industry:

- *Who controls the digitalized automotive ecosystem and its data sources?* Most digital services generate vast amounts of data. An important question therefore is who controls the data and act as an orchestrator, because data have an economic value. New value propositions and revenue models can emerge form reusing data.
- *Should data platforms be open, closed or hybrids? How to arrange governance?* As seen in the example of Volvo, car manufacturers tend to keep their platforms closed. At the same time, disclosing data can lead to generativity of mobility services. How to find a balance between open and closed platforms?
- *Where to locate the platform?* Connected cars platforms could be hosted on various locations: in the car, on an independent platform managed by a system integrator, or on the periphery being self-controlled by consumers.
- *How to deal with platform competition?* Platforms are offered by car manufacturers but also by operating system vendors like Apple and Google. A core concern is how car manufacturers should respond to threats of being `enveloped' into the platforms of operating system vendors (cf., Mohaghegzadeh and Svahn 2015).

Consumer issues: acceptance, security and privacy

Consumers are affected by digitalization of the automotive industries in various ways. First, a range of new value propositions is becoming available. A concern is what consumers actually desire from their 'connected car' experience or from eMobility solutions. A research issue is therefore:

- *What digital mobility services do consumers prefer and wish to pay for?* The question is what consumers want next to the core mobility service, and what is their willingness to pay for complementary or supplementary services.

With the amount of data collected due to IoT, security and privacy are core topics (Viereckl et al., 2015). Distant monitoring system can contribute to preventive maintenance, warning systems for engine problems, brake or tire problems, even helping to increase save drive behavior based on navigation support, automatic speed adjustments, real-time information on traffic flows, road conditions, possible accidents and based on peer2peer communication automatic sensor-based systems for keeping distance et cetera (Evans-Pughe, 2005), but there is also a downside, car become vulnerable to hackers, for instance via infotainment applications or remote access. This leads to the research issue:

- *How to guarantee security and safety of consumers?* Car-to-car communications and connections have to be stable and secured and give priority of safety information over entertainment data. At the same time critical software based systems have to be impossible to be hacked by outsiders. Authentication systems have to be in place. However one of the big issues is that the lifecycle in the automotive industry is up to 20 years, so solutions should hold for a long time (Koushanfar et al., 2012). An interesting question is where to embed security, in the car (e.g on an independent platform, by a transaction provider under control of the users, for instance on a smart card).

Privacy of consumers is also affected. Privacy is a core topic when for instance data is provided on driving behavior for services customization or price discounts for car insurance (De Reuver et al., 2016; Ohlsson et al., 2014). Weinberg et al. (2015) argue that providers should proactively consider privacy objectives, in order to build trust and to foster customer relationship. Data theft or unauthorized access require cyber security solutions for car IoT systems to guarantee trust (Dutton, 2014). With regard to privacy the question becomes relevant who owns and controls the data (Dutton, 2014). Data and access to data on customers and on customer behavior is considered to be a critical asset, and many providers and ecosystems will claim that they are the owners of the data (Weinberg et al.,2015).

- *How to balance privacy of consumers and opportunities of new mobility services?* At the upside smart transport systems can lead to avoiding congestions and efficient driving, at the downside it offers the opportunity to install road pricing and limiting drivers choice. In the same grain data on driving behavior can impact insurance companies pricing policies. Even affordance of safe connected car systems versus people who cannot afford to buy advanced cars might lead not only to a kind of digital divide but to uneven distribution of physical vulnerability. This leads to question with regard to appropriate government policies.

4 Conclusions

In this short paper, we developed an initial research agenda for digitalization in the automotive industry. Based on notions of connected cars, IoT, servitization and platformization, we suggested research issues on business models, platforms and consumer issues. While the practical relevance of these research issues alone already warrants pursuing the topics, we also argue that the complex nature of the automotive industry can lead to new theoretical insights. The current transformation in automotive industry provides an apt example of physical and digital convergence. Differing clock speeds between the rapidly evolving IT industry and the slow car industry provides challenges for developing new BMs and platforms, as do the unbalanced life-time cycles. The physical safety and digital threats on security provide an opportunity for conducting security and privacy research.

The literature we reviewed for this paper comprises of a limited number of conference and working papers that are rather diverse and focus on more or less unrelated topics. We interpret this as an indication for the lack of maturity of this research domain. Some papers are addressing the tension between the cyber physical systems (CPS) mainly from a business model and ecosystem perspective. Typically these papers originate in Germany and Sweden, two counties with a well-developed automotive industry. As next step, we plan to validate our research agenda with a focus group of experts from both the information systems and transportation domain.

References

Barney, J. (1991). Firm Resources and Sustainable Competitive Advantage. Journal of Management. Vol. 17, Iss. 1, pp. 99-120. DOI: 10.1177/014920639101700108.

Borgia, E. (2014). The Internet of Things vision: key features, applications and open issues. Computer Communications, 54, pp. 1–31. DOI: 10.1016/j.comcom.2014.09.008.

De Reuver, M. & H. Bouwman, (2012). Governing mobile service innovation in converging value networks. Journal of Business Research, Vol. 65, pp.347-354. DOI: 10.1016/j.jbusres.2011.04.016.

Dombrowski, U. & C. Engel (2014). Impact of Electric Mobility on the after Sales Service in the Automotive Industry. Procedia CIRP 16(0): 152-157. DOI: 10.1016/j.procir.2014.01.022.

Dutton, W.H. (2014). Putting to work: social and policy challenges for the Internet of Things. Info. Vol.16, Iss. 3, pp. 1-21.

Evans-Pughe, C. (2005). The connected car. IEEE Review. Transport Technology. pp. 42 – 46. DOI: 10.1049/ir:20050106

Fleisch, E., Weinberger, M. & Wortmann, F. (2015). Business Models and the Internet of Things. In: I.Podnar Žarko et al. (Eds.). FP& Open IoT Project Workshop, LCNS 9001, pp. 6-10. DOI: 10.1007/978-3-319-16546-2_2.

Gawner, A. (2014). Bridging differing perspectives on technological platforms. Toward an integrative framework. Research policy. Vol. 43, pp. 1239-1249. DOI: 10.1016/j.respol.2014.03.006.

Golestan, K., Soua, R., Karray, F., & Kamle M. (2015). Situation awareness within the context of connected cars: a comprehensive review and recent trends, Information Fusion, Vol. 29, pp. 68-83. DOI: 10.1016/j.inffus.2015.08.001

Hanelt, A., Piccinini, E. Gregory, R. Hildebrandt, B. & Kolbe, L. (2015). Digital Transformation of preliminary Industries. Exploring the impact of Digital trends on business Models of Automobile Manufacturers., in: Thomas, O., & F. Teutenberg (eds.).Proceedings of the 12th Internationalen Tagung Wirtschaftsinformatik. Osnabrück, pp. 1313-1327.

IBM Institute for business value (2015). Automotive 2025: Industry without borders, Executive Report,NY: IBM Corporation.

Kavis, M (2015). How connected cars will transform industries. Forbes [ONLINE] Available at: http://www.forbes.com/sites/mikekavis/2015/02/20/how-connected-cars-will-transform-industries/[Last accessed 7 March 2016].

Kote, T. (2015). How Silicon Valley will reinvent the auto industry. Forbes [ONLINE], Available at: http://www.forbes.com/sites/thejokote/2015/05/05/how-silicon-valley-will-reinvent-the-auto-industry/ [Last accessed 7 March 2016].

Koushanfar, F., Sadeghi, A-R. & Seudi, H. (2012). EDA for Secure and Dependable Cyber-cars: Challenges and Opportunities. Paper presented at DAC 2012, June 3-7, 2012 San Francisco.

KPMG. (2014). Me, my car, my life the ultra-connected age. KPMG International report.

Kyriazis, D. & Varvarigou, T. (2013). Smart, autonomous and reliable Internet of things, Procedia Computer Science, 21, pp.442-448. ISSN 1877-0509, http://dx.doi.org/10.1016/j.procs.2013.09.059.

Mikusz, M., Jud, C. & Schäfer, T (2015). Business Model patterns for the Connected Car and the Example of data orchestrator. In: J. Frenandes et al. (eds) ICSOB 2015, LNBIP, pp. 167-173.

Miorandi, D., Sicari, S., De Pellegrini, F. Chlamtac, I. (2012). Internet of things: Vision, applications and research challenges. Ad Hoc Networks, 10, 1497-1516. DOI. 10.1016/j.adhoc.2012.02.016.

Mohaghegzadeh, A. & Svahn F. (2015). Resource Transformation in Platform Envelopment. ECSI 2015 Research in Progress papers.

Ohlsson, J., P. Händel, S. Han & Wlech, R. (2014). Process Innovation with Disruptive Technology in Auto Insurance: lessons learned from a Smartphone based insurance telematics initiatives. In: J. vom Brocke & T. Schmiedel (eds.) Business Process Management: Driving Innovation in a Digital World. Springer.

Pfeffer J., & Salancik G (1978). The External Control of Organizations: A Resource Dependence Perspective. New York: NY. Haper and Row Publishers.

Piccinini, E., & Gregory, R.W. (2015). Transforming Industrial Business: the Impact of Digital Transformation on Automotive Organizations. 36th ICIS conference, Fort Worth, USA At Fort Worth, USA.

Seeger, G. & Markus, B. (2013). Mega and Consumer Trends – Towards Car-independent Mobile Applications. International Conference on Mobile Business (ICMB 2013). Paper, Available at: http://aisel.aisnet.org/icmb2013/27 [Last accessed 7 March 2016].

Svensson, G. (2003). Consumer driven and bi-directional value chain diffusion models, European Business Review, Vol. 15 Iss 6 pp. 390 – 400. DOI 10.1108/09600030510634599.

Turber, S., Brocke J.V., Gassmann, O. & Flesich, E. (2014). Designing Business Models in the Era of Internet of Things. 9th International Conference, DESRIST 2014, Miami, 22-24 May 2014, pp. 17-31.

Vargo, S., & Lusch. R. (2004). Evolving to a New Dominant Logic for Marketing, Journal of Marketing, 68 (January): pp. 1–17.

Venkatraman, V., El Sawy, O., Pavlou, P. & Bharadwai, A. (2014). Theorizing Digital Business Innovation: Platforms and capabilities in Ecosystems. Fox School of Business Research Paper No. 15-080. Available at SSRN: http://ssrn.com/abstract=2510111 [Last accessed 7 March 2016].

Viereckl, R., Ahlemann, D., Koster, A., & Jursch, S. (2015). Connected Car Study 2015: Racing ahead with autonomous cars and digital innovation, Strategy& http://www.strategyand.pwc.com/reports/connected-car-2015-study [Last accessed 7 March 2016].

Webster, J & Watson, R. (2002). Analysing the past to prepare the future: Writing a literature review, MIS Quarterly Vol. 26 No. 2, pp. xiii-xxiii/June 2002.

Weinberg, B., G. Milne, Y. Andonova, & F. Hajjat (2015). Internet of Things: Convenience vs. privacy and secrecy. Business Horizons, pp. 615-624. DOI: 10.1016/j.bushor.2015.06.005

Wernerfeldt, B. (1984). A Resource-based view of the firm. Strategic Management Journal. Vol. 5, iss.2, pp. 171-180.

Westerlund, M., Leminen, S., & Rajahonka, M. (2014). Designing Business Models for the Internet of Things. Technology Innovation Management Review, 4(7): 5-14. Available at: http://timreview.ca/article/807 [Last accessed 7 March 2016]./

29th Bled eConference

Digital Economy

June 19 - 22, 2016; Bled, Slovenia

Entropy-based approach for semi-structured processes enhancement

Julia Bilinkis (Stavenko)

National Research University Higher School of Economics (NRU HSE), Russia

ybilinkis@hse.ru

Elena Filimonova

National Research University Higher School of Economics (NRU HSE), Russia

efilimonova@hse.ru

Nikolay Kazantsev

National Research University Higher School of Economics (NRU HSE), Russia

nkazantsev@hse.ru

Anastasia Zueva

National Research University Higher School of Economics (NRU HSE), Russia

zueva_ag@mail.ru

Abstract

The paper analyses traditional quality control methods for business processes and their efficiency in respect to semi-structured process. We update a classical methodology to handle semi-structured processes: improve its execution and operational efficiency in a company. We propose Some new methods: under the Define step – a new method for describing business processes with the help of semantic maps; under the Measure step – a new method for the automated detection of non-random deviations (bottlenecks, errors); under the Analyse step – a new method for automated experts search to identify the root causes of business process problems based on an analysis of the information field.

Keywords: semi-structured process; business processes; flexibility; project management; system integration

1 Introduction

Business models are constantly changing. In order to react on market fluctuations and achieve higher customization of products companies seek how to make them “adjustable”. Among them, procedures that are based on the expert assessments and big data analysis are the core of modern enterprise.

A characteristic feature of such processes is the uncertainty of the input, output and variability of process instances. That is probably the most significant extension of traditional process definition coined by Hammer, Ciampi and Davenport. A high-level description of such processes may be stable, but the detailed problems of process instances during their execution are fuzzy defined and are difficult to replicate, as they are primarily dependent on the content and user behaviour. Thus, at the modelling and process automation step the decision is to be made in advance on all participants in the process and their actions and thus to create a detailed regulation of the process so it is almost impossible to monitor the implementation on its basis. Examples are processes for the production and provision of intellectual services, which are often prevalent in such sectors as education, information technology, smart production and all industries providing intellectual services (consulting, analytics, information brokerage, marketing and banking services, etc.).

Characteristic features of such processes are listed below [1]:

1. Customization to a specific consumer (i.e. intellectual service) is not standardized: provided to one client, it cannot be provided to another customer, since it requires data re-collection, analysis and information presentation;
2. Association of consumption process with the production process through constant interaction with consumers and fast response to demand;
3. Large number of sub-processes and tasks and interdependencies between tasks;
4. Each process task depends on other tasks, which leads to a large amount of feedbacks, the availability of information on the previous and subsequent process steps;
5. The use of explicit and implicit knowledge of experts. The behaviour of process performers depends on their knowledge, which is a constantly changing mix of experiences, values and incoming information;
6. Dependence on the context. The knowledge of subject area is used to perform the process, it includes tasks, documents, experts, and other indicators. The performed process is not limited to the orchestration of Web services and the sequence of tasks, but also obtaining all relevant information about the process;
7. Focusing on the executer, collaboration and decision-making requires the development and selection of integrated solutions among the fastest possible alternatives to achieve some certain goals. Responsibility of employees increases demands on their skills and competence;
8. Distributed processes. Process participants are not only employees of the company; the successful outcome of the process is highly dependent on corporate communications due to valuable ideas coming from the external environment and outflows of ideas out of the company which have no value for it.

This paper proposes an integrated approach to improving management efficiency (reaching goal of every business process separately while minimizing costs for its achievement under the influence of managerial decisions) based on new methods of analysis and monitoring, taking into account the specific characteristics of semi-structured processes listed above.

The paper is structured as follows: the describe research goal, objectives and methodology. The third chapter provides insights from business on semi-structural process optimization: DMAIC model, SIPOC and TQM. In the main fourth chapter we demonstrate the proposed refinements to DMAIC model. Finally, chapter V provides conclusions.

2 Goals and Objectives

The main goal of our on-going research is the development and testing of automated methods for quality monitoring of semi-structured processes using variance analysis of semi-structured processes. Our main hypothesis in frames of current paper is that *the current level of effectiveness of semi-structured processes can be identified and improved using entropy variations of the information field as the quality indicators of business process.*

To verify this hypothesis, the following objectives were set:

1) To analyze and update current approaches for the process analysis, justification and selection of the description of semi-structured process using information field (unstructured data);
2) To determine:
    a) causes of natural variability (process output forms the distribution, stable and predictable over time),
    b) a non-random variability (disturbances in the process) by measuring entropy characteristics;
3) To compare real process problems with the problems discovered,
4) To update DMAIC methodology for semi-structured business processes.

The main method of research consists of deductive gathering of scientific information and further analysis, practical case studies. On the basis of this analysis we coin new notions. According to Hevner[1] there are two main methodologies to scrutinize the IS: the first one is Behavioral science model and the second one is Design science model. Our research bases on the latter model. This concept sees the IS scrutinizing as a science artifact, aimed to solve organizational problems of the company. The main principle of the model is enhancing the efficiency of IS within the organization via design modelling. As a modelling language we used UML. Enhanced state of the information system takes place thanks to optimization of its development and integration, staff trainings and creating new functional abilities.

March and Smith [2] suggested their own descriptive method for IS research. This method comprises two design processes and four design science artifacts. These artifacts are so-called constructs, sub-models, methods and concretizations. Constructs are playing a role of descriptive elements and shaping the common model view (i.e. verbal language). Sub-models build description of the situation out of the set of constructs. Methods contain text or logical description as well as algorithms for defining interaction between sub-models. Concretizations unite constructs, methods and sub-models into a one single model.

This paper proposes some new tools that can be used at each step of this methodology for semi-structured business processes. Our main methods are: deductive trend search in the literature review and the entropy method for determining the degree of disorder of the system (characteristics of the unstructured information field).

3 Application of DMAIC methodology on semi-structured processes

To improve the operational efficiency consultants in business often use DMAIC methodology (Define, Measure, Analyse, Improve, Control), developed around "6 sigma" concept (Fig.1).

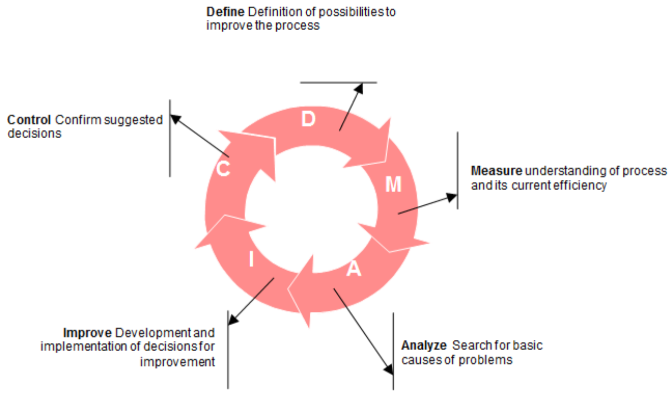


Figure 1. DMAIC methodology

DMAIC involves a gradual transition from the general understanding of the most effective solutions to the problems, with minimal cost and in the shortest time. DMAIC projects are always divided into five successive steps named after each letter and knowledge management approach for dissemination of project-related information. The cycle starts with identification requirements of customers and business, setting optimization goals, determining expert profiles for working groups what is included into a project charter.

To define the clear boundaries of the optimized process and its key participants SIPOC method (Supplier – Input – Process – Output – Customer) is often used.

S	I	P	O	C
External suppliers Domestic suppliers (employees, GSP management) Customers	Resources, documents, information, preliminary work	Description of process	Results of process	External customers Domestic customers Other interested person

VOC (Voice of Customer), technical conditions and information

Figure 2. SIPOC method: Supplier – Input – Process – Output – Customer.

The effectiveness of a structured process is easy to measure taking into account the fact that the set of works is always predetermined and structured and thus evaluating the performance of all the components, we can conclude about the effectiveness of the entire process. As indicators for monitoring the process parameters can be selected, which are relevant objectives of each function/sub-process with a certain periodicity of collection, using which the organization receive a well-balanced system of indicators of symptoms of problems.

Another technique that postulates that the product or service of poor quality is the result of unpredictable variability of the process (or input process parameters) is Total Quality Management (TQM). According to this technique process is statistically controlled when the only source of variation is the natural cause – a variability, originating from numerous sources and inherent in the process. Natural changes behave as a system of random factors with constant parameters.

While all process instances differ, they form a certain pattern as a group; it can be described as a distribution. The reduction of this variation requires management solutions and investment capital (for example, to purchase new equipment). If this is a normal distribution, it is characterized by two parameters: the mean and standard deviation. It is impossible to measure the mean and standard deviation in practice, as this would require the measurement of all possible instances of the process. Instead they use a number of measurements taken over time by measuring the sample mean and sample variance, respectively. Until the distributions of these parameters are within predetermined limits, the process is statistically controlled and natural variations are allowable. If they come out of the specified parameters, this is due to non-random changes that are not inherited by the process. Reduction of variation requires a special analysis of its causes.

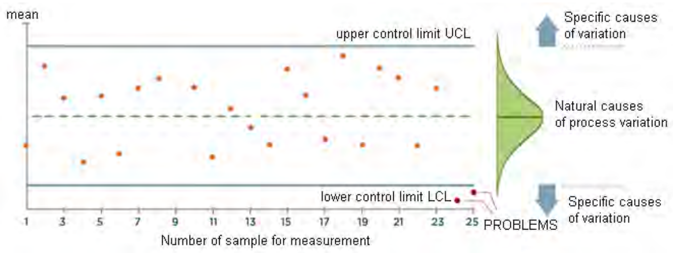


Figure 3. Natural and special causes of variation

First of all, the process must be statistically controlled; it can be done by identifying and addressing the special (non-random) causes of variability. The objective of quality control task is to supply statistical signal about the presence of non-accidental causes. Such a signal can accelerate the adoption of measures aimed at the elimination of non-random causes. This approach has proven itself to standardized processes with high volume output and low diversity.

But on the other hand, the work is not always being done consistently and with pre-defined structure, at a modern approach, it becomes clear that the process can contain both structured work and ad-hoc works, often the unique challenges. Such processes can be called nonlinear intelligent, dynamic and contextual by nature. The choice of indicators for semi-structured processes is not a trivial task, very often it’s possible to use only the delayed parameters of the process result, but in case of their usage it is difficult to respond quickly at problems emerging during the process implementation. The advantage of leading indicators is that they have the prognosis nature and allow the organization to adjust its actions quickly on the basis of comparison of the actual indicators values with planned values.

In the following sub-sections we propose to use the indicators related to the information field of the process as the elements of a subset of leading indicators for the semi-structural processes. In the following sections we describe each DMAIC methodology step with our refinements.

3.1 Define step using insights from information field

The semi structured process itself can be defined as a set of concerted efforts of the interacting participants - information and knowledge holders. We consider the activities of the company as a result of the functioning of the socio-technical system and the activities in process are aimed on searching for the required procedural decisions in the system of distributed information and knowledge. The efficiency of the entire process depends on the efficiency of search management. In terms of subject-oriented approach the subject (member of process) is the starting point to describe a situation or event. Subjects synchronize their activity through messaging to switch between their functional states. As part of the semi structured process performing, subjects generate content at a proper assessment of which it is possible to distinguish the purpose of the process and its semantic environment.

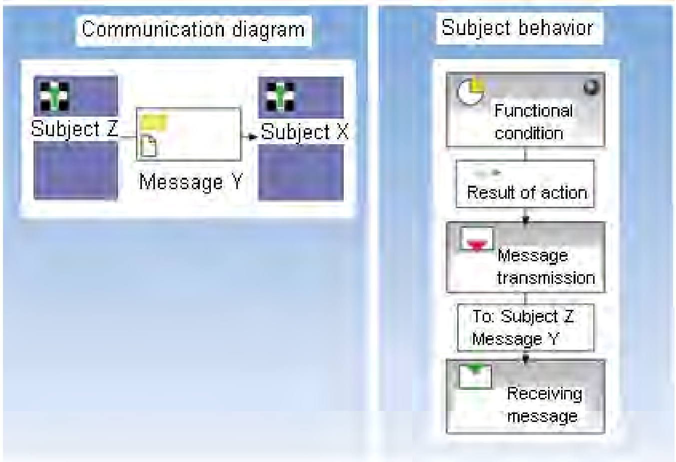


Figure 4: Presentation of the business process in terms of subject-oriented approach (Message transmission)

The idea of presenting processes with the help of unstructured information has been described by several authors. The formation of automation system model of an enterprise as a multilayer taxonomy has been made in work [3], where the company is regarded as a "*scale significant collection of various information entities*" [3] which can be classified by created taxonomy. In the work [3] structural units of the enterprise are root taxa, keywords are the end ones and define a business process – operations. Ontology definition and formal models of business processes of telecommunication enterprise are described in detail in the paper [4]; where the taxonomy of business processes was described based on the reference ontology, then the ontology was created based on real business processes of the organization, after their comparison and analysis. Both ontologies have been formed on the basis of a common glossary of terms.

