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Axel Winkelmann (Ed.)

# Proceedings of the Doctoral Consortium WI 2015

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Betriebswirtschaftliches Institut
Sanderring 2
D-97070 Würzburg
Tel.: +49 (0) 931 / 31-82901
Fax: +49 (0) 931 / 31-87274
http://www.bwl.uni-wuerzburg.de


Universitätsbibliothek Würzburg
Am Hubland
D-97074 Würzburg
Tel.: +49 (0) 931 / 31-85906
opus@bibliothek.uni-wuerzburg.de
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Die Diskussionspapiere des Betriebswirtschaftlichen Institus dienen der Darstellung vorläufiger Ergebnisse, die i. d. R. noch für spätere Veröffentlichungen überarbeitet werden. In dem vorliegenden Band ist eine Auswahl von Ergebnissen des Doctoral Consortiums am Rande der Tagung Wirtschaftsinformatik 2015 in Osnabrück festgehalten.

The discussion papers of the Institute of Business Management aim for presentation of preliminary results that are under rework for later publication. The discussion paper at hand contains a selection of results of the Doctoral Consortium of the International Conference on Wirtschaftsinformatik 2015 in Osnabrueck.

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# Programm Doctoral Consortium im Rahmen der WI 2015

*- Kolloquium für Doktoranden der Wirtschaftsinformatik -*

gesponsort durch: CTG Corporate Transformation Group

02. und 03. März 2015, Jugendherberge Osnabrück, Iburgerstr. 183a, 49082 Osnabrück

Organisation: Prof. Dr. Axel Winkelmann, Telefon: 0178-4024970

## Montag, 02. März 2015

| | | | | | | |
|---|---|---|---|---|---|---|
| bis 12:30 | Anreise | | | | | |
| 12:30 | Mittagessen | | | | | |
| 14:00 | Eröffnungsplenum | | | | | |
| 14:15 | Arbeitsgruppen | **Prof. Dr. Kundisch**<br>*Universität Paderborn*<br>**Prof. Dr. Sackmann**<br>*Universität Halle-Wittenberg* | **Prof. Dr. Breitner**<br>*Universität Hannover*<br>**Prof. Dr. Winkelmann**<br>*Universität Würzburg*<br>**Prof. Dr. Oliver Thomas**<br>*Universität Osnabrück* | **Prof. Dr. Alt**<br>*Universität Leipzig*<br>**Prof. Dr. Strecker**<br>*Fernuni Hagen* | **Prof. Dr. Leimeister**<br>*Universität Kassel / St. Gallen*<br>**Prof. Dr. Kautz**<br>*University of Wollongong* | **Prof. Dr. Dr. h.c. Becker, Prof. h.c.**<br>*Universität Münster*<br>**Prof. Dr. Thiesse**<br>*Universität Würzburg*<br>**Dr. Speck**<br>*CTG Corporate Transformation Group* |
| 14:30 | Vortrag 1 | **Christian Sillaber**<br>*Universität Innsbruck*<br>Data Quality Management in Information Systems Security Documentation | **Janina Kettenbohrer**<br>*Universität Bamberg*<br>The Human Side of Business Process Standardization - Exposé | **Enrico Graupner**<br>*Universität Mannheim*<br>On the Virtualizability of Retail Banking - An Empirical Examination | **Janine Viol**<br>*Universität Erlangen-Nürnberg*<br>Analysing Enterprise Social Network Data to Facilitate Knowledge Identification | **Matthias Gottlieb**<br>*TU München*<br>The Role of Information Technology in Affecting Decision-Making Behavior in the Context of Sustainable Energy Usage |
| 15:30 | Pause | | | | | |
| 15:45 | Vortrag 2 | **Johannes Epple**<br>*Universität St. Gallen*<br>Situational Cost Allocation Method for Business Intelligence Systems | **Martin Semmann**<br>*Universität Hamburg*<br>Post-project IT Benefits Management: A new perspective for IT service management | **Raffaele Ciriello**<br>*Universität Zürich*<br>Software Innovation Practices | **Sharif Amrou**<br>*Universität Hamburg*<br>Improving service productivity with transfer-supporting IT components: Design and evaluation of IT support for corporate training services | **Gerald Daeuble**<br>*Uni Hamburg*<br>Advancing Mobile Support Systems in the Area of Technical Customer Service - Requirement Analysis, Artifact Design and Evaluation |
| 16:45 | Pause | | | | | |
| 17:00 | Plenumsvortrag, Prof. Dr. Kautz | tba | | | | |
| 18:00 | Abendessen | | | | | |
| 19:00 | Plenumsvortrag, Dr. Speck, CTG | tba | | | | |
| danach | Möglichkeit zum persönlichen Austausch | | | | | |