That's why within the scope of the study the process would be described through:

• *Information field*, which is a set of messages which are exchanged between participants during process execution to achieve a certain objective;

• *Subjects* (participants of the project) - implicit expert knowledge carriers. The information field is given by the characterizing topics of the text information, which in turn are defined by terms.

Topic is not just a set of terms (keywords), it is not random, but stable characteristics of a set of semantically related terms, characterizing the process. This was confirmed in study [5].

3.2 Refinement of the second step (Measure) using performance of information field

At Measure step, the measurement is performed, it is gathered data on the problem (Y) and possible root causes (Xn): Y = f (x1, x2, …,xk), where Y is the result of a process, Xn – inputs and internal factors of the process.

For structured process at this step based on a generalized map of SIPOC/VSM a detailed process map is created, it includes marked process steps, tasks, operations, and decision-making moments in chronological order. The purpose for the semi-structured process is clearer than the way of its achieving, therefore the choice of the way will be determined in the course of achieving goal based on the information and would not be planned in advance, so it cannot be fixed in a low-level regulations or process model.

Defining of semi-structured processes can be impractical because of the measurement of the same parameter for different instances of the same business process, different values will be received faster due to the following reasons:

• Business process is characterized by complex logical and temporal structure, so a copy of it can be developed in different ways depending on numerous conditions;

• Objects incoming to the business process for different instances can have different values of the same parameters and that significantly affects the development of the whole business process;

• Subject actions of the business process can be changed under the influence of external and internal environment;

• Some activities within the business process related to decision-making can have an informal unregulated character.

• The above-described control maps method can be used only for structured processes. Control maps cannot be applied, if the inputs are not homogeneous, the process is not regular, the output parameters are unique. I.e. for semi-structured processes there must be developed a new approach which enables to:

• Define the non-random variation causes of the semi-structured process in order to respond to the situation when process parameters go beyond the scope and thus to identify problems before client meets them.

• Reduce the variability of the process, to improve the product or process input parameters, thus reducing the likelihood of unpredictable variations impact the process and lead to problems.

If we define a business process in the form of its information field; its content is designed to implement a specific goal in case of non-random changes terms describing these changes should appear in the information field. The indicators of the information field will be used as leading indicators, which are determined by detecting the abnormal variation in the references frequency to relevant terms by process participants. The paper shows that the meaningful terms should have strongly unequal distribution of the relative frequency of use among the employees and commonly used ones show approximately the same relative frequency of use.

To solve the task of the significant terms extraction from the commonly used ones, it was calculated the statistics of the *relative usage frequency* of t_i term for all texts written by a particular employee p_j:

$$TF\left(t_i, p_j\right) = \frac{m(t_i, p_j)}{\sum_k m_k}, \tag{1}$$

where$m\left(t_i, p_j\right)$is the number of uses t_i term by p_j person, and the denominator is the total number of occurrences of all terms by p_j person.

As a result, for each term, you can make a sample of the relative usage frequency of this term by the authors$TF\left(t_i, p_j\right)$, where n is the number of terms in the information field of the organization, N is number of authors:

$$\begin{matrix} TF(t_1, p_1) & \dots & TF(t_1, p_N) \\ \dots & \dots & \dots \\ TF(t_n, p_1) & \dots & TF(t_n, p_N) \end{matrix} \tag{2}$$

Several metrics can be offered to determine the significance of the term, based on the idea of nonlinear probability distribution. The simplest metric for the degree of changes in the values of the sample is determined by calculating their variances$D(t_i)$,that is, the variance of the relative frequency of use of the$t_i$term and standard deviationσ_i:

$$D(t_i) = \frac{(TF(t_i, p_1) - M)^2 + (TF(t_i, p_2) - M))^2 + \dots + (TF(t_i, p_N) - M))^2}{N-1} = \frac{1}{N-1} \sum_{k=1}^{N} (TF(t_i, p_N) - M))^2, \tag{3}$$

where M is an estimation of the expectation (the sample mean), the relative frequency of use of the term, is calculated as follows:

$$M(t_i) = \frac{TF(t_i, p_1) + TF(t_i, p_2) + \dots + TF(t_i, p_N)}{N} = \frac{1}{N} \sum_{k=1}^{N} TF(t_i, p_N) \tag{4}$$

The standard deviation of the relative usage frequency of the term is the square root of the variance:

$$\sigma(t_i) = \sqrt{D(t_i)} \tag{5}$$

Then the significance of the term for a particular author exceeds the expectation $M(t_i)$,measured in standard deviations $\sigma(t_i)$:

$$Impact(t_i\,; p_j) = \frac{(TF(t_i,p_j) - M(t_i))}{\sigma(t_i)} \tag{6}$$

According to the equation (8), it turns out that the negative values of $Impact(t_i\,; p_j)$ will have the authors which have rarely used the term, i.e. not experts on this term.

To normalize the weight of $Impact(t_i\,; p_j)$ calculation of arctangent function is used. The higher is the value of arctangent, the more significant is this word for the author:

$$\mathrm{FinalImpact}(t_i\,; p_j) = \mathrm{arctg}\ (\mathrm{Impact}(t_i\,; p_j)) \tag{7}$$

i.e. innovations are determined by identifying abnormal deviation of the term usage frequency.

Identification of the business process characteristics, which affect its quality indicators can be combined into a single function. All the considered characteristics are the variables in the objective function of the business process. Since the function is directional and has more than two parameters, we consider in this case the multi-criteria optimization, and an appropriate vector, which can be used to control the quality of the test process.

Some tasks can be solved based on analysis of information criterion, for instance, determining whether a business process corresponds to the reference one (officially required), revealing hidden company's processes, identifying trends and dependencies in the life cycle of business process. All of the tasks of identifying and applying the results in practice lead to the optimization of business processes and activities of the company as a whole.

3.3 The third step of the project optimization: search for experts, analysis of the root causes of problems

The root causes of process problems are determined and confirmed during the Analysis step. To do this, one should provide a list of reasons (critical) and how they are determined by an expert report. Then experts using tools such as the Ishikawa diagram and 5 Why perform a causal analysis to determine the root causes and make the prioritization of the most important reasons. To do this, one should identify the human expert for each deviation, a person who chooses and makes decisions based on information provided by the decision support system.

The amount of effort that are to be made in order to find an expert in the organization depends on several factors such as the size of the organization, the level of automation, the power of social relations within the organization, etc. In case if there is no automated expert search engine a task of finding the right person may take considerable efforts.

To identify experts within the process you need to:

1. the concept of topic, i.e. the set of semantically related terms
2. define the most relevant topic for each author.
3. match the topic with search query to select relevant authors (experts) not by words but by semantic units.

It is necessary to group all the important terms so that for any term to choose the relevant topic (group of terms) on the basis of the above tasks. For this reason, we used model in which each term is associated with many others. This model can be represented as a graph, its nodes are the terms and subgraphs are the topics, the adjacent topics have common terms (graph nodes).

Clustering is not the most effective way to solve this problem its result is a partition of the terms into clusters (one term cannot not be included in more than one cluster). A more efficient way is to calculate the semantic proximity of terms in which a list of related terms (TOP 50) is selected for each term. Different techniques are used to calculate the semantic similarity between the terms: PMI1, LSI2, LDA3, etc. [6]. PMI method is computationally less expensive, and thus works quite predictably, in addition it shows the greatest consistency in terms of experts [7].

This method involves determining the PMI-related terms based on their co-occurrence in each text. Input information is a set of unstructured text of each author, which they exchanged at work, this is a collection of D-documents.

The term means the word w, extracted from text ∈D (data) and having a high importance for informative text. Topic T is a set of semantically related key phrases, T = {w1, …, wN }. In the best case, all the terms which form the topic T refer the same category which is sufficiently narrow.

Statistical methods are based on the calculation of performance based on the co-occurrence of words. At the same time all the words are treated as points in N-dimensional space, and the problem of determining the semantic distance is reduced to two basic steps:

1) Set the coordinates of points in space.
2) Calculate the distance between the points. The last step requires the selection of suitable metric. In order to reduce the dimension of task being solved by clustering the N-dimensional space in which the presentation and clustering points is performed is built based on a set of T key phrases, selected in this step as follows:
   a) Set T is regarded as fixed dictionary at this step Vc, |Vc|=N.
   b) All key phrases v ∈ Vc are numbered.

1 Probabilistic Latent Semantic Indexing

2 Latent Semantic Analysis

3 latent Dirichlet allocation

c) Now, each word or phrase w ∈ V can be represented in the N-dimensional vector values of co-occurrence (fw) = (f1…fn), where fi indicates how often a word w occurs in conjunction with the word vi.

Thus, each key phrase appears as a point in N-dimensional space. The values expressing the degree of semantic proximity of sentences with phrases from Vc are to be taken as the coordinates of points fi having such characteristic: the bigger is the semantic proximity of the two considered words or phrases the bigger is the value. This PMI value for v and w phrases has such form:

$$\mathrm{PMI}(\mathrm{v},\mathrm{w}) = \log\frac{\mathrm{p}(\mathrm{v},\mathrm{w})}{\mathrm{p}(\mathrm{w})\mathrm{p}(v)} \tag{8}$$

Where p(w,v) is the frequency of co-occurrences of terms w and v, p (w) – frequency of the term w in the texts, p (v) –frequency of the term v in the texts. Words w and v are considered to be met jointly when they met at a distance not of less than N words. If two words are statistically independent, their PMI is equal to “0”.

4 Conclusions and constraints

All mentioned above refinements are sufficient from our experience *for handling semi-structured processes in modern business models.* The proposed changes need to be verified not only on set of industries but also in different cultural environments. Those are our intentions for continuation of this on-going research. The latter works would be aimed on fostering the fourth step and fifth step (controlling) solutions for improving the process on the basis of the identified factors. During fifth step the developed solutions are extended and fixed.

References

- **Journal Articles**

von Alan, R. H., March, S. T., Park, J., & Ram, S. (2004). Design science in information systems research. MIS quarterly, 28(1), 75-105.

March, S. T., & Smith, G. F. (1995). Design and natural science research on information technology. Decision support systems, 15(4), 251-266.

Konev, K.A. (2012): "Conceptual model of enterprise automation in the aviation industry based on multilayer taxonomy", UGATU.

Chistiv D.A., Kamaev V.A., Naboka M.V. "Ontological re-engineering of business processes of service provider", VolGTU.

David Newman, Sarvnaz Karimi, Lawrence Cavedon: "External Evaluation of Topic Modes", NICTA and The University of Melbourne Parkville, Victoria 3010, Australia.

Anton Korshunov, Andrey Gomzin. Topic modelling in natural language texts, ISP RAS, Moscow, Russia [Electronic resource].

http://www.ispras.ru/proceedings/docs/2012/23/isp_23_2012_215.pdf

J. Hockenmaier. Introduction to Natural Language Processing. Lectures at University of Illinois at Urbana-Champaign [Electronic resource].–Mode of access: http://www.cs.uiuc.edu/class/fa08/cs498jh/

Дулесов А.С., & Хрусталев В.И. (2012): Определение энтропии как меры информации при сопоставлении прогнозных и фактических показателей предприятия, Современные проблемы науки и образования, ISSN 2070-7428.

Зеленков Ю.А. (2013): «Об измерении эффективности бизнес-процессов и поддерживающих их информационных систем», Управление большими системами, ОАО «Научное Объединение «Сатурн», Рыбинск

Jae-Yoon Jung: «Measuring Entropy in Business Process Models», The 3rd International Conference on Innovative Computing Information and Control, 2008 г.

Olga Streibel: "Mining Trends in Texts on the Web", Networked Information Systems, Free University Berlin, K¨onigin-Luise-Str.24-26 , 14195 Berlin, Germany.

Лопатин В.А. (2008) Система управления бизнес-процессами // Управление в кредитной организации. № 6.

Кини Р.Л., Райфа Х. (1981) Принятие решений при многих критериях: предпочтения и замещения. — М: Радиосвязь.

Gromoff A., Kazantsev, N., Kozhevnikov, D., Ponfilenok, M. and Stavenko, Y. (2012). Newer Approach to Create Flexible Business Architecture of Modern Enterprise. Global Journal of Flexible Systems Management. 13(4), Springer-Verlag, 207-215

29th Bled eConference

Digital Economy

June 19–22, 2016; Bled, Slovenia

Factors influencing the Information Literacy of Students: Preliminary Analysis

Alenka Baggia

University of Maribor, Faculty of Organizational Sciences, Slovenia

alenka.baggia@fov.uni-mb.si

Anja Žnidaršič

University of Maribor, Faculty of Organizational Sciences, Slovenia

anja.znidarsic@fov.uni-mb.si

Mirjana Kljajić Borštnar

University of Maribor, Faculty of Organizational Sciences, Slovenia

mirjana.kljajic@fov.uni-mb.si

Andreja Pucihar

University of Maribor, Faculty of Organizational Sciences, Slovenia

andreja.pucihar@fov.uni-mb.si

Andrej Šorgo

University of Maribor, Faculty of Natural Sciences and Mathematics, Slovenia

andrej.sorgo@um.si

Tomaž Bartol

University of Ljubljana, Biotechnical Faculty

tomaz.bartol@bf.uni-lj.si

Blaž Rodič

Faculty of Information Studies, Slovenia

blaz.rodic@fis.unm.si

Danica Dolničar

University of Ljubljana, Faculty of Natural Sciences and Engineering

danica.dolnicar@ntf.uni-lj.si

Bojana Boh Podgornik

University of Ljubljana, Faculty of Natural Sciences and Engineering

bojana.boh@ntf.uni-lj.si

Abstract

Our changing society is forcing higher education to improve teaching habits in the context of higher level of information literacy (IL) among students. IL is necessary not for only education but is a skill needed for successful engagement in professional and private life. An IL test and a survey on information and communication technology (ICT) usage were conducted among students from seven different faculties in Slovenia. The presented research in progress presents a preliminary analysis of the IL testing and ICT usage among students, to propose the model of factors influencing the level of students' IL skills. According to the results, there are differences in IL, but they do not depend on the origin (faculty) of the student. ICT devices and applications usage could be an appropriate predictor of IL.

Keywords: Information literacy, Students, Influence, Factors, Application use, ICT use

1 Introduction

Information literacy (IL) is defined as an intellectual framework for understanding, finding, evaluating, and using information (ACRL, 2000). IL competencies and skills have been a significant subject in the area of higher education, influencing the design, content, teaching methodology and management of academic courses for the past two decades. Boh Podgornik, Dolničar, Šorgo, and Bartol (2015) argue that proficiency in IL skills may be accomplished by a combination of information and communication technology (ICT) skills, investigative methods, logic, critical thinking, discernment, and reasoning.

IL skills have been identified as one being crucial for successful academic studies, work and personal life (Eisenberg, Lowe, & Spitzer, 2004). Furthermore, IL is becoming increasingly important due to rapid technological development (Welsh & Wright, 2010). Students are expected to gain, deepen, and continuously improve their knowledge; therefore, the demand to use diverse information resources and a spectrum of methods available to use such resources is rising. Contemporary lecturers assume that students have certain IL skills in the current digital society. Thus, students in higher education are facing significant challenges in the enhancement of their study approaches.

According to Detlor, Julien, Serenko, and Booker (2010), student learning outcomes are influenced by IL program components. Limberg, Sundin, and Talja (2012) further define IL as "the ability to search for, select, critically evaluate and use information for solving problems in various contexts, such as independent project work in schools". Research by Johnston and Webber (2003) found IL to be a key discipline of the information society. The library is among the first places where a person becomes familiar with the concept of IL (Julien & Given, 2003; Robertson & Jones, 2009); furthermore, on some campuses, libraries are responsible for IL education (Hutchings & Willey, 2014). Higher education institutions represent the second step in the acquisition of IL competencies of a student.

A significant contribution to the stable integration of IL in higher education institutions in Slovenia has been the authorized translation of the US publication "Information Literacy Competency Standards for Higher Education" (ACRL, 2000; Stopar, Kotar, Pejova, & Knap, 2010). Since then, IL has been positioned as a key educational priority of higher education in Slovenia (Boh et al., 2014).

Despite the integration of IL standards into the educational process, students do not come to university well trained for academic research (Salisbury & Karasmanis, 2011). Johnston and Webber (2003) propose the "information literate university", where the focus is not only on teaching students to be information literate. Such a university requires a connected and coordinated work of all members of the university (Johnston & Webber, 2003). The aim of the information literate university is to enhance IL in order to give students an edge in academic, work and private environments throughout their lives (Maybee, 2006).

To identify the obstacles and develop an insightful and extended concept of IL competencies of students, researchers from six Slovenian faculties cooperated in a national project "Development of student IL as a support to solving authentic science problems" (J5-5535). The aim of the project is to develop and evaluate an efficient educational model for the IL of students. Integration of problem-based learning concepts into the educational process will be performed considering the criteria and indicators of IL in higher education.

This paper is organized as follows: in Section 2, a brief presentation of methods used in this research is given, including the development of the questionnaire. In Section 3, results of the research are presented. Based on the presented results, Section 4 includes a discussion of proposed hypotheses. In Section 5, conclusions and implications for future research are given.

2 Literature review

There are many studies on IL assessment in different contexts, developing and using various tests as research instruments (e.g. Mery, Newby, & Peng, 2012; Mittermeyer, 2005; O'Connor, Radcliff, & Gedeon, 2002). Most of them follow the recommendations of various IL standards (e.g. Gross & Latham, 2012; Thornton, 2008). However, most of the studies are conducted by librarians, sometimes in cooperation with researchers or IL educators. A detailed review of IL assessment tools, design, and content of available IL tests (ILT) and questionnaires are presented in Boh et al. (2015). However, there is no final general agreement on which methodology or which specific IL test format serves best to evaluate the IL of students in higher education. Furthermore, there are few studies investigating factors influencing IL skills.

Previous research showed weak knowledge of ICT literacy (Katz, 2007) and digital literacy (Eshet-Alkalai & Amichai-Hamburger, 2004) among college and high school students. Factors affecting IL achievement in high schools, focusing on teachers', librarians', and student's perspectives, are presented by Varlejs & Stec (2014). Authors propose that understanding and commitment of school leaders is necessary to improve the IL of students. Although there are indices, that the performance in IL depends on the major topic of the study, there is no doubt, that IL knowledge can be improved with courses that teach and require IL skills to be used (Kiliç-Çakmak, 2010; Williams & Evans, 2008).

Detlor, Julien, Willson, Serenko, and Lavallee (2011) propose three basic groups of factors affecting IL instructions at business schools: learning environment factors, IL program components, and student demographics. Although the IL student learning outcomes are affected by several individual factors, they are rarely under the control of librarians and teachers (Martin, 2011). Demographic and academic characteristics that may predict success in an IL test are presented by Godbey, Ladd, and Fabbi (2014). Only one of the proposed group of factors considering the influence of school (principals monitoring of teachers' ICT use), and both items considering individual attributes of a student (gender and parental socioeconomic status), have a significant impact on students' computer and information literacy (Lorenz, Eickelmann, & Gerick, 2015). Experiments on digital literacy shed further insights into information skills (Eshet-Alkalai & Amichai-Hamburger, 2004), in which older experiment participants performed better in information literacy compared to the younger participants who performed better in computer use.

Although, according to Šorgo, Bartol, Dolničar, and Boh Podgornik (n.d.), attributes of digital natives are poor predictors of information literacy, and the frequency of digital devices usage does not directly influence information literacy, the aim of this research is to evaluate and propose constructs in order to determine if they could be eligible factors that affect the IL of students.

3 Methodology

3.1 Study design and participants

The presented research is part of a broader study on the use of problem-based learning (PBL) in an e-learning environment to improve students' IL skills. The study was designed as a natural experiment, where control and treatment groups of students were observed in their natural study environment. Courses, in which the experiment was conducted, were selected based on the possibilities to employ a PBL in an e-learning environment. The IL-related content was designed and implemented by university professors, with problem-based examples from the domains of the study programme. Pre- and post-tested students completing an ILT and ICT usage questionnaire before taking any IL-specific classes were considered to be a control group, while students pre- and post-tested after participating in a PBL-IL course were a treatment group. To assess the impact of PBL e-learning use on IL, two questionnaires were administered pre- and post-participation in the course. This study focuses only on the pre-test results of the two measuring tools: Information Literacy Test and ICT usage questionnaire.

Testing of the students began in the 2013/14 academic year and will be finished by the end of the 2015/16 academic year. The current group of 850 tested students consisted of students from two different Slovenian universities (six faculties) and one autonomous faculty. All students were involved in different courses, which included IL topics. Participation was voluntary. Surveying was performed as an e-learning activity with the supervision of an educator.

3.2 Instruments and variables

The ILT was developed as a measure to evaluate students' IL. The final test consists of 40 multiple-choice questions. Each question offers a choice of four possible answers, arranged in alphabetical order. Only one of the possible answers is the correct answer. It is not possible to select "No answer" or "Other" as an answer. The detailed process of the ILT development is presented in Boh Podgornik, Dolničar, Šorgo, and Bartol (2015).

According to ACRL standards (ACRL, 2000), the IL assessment was divided into five groups defining the information-literate student:

1. Determines the nature and extent of the information needed (ACRL1).
2. Accesses needed information effectively and efficiently (ACRL2).
3. Evaluates information and its sources critically and incorporates selected information into his or her knowledge base and value system (ACRL3).
4. Individually or as a member of a group, uses information effectively to accomplish a specific purpose (ACRL4).
5. Understands many of the economic, legal, and social issues surrounding the use of information and accesses and uses information ethically and legally (ACRL5).

The five groups of ACRL standards are measured in detail as constructs in the test; they are all measured with several different items (questions). Construct ACRL1 was measured with 15, ACRL2 with 10, ACRL3 with five, ACRL4 with four, and ACRL5 with seven items. Due to an easier comparison of constructs' scores, the ratio of achievements for each construct was calculated. The reliability test with a Cronbach's alpha value of 0.723 confirms the reliability of the ILT with 40 questions.

In addition, a survey aiming to explore the habits and use of ICT among students was conducted. There were 35 questions aiming at the exploration of students' habits regarding the ICT application and device usage. The students were asked: a) which ICT devices they own and how often they use them, b) to what extent they use different ICT applications, c) to what extent they use ICT and applications for educational purposes, and d) how self-confident they feel when working on the internet.

Among the 35 questions on ICT usage, there were four about the usage of ICT devices, focusing on the usage of the smartphone, tablets, portable, and stationary computers. The items were measured on a 5-point Likert-type scale of frequency, on which "1" means "never" and "5" means "more than once per day". According to the distribution of answers, values of skewness and kurtosis, it was decided that data about the usage of ICT devices should be represented as dichotomous variables. Therefore, all answers marked from 1 or 2 on the Likert scale were recoded to 0, stating that the student does not use advanced applications, and answers marked from 3 to 5 on the Likert scale as 1, stating the student uses advanced applications more than several times per week and is thus considered to be a user of advanced applications.

The questionnaire included 16 questions regarding the usage of different ICT applications. Since the questions on ICT application usage are quite diverse, five groups of questions are proposed based on our tentative assumptions. Exploratory Factor Analysis (EFA) was conducted to evaluate the proposed groups or latent constructs. EFA confirmed a hypothesized five latent constructs structure. The latent constructs and their items are proposed in Table 1.

Latent construct	Item
Application usage for learning	Using bibliographic databases (e. g. Cobiss, Scopus, Web of Science, EBSCO)
	Prepairing seminar and project works
	Reading e-books and scientific papers
	Working with office tools (MS Office, Open Office)
Application usage for searching and communication	Searching for information (e. g. Google)
	Watching videos (e. g. YouTube)
	Communication (e-mail, MSN, Skype)
	Using web maps (e.g. Google Maps, Google Earth)
	Reading newspapers and daily news at the Internet portals
	Using social networks, forums and blogs (e. g. Facebook, Twitter)
	Using e-learning materials and e-textbooks
Professional advanced application usage	Programming
	Designing web pages
Freetime advanced application usage	Editing and processing photos (e. g. Picasa, Photoshop)
	Editing and processing videos and animations
Other	Playing games

Table 1: Constructs and items to measure ICT application usage.

Items presented in Table 1 were measured on a 5-point Likert-type scale of frequency, on which “1” means “never” and “5” means “more than once per day”.

The first question of ICT and application usage for learning was about the total number of courses in which the student was involved the current year. Furthermore, the extent of ICT and application usage for educational purposes was measured as the ratio of courses where ICT and applications were used as:

- Individual usage at the faculty (e.g. simulations, animations, programming)
- Web interaction with lecturer to perform study assignments (e.g. Moodle)
- Individual search of sources and information on the web for seminar assignment
- Advanced search in specialized databases

In addition, self-confidence when working on the internet was measured with 10 items on a 5-point Likert-type scale for the level of agreement, on which “1” means “strongly disagree” and “5” means “strongly agree”.

4 Results

In this paper, an analysis of the pre-test results of ILT and ICT use is presented. A total of 750 students (69% female and 31% male) participated in the pre-test survey. The age of the respondents ranges from 18 to 52 years with an average age of 21.42 years and standard deviation 3.342 years. The proportion of different study fields (faculties) are represented in Figure 1; 47% of students came from natural sciences studies and 53% from social sciences.

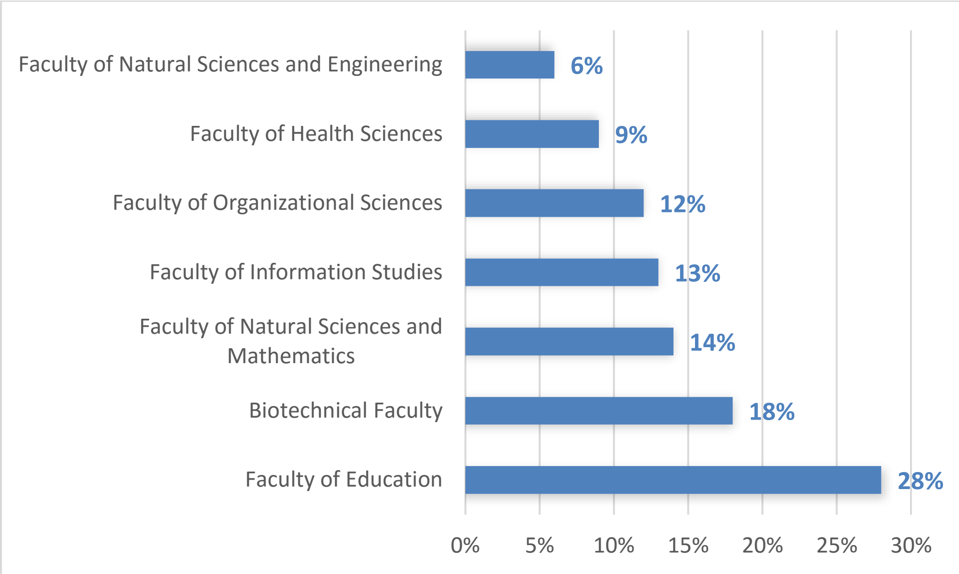


Figure 1: Shares of respondents from different faculties.

The ILT maximum value is 40 (each correctly answered question accounts for 1 point). The ILT revealed that the average achievement at the pre-test was 26.60 points with an SD of 4.90. This means that the average achievement was 67% of the total score, while the minimum and maximum achievements were 20% and 98% respectively, with an SD of 4.902%.

The level of IL skills increases with the year of study, from the first and second year of study, where the average score achievement is 66% of the maximum score, the average score rises to 68% and 73% in the third and fourth years of study, respectively. There are no significant differences in achievements regarding the gender of the respondent. We performed ANOVA to test for differences in score achievement between the faculties. ANOVA revealed that there were no statistically significant differences at 5% significance level in the results of the ILT between seven faculties involved in the testing. Figure 1 shows the overall ILT score achievement of the pre-tested students at individual faculties. Overall students have similar results in IL skills.

.

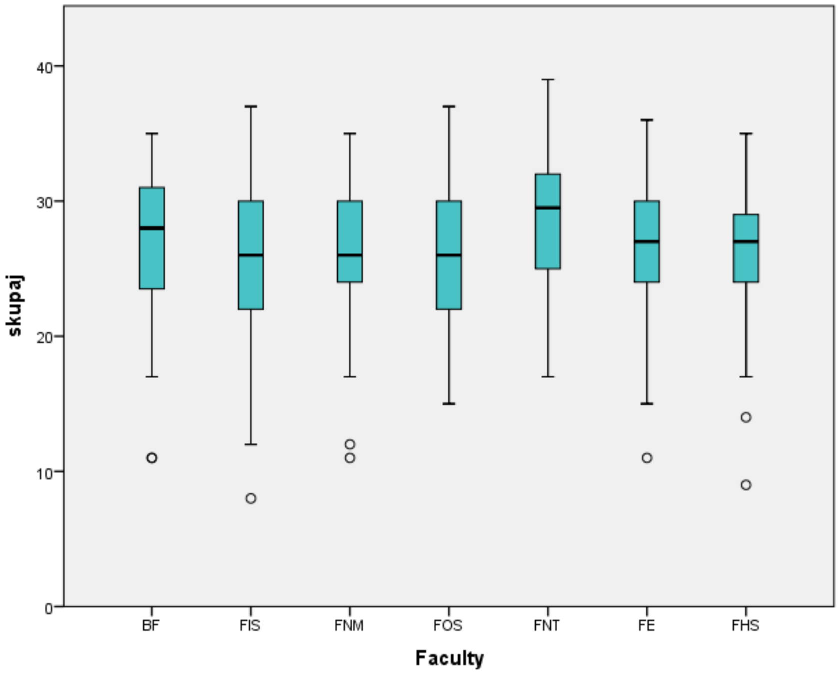


Figure 1: Score achievement at the ILT pre-test.

The results of ACRL standard groups showed different levels of IL in individual components, as presented in Figure 2.

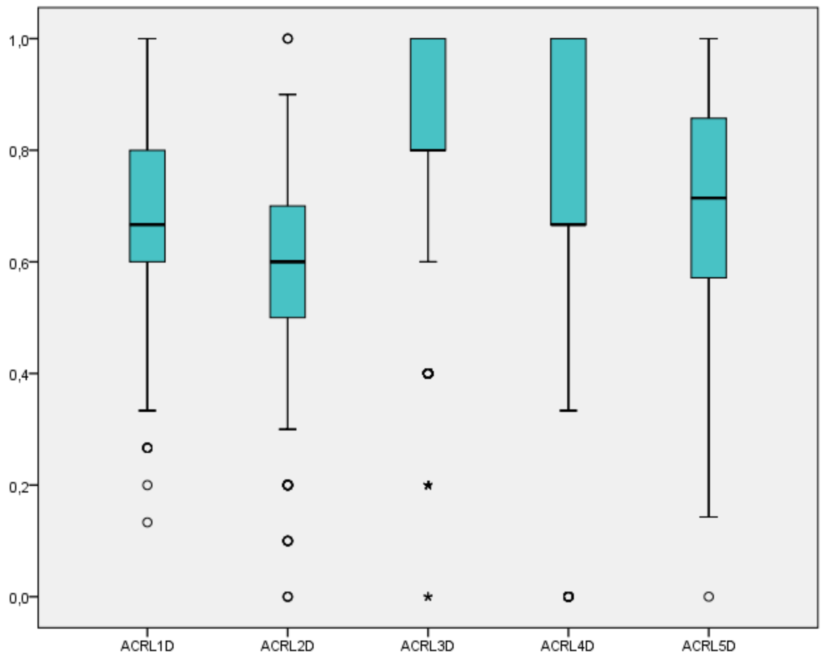


Figure 2: ILT achievements in individual groups of IL according to ACRL.

The analysis of IL skills shows that students have different levels of skills on individual topics of IL–ACRL. The highest level of IL skills is observed in ACRL3 (critical evaluation and use of information and its sources) and ACRL4 (uses information for problem-solving individually or as a group), with ACRL3 having the smallest variability in data. The level of IL skills is the lowest in ACRL2 (effective and efficient access to information). The understanding of economic, legal, and social issues surrounding the access and use of information (ACRL5) shows the largest variability.

Our aim is to identify some individual factors which could, in addition to the proposed components, influence the IL of students.

4.1 ICT usage questionnaire analysis

Analysis of the ICT use revealed that the most frequently used ICT device is the smartphone, followed by the portable computer (laptop); 90% of students use smartphones more than several times per week, and 85% of students use portable computers more than several times per week.

While there are no statistically significant differences in the frequency of smartphone and tablet usage, female students ($M = 0.899$, $SD = 0.302$) use portable computers more often than their male counterparts do ($M = 0.745$, $SD = 0.437$); $t(332.335) = -4.868$, $p = 0.000$. In contrast, as presented in Figure 2, male students ($M = 0.565$, $SD = 0.497$) use desktop computers more often than their female counterparts do ($M = 0.329$, $SD = 0.470$); $t(424.294) = 6.101$, $p = 0.000$).

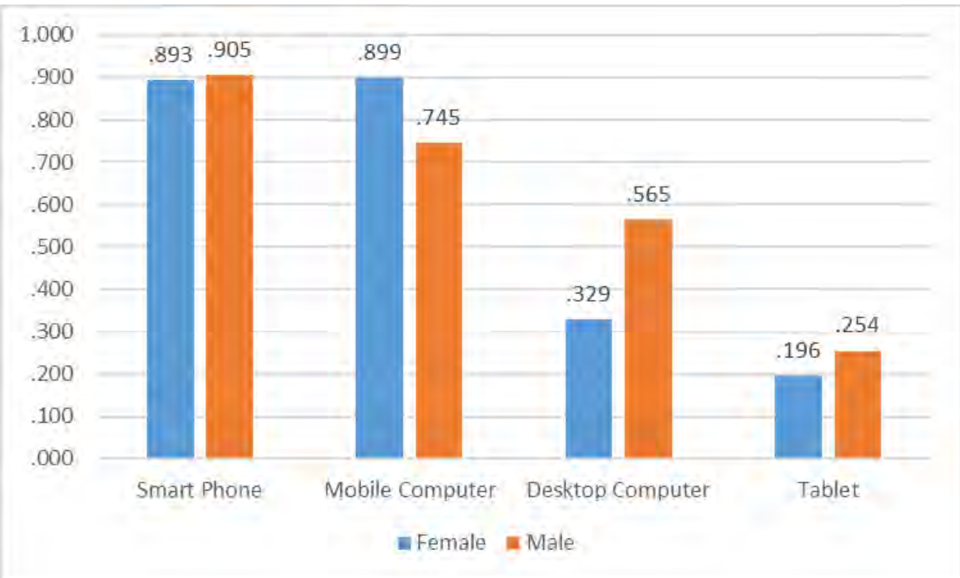


Figure 2: Daily usage of ICT devices.

The average levels of ICT application usage organized according to the proposed latent constructs are presented in Table 2.

Latent construct	Item	Mean	SD
Application usage for learning	Using bibliographic databases (e. g. Cobiss, Scopus, Web of Science, EBSCO)	2.15	.730
	Prepairing seminar and project works	2.33	.639
	Reading e-books and scientific papers	2.25	.885
	Working with office tools (MS Office, Open Office)	2.81	.974
Application usage for searching and communication	Searching for information (e. g. Google)	4.48	.708
	Watching videos (e. g. YouTube)	3.87	.951
	Communication (e-mail, MSN, Skype)	3.82	1.010
	Using web maps (e.g. Google Maps, Google Earth)	2.67	.835
	Reading newspapers and daily news at the Internet portals	3.23	1.090
	Using social networks, forums and blogs (e. g. Facebook, Twitter)	4.23	1.010
	Using e-learning materials and e-textbooks	3.18	.950
Professional advanced application usage	Programming	1.53	.886
	Designing web pages	1.30	.625
Freetime advanced application usage	Editing and processing photos (e. g. Picasa, Photoshop)	1.96	.899
	Editing and processing videos and animations	1.54	.723
Other	Playing games	2.20	1.155

Table 2: Descriptive statistics for Items of latent constructs describing application usage.

According to the results presented in Table 2, students rarely spend time using advanced applications, either for professional or personal (free time) use. The average frequency is slightly higher when playing games or individual application usage for learning. Moreover, students spend most of the time using applications for searching and communicating on the web.

The ratio of courses that promote individual ICT usage ranges from 19% to 50% at individual faculties. The ratio of courses in which ICT usage for interaction with lecturers is promoted is the highest at the Faculty of Organizational Sciences (80%), where half of the study process is performed as e-study. For the same reason, the ratio of ICT usage for individual seminar work reaches the highest value at Faculty of Organizational Sciences (57%). The highest share of the courses that require specialized search in different databases is at the Faculty of Organizational Sciences (33%).

Self-confidence when working on the internet was measured with 10 items. Results of mean values and SD are given in Table 3.

Item	Mean	SD
Because I know that I can find any information on the Web without the help of others.	4.09	.864
Because I know that I can solve problems by finding help on the discussion forums on Internet	3.34	1.108
When I need to present my own solutions and opinions to the others on the Web.	3.20	1.026
When I must learn new skills to work with new programmes.	3.61	1.039
By participating in forums and Web communities deling with professional and scientific issues.	3.05	1.016
When communicating in Web communities and social networks.	3.94	.948
In solving problem that can emerge when working on the Internet.	3.43	1.002
Using information searching strategies on Web search engines such as Google, Yahoo, Bing, etc.	4.19	.845
Using searching strategies within local e-libraries and bibliographic databases.	3.73	1.005
Using searching strategies within international bibliographic databases, such as Web of Science and Scopus	2.89	1.132

Table 3: Descriptive statistics for Items describing self-confidence when working on the WWW.

The results indicate that students feel most self-confident when using web search engines, such as Google, Yahoo and Bing, while the case is the opposite regarding search strategies in bibliographic databases.

5 Conclusions and proposal for future work

This research addresses the problem of stimulating information literacy by employing problem-based learning in an e-learning environment. For this purpose, we have developed and assessed an IL test and ICT use questionnaire, which were administered in a natural experiment with students at seven Slovene faculties. A preliminary investigation on IL and ICT use based on a pretested group of students is presented. Since we have identified several statistically significant differences among faculties in IL skills, we wanted to identify the factors influencing the IL of students. According to our tentative assumptions and confirmed with EFA, several latent constructs were proposed as ICT usage indicators.

To obtain the first insight into the proposed latent constructs, the skewness and kurtosis for constructs and corresponding items had to be calculated. Following that, we were able to assess if the data are appropriate for Confirmatory Factor Analysis (CFA) and Structural Equation Modeling (SEM), while the absolute values of skewness and kurtosis up to 2.3 are, according to Lei and Lomax (as cited in (Lee & Lehto, 2013)), not problematic.

The sample size of 750 is sufficient to achieve the statistical power necessary for SEM with three or more measured items per latent variable. The sample size also clearly satisfies Loehlin's rule of thumb (Siddiqui, 2013), which states that the sample size should be at least 50 more than eight times the number of measured items in the model (which is equal to 290 in our case). Our sample size also meets the criterion that an ideal sample size-to-parameters ratio would be 20:1 (Kline, 2011); it is 25:1 in our case. Since the project of IL assessment is ongoing, we can even expect to obtain at least an additional 50 responses to the questionnaire.

In the next stage, when all the responses will be available, the internal reliability of the constructs will be further investigated with CFA. The component validity of each scale will be assessed using CFA, and it will be evaluated through the convergent validity and the discriminant validity.

The convergent validity should be examined based on three concepts (Fornell & Larcker, 1981; Koufteros, 1999):

- Estimates of standardized factor loadings should exceed 0.5 (or even 0.7), or absolute values of corresponding z-values (which are calculated as the ratio of the non-standardized factor loading to its standard error) should be greater than 2 or 2.576 to be considered as significant at the 5% or 1% significance level, respectively.
- Composite reliability (CR) for each latent variable should exceed 0.7.
- Average variance extracted (AVE), which measures the amount of the common variance between the indicators and their construct in relation to the amount of variance attributable to measurement error for each latent variable, should exceed 0.5.

To investigate the discriminant validity of the measurement model, the square root of the AVE of each latent variable will be compared to the correlations between the latent variables, where values of the square root of AVE for the corresponding latent variable have to be greater than the corresponding correlations between latent variables to confirm discriminant validity. In addition, to confirm that the two scales do not correlate, the correction of attenuation of the correlation due to measurement error will be calculated (Crocker & Algina, 2008), where (according to the rule of thumb) values below 0.85 indicate that discriminant validity exists between two scales. In the final step, SEM will be used to test the predicted relationships among the components and factors that influence the IL of students.

By defining the influencing factors and by gaining a comprehensive understanding of the IL problem, curriculum and courses can be enhanced to encourage students' IL literacy skills.

Acknowledgement

This research is a part of the J5-5535 national project funded by the Slovenian Research Agency.

References

ACRL. (2000). *Information Literacy Competency Standards for Higher Education*. *Community & Junior College Libraries*. Retrieved from http://www.ala.org/ala/mgrps/divs/acrl/standards/informationliteracycompetency.cfm

Boh Podgornik, B., Dolničar, D., Šorgo, A., & Bartol, T. (2015). Development, testing, and validation of an information literacy test (ILT) for higher education. *Journal of the Association for Information Science and Technology*, n/a–n/a. http://doi.org/10.1002/asi.23586

Boh, B., Dolničar, D., Šorgo, A., Bartol, T., Rodič, B., Vrtačnik, M., … Baggia, A. (2014). ARE SLOVENE STUDENTS INFORMATION LITERATE? First national survey results on information literacy on a sample of students from six Slovenian faculties. In *EDUvision*

2014 (pp. 105–116).

Crocker, L. M., & Algina, J. (2008). *Introduction to classical and modern test theory*. Mason, Ohio: Cengage Learning.

Detlor, B., Julien, H., Serenko, A., & Booker, L. (2010). Factors Affecting Student Learning Outcomes of Information Literacy Instruction. *Proceedings of the American Society for Information Science and Technology*, *47*(1), 1–2.

Detlor, B., Julien, H., Willson, R., Serenko, A., & Lavallee, M. (2011). Learning outcomes of information literacy instruction at business schools. *Journal of the American Society for Information Science and Technology*, *62*(3), 572–585. http://doi.org/10.1002/asi.21474

Eisenberg, M. B., Lowe, C. A., & Spitzer, K. L. (2004). *Information Literacy: Essential Skills for the Information Age*. *Journal of Chemical Information and Modeling* (2nd ed.). Westport, CT: Greenwood Publishing Group. http://doi.org/10.1017/CBO9781107415324.004

Eshet-Alkalai, Y., & Amichai-Hamburger, Y. (2004). Experiments in Digital Literacy. *CyberPsychology and Behavior*, *7*(4), 421–429. http://doi.org/10.1089/cpb.2004.7.421

Fornell, C., & Larcker, D. F. (1981). Evaluating Structural Equation Models with Unobservable Variables and Measurement Error. *Journal of Marketing Research*, *18*(1), 39–50. http://doi.org/10.2307/3151312

Godbey, S., Ladd, S., & Fabbi, J. (2014). Teaching Teachers : A Study of Factors Impacting the Information Literacy of. In *European Conference on Information Literacy* (p. 81).

Gross, M., & Latham, D. (2012). What's skill got to do with it?: Information literacy skills and self-views of ability among first-year college students. *Journal of the American Society for Information Science and Technology*, *63*(3), 574–583. http://doi.org/10.1002/asi.21681

Hutchings, J., & Willey, M. (2014). Resilience and Redirection: Information Literacy in Louisiana Higher Education. *Libraties and the Academy*, *14*(2), 239–253.

Johnston, B., & Webber, S. (2003). Information literacy in higher education: a review and case study. *Studies in Higher Education*, *28*(3), 335–352. http://doi.org/10.1080/03075070310000113441

Julien, H., & Given, L. M. (2003). Faculty-Librarian Relationships in the Information Literacy Context: A Content Analysis of Librarians' Expressed Attitudes and Experiences. *Proceedings of the Annual Conference of CAIS/Actes Du Congrès Annuel de l'ACSI*. Retrieved from http://www.cais-acsi.ca/ojs/index.php/cais/article/view/402

Katz, I. R. (2007). ETS research finds college students fall short in demonstrating ICT literacy. *College & Research Libraries News*, *68*(1), 35–37. http://doi.org/Article

Kiliç-Çakmak, E. (2010). Learning strategies and motivational factors predicting information literacy self-efficacy of e-learners. *Australasian Journal of Educational Technology*, *26*(2), 192–208.

Kline, R. B. (2011). *Principles and practice of structural equation modeling*. Guilford publications.

Koufteros, X. A. (1999). Testing a model of pull production: a paradigm for manufacturing research using structural equation modeling. *Journal of Operations Management*, *17*(4), 467–488. http://doi.org/10.1016/S0272-6963(99)00002-9

Lee, D. Y., & Lehto, M. R. (2013). User acceptance of YouTube for procedural learning: An extension of the Technology Acceptance Model. *Computers and Education*, *61*(1), 193–208. http://doi.org/10.1016/j.compedu.2012.10.001

Limberg, L., Sundin, O., & Talja, S. (2012). Three Theoretical Perspectives on Information Literacy. *Human It*, *11*(2), 93–130. Retrieved from http://etjanst.hb.se/bhs/ith/2-11/llosst.htm

Lorenz, R., Eickelmann, B., & Gerick, J. (2015). What Affects Students' Computer and Information Literacy around the World ? – An Analysis of School and Teacher Factors in High Performing Countries. *SITE 2015 - Las Vegas*, *March 1-6*, 1212–1219.

Martin, J. (2011). Investigation of factors affecting information literacy student learning outcomes fails to undercover significant findings. *Evidence Based Library and Information Practice*, *6*(2), 59–60.

Maybee, C. (2006). Undergraduate Perceptions of Information Use: The Basis for Creating User-Centered Student Information Literacy Instruction. *The Journal of Academic Librarianship*, *32*(1), 79–85. http://doi.org/10.1016/j.acalib.2005.10.010

Mery, Y., Newby, J., & Peng, K. (2012). Why One-shot Information Literacy Sessions Are Not the Future of Instruction: A Case for Online Credit Courses. *College & Research Libraries*, *73*(4), 366–377. http://doi.org/10.5860/crl-271

Mittermeyer, D. (2005). Incoming first year undergraduate students: How information literate are they? *Education for Information*, *23*(4), 203–232.

O'Connor, L. G., Radcliff, C. J., & Gedeon, J. A. (2002). Applying Systems Design and Item Response Theory to the Problem of Measuring Information Literacy Skills. *College & Research Libraries*, *63*(6), 528–543. http://doi.org/10.5860/crl.63.6.528

Robertson, M. J., & Jones, J. G. (2009). Exploring Academic Library users' Preferences of delivery Methods for Library Instruction. *Reference & User Services Quarterly*, *48*(3), 259–269. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=lxh&AN=37194482&site=ehost-live

Salisbury, F., & Karasmanis, S. (2011). Are they Ready? Exploring Student Information Literacy Skills in the Transition from Secondary to Tertiary Education. *Australian Academic & Research Libraries*, *42*(1), 43–58. http://doi.org/10.1080/00048623.2011.10722203

Siddiqui, K. (2013). Heuristics for sample size determination in multivariate statistical techniques. *World Applied Sciences Journal*, *27*(2), 285–287. http://doi.org/10.5829/idosi.wasj.2013.27.02.889

Stopar, K., Kotar, M., Pejova, Z., & Knap, N. (2010). *Merila in kazalci informacijske pismenosti v visokem šolstvu [Authorized translation of Information Literacy Competency Standards for Higher Education]*. Ljubljana. Retrieved from http://www.old.zbds-zveza.si/dokumenti/merila-in-kazalci-informacijske-pismenosti-v-visokem-solstvu.pdf.

Šorgo, A., Bartol, T., Dolničar, D., & Boh Podgornik, B. (n.d.). Attributes of digital natives as predictors of information literacy in higher education. *British Journal of Educational Technology*.

Thornton, S. (2008). Pedagogy, Politics and Information Literacy. *Politics*, *28*(1), 50–56. http://doi.org/10.1111/j.1467-9256.2007.00310.x

Varlejs, J., & Stec, E. (2014). Factors Affecting Students' Information Literacy as They Transition from High School to College. *School Library Research*, *17*, 23. Retrieved from http://www.ala.org/aasl/sites/ala.org.aasl/files/content/aaslpubsandjournals/slr/vol17/SLR_FactorsAffecting_V17.pdf

Welsh, T. S., & Wright, M. (2010). *Information Literacy in the Digital AgeNo Title: An Evidence-Based Approach*. Oxford: Chandos Publishing.