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12. Internationale Tagung Wirtschaftsinformatik 2015

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# Programm Doctoral Consortium im Rahmen der WI 2015

*- Kolloquium für Doktoranden der Wirtschaftsinformatik -*

02. und 03. März 2015, Jugendherberge Osnabrück, Iburgerstr. 183a, 49082 Osnabrück

Organisation: Prof. Dr. Axel Winkelmann, Telefon: 0178-4024970

## Dienstag, 03. März 2015

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| | Arbeitsgruppen | **Prof. Dr. Kundisch**<br>*Universität Paderborn*<br>**Prof. Dr. Sackmann**<br>*Universität Halle-Wittenberg* | **Prof. Dr. Breitner**<br>*Universität Hannover*<br>**Prof. Dr. Winkelmann**<br>*Universität Würzburg*<br>**Prof. Dr. Oliver Thomas**<br>*Universität Osnabrück* | **Prof. Dr. Alt**<br>*Universität Leipzig*<br>**Prof. Dr. Strecker**<br>*Fernuni Hagen* | **Prof. Dr. Leimeister**<br>*Universität Kassel / St. Gallen*<br>**Prof. Dr. Kautz**<br>*University of Wollogong* | **Prof. Dr. Dr. h.c. Becker, Prof. h.c.**<br>*Universität Münster*<br>**Prof. Dr. Thiesse**<br>*Universität Würzburg*<br>**Dr. Speck**<br>*CTG Corporate Transformation Group* |
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| 11:15 | Pause | | | | | |
| 11:30 | Feedback der Professoren an die Doktoranden | | | | | |
| 12:30 | Mittagessen | | | | | |
| ca. 14:00 | Ende der Veranstaltung | | | | | |

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# Integrated, Open E-Learning Systems in Public Administrations

Developing a model for the use and development of an integrated, open e-Learning System in the Public Sector

Julia D. Stoffregen [1,2]

[1] University of Applied Sciences Ruhr West, Institute for Computer Science, Bottrop, Germany
[2] University of Jyväskylä, Dept. of Computer Science and Inf. Systems, Jyväskylä, Finland
{julia.stoffregen}@hs-ruhrwest.de

**Abstract.** The article discusses the design and initial results of the doctoral study which develops a context model for an integrated, open E-Learning System in Public Administrations. Following Action Design Research principles, the empirical study contributes to theory and practice by systematically exploring the state of barriers to e-Learning across public administrations. In a second step, a contextualization model is developed which captures the factors of socio-cultural contexts in public administrations. It provides general guidance to practitioners in the analysis and contextualization of open e-Learning systems while advancing the theoretical background of models in associated fields. In a third step, the model is applied and evaluated in the four European Countries Germany, Ireland, Luxembourg and Montenegro within the project frame EnhAnced Government LEarning (EAGLE). Initial outcomes are discussed throughout the article.

**Keywords:** e-Learning, Open Educational Resources, Public Administration.

## 1 Introduction

Over more than a decade, digitalization trends and 'new public management' reforms have shaped the public sector and reformed political and administrative processes [1]. Public sectors opened to the input and advice of peer administrations and of firms in the private sector [2]. Following the introduction of Open Government, Open Innovation and e-Government [1,2], to mention just a few, it is thus a surprise that the training of public employees has not systematically been taken to the next level as well, namely to open e-Learning.