Williams, M. H., & Evans, J. J. (2008). Factors in Information Literacy Education. *Journal of Political Science Education*, *4*(1), 116–130. http://doi.org/10.1080/15512160701816234

29th Bled eConference
Digital Economy:
June 19 - 22, 2016; Bled, Slovenia

E-Health Solutions:
Mobile Devices and Sensors in a clinical Environment

Nilmini Wickramasinghe, Organizer
Epworth Healthcare & Deakin University, Melbourne, Australia
nilmini.wickramasinghe@epworth.org.au

Panelists

Professor Marko Bohanec,
Jožef Stefan Institute, Ljubljana, Slovenia, and University of Nova Gorica, Slovenia
marko.bohanec@ijs.si

Andreas Buchenscheit
Cortex Media GmbH, Ulm & DHBW Heidenheim & Ulm University of Applied Sciences, Germany
a.buchenscheit@cortex-media.de

Professor Bojan Cestnik
Temida d.o.o. and Jozef Stefan Institute, Ljubljana, Slovenia,
bojan.cestnik@ijs.si

Vladislav Rajkovic
University of Maribor, Slovenia
vladislav.rajkovic@gmail.com

Drago Rudel
MKS Electronic Systems Ltd. & General Hospital Slovenj Gradec, Slovenia
drago.rudel@mks.si

Dr Luuk Simons
Delft University of Technology, The Netherlands
l.p.a.simons@tudelft.nl

Professor Elliot Sloane
Villanova University, USA
ebsloane@gmail.com

Professor Doug Vogel
Harbin Institute of Technology, Harbin, P. R. of China
vogel.doug@gmail.com

Professor Nilmini Wickramasinghe
Epworth Healthcare & Deakin University, Melbourne, Australia
nilmini.wickramasinghe@epworth.org.au

Outline

There are two key challenges in today's healthcare system: One is the significant cost pressure on healthcare delivery and the second is the rapid growth of the field of medical informatics and e-health, increasingly using ambient and pervasive technologies. In addition, there is a trend to foster active patient participation in their care. Patients of all ages are becoming more and more familiar with technology, especially mobile devices. Therefore, it is prudent to look at the application of such technologies for healthcare with the goal to facilitate value-driven healthcare delivery. Here, a new field of research is evolving which is focused on ambient and pervasive technologies for healthcare. This rapidly growing area is expected to play an increasingly important role for healthcare globally. This panel will unpack a variety of issues, barriers and facilitators in this emerging area for healthcare delivery.

29th Bled eConference
Digital Economy
June 19 - 22, 2016; Bled, Slovenia

Ubiquitous Computing for Well-being and Ambient Assisted Living

Juergen Seitz, Organizer
DHBW Heidenheim, Germany
seitz@dhbw-heidenheim.de

Panelists

Andreas Buchenscheit
Cortex Media GmbH, Ulm & DHBW Heidenheim & Ulm University of Applied Sciences, Germany
a.buchenscheit@cortex-media.de

Professor Christer Carlsson
Åbo Akademi University, Turku, Finland
christer.carlsson@abo.fi

Professor Matjaž Gams
Jožef Stefan Institute
matjaz.gams@ijs.si

Dr. Christian Kittl
evolaris next level GmbH, Graz, Austria
Christian.Kittl@evolaris.net

Professor Peter Hermann
NTNU Trondheim, Norway
herrmann@item.ntnu.no

Professor Vladislav Rajkovič
University of Maribor
vladislav.rajkovic@fov.uni-mb.si

Professor Doug Vogel
Harbin Institute of Technology, Harbin, P. R. of China
vogel.doug@gmail.com

Professor Nilmini Wickramasinghe
Epworth Healthcare & Deakin University, Melbourne, Australia
nilmini.wickramasinghe@epworth.org.au

Outline

Ubiquitous computing means that IT services seem to be available anytime and everywhere. Any device in any location can be connected to the system and exchange data in any format. Components are inexpensive and robust. New components and services can be added easily. How can well-being and ambient assisted living benefit from this technology? How could ubiquitous computing look like in this area? What are benefits and challenges? Which risks and weaknesses exist? Which new fields of research are coming up in this area with this technology?

29th Bled eConference
Digital Economy
June 19 - 22, 2016; Bled, Slovenia

E-Health Solutions: *Big Data in Healthcare*

Nilmini Wickramasinghe, Organizer
Epworth Healthcare & Deakin University, Melbourne, Australia
nilmini.wickramasinghe@epworth.org.au

Panelists

Professor Bojan Cestnik
Temida d.o.o. and Jozef Stefan Institute, Ljubljana, Slovenia,
bojan.cestnik@ijs.si

Isabella Eigner
FAU Erlangen-Nuremberg, Germany
isabella.eigner@fau.de

Mirjana Kljajić Borštnar
University of Maribor, Slovenia
Mirjana.Kljajic@fov.uni-mb.si

Vladislav Rajkovic
University of Maribor, Slovenia
vladislav.rajkovic@gmail.com

Dr Jonathan Schaffer
Cleveland Clinic, Cleveland, U. S. A.

Professor Juergen Seitz
DHBW Heidenheim, Germany
seitz@dhbw-heidenheim.de

Professor Johan Versendaal
University of Applied Sciences, Utrecht, The Netherlands
johan.versendaal@hu.nl

Professor Doug Vogel
Harbin Institute of Technology, Harbin, P. R. of China
vogel.doug@gmail.com

Outline

Today many healthcare delivery systems are emphasizing value creation as a key imperative. Such a conceptualization necessitates analysis of data and predictive risk mitigation strategies. This panel will examine key health big data issues, skills, analytic tools and techniques to enable a value driven focus to be achieved as well as unpack many of the unintended consequences of such approaches.

29th Bled eConference

Digital Economy

June 19 - 22, 2016; Bled, Slovenia

SMEs Practices and Challenges in Business Model Innovation – ENVISION Project Workshop

Co-chairs:

Andreja Pucihar, Associate Professor, Faculty of Organizational Sciences
University of Maribor, Slovenia
Harry Bouwman, Professor, Delft University of Technology, The Netherlands

Presenters:

Digitalization of the Business World: Developments and Challenges
Hans-Dieter Zimmermann, Professor, FHS St. Gallen University of Applied Sciences, Switzerland

Digitalisation of Manufacturing - Opportunities and Threats for SMEs
Christian Kittl, Managing Director, evolaris next level GmbH, Graz, Austria

Empowering SME Business Model Innovation – ENVISON Tooling
Harry Bouwman, Professor, Delft University of Technology, The Netherlands
Marikka Heikkilä, Senior Researcher Fellow, University of Turku, Turku School of Economic, Finland

SecondCoach Business Model Design – A Case of Slovenian Start Up Company
Andrej Zupan and Matevž Oman

Workshop Outline

In digital era, business model innovation (BMI) is becoming one of key activities every enterprise must continuously undertake in order to survive and thrive (Hanelt, Hildebrandt, & Polier, 2015). Numerous evidences of successful stories as well as failures emphasize the importance of “reassessing and redesigning the way enterprises create, deliver and capture value or in short; the importance of business model innovation” (Florén & Agostini, 2015). Enterprises must continuously evaluate, adjust and develop their BMs to remain competitive over time and sustain growth in the future (Amit & Zott, 2012; Teece, 2010; Zott & Amit, 2009).

The importance of BMI is rather clear, however many enterprises still struggle with it (Florén & Agostini, 2015) and managers are actively seeking guidance on how to innovate their BMs (Casadesus-Masanell & Ricart, 2010; Florén & Agostini, 2015).

Recent report of European Commission on "The Need for Innovations in Business Model – Final Policy Brief" (Barjak, Niedermann, & Perrett, 2014) shows that European enterprises still lack awareness and knowledge about approaches and proper tools on how to systematically design, re-think and innovate their BMs. Situation is even more alarming among SMEs which represent 99,8 % of all enterprises and are key drivers for economic growth, innovation, employment and social integration in the European Union (European Commission, 2014).

The workshop has been prepared in the scope of the EU project: Empowering SME business model innovation – ENVISION, which aims at activating and supporting SMEs to innovate their BMs.

The aim of the workshop is to discover SMEs practices and challenges in business model innovation.

The workshop will be started with an overview of developments and challenges of digitalization of the business world. After that opportunities and threats for SMEs from digitalization of manufacturing will be presented. Next presentation will be focused on ENVISON tooling – online tools, which have been developed in ENVISON project to help and support BM innovation in SMEs. After this presentation, a BM design case of Slovenian start-up company – SecondCoach will be presented.

After all the presentation, a discussion with representatives of participating SMEs will be organized. The aim is to discover SMEs practices, challenges and needs for support in BMI processes.

Acknowledgment

The work leading to these results has received funding from the European Community's Horizon 2020 Programme (2014–2020) under grant agreement 645791. The content herein reflects only the authors' view. The European Commission is not responsible for any use that may be made of the information it contains.

References

Amit, R., & Zott, C. (2012). Creating Value Through Business Model Innovation. *MIT Sloan Management Review*, *53*(53310), 41–49. doi:10.2139/ssrn.1701660

Barjak, F. ., Niedermann, A. ., & Perrett, P. (2014). The Need for Innovations in Business Models - Final Policy Brief, (May), 1–52. Retrieved from https://ec.europa.eu/research/innovation-union/pdf/expert-groups/ERIAB-BMI_PB_new_business_models.pdf

Casadesus-Masanell, R., & Ricart, J. E. (2010). From strategy to business models and onto tactics. *Long Range Planning*, *43*(2-3), 195–215. doi:10.1016/j.lrp.2010.01.004

European Commission. (2014). SMEs' access to public procurement markets and aggregation of demand in the EU, (February). Retrieved from http://ec.europa.eu/internal_market/publicprocurement/docs/modernising_rules/smes-access-and-aggregation-of-demand_en.pdf

Florén, H., & Agostini, A. (2015). The Business Model Innovation Map a Framework for Analyzing Business Model Innovation. 24th IAMOT Conference, Cape Town, South Africa, 8-11 June, 2015, (JUNE), 2192–2207.

Hanelt, A., Hildebrandt, B., & Polier, J. (2015). Uncovering the Role of Is in Business Model Innovation – a Taxonomy-Driven Aproach To Structure the Field. *Twenty-Third European Conference on Information Systems (ECIS)*, (2010), 1–18. Retrieved from http://aisel.aisnet.org/cgi/viewcontent.cgi?article=1070&context=ecis2015_cr

Teece, D. J. (2010). Business models, business strategy and innovation. *Long Range Planning*, *43*(2-3), 172–194. doi:10.1016/j.lrp.2009.07.003

Zott, C., & Amit, R. (2009). Business Model Innovation: Creating Value In Times Of Change. *Universia Business Review*, *3*, 108–121. doi:10.2139/ssrn.1701660

DIGITAL WELLNESS SERVICES FOR YOUNG ELDERLY

Workshop on Emerging Markets

The “ageing population of EU” now denotes the issues with deteriorating health conditions of the 75+ aged citizens and questions of how a modern society should cope with the issues. We have for a few years focused on pro-active prevention; there is an age group we now call the young elderly – the age group 60-75 years – for which we should develop programs that will keep them healthy, active and independent also when they reach the 75+ age group; to be more precise, we should find ways to reduce or eliminate functional impairment with increasing age.

Functional impairment covers cognitive, physical, social and emotional impairment that can be described in multiple dimensions and with multiple attributes, which gives some challenges to understand what impairments should be dealt with. There is also the notion that increasing impairment in one function can be compensated with improvements in some other functions, and that functional impairments change over time.

Pro-active prevention is through interventions in daily routines of the young elderly that will introduce subsets of wellness routines.

We propose that the interventions could be digital wellness services implemented with applications for mobile smartphones and effective back-end support from cloud services, that allow simultaneous support of hundreds of thousands of users, analysis of wellness data produced by smartphones, sensor systems and digital add-on devices, and statistics offered users on their individual wellness programs, summaries on their progress relative to individual goals, suggestions for alternative activities, proposed development of the program and reports that can be transferred to health care and social care systems.

There will be some positive, practical and immediate effects of the intervention program that can be monitored and measured, and some more long-term, assessable impacts. In common sense terms it is clear that if hundreds of thousands of young elderly citizens will have better health for 10 years or more, the health and social care costs will show savings on the scale of billions of euro annually (in Finland the estimate is around 1.0-1.2 B€ annually).

The workshop will work out some of the issues and discuss what will be needed in terms of knowledge, technology and resources to handle the growing demand for digital wellness services for the young elderly and to build ecosystems of service developers, providers and distributors to cope with the emerging markets.

Speakers:

1. Prof Dr Doug Vogel: Sustaining Behavioural Change for Wellness Routines
2. Dr Marikka Heikkilä: Business Models and Applications for Wellness Services
3. Prof Dr Harry Bouwman: Business Modelling in Interaction with Technical Artefact Development

Chair and moderator: Prof Dr Christer Carlsson, IAMSR/Abo Akademi University

29th Bled eConference

Digital Economy

June 19 - 22, 2016; Bled, Slovenia

Predictive Analytics for Risk and Cost Management of Standardized Treatment Processes in Hospitals

Isabella Eigner

Institute of Information Systems, FAU Erlangen-Nuremberg, Germany

Isabella.Eigner@fau.de

Abstract

Hospitals have access to a massive amount of data that is already collected for medical and administrative purposes. However, the potential of this data is not fully exploited yet. This stems from the difficulty of extracting useful information and patterns from the scattered and partly inconsistent hospital data. The aim of this research is to find actionable information and patterns that can enhance decision making in hospitals and visualize relevant insights to the respective decision makers. For this purpose, standardized treatment processes, such as hip and knee replacements, are analysed from a cost perspective using a time-driven activity-based costing approach to find fluctuations and optimization potentials within the individual process steps. Additionally, the risk of readmission for these treatments is analysed by developing a risk prediction model based on past patients. By considering both cost and risk factors the optimal time for patient discharge is determined to support decision-makers on patient treatment and strategy.

Keywords: Healthcare Analytics, Predictive Modelling, Risk Prediction, Cost Management, Patient Discharge

1 Motivation & Objective

As a result of the demographic change and medical advances, demand for healthcare services is increasing steadily. The current supply of resources and qualified employees cannot satisfy this required demand (Deloitte, 2015; Kick, 2005). The health expenditures in Germany rise with a continuous share on the GDP (290 billion in 2010 to 315 billion in 2013) (Statistisches Bundesamt, 2015). Studies show that the aging population is a major influence on this development (cf. Figure 1). Nearly have of lifetime expenditures for healthcare services arise in the senior years (Alemayehu & Warner, 2004). Remedial action for these restrictions can be taken either through an increase in efficiency (rationalization) or an limitation in provided services (rationing) (Kick, 2005). Using predictive analytics to support decision-making, hospitals tasks can be strategically planned and performed more efficiently and pressure on the personnel thus can be reduced.

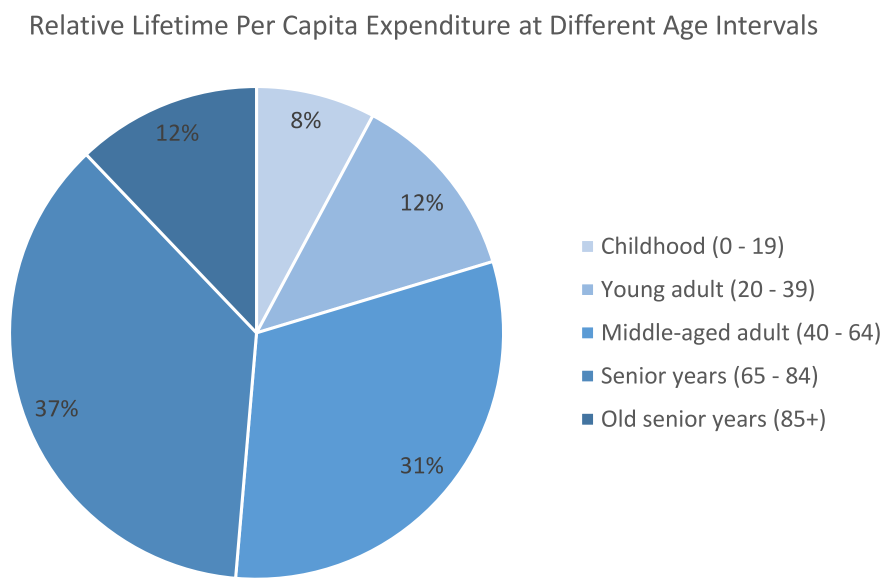


Figure 1: Relative Lifetime Per Capita Expenditure at Different Age Intervals (Alemayehu & Warner, 2004)

However, data acquired in hospitals highly varies in quality and consistency and is often scattered among different information systems. These types of data involve medical data for diagnostic and treatment purposes, financial and insurance data, research data and administrative data from the internal organization (Health Sciences Library, 2015). Although hospitals already collect and thus have access to these sources, the potential of using this data to gather insights for enhanced decision-making is often not fully exploited (Patil, Raul, Shroff, & Maurya, 2014). Many applications already use data mining to support certain hospital activities to detect high risk or high cost patients (Chechulin, Nazerian, Rais, & Malikov, 2014; Lin, 2015; Silver et al., 2001), optimize resource utilization (Phillips-Wren, Sharkey, & Dy, 2008) or improve customer relationship management (Ngai, Xiu, & Chau, 2009). By combining the prospect of cost minimization with the reduction of risk of readmission, patient-value and outcome can be increased accordingly. Using predictive data mining techniques, pre-existing data is analysed to find interesting patterns and insights that can enhance the decision-making process in hospitals.

2 Introduction

Healthcare analytics has been a growing research area for the past few years, especially focusing on how to deal with the massive amount of data that arises in this area (Koh & Tan, 2005; Raghupathi & Raghupathi, 2014). Its applications comprise fraud detection (Aral, Güvenir, Sabuncuoğlu, & Akar, 2012; Christy, 1997; Srinivasan & Arunasalam, 2013), providing clinical decision support in diagnosis (Emanet, Öz, Bayram, & Delen, 2014) and risk prediction (Son, Kim, Kim, Choi, & Lee, 2010). Financial and administrative actions can also be supported through data mining approaches, e.g. by reducing patient length-of-stay (Kudyba & Gregorio, 2010) and optimizing resource allocation (Jones et al., 2008). Using different data mining methods, prediction models for analysing medical and administrative data can be put into action to gain relevant insights and guidelines (Bellazzi & Zupan, 2008). From a research perspective, the use of prediction methods is a key element in IS theory (Gregor, 2006). Additionally, the importance of information systems in healthcare has been widely emphasised and acknowledged (Fichman, Kohli, & Krishnan, 2011). Therefore, the application of predictive modelling to enhance healthcare services by providing data-driven decision support represents an important and interesting area in IS research.

One application of healthcare analytics is clinical decision support, which aims at providing insights to clinical providers by "disseminating timely, actionable information […] at the point of care when the information is required and is the most useful" (Strome, 2015). With the help of clinical decision support systems, relevant stakeholders, such as clinicians, staff and patients can be supported with "knowledge and person-specific information intelligently filtered or presented at appropriate times, to enhance health and health care." (Osheroff et al., 2007)

To determine the right suggestion to the relevant stakeholders, predictive analytics methods are used to extract patterns from historical data to create empirical predictions as well as methods for assessing the quality of those predictions in practice (Shmueli & Koppius, 2010). Predictive analytics are part of data mining, which aims at deriving models that can e.g. use patient specific information to predict a specific outcome. Thereby clinical decision-making for prognosis, diagnosis or treatment planning can be supported (Bellazzi & Zupan, 2008). As opposed to descriptive models that aim to identify human-interpretable patterns and associations in existing data based on pre-defined attributes, predictive analytics tries to foresee outcomes or classifications for new input data using a special response variable, thus the classification (Bellazzi & Zupan, 2008). Different methods for predictive modelling have been adapted for analytical healthcare purposes and decision support systems, such as the Bayesian classifier (Chan & Lan, 2001), Bayesian networks , k-nearest neighbour (Liang & Gong, 2015), decision trees (Chae, Kim, Tark, Park, & Ho, 2003; Delen, Walker, & Kadam, 2005), artificial neural networks (Delen, Fuller, McCann, & Ray, 2009), support vector machines (Son et al., 2010) or regression models (Chechulin et al., 2014; Phillips-Wren et al., 2008). Considering existing literature and current approaches, the main research question and subquestions are described as follows:

How can predictive modelling (of risk of readmission) be used to find the optimal point of patient discharge for minimal costs?

- Which medical and organizational factors influence patient risk of readmission for standardized treatment processes?
- Which cost factors arise in standardized treatment processes?
- Which medical and organizational factors influence patient length of stay for standardized treatment processes?
- How can the point of discharge be selected for minimal costs and minimal risk of readmission?

Research Design

As an underpinning framework to answer the proposed questions, focussing on the development and implementation of the risk and cost model, the design science cycles by Hevner (2007) (see Figure 2), based on the design science research framework proposed in 2004 (Hevner, March, Park, & Ram, 2004), is used. A problem is sought to be solved by designing and developing an artefact, in this case the respective prediction model and optimization algorithm.

This artefact will be implemented in an integrated software system to provide a visualization tool for further evaluation. To overcome the challenge of under- or overfitting, the evaluation of the predictive model uses cross-validation based on an unbiased, large hospital data set of an Australian hospital group.

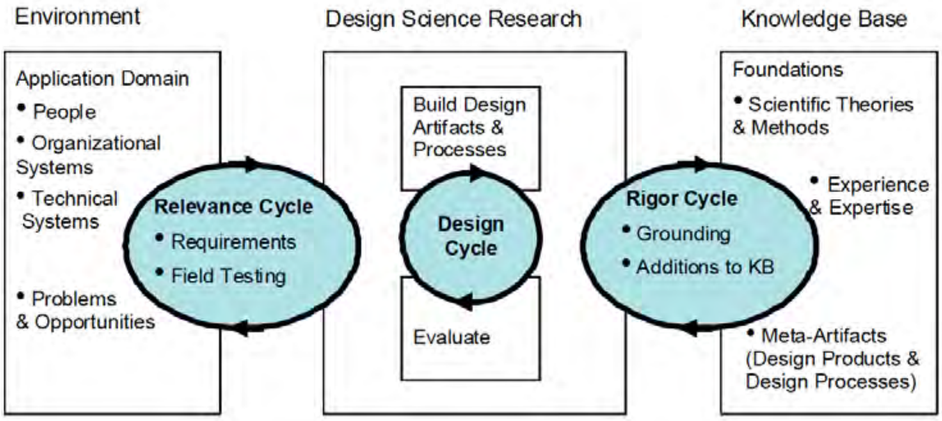


Figure 2: Design Science Cycle (Hevner 2007)

Based on the environment and stakeholder analysis occurring problems in standardized treatment processes and relevant data mining methods are identified (relevance cycle). The resulting model and optimization should be accessible through an intuitive user interface and recommendations based on this model have to be appropriately visualized to effectively support the decision-making process in patient treatment and planning (design cycle). For this purpose, the software system displaying the predictive model and resulting recommendations is deployed. Through iterative cycles, the previously identified stakeholders evaluate the system to ensure a high usability and reliability. A literature review on the state-of-the-art methods and approaches of current risk prediction models has to be done to utilize and build up on existing knowledge found in this area (rigor cycle). For this purpose, the presented research is divided into five parts, each based on different research methods. Figure 3 gives an overview of the stages of the research project. In a first step, the environment and important stakeholders in the hospital context are identified and classified and current issues in standardized treatment processes are analysed. For this purpose, a literature review as well as expert interviews with hospital personnel is conducted, to detect important roles and resources and analyse the critical hospital processes in detail. These results will be enriched through exploratory data analyses of already available hospital data currently collected for these processes.

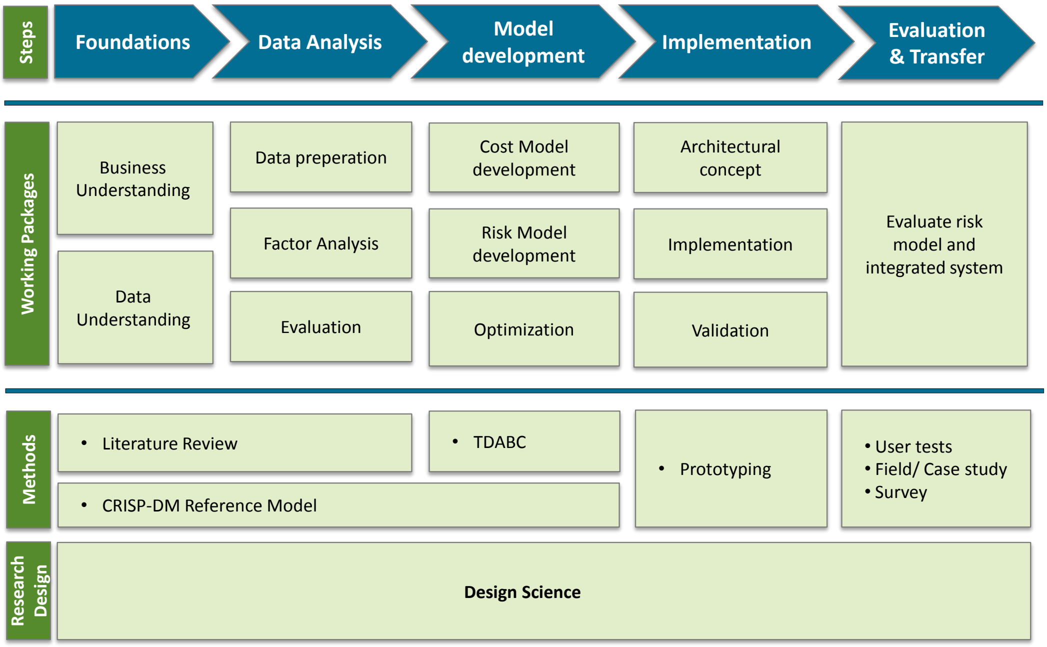


Figure 3: Research framework

After specifying the relevant influences and resources in hospital activities, in a next step, the required data for the following analyses has to be defined. This part of the research follows the CRISP-DM Reference model (see Figure *4*), which is further subcategorized into six sub-steps that are conducted in an iterative process. The business understanding from the foundations literature review is furthermore complemented by the data understanding, thus a detailed analysis of the type of the relevant data and the potential need for additional data acquisition is required. Once the necessary data is gathered, it has to be cleaned and structured for further analysis. As a big part of the data is still acquired manually, the data sources are checked for accuracy to find out what data is reliable and where mistakes might result in incorrect data that has to be disregarded or rechecked for further analyses.

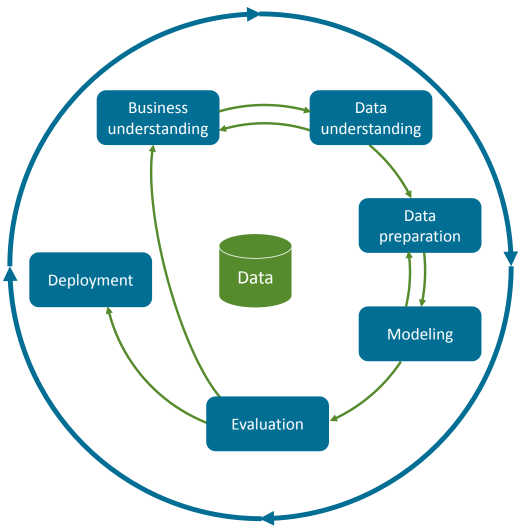


Figure 4: CRISP-DM reference model (Shearer, 2000)

The prepared data set is furthermore analysed to identify relevant attributes that influence patient readmission for specific standardized treatment processes. These attributes include administrative, demographic and medical data as well as information on patient length of stay and readmission of past patients. After identifying influencing factors for patient readmission, a predictive risk model is developed to determine the risk of readmission for new patients.

On the other hand, the actual costs for these treatment processes are determined by conducting a time-driven activity based costing analysis with hospital personnel at an Australian hospital group. To this end, each step of the treatment process is displayed in a process map with every resource allocated to this step. Furthermore, the required time for each process step is documented and lastly priced individually based on the identified time and resource consumption. In addition to treatment and procedure costs, the costs for hospitalization depending on patient length of stay have to be included in the calculation. Finally, the costs for readmission have to be determined to evaluate them in the later optimization problem. Figure 5 gives an overview of the proposed approach for the optimization problem.

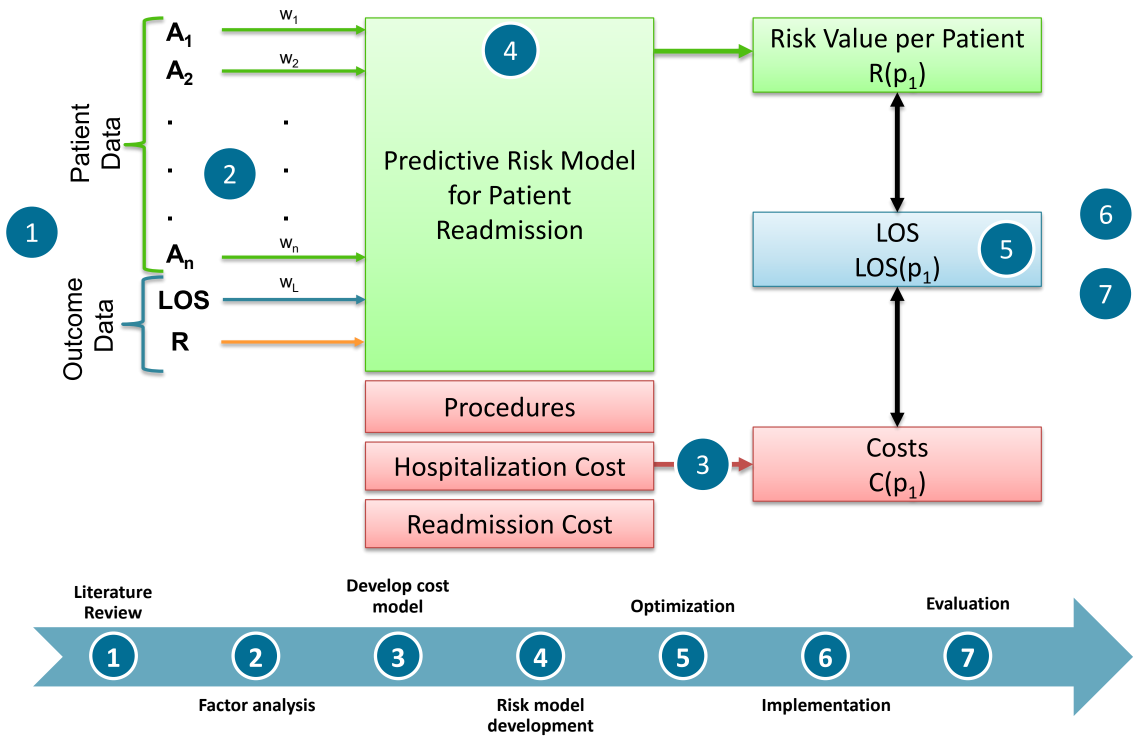


Figure 5: Process for Cost and Risk Optimization

3 Future Development

The goal of this research is the design and development of a predictive risk and cost model to support decision-making in hospitals and optimize patient discharge. By analysing relevant stakeholders in the hospital context and close examination of quality and processing of hospital data, actionable information and patterns are sought to be used for further analysis. The resulting models and algorithm are implemented in an integrated and modular decision support system to guide clinical staff and other relevant actors in their daily activities. With the support of such a system, pressure on personnel could be reduced, leading to fewer errors and a higher quality in patient treatment as well as lower costs for hospital management.

As I am still in an early stage of my research, I expect to receive useful feedback concerning my overall approach and research design including a discussion on further proceedings and next steps. Especially the use of appropriate research methods and planned implementation is a major concern. Another discussion point is the relevance and expected impact for different application domains that could be influenced by this research. I aim to finish my fundamental literature review and theoretical grounding until the mid of 2016. The next step will be expert interviews to be conducted with medical personnel in an Australian healthcare group in August 2016 and a subsequent qualitative analysis of the interview results. The finding from literature should be further advanced and supplemented both by the expert interviews and the concurrent quantitative analysis of the hospital data.

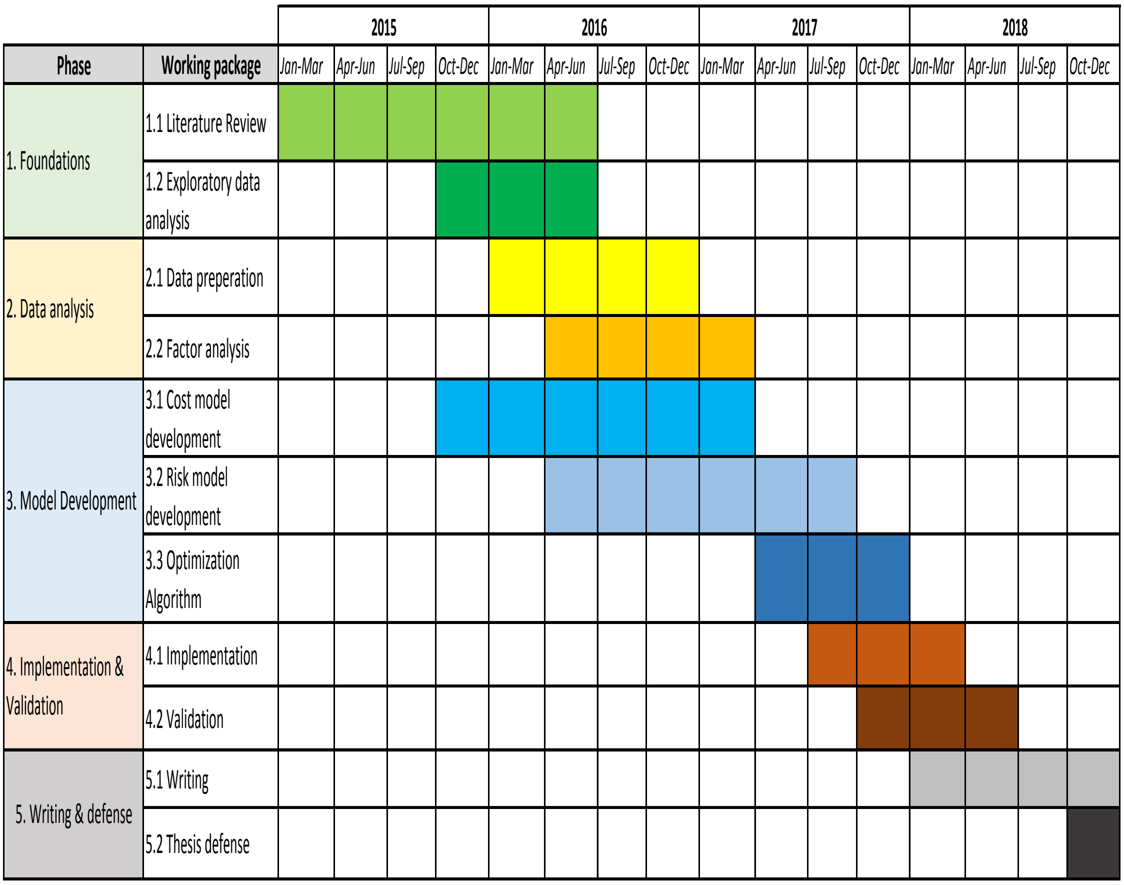


Figure 6: Research Timeline

Reference List

Alemayehu, B., & Warner, K. E. (2004). The lifetime distribution of health care costs. *Health services research, 39*(3), 627–642.

Aral, K. D., Güvenir, H. A., Sabuncuoğlu, I., & Akar, A. R. (2012). A prescription fraud detection model. *Computer methods and programs in biomedicine, 106*(1), 37–46.

Bellazzi, R., & Zupan, B. (2008). Predictive data mining in clinical medicine: current issues and guidelines. *International journal of medical informatics, 77*(2), 81–97.

Chae, Y. M., Kim, H. S., Tark, K. C., Park, H. J., & Ho, S. H. (2003). Analysis of healthcare quality indicator using data mining and decision support system. *Expert Systems with Applications, 24*(2), 167–172.

Chan, C. L., & Lan, C. H. (2001). A data mining technique combining fuzzy sets theory and Bayesian classifier-An application of auditing the health insurance fee. In *Proceedings of the international conference on artificial intelligence* (Vol. 402408).

Chechulin, Y., Nazerian, A., Rais, S., & Malikov, K. (2014). Predicting Patients with High Risk of Becoming High-Cost Healthcare Users in Ontario (Canada). *Healthcare Policy, 9*(3), 68–79.

Christy, T. (1997). Analytical tools help health firms fight fraud. *Insurance & Technology, 22*(3), 22–26.

Delen, D., Fuller, C., McCann, C., & Ray, D. (2009). Analysis of healthcare coverage: A data mining approach. *Expert Systems with Applications, 36*(2), 995–1003.

Delen, D., Walker, G., & Kadam, A. (2005). Predicting breast cancer survivability: a comparison of three data mining methods. *Artificial Intelligence in Medicine, 34*(2), 113–127.

Deloitte (2015). 2015 Global health care outlook: Common goals, competing priorities, from http://www2.deloitte.com/content/dam/Deloitte/global/Documents/Life-Sciences-Health-Care/gx-lshc-2015-health-care-outlook-global.pdf.

Emanet, N., Öz, H., Bayram, N., & Delen, D. (2014). A comparative analysis of machine learning methods for classification type decision problems in healthcare. *Decision Analytics, 1*(1), from http://dx.doi.org/10.1186/2193-8636-1-6.

Fichman, R. G., Kohli, R., & Krishnan, R. (2011). Editorial Overview —The Role of Information Systems in Healthcare: Current Research and Future Trends. *Information Systems Research, 22*(3), 419–428.

Gregor, S. (2006). The Nature of Theory in Information Systems. *MIS Q, 30*(3), 611–642, from http://dl.acm.org/citation.cfm?id=2017296.2017300.

Health Sciences Library (2015). *Data Resources in the Health Sciences.* Retrieved August 16, 2015, from http://guides.lib.uw.edu/hsl/data/findclin.

Hevner, A. R. (2007). A Three Cycle View of Design Science Research. *Scandinavian Journal of Information Systems*, (19).

Hevner, A. R., March, S. T., Park, J., & Ram, S. (2004). Design Science Research in Information Systems. *MIS Quarterly, 28*(1), 75–105.

Jones, S. S., Thomas, A., Evans, R. S., Welch, S. J., Haug, P. J., & Snow, G. L. (2008). Forecasting Daily Patient Volumes in the Emergency Department. *Academic Emergency Medicine, 15*(2), 159–170, from http://dx.doi.org/10.1111/j.1553-2712.2007.00032.x.

Kick, H. A. (Ed.) (2005). *Ethik interdisziplinär: Bd. 10. Gesundheitswesen zwischen Wirtschaftlichkeit und Menschlichkeit.* Münster: Lit.

Koh, H. C., & Tan, G. (2005). Data Mining Applications in Healthcare. *Journal of healthcare information management*, (19), 64–72.

Kudyba, S., & Gregorio, T. (2010). Identifying factors that impact patient length of stay metrics for healthcare providers with advanced analytics. *Health informatics journal, 16*(4), 235–245.

Liang, C., & Gong, Y. (2015). Enhancing Patient Safety Event Reporting by K-nearest Neighbor Classifier. *Studies in health technology and informatics, 218*, 93–99.

Lin, Y.-K. (2015). *Health Analytics and Predictive Modeling: Four Essays on Health Informatics:* The University of Arizona.

Ngai, E., Xiu, L., & Chau, D. (2009). Application of data mining techniques in customer relationship management: A literature review and classification. *Expert Systems with Applications, 36*(2), 2592–2602.

Osheroff, J. A., Teich, J. M., Middleton, B., Steen, E. B., Wright, A., & Detmer, D. E. (2007). A roadmap for national action on clinical decision support. *Journal of the American Medical Informatics Association : JAMIA, 14*(2), 141–145.

Patil, P., Raul, R., Shroff, R., & Maurya, M. (2014). Big Data in Healthcare. *International Journal of Research in Information Technology, 2*(2), 202–208.

Phillips-Wren, G., Sharkey, P., & Dy, S. M. (2008). Mining lung cancer patient data to assess healthcare resource utilization. *Expert Systems with Applications, 35*(4), 1611–1619.

Raghupathi, W., & Raghupathi, V. (2014). Big data analytics in healthcare: promise and potential. *Health Information Science and Systems, 2*(1), 3.

Shearer, C. (2000). The CRISP-DM Model: The New Blueprint for Data Mining. *The Journal of Data Warehousing*, (5(4)).

Shmueli, G., & Koppius, O. (2010). Predictive Analytics in Information Systems Research. *SSRN Electronic Journal*,

Silver, M., Sakata, T., Su, H. C., Herman, C., Dolins, S. B., & O'Shea, M. J. (2001). Case study: how to apply data mining techniques in a healthcare data warehouse. *Journal of healthcare information management : JHIM, 15*(2), 155–164.

Son, Y.-J., Kim, H.-G., Kim, E.-H., Choi, S., & Lee, S.-K. (2010). Application of support vector machine for prediction of medication adherence in heart failure patients. *Healthcare informatics research, 16*(4), 253–259.

Srinivasan, U., & Arunasalam, B. (2013). Leveraging Big Data Analytics to Reduce Healthcare Costs. *IT Professional, 15*(6), 21–28.

Statistisches Bundesamt (2015). *Gesundheitsausgabenrechnung,* from https://www.gbe-bund.de/oowa921-install/servlet/oowa/aw92/dboowasys921.xwdevkit/xwd_init?gbe.isgbetol/xs_start_neu/&p_aid=i&p_aid=38311585&nummer=655&p_sprache=D&p_indsp=-&p_aid=47799513.

Strome, T. L. (2015). *Healthcare Analytics: From Data to Knowledge to Healthcare Improvement:* John Wiley & Sons Inc.

29th Bled eConference

Digital Economy

June 19 - 22, 2016; Bled, Slovenia

Social Media for Development: *research design to investigate Dutch international development NGOs*

Anand Sheombar

Manchester Metropolitan University Business School, UK

& Utrecht University of Applied Sciences, The Netherlands

anand.sheombar@hu.nl (or sattianandsing.sheombar@stu.mmu.ac.uk)

Abstract

This paper describes a research design addressing social media adoption and use by development NGOs in the Netherlands. The methodology of (Glaserian) grounded theory method, combined with a multiple case study is being applied. Case studies are particularly valuable for understanding complex phenomena in context. The combination of case study research and Grounded Theory works well for theory building and has been applied in Information Science before. The paper presents preliminary results of the analysis of six Dutch development NGOs on possibilities and threats of social media for their work. Follow-up steps in the research process for data collection along the merging themes are discussed.

Keywords: Social Media, Organisational Social Media, International Development, Non-Governmental Organisations, ICT for Development, Communication for Development.

1 Introduction

In recent years the usage of social media has grown dramatically (Kaplan & Haenlein, 2010), and development organisations are not alone in considering how social media might help them achieve their aims. Social media use by many Dutch development organisations has increased (Turnhout, 2009; Schellens, 2011). However, for many of these organisations, the benefits or the potential uses of social media in the development context are not entirely clear. ICT as an enabler of development is referred to as ICT for Development (ICT4D or ICTD). ICT for development is aimed at bridging the digital divide[1] and aiding economic development by ensuring equitable access to up-to-date communications technologies (UNDP-APDIP, 2004). The concept of 'Development' is highly debated and often not clarified in ICT for Development projects (Avgerou, 2010; Unwin, 2014). It is both value relative, as it has different meanings to different people, depending on what is considered like economic, geographic, political, social, cultural, religious, ethnic contexts, as well as it is theory relative, as it depends on theories and different academic disciplines about what will lead to progress (Prakash & De, 2007; Reddi, 2011). From an idea originally focused at economic growth and Western style modernisation and industrialisation, it has evolved to a –rather holistic- human development paradigm, that looks at the process of development through a more people-centred and humane approach (Mchombu et al., 2004; Pieterse, 2010). The human development approach recognises the importance of the well-being of all people instead of solely a narrow focus on economic growth (Mchombu et al., 2004). The global development goals (Millennium Development Goals or MDGs) are based on the human development approach.

Heeks (2014) argues that the ICT4D field is struggling with grasping the potential of emerging technologies such as cloud and social media. How social media is used in the area of development is a key issue for development NGOs (Waters, 2009; Kanter & Fine, 2010). The impact of social media for development purposes is still an on-going research process where few have conducted systematic research yet. Therefore the focus of the research is on understanding how the developments NGOs cope with social media.

1.1 Social media use by non-profit organisations

The concept of social media has a technological foundation, it is a social phenomenon, and has overarching principles. For the purpose of this research, social media is defined as a techno-social system for participatory culture, having characteristics like: openness, participation, conversation, connectedness and community. This definition relies heavily on the ideas set forward by Fuchs (2013) and Mayfield (2008). The terms social media, social networks (SNSs)

[1] The term "digital divide" refers to the gap between individuals, households, businesses and geographic areas at different socio-economic levels with regard to both their opportunities to access information and communication technologies (ICTs) and to their use of the Internet for a wide variety of activities. (OECD, 2006)

and web 2.0 are often interchanged in usage (Parameswaran, 2007; Iriberri & Leroy, 2009; Zuniga & White, 2009). All definitions share at least the characteristics participation, openness, conversation, connectedness and community (Mayfield, 2008). Participation refers to the encouragement of contributing and feedback from everyone. Openness refers to the apparent lack of barriers to access, make use and share content. The conversation characteristic is with social media extended to two-way conversation rather than merely broadcasting. Connectedness highlights the ability to link to other sites, resources and people with social media. Lastly, community reflects group forming around common interests. “Social technologies can empower anyone to have a positive impact on the society by creating networking effects and initiating community engagement”, Bresciani and Schmeil (2012) declare. Kanter and Fine (2010) suggest that non-profit organisations have the ability to reinforce their organisational support and brand by tapping into social technologies. “Social technologies can empower anyone to have a positive impact on the society by creating networking effects and initiating community engagement”, Bresciani and Schmeil (2012) declare. Kanter and Fine (2010) suggest that non-profit organisations have the ability to reinforce their organisational support and brand by tapping into social technologies. Waters et al. (2009) argue that non-profit organisations lag behind others in social media adoption, waiting to see how others use this new technology. Although many studies are U.S. based the studies conducted elsewhere like in Europe do show similar patterns (Sheombar, 2012; Verhoeven et al., 2012; Magee & Mitchel, 2015).

1.2 Social media and development organisations

More and more development organisations are discovering the power of social media to affect change (Ørecomm, 2012). Social media have been used for social good, such as organising community activism, for empowering citizens, and for coordinating emergency or disaster relief efforts (Bresciani & Schmeil, 2012). Zuniga and White (2009) argue that the relevance of social media in the context of aid and development covers four broad areas; connecting with other; collaborating with other people; creating and sharing content; and finding, using, organizing and reusing content.

Masetti-Zannini (2007), van Stam (2014) and Owiny et al. (2014) advocate that development NGOs should embrace traditional knowledge-management practices and social Web 2.0 technology to tap into the indigenous knowledge and voices of the South. Although Internet access facilitates the control or influence of individual people and small organisations and stimulates agency, it is not certain that the poorest will be reached and engaged (Baud, 2009; McLennan, 2015; Ackland & Tanaka, 2016). Thompson and Heeks urge for further research including empirical examples of attempts to introduce Web 2.0 (social media) models to serve developmental aims (Heeks, 2008; Thompson, 2008). This study serves as a particular example to that aim.

Non-governmental organisations (NGOs) are active players in the field of international development, both as providers of aid and services to underprivileged communities as well as policy advocates (Clarke, 1998; Atack, 1999). They are recognised as key third sector actors in the landscapes of international development, humanitarian action, human rights, environment and many other areas of public action (Lewis, 2010). Despite the enormous diversity of NGOs, a general definition of NGOs is nonetheless possible within the context of this research. The essence of this definition is a set of five core structural or operational features that differentiate the NGOs from other types of social institutions. NGOs have the following five characteristics: *institutionalised organisation, separate from the government (non-state), non-profit, self-governing and often some degree of voluntary participation in its activities* (Korten, 1990; Salamon & Anheier, 1992; Lewis & Kanji, 2009).