Open e-Learning stands for training activities conducted via digital means which include the use (and creation) of Open Educational Resources (OER) [3]. OER means that educational materials can be re-vised, re-used, (re)-mixed, and re-distributed [4, p.39] and have a corresponding license [3,4]. For learning practices OER imply that learners are self-regulatory and active in the realization of training programs. They can share materials with interested peers and may collaboratively create new OER's about experiential insights. A benefit among the collaborative learning mode is therefore individualization; the flexibility to schedule training according to personal preferences [5].

Given the spread of digital networks, open e-Learning programs are nowadays used by learners all across the globe. They have diverse learning needs which are shaped from factors of their socio-cultural context [6]. To secure that learners have an equal opportunity to avail of e-Learning benefits, the systems thus need to accommodate the range of socio-cultural contexts, too. The system requires a contextualization model which allows for development and use processes which are responsive to socio-cultural contexts [7]. Adapted for local means, open e-Learning can more easily be integrated into the range of diverse learning and workplace contexts.

Increasingly, these insights become relevant for the public sector, too. The promises of flexible learning schedules or efficient training systems attract attention because of limited budgets [8,9] and the high workload in public offices [10, pp.42-45]. Public employees would be interested in collaborative learning [e.g. 10, pp.57f.] but few programs seem to be open to all public employees [11]. From Eidson's extensive study, findings indicate that promises of e-Learning are 'illusionary' and require further investigation [10, p.56]. A higher number of barriers appear in implementation processes as expected, and they appear to be distinct as those barriers known from higher educational contexts [10]. Given the infancy of the field, e-Learning Systems in the public sector have not elaborated contextualization models, yet, which allow for a systematic analysis and adaptation to socio-cultural contexts. It would facilitate to embed e-Learning systems into the workplace context. From a practical managerial perspective, this may relate to the fact the implications of developing and integrating e-Learning systems seem not to be thoroughly evaluated [8]. From a theoretical perspective, e-Learning systems in public administrations have not been studied with a socio-technical paradigm, hence, including considerations about the role of factors in the socio-cultural contexts. There is a need for a holistic e-Learning system, a managerial concept which is sensible to socio–technical and –cultural aspects for the development and use of training platforms in public administrations [cf.11,10,12]. Against this background, the doctoral study aims at answering the research questions (1) what is the state and barriers to open e-Learning in the public sector; (2) which factors in the socio-cultural context shape the development and use of open e-Learning Systems, and (3) which interventions suit best to achieve a contextualization process for open e-Learning systems in public administrations?

The following paper will sketch the study design to answer the questions. The three intermediate steps which underpin the development of this model will be outlined in chapter 2: Firstly, the state and barriers to open e-Learning is explored. Secondly, the background for designing a cultural contextualization is discussed. Thirdly, interventions are defined to advance the development of an e-Learning platform. They will be applied and evaluated in the project EAGLE[1]. In chapter 3, the research method and related considerations for the steps are introduced. Finally, chapter 4 will provide initial results and outline discussion points and questions for future research.

[1] www.eagle-learning.eu.

# 2 Conceptual Background

## 2.1 State and Barriers of open E-Learning in Public Administrations

E-Learning refers to a learning situation in which training is delivered through digital means [adapted from 13, p.28; 10, pp.5f.]. E-Learning in the public sector refers to blended e-Learning programs [14,15] as well as to stand-alone e-Learning platforms [10,13]. Barriers to e-Learning describe "*…any challenge, [...] that might prevent a single person, a group or an organization to reach an objective and success in a specific context ...[]*" [16, p.5]. Their systematic assessment informs what factors in socio-cultural contexts are important to consider for a successful design and implementation of the systems. Until now, only few elaborated studies about e-Learning in the public sector have been published. Chen [12] has found that the perceived effectiveness of e-Learning of among public employees in Taiwan is positive and can be explained by perceived innovative characteristics. Among others, these include perceived increased training opportunity and flexibility [12]. Eidson's [10] study is more critical about these aspects but her study supports both are important among a wide range of barriers [10, pp.179f.]. From both studies it appears that managerial efforts require more research; the benefits of e-Learning in workplaces have not been realized yet [12, p.462]. Moreover, collaborative activities and social interaction are yet sufficiently realized [10,12]. Bimrose et al. [17] elaborates on the later point, social interaction and identity formation through public sector e-Learning. The authors highlight that a change of capabilities, roles and professional identity is interrelated and that this process can be supported by human and technical facilitators online [17, pp. pp.58f.]. Correspondingly, the authors develop a theoretical 'facilitation framework' which, however, does not go beyond the description of difficulties. Similarly as the majority of studies [exception 18] the three articles above focus mainly on single cases studies where e-Learning systems are introduced on a domestic (national) level. Blindenbacher and Nashat [11] provide an exception in this respect and focus the international level. From a policy learning perspective, the authors elaborate a knowledge creation framework [11, chapter 4.3.]. Barriers in this article inform about training processes, including e-Learning. While the framework addresses managerial aspects, guidance is provided on a macro level and for the planning of learning events in a general sense. Thus, also this study does not inform about barriers which appear in collaboration across administrations. Overall, the influence of previous outlined barriers cannot be explained. So the barrier studies are important to consider but do not provide an informative concept for the development of a contextualization model.