2 Problem definition

The impact of social media for development purposes is still an on-going research process where few have conducted systematic research yet. Organisations are trying to get to grips with the latest digital technologies, and Dutch development NGOs are no different. Incorporating these new rapidly evolving digital technologies like social media bring challenges to these organisations. Walsham et al. (2007) argue more research is needed on the role of NGOs when applying ICT such as social media for development. Whether ICT can have a transformational contribution remains an open question (Heeks, 2010). Avgerou (2010) states that "every ICT for Development study incorporates implicit assumptions about the way IT innovation occurs in the context of development, and about the meaning and the nature of the process of development toward which such innovation is intended to contribute." Viewing social media as an innovation in the development context enables us to see the research problem differently, because the use of social media by development NGOs is assessed for its development outcome. Are social media used as western technology for development purposes or are local social media or appropriated social media used for these? This sheds light on the impact, potential and pitfalls of social media use by development NGOs.

The NGOs and their staff try to make sense of social media and its value for development projects while they lack complete knowledge of these new technologies or are overwhelmed by the various social media and their applications which therefore have the potential for multiple interpretations and effects. In that sense social media can be called equivocal technology where organisations such as the development NGOs struggle with sense making on the application of social media for their projects (Berente et al., 2011). Even when equivocal technology such as social media are thought to make new organisational usage possible, the specific applications are not well stated or comprehended or information is incomplete or ambiguous (Swanson & Ramiller, 1997). This quest for sense making brings up an overall contextual overlay for this research project. Therefore the focus of the research is on understanding how the developments NGOs cope with social media. The research question is formulated as:

How do Dutch NGOs perceive the opportunities and pitfalls of social media as a tool for their development projects?

The approach of the study is to analyse in a conceptual manner without focusing on any particular social media technology or relying too much on today's social media technology. This implies to look deeper into the emerging and (un)expected associated attributes of technology by human interaction.

3 Methodology

This section discusses the research design and justifies the approach adopted for the study. Given the exploratory nature of this research, a qualitative research approach has been adopted (Glaser & Strauss, 1967). The methodology of grounded theory method, combined with a multiple case study is being applied. In this study, the research approach used is the Glaserian grounded theory method (Glaser, 1978; Glaser, 2002). It is being used for both data analysis as well as theory building. Evidence suggests that the combination of case studies and grounded theory method has been rewarding for Information Science researchers (Lehmann, 2001).

3.1 Theory Building with Case Studies

Case studies are an established way of theory building (Fernández & Lehmann, 2005; Eisenhardt & Graebner, 2007). Case studies are particularly valuable for understanding complex phenomena in context (Crotty, 1998; Jones, 2002), and according to Yin (2003) when users' intentions, technology use patterns, and social impacts cannot be clearly separated from the social, technological, and organisational contexts in which they occur. Every researched development organisation is one case study, the context is social media use and the units of analysis are determined from the conceptual lens (Gillham, 2000; Yin, 2003).

Evidence suggests that the combination of case studies and Grounded Theory has been rewarding for Information Science researchers (Lehmann, 2001; Allan, 2003). Eisenhardt (1989) describes how to build theories in case study research, where she explicitly advocates Yin's (2003) case study method and Glaser and Strauss's Grounded Theory. According to Eisenhardt (1989, p. 547), using case data to build theory has three major strengths: "*1) theory building from case studies, 2) The emergent theory 'is likely to be testable with constructs that can be readily measured and hypotheses that can be proven false', 3). The 'resultant theory is likely to be empirically valid' because a level of validation is performed implicitly by constant comparison, questioning the data from the start of the process*". When combining methods like case study and grounded theory, care must be taken to ensure that the principles of case study research do not distort true emergence for theory generation (Fernández, 2003). For example Yin (2003), assumes theory development prior to data collection. This assumption is in opposition to the principle idea of the grounded theory methodology where theory emerges from the data. Therefore, when combining case study and grounded theory, the researcher must clearly specify which methodology is steering the study. A way to resolve this issue is to use an initial high-level conceptual framework as guiding instrument for both the a 'non-committal' literature research as well for conceptualisation of the research problem while not distorting the emergence of theory from the data (Glaser, 2002; Urquhart & Fernández, 2013).

Step	Activity	Examples of how the approach is used in this study
1. Getting Started	• Definition of research question • Possibly a priori constructs • Neither theory nor hypotheses	• A broad research problem that relates to social media for development was initially formulated. • A preliminary literature review identifies some broad constructs.
2. Selecting Cases	• Specified population • Theoretical, not random, sampling	• 6 cases were analysed for the pilot study and additional cases are added based on theoretical sampling—each case is added to the list for the purpose of substantiating the emerging theory.
3. Crafting Instrument s and Protocols	• Multiple data collection methods • Qualitative and quantitative data combined	• Multiple data collection methods were used: semi-structured and unstructured interviews, document analysis, participant observation and focus groups. • Multiple sources of data: interview transcripts, reports, social media and websites, photos. • Qualitative data collected and used by a single investigator.
4. Entering the Field	• Overall data collection and analysis • flexible and opportunistic	• Detailed field notes and analytical memos help to make adjustments to the interview guide and the case study design during the data collection process.
5. Analysing Data	• Within-case analysis • Cross-case pattern search using divergent techniques.	• Detailed write-ups for each case. • Cases are individually analysed first for constructs and relationships in the data followed by within group analysis for similarities and differences of these constructs and their relationships. Finally, analysis across all cases is conducted for similar and different patterns in the constructs and relationships.
6. Shaping Hypotheses	• Iterative tabulation of evidence for each construct. • Search evidence of "why" behind relationships.	• Constructs emerging from the data compared with the evidence obtained from the consecutive cases.
7. Enfolding Literature	• Comparison with conflicting literature • Comparison with similar literature.	• Emergent theory compared with the relevant literature areas
8. Reaching Closure	• Theoretical saturation when possible.	• Reaching of theoretical saturation achieved when no additional data was found to be contributing to extend the theory.

Table 1: Adaptation of Eisenhardt's (1989) Framework to Build Theory from Case Study Research

Eisenhardt (1989) describes a framework that has also been recommended by Urquhart (2013) for research design using case studies (Table 1). The steps described are: Getting Started, Selecting Cases, Crafting Instruments and Protocols, Entering the Field, Analysing the Data, Shaping Hypotheses or Theory, Enfolding Literature, and Reaching Closure. This approach is being adopted for the study and described in Table 1. Although the table seems to suggest a linear process the actual nature of this process is iterative where there researcher is forced to backtrack certain steps. However, this deconstruction in logical steps helps in planning and managing the research project (Fernández, 2003).

3.2 Using Grounded Theory

The main purpose of the Grounded Theory method is *theory building.* In their seminal work *The Discovery of Grounded Theory*, the originators of Grounded Theory, Barney Glaser and Anselm Strauss (1967), described the research process as the discovery of theory through the rigours of social research. Grounded Theory approaches are becoming increasingly common in the Information Science (IS) research literature because the method is extremely useful in developing context-based, process-oriented descriptions and explanations of the phenomenon (Orlikowski & Baroudi, 1991; Matavire & Brown, 2008).

The term "grounded" refers to the fact that this means not just abstract theorising, instead the theory needs to be grounded or rooted in observation (Urquhart, 2001; Trochim, 2006; Urquhart, 2013). There are two major streams of scholarly thinkers within Grounded Theory. Grounded Theory according to Glaser emphasises induction or emergence, and the individual researcher's creativity within a clear frame of stages, while Strauss is more interested in validation criteria and a systematic approach (Gibbs, 2010).The one proposed for application for this research is that one of Glaser. Glaser uses three coding structures, namely open, selective and theoretical coding, at incremental levels of abstraction.

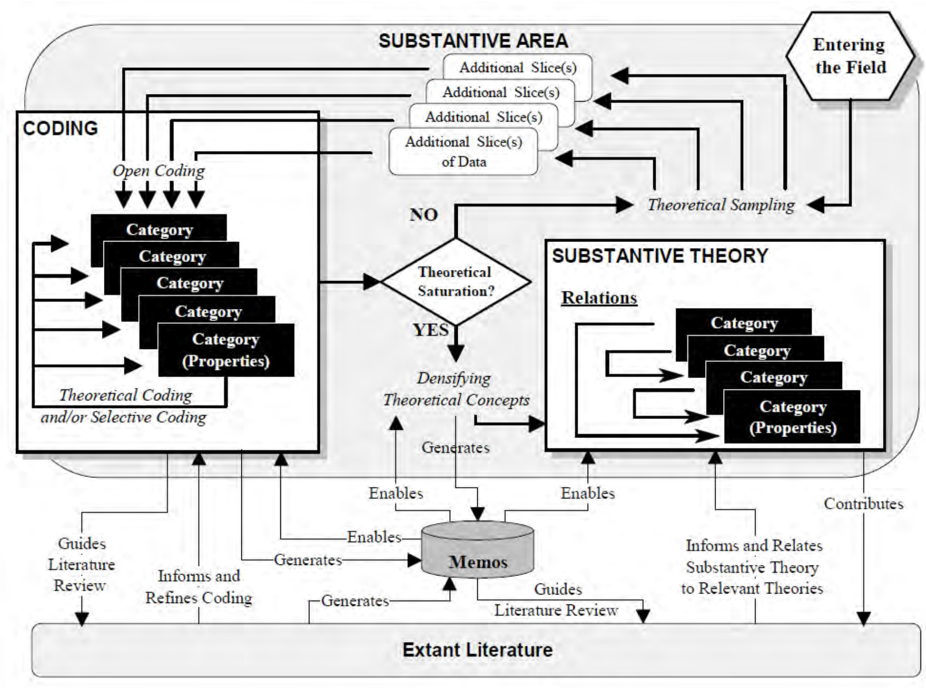


Figure 1: Schematic overview of Grounded Theory method. Source: Fernández (2003); derived from Lehmann (2001)**.**

Glaser and Strauss (1967) stress the importance of 'theoretical sensitivity' in Grounded Theory. The researcher establishes emerging impressions from the evidence, conceptualises the data, and then analyses emerging relationships between concepts. Constant comparison with previous data, categories, concepts and constructs is an essential part of the applied method. Constant comparison is the process of constantly comparing instances of data that you have labelled as a particular category with other “slices” of data, to see if these categories fit and are applicable (Urquhart, 2013). In this study, the slices of data are not only coming from interviews, but also from social media sources and other secondary data. Figure 1 describes the cycle of data collection and analysis. Data analysis proceeds from open coding (identifying categories, properties and dimensions) through selective coding (clustering around categories), to theoretical coding (Trochim, 2006; Urquhart, 2013). Theoretical coding considers the relationships between codes by generating hypotheses for integration into a theory (Glaser, 1978; Fernández, 2003). Data saturation has been reached when data collection no longer contributes to elaboration of the phenomenon being investigated (Urquhart, 2001; Egan, 2002). The so called ‘saturated’ concepts are then condensed as much as possible to the relationships between core categories, which then form a ‘grounded’ theory (Urquhart et al., 2010).

3.3 Justification of methods

Grounded Theory combined with case study research method is suitable for to this qualitative study. The combination of case studies and Grounded Theory has been rewarding for IS researchers as claimed by Lehmann (2001) and Allan (2003). Férnandez (2003), Gregor & Hart (2005) and Goulding (2002) argue that the reason for using the Grounded Theory approach is consistent with the three main reasons suggested by Benbasat et al. (1987) for using a case study strategy in Information Systems (IS) research, namely: “the research can study IS in a natural setting and generate theories from practice, the researcher can answer the questions that lead to an understanding of the nature and complexity of the processes taking place, and third it is an appropriate way to research a previously little studied area”, which is the case with social media usage in the context of aid and development organisations. Urquhart and Vaas (2012) emphasise the role the Information Science discipline can have in theorising about social media. The combination of case study research and Grounded Theory works well for theory building and has been applied in Information Science before. The Grounded Theory methodology for this research is consistent with the epistemology of interpretivism. Additionally, case study fits with the stated research problem because it is exploring a phenomenon that is not confined by boundaries (Eisenhardt & Graebner, 2007).

3.4 Data Collection – Pilot Data

As initial step for this research, a pilot study was conducted. Aid & development organisations in the Netherlands who are actively using social media were identified by desk research, an online survey (Sheombar, 2012), and also through consultation of experts in the aid & development field. Six of those organisations were chosen as sample group for a pilot study that has been conducted. Some of the characteristics of the analysed aid and development organisations for the pilot study are summarised in Table 2. Staff size is from ‘Small’ for less than 11, ‘Mid-size’ for 11 till 75, to ‘Large for more than 75 people. Each organisation’s focus on one or more areas of interest is considered, for example only healthcare or a broad range of themes like education and poverty reduction. Finally the use of social media use across the whole organisation or mainly located in one department is presented in the table.

Development NGO alias	Inter-viewees	Age of Organisation	Staff size	Focus area(s)	Organisation-wide/Dept. Focused use of social media
Crowdsourcing	2	1-5 years	Mid-size	Crowdfunding and wisdom of the crowd	Organisation-wide
Water & platform	1	6-15 years	Mid-size	Originally in water projects and now data management in development projects	Organisation-wide
Mobile phone focused	1	1-5 years	Mid-size	Mobile communication for development	Organisation-wide
Confederated	2	> 15 years	Large	Emergency relief, poverty and inequality, women's rights, fair-trade, climate change, refugees, micro finance and education,	Department-focused
Traumatised children	1	6-15 years	Large	Youth (post-war) trauma care	Department-focused
Advocacy	2	> 15 years	Large	Transparency, women's rights, freedom of speech, sustainable development, sexual and reproductive rights	Organisation-wide

Table 2: Characteristics of the examined development organisations.

3.5 Theoretical sampling: from pilot data to additional cases and slices of data

Additional cases for this research are sampled using the principle of theoretical sampling. Theoretical sampling refers to the process of choosing new cases to compare with ones that have already been studied. It is a purposeful selection approach based on analytic grounds (Myers, 2008; Urquhart et al., 2010). The data collection (or theoretical sampling) for this research is initially based on the emerging concepts from the pilot study.

Urquhart (2013), building on Glaser and Strauss (1967) sketches four major strategies for theoretical sampling: minimising or maximising the disparities either between groups (e.g. the international development NGOs), or between concepts in the data (Table 3). Urquhart (2013), citing Glaser and Strauss (1967) states the sampling strategy is driven by two major questions: "what (sub)groups does one turn next in data collection & for what theoretical purpose?". Urquhart and Vaast (2012) contend that a systematic approach of theoretical sampling would be of much aid to social media researchers who face a variety of data sources. Breckenridge (2009) argues that "theoretical sampling does not aim for full descriptive coverage, but systematically focuses and narrows data collection in the service of theoretical development".

Group differences	Concepts in data: Similar	Concepts in data: Diverse
Maximised In this study, examining differences in NGO size and activity area	• Identifying/developing fundamental uniformities of greatest scope • In this study, I will see how saturated some categories are and develop further based on saturation (Urquhart 2013)	• Diversity in data quickly forces dense developing of property of categories; • Integrating of categories and properties; • Delimiting scope of theory • In this study, I will look at categories that are diverse and try and develop them – based on level of saturation (Urquhart 2013)
Minimised In this study, considering the similarities such as size and activity area	• Verifying usefulness of category; • Generating basic properties; • Establishing a set of conditions for a degree of category • In this study, I will see how saturated some categories are and develop further based on saturation (Urquhart 2013)	• Identifying fundamental differences of category and hypotheses • In this study, I will look at categories that are diverse and try and develop them – based on level of saturation (Urquhart 2013)

Table 3: Options for theoretical sampling. Source: Urquhart (2013, p. 65) adapted from Glaser and Strauss (1967)

The sampling strategy actually stipulates different ways of constructing theory that becomes broader or deeper. Initial sampling (as in the pilot study) are based on a general formulated problem, but as soon as data are collected and the coding has begun the researcher is led by theoretical sampling for 'slices of data' in the "directions which seems relevant and work" (Glaser, 1978).

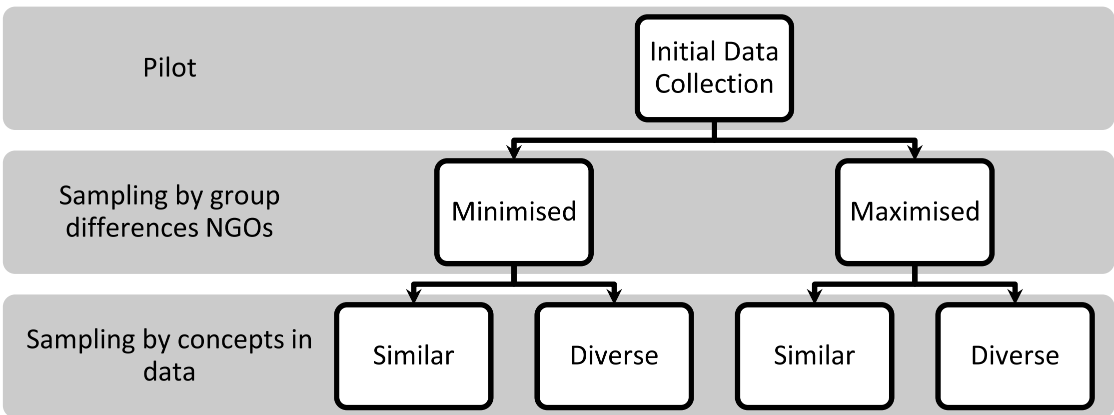


Figure 2: Theoretical sampling strategies.

In grounded theory sampling is driven by conceptual emergence and limited by theoretical saturation (Fernández, 2003). This sampling strategy is visualised in the scheme of Figure 2. Sampling after the initial data collection phase follows the sampling strategy of either seeking much variation among the NGOs or minimising those differences. Another part of the sampling strategy consists of sampling around similar concepts found in the data or a diverse range of concepts.

4 Preliminary results & follow-up steps

Data analysis is being conducted using grounded theory method. Data analysis proceeds from open coding (identifying categories, properties and dimensions) through selective coding (clustering around categories), to theoretical coding (Urquhart, 2013). The occurrences of the open codes in the pilot study cases show the emerging pattern of the identified selective codes. The selective codes reveal the themes that are apparent in the data. The selective codes (i.e. categories) were identified after grouping the open codes and finding close conceptual relation among the open codes that were clustered.

4.1 Three emerging themes

Three main themes, based on selective codes, emerged from the analysis. The selective codes which were the basis for the three themes were identified after grouping the open codes and finding close conceptual relationships among the open codes. The selective code 'Potential Organisational Uses of Social Media' refers to all uses of social media in the context of an organisation. It does not necessarily mean this defines organisational social media, but it tells how the respondents in the context of their work and organisation perceive what social media means to them. The selective code 'Adapting Social Media to Development Context' reflects the specific ways social media may be used in the context of development. And finally, the selective code 'Potential Disadvantages' refers to potential issues that are arising when using social media

4.2 Relationships between themes

As a first step in a preliminary theory building effort about how Dutch development NGOs might consider social media adoption, theoretical coding (Glaser, 1978) was carried out, where relationships between the themes were analysed. A preliminary diagram of the themes and their relationships emerged. The first relationship that emerged is that between the selective code 'Potential Disadvantages' that may impede 'Potential Organisational Uses of Social Media'. The second relationship that was identified between the emerging themes is 'Potential Organisational Uses of Social Media' and 'Adapting Social Media to Development Context' where the first may motivate the latter. The third relationship identified is how the themes 'Adapting Social Media to Development Context' interacts (bi-directional) with 'Potential Disadvantages'. All three relationships are exemplified by examples. The three themes combine into a diagram that shows the emergent themes and their relations (Figure 3). The ideas those organisations and their staff have of the disadvantages of social media use, the threats it brings or the hurdles that have to be crossed, impede the attributed potential of social media use by the organisation. In its turn organisational media may motivate adapting it for a development context. This adaptation of social media for development interacts with the potential disadvantages of social media. The bi-directional nature of this interaction is illustrated by the two quotes linked to the double arrow in the diagram.

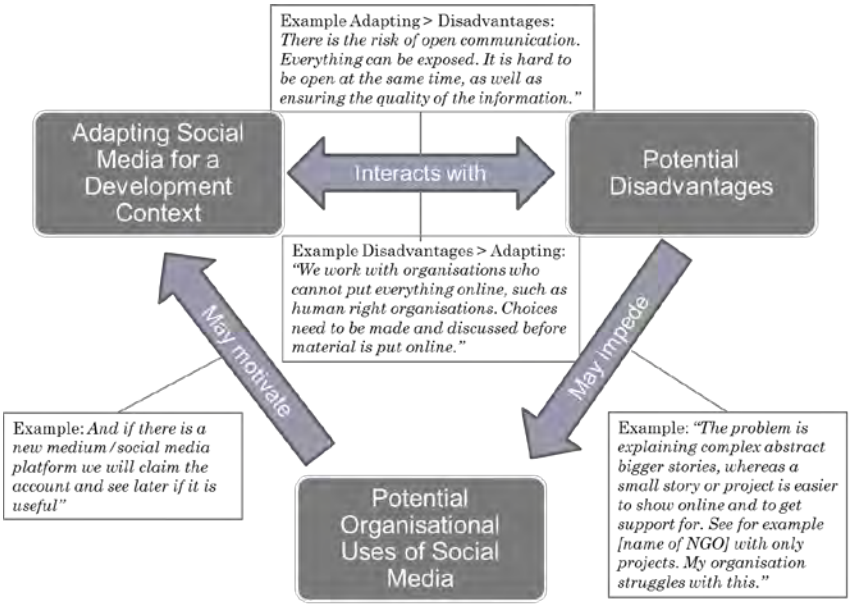


Figure 3. Relationship between themes for Social Media and Development NGOs.

An initial step in validation of the emergent themes has been undertaken by linking to existing literature and discussing its relevance and has been published recently (Sheombar et al., 2015). This as an intermediate step toward the final result of a grounded theory study: an integrated and comprehensive grounded theory that explains a process or scheme associated with a phenomenon, cf. Birks and Mills (2011).

4.3 Further research development

Returning to research question "How do Dutch NGOs perceive the opportunities and pitfalls of social media as a tool for their development projects?" the findings of this pilot study provide an emerging theory of social media use by these NGOs in the context of international development. From the preliminary framework of emerging themes diagram (Figure 3) it becomes apparent that potential disadvantages associated with social media use may impede the organisational use, whereas the identified potential organisational uses of social media may motivate use and adapting the social media for a development context. On its turn the use in a development context may reveal potential disadvantages, whereas potential disadvantages may influence the use or non-use of social media for particular developmental activities, hence a bidirectional interaction between these themes. As a next step for this research more data along these theoretical concepts is being collected, over a broader range of cases in order to build a deeper theory of wider scope, using theoretical sampling (Glaser, 1978). Sustainable development is a challenge for NGOs. Social media may leverage inclusiveness and sustainability in development projects. Furthermore, as follow-up to these findings the nature of NGOs related to their social media activities is investigated. An interesting classification of NGOs along their historic advance has been suggested by Korten (1987). The classification scheme includes the following typologies of NGOs (originally seen as sequential generations of NGOs): emergency assistance, development, development as self-reliant political process, human and sustainable development and development beyond aid oriented NGOs. This classification is based on synthesis of ideas from Korten (1987); Korten (1990), De Senillosa (1998), Bendell and Murphy (1999) and Fowler (2000). Considering this classification of the development strategies used by NGOs, and how social media supports those strategies, adds a useful perspective to this research. Initial data analysis in this direction has been fruitful (Sheombar et al., 2015). It may be that social media use in these organisations span a number of these development activities. This study considers those implications in the context of interventions using social media by NGOs in international development. The design of the study is such that it explores what consequences the use of social media has on social and organisational dynamics of these organisations. The research intention is to create practical contribution to the studied development NGOs. I've created a Facebook group where news related to social media for development is being curated[2]. It already has attracted more than 2500 followers from academics, NGO-professionals and others across the world. I am inspired by social media and will probably use blog and e-book format to disseminate practical results of this research to practitioners from the development NGOs.

[2] The Facebook group on social media for development is https://www.facebook.com/groups/SoMe4D/

References

Ackland, R., & Tanaka, K. (2016). Spotlight 3: Social media *World Development Report 2016: Digital Dividends* (pp. 148-150): World Bank.

Allan, G. (2003). The Electronic Journal of Business Research Methods (EJBRM).

Atack, I. (1999). Four Criteria of Development NGO Legitimacy. *World Development, 27*(5), 855-864. doi: http://dx.doi.org/10.1016/S0305-750X(99)00033-9

Avgerou, C. (2010). Discourses on ICT and Development. *Information technologies and international development, 6*(3), 1-18.

Baud, I. (2009). Welkom in de ongelijke wereld *Heilige Huisjes: Een frisse blik op Internationale Samenwerking* (pp. 14-20): IS-academie & Dutch Ministry of Foreign Affairs.

Benbasat, I., Goldstein, D. K., & Mead, M. (1987). The case research strategy in studies of information systems. *MIS Q., 11*(3), 369-386. doi: 10.2307/248684

Bendell, J., & Murphy, D. F. (1999). Partners in Time? Business, NGOs and Sustainable Development. Geneva: The United Nations Research Institute for Social Development (UNRISD).

Berente, N., Hansen, S., Pike, J. C., & Bateman, P. J. (2011). Arguing the value of virtual worlds: patterns of discursive sensemaking of an innovative technology. *MIS Quarterly, 35*(3), 685-710.

Birks, M., & Mills, J. (2011). *Grounded Theory: A Practical Guide*: SAGE Publications.

Breckenridge, J. (2009). Demistifying Theoretical Sampling in Grounded Theory Research. *Grounded Theory Review, 8*(2).

Bresciani, S., & Schmeil, A. (2012, 18-20 June 2012). *Social media platforms for social good.* Paper presented at the Digital Ecosystems Technologies (DEST), 2012 6th IEEE International Conference on.

Clarke, G. (1998). Non-Governmental Organizations (NGOs) and Politics in the Developing World. *Political Studies, 46*(1), 36-52. doi: 10.1111/1467-9248.00128

Crotty, M. (1998). *The Foundations of Social Research*: Sage.

De Senillosa, I. (1998). A new age of social movements: A fifth generation of non-governmental development organizations in the making? *Development in Practice, 8*(1), 40-53. doi: 10.1080/09614529853972

Egan, T. M. (2002). Grounded Theory Research and Theory Building. *Advances in Developing Human Resources, 4*(3), 277-295. doi: 10.1177/1523422302043004

Eisenhardt, K. M. (1989). Building Theories from Case Study Research. *The Academy of Management Review, 4*(4), 532-550.

Eisenhardt, K. M., & Graebner, M. E. (2007). Theory building from cases: opportunities and challenges. *Academy of Management Journal, 50*(1).

Fernández, W. D. (2003). *Metateams in Major Information Technology Projects: A Grounded Theory on Conflict,Trust, Communication, and Cost.* (Doctor of Philosophy,), Queensland University of Technology.

Fernández, W. D., & Lehmann, H. P. (2005). Achieving rigour and relevance in Information Systems Studies: using grounded theory to investigate organizational change. *The Grounded Theory Review, 5*(1).

Fowler, A. (2000). NGDOs as a moment in history: Beyond aid to social entrepreneurship or civic innovation? *Third World Quarterly, 21*(4), 637-654. doi: 10.1080/713701063

Fuchs, C. (2013). *Social Media, A Critical Introduction*: SAGE Publications Ltd.

Gibbs, G. R. (2010). Grounded Theory - Core Elements: University of Huddersfield.

Gillham, B. (2000). *Case study research methods*. London: Continuum.

Glaser, B. G. (1978). *Theoretical Sensitivity: Advances in the methodology of Grounded Theory.* Mill Valley, CA: Sociology Press.

Glaser, B. G. (2002). Conceptualization: On Theory and Theorizing Using Grounded Theory. *International Journal of Qualitative Methods, 1*(2).

Glaser, B. G., & Strauss, A. L. (1967). *The discovery of grounded theory: strategies for qualitative research*. Hawthorne, NY: AldineTransaction.

Goulding, C. (2002). *Grounded Theory: A Practical Guide for Management, Business and Market Researchers*: Sage.

Gregor, S. D., & Hart, D. N. (2005). *Information systems foundations: constructing and criticising*: ANU E Press.

Heeks, R. (2008). ICT4D 2.0: The Next Phase of Applying ICT for International Development. *Computer, 41*(6), 26-33. http://research.microsoft.com/en-us/um/people/cutrell/papers/heeks-ictd%20two-point-zero.pdf

Heeks, R. (2010). Do information and communication technologies (ICTs) contribute to development? *Journal of International Development, 22*(5), 625-640. doi: 10.1002/jid.1716

Heeks, R. (2014). ICT4D 2016: New Priorities for ICT4D Policy, Practice and WSIS in a Post-2015 World *Development Informatics Working Paper Series*. Manchester: Centre for Development Informatics, Institute for Development Policy and Management, SEED, University of Mancheste.

Iriberri, A., & Leroy, G. (2009). A life-cycle perspective on online community success. *ACM Computing Surveys, 41*(2), 1-29.

Jones, P. H. (2002). Embedded values in innovation practice: Toward a theory of power and participation in organizations http://redesignresearch.com/pde-3.htm

Kanter, B., & Fine, A. (2010). *The Networked Nonprofit Connecting with Social Media to Drive Change*: Jossey-Bass.

Kaplan, A. M., & Haenlein, M. (2010). Users of the world, unite! The challenges and opportunities of Social Media. *Business Horizons, 53*(1), 59-68.

Korten, D. C. (1987). Third generation NGO strategies: A key to people-centered development. *World Development, 15, Supplement 1*(0), 145-159. doi: http://dx.doi.org/10.1016/0305-750X(87)90153-7

Korten, D. C. (1990). *Getting to the 21st century: voluntary action and the global agenda*: Kumarian Press.

Lehmann, H. P. (2001). *A Grounded Theory of International Information Systems.* (PhD), University of Auckland, Auckland, New Zealand. Retrieved from http://hdl.handle.net/2292/626

Lewis, D. (2010). Nongovernmental Organizations, Definition and History. In H. Anheier & S. Toepler (Eds.), *International Encyclopedia of Civil Society* (pp. 1056-1062): Springer US.

Lewis, D., & Kanji, N. (2009). *Non-Governmental Organizations and Development*: Taylor & Francis.

Magee, H., & Mitchel, M. (2015). Social Media - Making Your Voice Heard': IBT (The International Broadcasting Trust)

Masetti-Zannini, A. (2007). Web 2.0 and International Development NGOs. *Knowledge Politics Quarterly (KPQ), 1*(1).

Matavire, R., & Brown, I. (2008). *Investigating the use of "Grounded Theory" in information systems research*. Paper presented at the Proceedings of the 2008 annual research conference of the South African Institute of Computer Scientists and Information

Technologists on IT research in developing countries: riding the wave of technology, Wilderness, South Africa.
Mayfield, A. (2008). What is Social Media? *icrossing*. http://www.icrossing.co.uk/fileadmin/uploads/eBooks/What_is_Social_Media_iCrossing_ebook.pdf
Mchombu, K. J., Evans, G., & Oxfam-Canada. (2004). *Sharing Knowledge for Community Development and Transformation : a Handbook*: Oxfam Canada.
McLennan, S. J. (2015). Techno-optimism or Information Imperialism: Paradoxes in Online Networking, Social Media and Development. *Information Technology for Development*, 1-20. doi: 10.1080/02681102.2015.1044490
Myers, M. D. (2008). *Qualitative Research in Business & Management*: SAGE Publications.
OECD. (2006, 4 January 2006). Digital Divide. *Gloassary of statistical terms.* Retrieved 27 June 2009, from http://stats.oecd.org/glossary/detail.asp?ID=4719
Ørecomm. (2012). *Social Media in Development Cooperation*. Malmö University and Roskilde University: Ørecomm - Centre for Communication and Glocal Change.
Orlikowski, W. J., & Baroudi, J. J. (1991). Studying Information Technology in Organizations: Research Approaches and Assumptions. *Information Systems Research, 2*(1), 1-28.
Owiny, S. A., Mehta, K., & Maretzki, A. N. (2014). *The Use of Social Media Technologies to Create, Preserve, and Disseminate Indigenous Knowledge and Skills to Communities in East Africa* (Vol. 8).
Parameswaran, M. (2007). Social computing: an overview. *Communications of the Association for Information Systems, 19*, 762-780.
Pieterse, J. N. (2010). *Development Theory*: SAGE Publications.
Prakash, A., & De, R. (2007). Importance of development context in ICT4D projects: A study of computerization of land records in India. *Information Technology & People, 20*(3), 226-281. doi: 10.1108/09593840710822868
Reddi, U. R. V. (2011). Primer 1: An Introduction to ICT for Development. In U. R. V. Reddi (Ed.), *Primer Series on ICTD for Youth*: UN-APCICT/ESCAP.
Salamon, L. M., & Anheier, H. K. (1992). *In Search of the Nonprofit Sector I: The Question of Definitions*: Johns Hopkins Institute for Policy Studies.
Schellens, N. (2011). Openheid over ontwikkelingssamenwerking via sociale media. Retrieved 1 January 2013, from http://www.viceversaonline.nl/2011/09/openheid-over-ontwikkelingssamenwerking-via-sociale-media/
Sheombar, A. (2012). *A quick overview of social media use by Dutch aid & development NGOs (poster presentation)*. Paper presented at the 4th European Communication Conference (ECREA) [Conference], Istanbul, Turkey. http://www.slideshare.net/anandsheombar/poster-presentation-ecrea2012-anand-sheombar
Sheombar, A., Urquhart, C., Ravesteijn, P., & Ndhlovu, T. (2015). *Social Media in the Context of Development: A Case Study of Dutch NGOs.* Paper presented at the ECIS - European Conference on Information Systems, Münster, Germany.
Swanson, E. B., & Ramiller, N. C. (1997). The Organizing Vision in Information Systems Innovation. *Organization Science, 8*(5), 458-474. doi: doi:10.1287/orsc.8.5.458
Thompson, M. (2008). ICT and development studies: Towards development 2.0. *Journal of International Development, 20*(6), 821-835. doi: 10.1002/jid.1498
Trochim, W. M. K. (2006, 10/20/2006). Qualitative Methods. *Research Methods Knowledge Base.* from http://www.socialresearchmethods.net/kb/qualmeth.php

Turnhout, W. (2009, 24 November 2009). Sociale platformen de toekomst voor internationale ontwikkelingssamenwerking. *Dutch Cowboys.* Retrieved 24 January 2013, from http://www.dutchcowboys.nl/socialmedia/18394

UNDP-APDIP. (2004). *Information and Communications Technology for Development - A Sourcebook for Parliamentarians* (R. E. I. P. Limited Ed.): United Nations Development Programme - Asia Pacific Development Information Programme (UNDP-APDIP).

Unwin, T. (Producer). (2014, 16 May 2014). Can ICTs really make a difference to the lives of poor people and marginalised communities? *Symposium "Perspectives on ICT4D"*. Retrieved from w4ra.org/2014/05/13/live-streaming-the-vu-symposium-perspectives-on-ict4d-16-may-2014

Urquhart, C. (2001). An Encounter with Grounded Theory: Tackling the Practical and Philosophical Issues. *Qualitative Research in Information Systems: Issues and Trends*, 104-140.

Urquhart, C. (2013). *Grounded Theory for Qualitative Analysis: A Practical Guide*: Sage.

Urquhart, C., & Fernández, W. (2013). Using grounded theory method in information systems: the researcher as blank slate and other myths. *Journal of Information Technology, 28*(3), 224-236.

Urquhart, C., Lehmann, H., & Myers, M. D. (2010). Putting the ‘theory’ back into grounded theory: guidelines for grounded theory studies in information systems. *Information Systems Journal, 20*(4), 357-381. doi: 10.1111/j.1365-2575.2009.00328.x

Urquhart, C., & Vaast, E. (2012). *Building Theory From Case Studies In The Web 2.0 Era: A New Frontier For IS Research.* Paper presented at the Thirty Third International Conference on Information Systems, Orlando.

van Stam, G. (2014). *Thoughts on African Content and Implementation Strategies involved in ICT Access in (rural) Africa*. Paper presented at the Human Sciences Research Council (HSRC) Seminar Series, Pretoria, South Africa. http://www.hsrc.ac.za/uploads/pageContent/4554/African%20Content%20and%20Implementation%20Strategies%20HSRC%202014.pdf

Verhoeven, P., Tench, R., Zerfass, A., Moreno, A., & Verčič, D. (2012). How European PR practitioners handle digital and social media. *Public Relations Review, 38*(1), 162-164. doi: http://dx.doi.org/10.1016/j.pubrev.2011.08.015

Walsham, G., Robey, D., & Sahay, S. (2007). Foreword: Special Issue On Information Systems In Developing Countries. *MIS Quarterly, 31*(No. 2, Special Issue On Information Systems In Developing Countries), 317-326.

Waters, R. D. (2009). The Use of Social Media by Nonprofit Organizations: An Examination from the Diffusion of Innovations Perspective. In T. Dumova & R. Fiordo (Eds.), *Handbook of research on social interaction technologies and collaboration software: Concepts and trends*: IGI Global.

Waters, R. D., Burnett, E., Lamm, A., & Lucas, J. (2009). Engaging stakeholders through social networking: How nonprofit organizations are using Facebook. *Public Relations Review, 35*(2), 102-106.

Yin, R. K. (2003). *Case study research: design and methods* (3rd ed.). Thousand Oaks, Calif.: Sage Publications.

Zuniga, L., & White, N. (2009). Module Web 2.0 and Social Media for Development. from FAO http://www.imarkgroup.org/moduledescription_en.asp?id=109

29th Bled eConference
Digital Economy
June 19 - 22, 2016; Bled, Slovenia

Learning Analytics From a Resource-Based View Perspective:
Towards a Learning Analytics Capability Model

Justian H. Knobbout
HU University of Applied Sciences Utrecht, the Netherlands
justian.knobbout@hu.nl

Abstract
Within higher educational settings, Learning Analytics measures, collects, analyses and reports on learner data in order to optimize learning and the environment in which the learning occurs. Learning Analytics aim to improve learning processes at the level of students and teachers and is, for example, used to analyze student behavior within digital learning environments, monitor the usage of course material, and predict whether students will fail a certain course or dropout entirely. Institutes willing to use Learning Analytics need to possess the right resources, i.e., assets and capabilities. Several frameworks provide insight in the required assets but they cannot answer the question what capabilities are necessary to successful apply Learning Analytics. Therefore, a PhD research aimed at developing an answer to that question is proposed. The results of five research sub questions lead to the development of a Learning Analytics Capability Model, taking into account situational factors and capability maturity. This paper elaborates on the fundaments of the proposed PhD research.

Keywords: Learning Analytics , Capabilities, Assets, Resource-Based View, PhD Research

1 Introduction

In recent years, the educational domain witnessed the development and application of various forms of analytics. One of the upcoming methods is Learning Analytics, which is "the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environment in which it occurs" (Ferguson, 2012; Clow, 2013). Learning Analytics aim to improve learning processes at the level of students and teachers (Long & Siemens, 2011) and is, for example, used to analyze student behavior within digital learning environments, monitor the usage of course material, and predict whether students will fail a certain course or dropout entirely. Several researches show a positive connection between the deployment of Learning Analytics systems and educational outcomes (Arnold & Pistilli, 2012; LACE, 2016). Learning Analytics can therefore be a valuable asset to higher educational institutes. In order to achieve desired results, organizations must utilize their assets by performing coordinated sets of tasks (Helfat & Peteraf, 2003). The ability to do so lies in an organization's capabilities. Capabilities are repeatable patterns of actions in the use of these assets (Wade & Hulland, 2004) and involve "complex patterns of coordination between people and between people and other resources" (Grant, 1991). Although some Learning Analytics frameworks provide insight in required assets to successfully use Learning Analytics (cf. Arnold, Lonn & Pistilli, 2014; Greller & Drachsler, 2012), a distinctive set of necessary capabilities is momentarily non-existing. This PhD research aims at designing such a set whilst taking into account a wide variety of educational contexts. The main research question is formulated as follows: *"Which Learning Analytics capabilities benefit teachers and learners in Dutch higher educational institutes?* This PhD research proposes various research methods in order to provide an answer to the main and sub research questions, including an extensive literature review, semi-structured interviews with experts in the field of Learning Analytics, and simulations.

This paper is structured as follows. Section 2 elaborates on the problem definition, including the research main and sub questions. Section 3 describes the research's methodology and expected results. Finally, section 4 elaborates on the future development.

2 Problem definition

Nowadays, the application of (big) data analysis is seen in many industries. Data analytics can be described as “the extensive use of data, statistical and quantitative analysis, explanatory and predictive models, and fact-based management to drive decisions and actions” (Davenport & Harris, 2007). In recent years, the availability of big data led to the further development of a variety of analytical techniques and technologies, for instance, data mining, cluster analysis and machine learning (Maltby, 2011). Companies like Amazon, Google, and Netflix use data analytics and can be categorized as analytical competitors: organizations that extensively and systematically apply analytics in order to perform better than their competitors (Davenport & Harris, 2007). They act on the assumption that sustainable competitive advantages can be achieved by the use of analytics, when executed in the right way. Not only companies heavily relying on IT can benefit from analytics, there are multiple examples of its application in for example sport teams as Boston Red Sox and the German national football team (Norton, 2014). The extensive use of data in order to guide decision-making is applied in, among others, financial services, retail, eCommerce, telecommunication, and the transportation industry.

2.1 Analytics in the educational industry

Although frequently applied within in the industries described earlier, analytics is yet an upcoming topic of interest within the higher educational domain. Data usage within educational institutes has been quite inefficient in the past, however, this is likely to change (Long & Siemens, 2011). Drivers for this change are the ability to capture big data related to concerns regarding the performance of educational institutes and the increased use of online learning (Ferguson, 2012). Besides complete e-learning – i.e., all teaching taking place online – blended learning becomes more and more popular as well (Porter et al., 2014). Blended learning is a combination of “traditional” face-to-face education and technology-mediated instruction. According to Baker & Siemens (2014) other reasons for the development of analytics within this domain are “a substantial increase in data quantity, improved data formats, advances in computing, and increased sophistication of tools available for analytics.” Tools relate to instruments required to manage educational data but also those required in order to analyze and visualize the stored data. As these Learning Analytics tools become easier to use, the number of individuals able to work with them increases as well and includes teachers, learning design developers and administrators. The analytical spectrum within education consists of several main areas, including Educational Data Mining, Academic Analytics and Learning Analytics (Siemens, 2011; Romero-Zaldivar et al., 2012). Educational Data Mining is a sub-set of the broader field of data mining, interested at finding yet unknown and possibly useful data patterns (Ferguson, 2012). Academic analytics takes place at institutional level and above and focusses on the needs of administrators and managers, for example by providing indicators how the institute is performing (Van Barneveld, Arnolds & Campbell, 2012). Important measures at this level are student retention and graduation rates (Elias, 2011). Learning analytics takes place at course- and departmental level, thereby benefiting learners and lecturers. Buckingham Shum (2012) makes a similar differentiation between analytics at macro, meso, and micro level. However, there is no clear distinction among the terms as there is wide overlap between them, showing their close proximity (Romero-Zaldivar et al., 2012).

2.2 Learning Analytics: definitions and objectives

An often used definition of Learning Analytics is provided at the 1st Conference on Learning Analytics and Knowledge: “Learning Analytics is the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environment in which it occurs" (Ferguson, 2012; Clow, 2013). Another definition is given by Duval (2012), who states that learning analytics is about "collecting traces that learners leave behind and using those traces to improve learning". Both definitions stress the importance of improving learning for the benefits of learners, especially those at higher educational institutes. In Learning Analytics literature, the word learner can be read as student and instructor as teacher. The term learner is, however, somewhat ambiguous as teachers can learn about the educational process as well (Greller & Drachsler, 2012). Campbell & Oblinger (2007) defined five steps to follow when applying Learning Analytics: capture, report, predict, act, and refine. Clow (2012) used these steps to formulate the Learning Analytics Cycle; a cycle process where learners generate data which is captured, analyzed and visualized, in turn leading to learner-affecting interventions. This closes the loop. When learners are faced with the interaction, they generate data again, which again can be measured, collected et cetera, starting the cycle again (Figure 1).

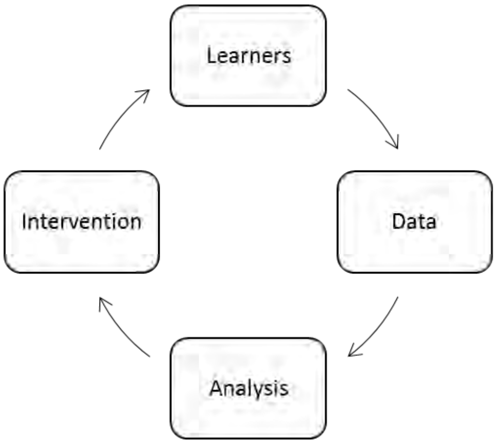


Figure 1: Learning Analytics Cycle (Clow, 2012)

One of the few well-documented Learning Analytics systems is Course Signals – Purdue University's student success system (Arnold & Pistilli, 2012). It inputs four types of data from various sources in a predictive model in order to identify students at risk of failing a course. These data relate to performance, effort, academic history, and student characteristics. Based on an algorithm, students are categorized in one of three categories. This is shown as a traffic light in a dashboard. Teachers see the results of all students in their course; students are able see their own status. Based on the information from the dashboard, teachers can decide to intervene on at-risk students by e.g. sending emails or text messages, initiate a face-to-face meeting, or referral to an academic advisor. This particular system's goal is to predict which students will fail a course. The objectives of Learning Analytics, however, can be divers and Learning Analytics systems are applied for various reasons (IBM, 2011; Verbert et al., 2012; Chatti et al., 2014). See Table 1 for an overview of different Learning Analytics objectives as mentioned by different researchers and the similarity between them. A systematic literature review performed by Papamitiou & Economides (2014) shows that most researches within the Learning Analytics field tend to focus on student behavior modeling and prediction of performance. This is not an easy exercise as context is of influence on Learning Analytics (Gašević et al., 2016). Context can relate to, among others: Learning Analytics objectives (IBM, 2011; Verbert et al., 2012; Chatti et al., 2014), learning design (Lockyer, Heathcote & Dawson, 2013), students (De Boer & Kamphuis, 2014), cohort (Tempelaar, Rienties & Giesbers, 2015), and instructors (Van Leeuwen, 2015).

Table 1: Learning Analytics Objectives

IBM (2011)	Chatti et al. (2014)	Verbert et al. (2012)
Predicting potential	Prediction and intervention	
Preventing drop-out		
Spotting outliers for early intervention		
Measuring and monitoring student achievement	Monitoring and analysis	Detecting undesirable learner behaviors
Identifying and developing key attributes of good teachers	Tutoring and mentoring	Enhancing social learning environments
Analyzing standardized testing to even out performance	Assessment and feedback	Detecting affects of learners
Reporting results	Awareness and reflection	Increasing reflection and awareness
	Adaptation	Suggesting relevant learning resources
	Personalization and recommendation	
Testing and evolving curricula		

To perform all activities required to turn student data into actionable insights, i.e., going through the entire Learning Analytics Cycle (Clow, 2012), the development, implementation and deployment of a Learning Analytics system is required. Such an approach is taken by, for instance, Dyckhoff et al. (2012) who designed a Learning Analytics toolkit for teachers. The back- and front-end of the toolkit where developed in parallel, after which the toolkit was implemented and put into practice. However, a vast amount of researchers primarily focusses on the development phase (cf. Macfadyen & Dawson, 2010; Romero-Zaldivar et al., 2012; Baker et al., 2015). That is, what is technically possible, which measures should be included, what requirements do systems have or in what way can these requirements designed into the system. There are only few documented large-scale deployments of Learning Analytics systems covering all three aforementioned phases (Ferguson et al., 2014). Examples of these systems are Course Signals (Arnold & Pistilli, 2012), RioPACE (Smith, Lange & Huston, 2012), and Open Academic Analytics Initiative (Jayaprakash et al., 2014; Lauría et al., 2013). Nonetheless, many other institutes are curious to discover the benefits of Learning Analytics and are exploring ways to implement it in their operations. This is not an easy exercise, as many challenges arise, e.g.; changes to the existing information systems by implementing a Learning Record Store and customizing data streams (Apereo, 2015; del Blanco et al., 2013); managing the increase in workload for teachers (Whale, Valenzuela & Fisher, 2013); and making sure all activities are in compliance with privacy legislation (Jisc, 2015). Whilst some of these problems relate to either existing or to-be obtained assets, others involve the necessary capabilities to effectively use these assets. Challenges like these lie at the heart of the resource-based view.

2.3 Learning Analytics from a Resource-Based View's perspective

The resource-based view attributes an organization's performance to its resources and its ability to leverage these resources (Bharadwaj, 2000). In order to obtain sustained competitive advantages, organizations must possess resources which are valuable, rare, hard to imitate, and non-substitutable. Resources relate to assets and capabilities (Wade & Hulland, 2004; Helfat & Peteraf, 2003). Assets are either tangible or intangible and involve anything which can be used by companies to create, produce and offer its goods or services to a market. Capabilities, on the other hand, are repeatable patterns of actions in the use of these assets (Wade & Hulland, 2004). They involve "complex patterns of coordination between people and between people and other resources" (Grant, 1991) and essentially are a number of interacting routines. Capabilities are a special kind of resource, as they refer to an organization's capacity to deploy other resources and ownership cannot be transferred between organizations (Makadok, 2001). They cannot be bought but need to be build. When we look at Learning Analytics from a resource-based view perspective, (most) resources related to Learning Analytics, e.g., availability of clean information, availability of open tools and data, and access to relevant scientific literature are commodities and therefore available for all organizations in the educational industry. Therefore, the difference between higher educational institutes with successful operational Learning Analytics systems and institutes without these systems results from their ability to build the right capabilities.

2.4 Research main question

As described, only a few higher educational institutes have operational, large-scale Learning Analytics systems at their disposal. Many others are working on small-scale initiatives and proofs-of-concept or have interest at Learning Analytics but yet have to start developing necessary capabilities. This PhD research aims at supporting these institutes – and in particular institutes in the Netherlands – by providing an answer to the following main research question:

"Which Learning Analytics capabilities benefit teachers and learners in Dutch higher educational institutes?

Our objective is to enable higher educational institutes, i.e., research universities and universities of applied sciences (EP-nuffic, 2016), to reap the benefits of Learning Analytics and define success as an increase of learning due to analytics activities. As the concept learning differs between pedagogical theorists, we initially adopt the definitions of improved learning and dependent variables as used in researches added to Learning Analytics Community Exchange's evidence hub. These include, non-exhaustively, degree of participation in online discussions (Wise et al., 2014), learning performance such as completion and pass rates (Rienties, Toetenel & Bryan, 2015), degree of self-regulated learning (Tabuenca et al., 2015), and grades awarded for various assignments (Whitelock et al., 2015). The aim is to design a Learning Analytics Capability Model which could serve as a framework for leveraging capabilities. Our perspective will primarily be from an Information Systems (IS) point of view. Within educational institutes, student data is produced, collected and stored in multiple IS such as Student Information Systems and Virtual Learning Environments. Effective Learning Analytics combine data sources in order to provide rich information about learners (Siemens, 2013; Tempelaar, Rienties & Giesbers, 2015; Arnold & Pistilli, 2012). The challenge is to connect existing systems with a to-be implemented Learning Analytics system, including the usage of a Learning Record Store – a data warehouse where learner data is stored using a data standard (Apereo, 2015). Important capabilities similar to the ones from Learning Analytics frameworks (Bichsel, 2012; Greller & Drachsler, 2012; Arnold, Lonn & Pistilli, 2014; Colvin et al., 2015; Norris & Baer, 2013; Ferguson et al., 2014) can be found in IS research regarding the deployment of comparable systems like Business Intelligence (Yeoh & Koronios, 2010), Enterprise Resource Planning (Hong & Kim, 2002), and Business Analytics (Trkman et al., 2010).

2.5 Research sub questions

From the main research question the following sub-questions can be derived:

1. What defines successful effect of Learning Analytics?
2. Which assets are required in order to successfully apply Learning Analytics?
3. Which capabilities are required in order to successfully apply Learning Analytics?
4. To what degree do capabilities' maturity influence successful Learning Analytics?

Ad 1: What defines successful effect of Learning Analytics?
We recall the definition of Learning Analytics, which is "the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environment in which it occurs" (Ferguson, 2012; Clow, 2013). A properly functioning Learning Analytics system should therefore be able to understand and optimize learning and the environment where this learning takes place. This is a broad definition; the aim of this sub question is to specify when Learning Analytics application is successful. That is, how can learning be measured and improvement be monitored? The Learning Analytics Community Exchange's evidence hub provides proof which supports or falsifies the propositions that Learning Analytics: 1) improve learning outcomes, 2) improve learning support and teaching, 3) are taken up and used widely, and 4) are used in an ethical way. By analyzing scientific literature from both this evidence hub and other sources, a set of variables of learning can be identified.

Ad 2: Which assets are required in order to apply Learning Analytics?
Existing Learning Analytics frameworks (Bichsel, 2012; Greller & Drachsler, 2012; Arnold, Lonn & Pistilli, 2014; Colvin et al., 2015; Norris & Baer, 2013; Ferguson et al., 2014) all supply assets to acquire for Learning Analytics. Although there is overlap between the mentioned assets, there are various differences we would like to research. Moreover, we are interested in the assets identified as important within literature and those distilled from best-practices. The former will be analyzed by performing a literature review on relevant scientific work. A method to find concepts from within research articles as described by Dreher & Dreher (2011) is proposed. An already established databank with over 120 scientific articles regarding Learning Analytics could serve a starting point for the review. The search for concepts from best-practices will also involve a literature review, although in this search also non-scientific publications will be allowed. This as many institutes publish information about their implementation efforts on their websites or at the sites of organizations which support learning analytics like LACE, EDUCAUSE and SURF. In order to identify resources from best-practices, experts in the field of Learning Analytics system architecture as well as IT professionals experienced with Learning Analytics systems will be interviewed. As this sub question involves qualitative research, these interviews will be semi-structured (Bryman & Bell, 2007). The interview protocols will be fed with the output of the literature reviews as well as the protocol provided by Colvin et al. (2015). Eventually, the results of both researches are combined in order to answer this sub question.

Ad 3: Which capabilities are required in order to apply Learning Analytics?
A capabilities is a kind of resource which purpose it is to enhance the productivity of the available assets (Makadok, 2001). They can either be operational or dynamic (Helfat & Peteraf, 2003). In sub question 2 we identified necessary assets for the deployment of Learning Analytics. In this

sub question, we will specifically focus on capabilities. First, we need to establish a clear definition of capability as “proliferation of definitions and classifications has been problematic for research using the [resource-based view], as it is often unclear what researchers mean by key terminology" (Wade & Hulland, 2004). A literature research is proposed in order to do so. Then, by reviewing existing Learning Analytics models and consulting Learning Analytics experts, a set of capabilities is formulated. Additionally, for the domain of Learning Analytics is relatively young, this sub question will include the research of analytics capabilities in other industries. For example, Sharma et al. (2010) identify the use of Business Analytics within industries like insurance, banking and IT. This set drafts the foundation of a Learning Analytics capability model.

Ad 4: To what degree do capabilities’ maturity influence successful Learning Analytics?
Like organisms and products, capabilities evolve over time and follow a lifecycle (Helfat & Peteraf, 2003); they are founded, need to grow and become mature. Maturity models help to assess the level of development of capabilities, processes, and resources (Cosic, Shanks & Maynard, 2012). The authors developed a Business Analytics Capability Maturity Model and state that when capabilities mature over time, they will lead to greater business value. As Business Analytics and analytics within educational settings share many characteristics (van Barneveld, Arnolds & Campbell, 2012) we hypothesize that Learning Analytics capabilities add more value when they mature as well. We propose to apply Becker, Knackstedt & Pöppelbuss’ (2009) maturity model development guidelines in order to design a maturity model for Learning Analytics capabilities. Subsequently, the effect of the degree of capability maturity on the successful effect of Learning Analytics will be measured during case studies.

The connection between the sub questions is shown in a conceptual model (Figure 2). The set of resources of an institutes comprises its assets and resources (sub questions 2 and 3). The successful effects of Learning Analytics (sub question 1) depend on these capabilities. Finally, the effect size is moderated by the degree of capability maturity (sub question 4).

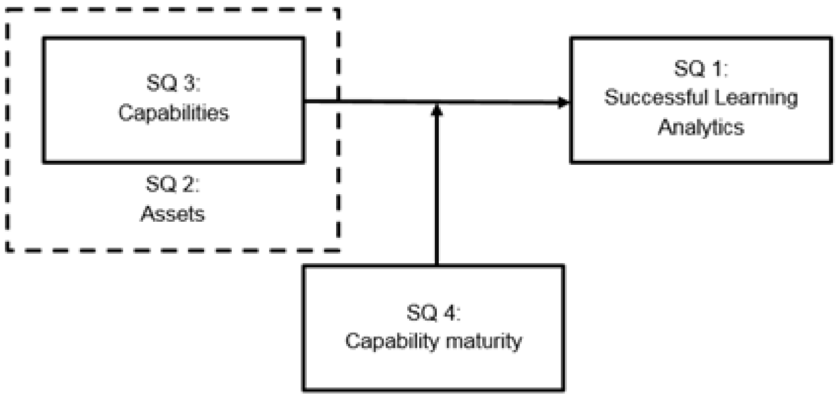


Figure 2: Conceptual Model of the Research Sub Questions

3 Research Methodology and Expected Results

The aim of this PhD research is to design a set of capabilities which lead to successful Learning Analytics. As explained in section 3, we take an Information System (IS) perspective. Therefore, a design science approach for IS research as elaborated on by Hevner et al. (2004) is proposed. Hevner et al. developed the IS Research Framework (Figure 3) which allows for both relevant and rigor research. The environmental side of the framework is composed of people, organizations and their technology, which eventually translate into the business needs as perceived by the researcher. Capabilities are explicitly part of the environmental side of the model. It drafts the context in which the research takes place, as mentioned in sub questions 4 and 5. The knowledge base of the framework, on the other hand, "provides the raw materials from and through which IS research is accomplished". It defines the foundations and methodologies on which the research is build. The objectives of sub questions 1, 2 and 3 are to provide this foundation. Eventually, combining both sides will lead to the design of our artifact – the Learning Analytics Capability Model.

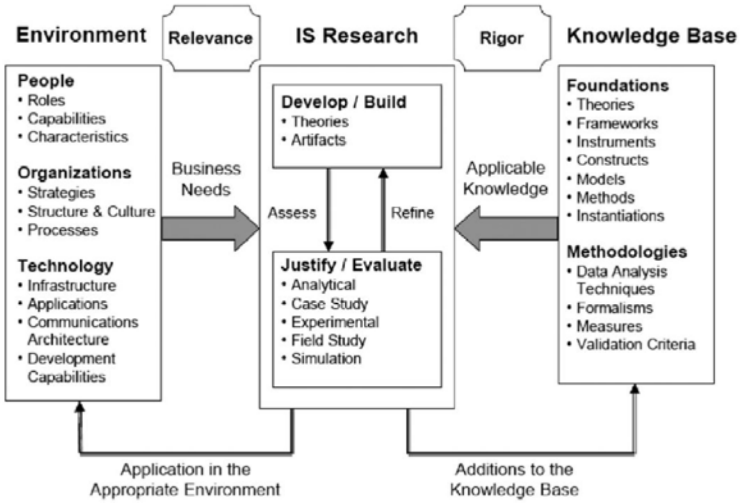


Figure 3: Information Systems Research Framework (Hevner et al., 2004)

Each research sub question leads to distinctive outcomes. Per sub question, the expected outcome is shown in Table 2.

Table 2: Expected Outcome Per Research Sub Question

	Data collection	Expected outcome
SQ 1	Literature review	Set of definitions of successful Learning Analytics
SQ 2	Literature review, semi-structured expert interviews	Defined set of assets required to successful apply Learning Analytics
SQ 3	Literature review, semi-structured expert interviews	Defined set of capabilities required to successful apply Learning Analytics
SQ 4	Literature review, semi-structured expert interviews, case studies	Effect sizes of capability maturity on Learning Analytics success

4 Future Development

During the proposed PhD research, five research sub questions will be answered. Together, the results will lead to the development of a Learning Analytics Capability Model, taking into account situational factors and capability maturity. Each sub question will lead to one or multiple research papers which will be submitted to relevant journals. These include, non-exhaustive: *Journal of Learning Analytics, Journal of Educational Data Mining, Computers & Education, The Internet and Higher Education, International Journal of Technology Enhanced Learning,* and *Journal of Education, Technology & Society.* Moreover, results will be presented at conferences like *Learning Analytics and Knowledge (LAK) Conference, Bled eConference,* and *International Conference on Information Systems.*

The next step in the research is the submission of the final version of the PhD research proposal to the Graduate School of Open University, the Netherlands. In parallel, a paper related to the first sub question is drafted. Both activities should be finished mid-2016. In turn, during the coming two years the other papers and final PhD thesis will be written.

References

Apereo (2015) *The Learning Analytics Diamond*.

Arnold, K. E., Lonn, S., & Pistilli, M. D. (2014). An exercise in institutional reflection: The learning analytics readiness instrument (LARI). In*Proceedings of the Fourth International Conference on Learning Analytics And Knowledge* (pp. 163-167). ACM.

Arnold, K. E., & Pistilli, M. D. (2012, April). Course signals at Purdue: using learning analytics to increase student success. In *Proceedings of the 2nd International Conference on Learning Analytics and Knowledge* (pp. 267-270). ACM.

Baker, R., Lindrum, D., Lindrum, M.J., Perkowski, D. (2015) Analyzing Early At-Risk Factors in Higher Education e-Learning Courses. Proceedings of the 8th International Conference on Educational Data Mining, 150-155.

Baker, R., Siemens, G. (2014) Educational data mining and learning analytics. In Sawyer, K. (Ed.) Cambridge Handbook of the Learning Sciences: 2nd Edition, pp. 253-274.

Buckingham Shum, S. (2012). *Learning Analytics*. UNESCO Policy Brief

Barneveld, A. van, Arnold, K. E., & Campbell, J. P. (2012). Analytics in higher education: Establishing a common language. *EDUCAUSE learning initiative*, *1*, 1-11.

Becker, J., Knackstedt, R., & Pöppelbuß, D. W. I. J. (2009). Developing maturity models for IT management. *Business & Information Systems Engineering*, *1*(3), 213-222.

Bharadwaj, A. S. (2000). A resource-based perspective on information technology capability and firm performance: an empirical investigation. *MIS quarterly*, 169-196.

Bichsel, J. (2012). *Analytics in higher education: Benefits, barriers, progress, and recommendations*. EDUCAUSE Center for Applied Research.

Boer, M. de, & Kamphuis, A. (2014). Vraaggestuurde didactiek en begeleiding bij de HU: Stimuleringsproject LA nr. 10. Retrieved from https://www.surfspace.nl/artikel/1494-vraaggestuurde-didactiek-en-begeleiding-bij-de-hu-stimuleringsproject-la-nr-10/ on 15 June 2015

Bryman, A., & Bell, E. (2007). *Business Research Methods 2e*. UK: Oxford university press.

Campbell, J.P. and Oblinger, D.G. 2007. Academic Analytics. *EDUCAUSE Quarterly*. October (2007).

Chatti, M. A., Lukarov, V., Thüs, H., Muslim, A., Yousef, A. M. F., Wahid, U., Greven, C., Chakrabarti, A., Schroeder, U. (2014). Learning Analytics: Challenges and Future Research Directions. eleed, Iss. 10.

Clow, D. (2012). The learning analytics cycle: closing the loop effectively. In *Proceedings of the 2nd international conference on learning analytics and knowledge* (pp. 134-138). ACM.

Clow, D. (2013). An overview of learning analytics. Teaching in Higher Education, 18(6), 683-695.

Colvin, C., Rogers, T., Wade, A., Dawson, S., Gašević, D., Buckingham Shum, S., & Fisher, J. (2015). *Student retention and learning analytics: A snapshot of Australian practices and a framework for advancement*. Research Report). Canberra, Australia: Office of Learning and Teaching, Australian Government.

Cosic, R., Shanks, G., & Maynard, S. (2012, January). Towards a business analytics capability maturity model. In *ACIS 2012: Location, location, location: Proceedings of the 23rd Australasian Conference on Information Systems 2012*(pp. 1-11). ACIS.

Davenport, T. H., & Harris, J. G. (2007). Competing on analytics: The new science of winning. Harvard Business Press.

Del Blanco, Á., Serrano, Á., Freire, M., Martínez-Ortiz, I., & Fernández-Manjón, B. (2013, March). E-Learning standards and learning analytics. Can data collection be improved by using standard data models?. In *Global Engineering Education Conference (EDUCON), 2013 IEEE* (pp. 1255-1261). IEEE.

Dreher, N., & Dreher, H. (2011). Empowering doctoral candidates in finding relevant concepts in a literature set. *International Journal of Doctoral Studies*, 6, 33-49.

Duvel, E. (2012). *Learning Analytics and Educational Data Mining*. Retrieved from https://erikduval.wordpress.com/2012/01/30/learning-analytics-and-educational-data-mining/ on 1 February 2015

Dyckhoff, A. L., Zielke, D., Bültmann, M., Chatti, M. A., & Schroeder, U. (2012). Design and implementation of a learning analytics toolkit for teachers. *Journal of Educational Technology & Society*, 15(3), 58-76.

EP-nuffic (2016). *Higher Education in The Netherlands*. Retrieved from https://www.studyinholland.nl/documentation/higher-education-system-in-the-netherlands.pdf on 25 March 2016

Elias, T. (2011) *Learning Analytics, Definitions, Processes and Potential*.

Ferguson, R. (2012). Learning analytics: drivers, developments and challenges. *International Journal of Technology Enhanced Learning*, 4(5), 304-317.

Ferguson, R., Clow, D., Macfadyen, L., Essa, A., Dawson, S., & Alexander, S. (2014). Setting learning analytics in context: overcoming the barriers to large-scale adoption. In *Proceedings of the Fourth International Conference on Learning Analytics And Knowledge* (pp. 251-253). ACM.

Ferguson, R., & Shum, S. B. (2012, April). Social learning analytics: five approaches. In *Proceedings of the 2nd international conference on learning analytics and knowledge* (pp. 23-33). ACM.

Gašević, D., Dawson, S., Rogers, T., & Gasevic, D. (2016). Learning analytics should not promote one size fits all: The effects of instructional conditions in predicting academic success. *The Internet and Higher Education*, 28, 68-84.

Grant, R. M. (1991). The resource-based theory of competitive advantage: implications for strategy formulation. *California management review*, *33*(3), 114-135.

Greller, W., & Drachsler, H. (2012). Translating Learning into Numbers: A Generic Framework for Learning Analytics. *Educational technology & society*,*15*(3), 42-57.

Helfat, C. E., & Peteraf, M. A. (2003). The dynamic resource-based view: Capability lifecycles. *Strategic management journal*, *24*(10), 997-1010.

Hevner, A., March, S., Park, J., & Ram, S. (2004). Design science in information systems research. *MIS quarterly*, *28*(1), 75-105.

Hong, K. K., & Kim, Y. G. (2002). The critical success factors for ERP implementation: an organizational fit perspective. *Information & Management*,*40*(1), 25-40.

IBM. (2011). *Analytics for achievement: Understand success and boost performance in primary and secondary education*.

Jayaprakash, S. M., Moody, E. W., Lauría, E. J., Regan, J. R., & Baron, J. D. (2014). Early alert of academically at-risk students: An open source analytics initiative. *Journal of Learning Analytics*, *1*(1), 6-47.

Jisc (2015) *Code of practice for learning analytics.*

Lauría, E. J., Moody, E. W., Jayaprakash, S. M., Jonnalagadda, N., & Baron, J. D. (2013). Open academic analytics initiative: initial research findings. In *Proceedings of the Third International Conference on Learning Analytics and Knowledge* (pp. 150-154). ACM.

Learning Analytics Community Exchange (LACE) (2015). http://evidence.laceproject.eu/

Leeuwen, A. van, (2015). *Teacher Regulation of CSCL: Exploring the complexity of teacher regulation and the supporting role of learning analytics* (Doctoral dissertation).

Leeuwen, A. van, Janssen, J., Erkens, G., & Brekelmans, M. (2014). Supporting teachers in guiding collaborating students: Effects of learning analytics in CSCL. *Computers & Education*, 79, 28-39.

Lockyer, L., Heathcote, E., & Dawson, S. (2013). Informing pedagogical action: Aligning learning analytics with learning design. *American Behavioral Scientist*, 0002764213479367.

Long, P. & Siemens, G. (2011). Penetrating the fog: Analytics in learning and education. *Educause Review*, 46(5), 30-32.

Macfadyen, L. P., & Dawson, S. (2010). Mining LMS data to develop an “early warning system” for educators: A proof of concept. *Computers & Education*,*54*(2), 588-599.

Makadok, R. (2001). Toward a synthesis of the resource-based and dynamic-capability views of rent creation. *Strategic management journal*, *22*(5), 387-401.

Maltby, D. (2011). Big Data Analytics. In *74th Annual Meeting of the Association for Information Science and Technology* (ASIST) (pp. 1-6).

Norris, D. M., & Baer, L. L. (2013). Building organizational capacity for analytics. *Educause Learning Initiative*, 7-56.

Norton, S. (2014). *Germany’s 12th Man at the World Cup: Big Data*. Retrieved from http://blogs.wsj.com/cio/2014/07/10/germanys-12th-man-at-the-world-cup-big-data/ on 21 September 2015

Papamitsiou, Z., & Economides, A. A. (2014). Learning Analytics and Educational Data Mining in Practice: A Systematic Literature Review of Empirical Evidence. *Journal of Educational Technology & Society*, *17*(4), 49-64.

Porter, W. W., Graham, C. R., Spring, K. A., & Welch, K. R. (2014). Blended learning in higher education: Institutional adoption and implementation.*Computers & Education*, *75*, 185-195.

Rienties, B., Toetenel, L., & Bryan, A. (2015, March). Scaling up learning design: impact of learning design activities on LMS behavior and performance. In *Proceedings of the Fifth International Conference on Learning Analytics And Knowledge* (pp. 315-319). ACM.

Romero-Zaldivar, V. A., Pardo, A., Burgos, D., & Kloos, C. D. (2012). Monitoring student progress using virtual appliances: A case study. *Computers & Education*, *58*(4), 1058-1067.

Sharma, R., Reynolds, P., Scheepers, R., Seddon, P. B., & Shanks, G. G. (2010, August). Business Analytics and Competitive Advantage: A Review and a Research Agenda. In DSS (pp. 187-198).

Siemens, G. (2011). *Learning and Academic Analytics*. Retrieved from http://www.learninganalytics.net/?p=131 on 29 October 2014.

Siemens, G. (2013). Learning analytics: The emergence of a discipline.*American Behavioral Scientist*, 0002764213498851.

Smith, V. C., Lange, A., & Huston, D. R. (2012). Predictive Modeling to Forecast Student Outcomes and Drive Effective Interventions in Online Community College Courses. *Journal of Asynchronous Learning Networks*,*16*(3), 51-61.

Tabuenca, B., Kalz, M., Drachsler, H., & Specht, M. (2015). Time will tell: The role of mobile learning analytics in self-regulated learning. *Computers & Education*, *89*, 53-74.

Tempelaar, D. T., Rienties, B., & Giesbers, B. (2015). Stability and sensitivity of Learning Analytics based prediction models.

Trkman, P., McCormack, K., De Oliveira, M. P. V., & Ladeira, M. B. (2010). The impact of business analytics on supply chain performance. *Decision Support Systems*, *49*(3), 318-327.

Verbert, K., Manouselis, N., Drachsler, H., & Duval, E. (2012). Dataset-driven research to support learning and knowledge analytics. Educational Technology & Society, 15(3), 133-148.

Wade, M., & Hulland, J. (2004). Review: The resource-based view and information systems research: Review, extension, and suggestions for future research. *MIS quarterly*, *28*(1), 107-142.

Whale, S., Valenzuela, F. R., & Fisher, J. (2013). Implementing Timely Interventions to Improve Students' Learning Experience. *Electric Dreams. Proceedings ascilite*, 908-912.

Whitelock, D., Twiner, A., Richardson, J. T., Field, D., & Pulman, S. (2015, March). OpenEssayist: a supply and demand learning analytics tool for drafting academic essays. In *Proceedings of the Fifth International Conference on Learning Analytics And Knowledge* (pp. 208-212). ACM.

Wise, A., Zhao, Y., & Hausknecht, S. (2014). Learning analytics for online discussions: Embedded and extracted approaches. *test*, *1*(2), 48-71.

Yeoh, W., & Koronios, A. (2010). Critical success factors for business intelligence systems. *Journal of computer information systems*, *50*(3), 23-32.