To provide a starting point for systemizing the insight and lessons learned from previous studies and related domains, a systematic literature review was conducted [19]. As a result a contextualized Barrier Framework for open e-Learning in the public sector was created which extends the Barrier Framework for knowledge sharing and e- learning [20]. A high range of barriers was found for the dimension context, social and technical barriers [19]. Among these dimensions and categories, support was found for the limited time public employees can spend for learning activities at the workplace [10,21]. Also if the technical system is flawed or mismatches security regulations, e-

Learning is difficult to realize [10]. More importantly, new insights were found, for example, about openness (important for the intended use of OER) and social interaction. Concerning the first point, the use of OER was not promoted in a single study. In some cases the e-Learning systems were built upon open source solutions [14]. But mainly programs were closed for selected participants or domestic levels [11,14]. Would the use of OER in e-Learning programs make a difference? The study of Stefanick and LeSage indicates a positive response. Public employees tend to fear mis-speaking in public [22, p.244]. "*Although open entry and participation may be commendable principles for many virtual communities, the same ease of entry and transparency are certain to be anathema to many local officials*" [22, p.244]. However, Stefanick and LeSage's study does not particularly address OER. Therefore associated barriers and implications need to be more clearly defined. Concerning the second point, the role of social interaction could be illuminated. Learners need to develop a shared understanding and trust to each other to use platforms [23,24]. Also understanding and trust between learners and developers needs to be built. Developers, on the one side, have difficulties to understand requirements of the socio-cultural contexts [25]. Public employees, on the other side, mistrust that developers (and external consultants) can capture their knowledge and establish a system which enhances this knowledge [23,22].
These points reflect only some of the new barriers which were revealed by the cBF. Yet, the range and categorization of barriers needs to be refined. The categories and subcategories of barriers are descriptive and not empirically validated. Furthermore, the review has hinted at the ambiguous nature of factors [19]. Especially the role of culture is disputed. Some authors differ between cultural and structural factors in their analysis but acknowledge they are intertwined [24]. In most of the articles culture is seen as an important factor, too, but the meaning and associated factors are not defined [14,21,26]. This gap in the research domain will be addressed in the following chapter. So far, the insight about the state and barriers to e-Learning in the public sector will be summarized. Several studies have been published about the phenomenon e-Learning in public administrations. While some studies provide more elaborate hindsight on behalf of qualitative and quantitative factors, most articles do not systematically address the role of barriers. This includes neglecting theoretical considerations how factors of the socio-cultural context shape the development and use of e-Learning systems. In order to develop a contextualization model for theory and practice it is therefore elaborate further on factors of socio-cultural contexts.

## 2.2 Conceptualizing the influence of socio-cultural context

The role of socio-cultural context in the design and development of e-Learning System increasingly attracts interest in the public sector. Factors of socio-cultural contexts shape the development and use of the e-Learning systems. Particularly when open e-Learning systems are opened to collaboration across different sectors and countries, it is important to integrate and respond to these factors [5]. One reason for conceptualizing influences is to avoid unintended consequences of projects. Potential negative effects range from the misunderstanding of collaborators or of learning contents to retention of participation in the training program [10]. Another reason is to advance studies

about the e- Learning in public administration compared to studies in the context of higher education. The later has already elaborated advanced frameworks to capture the role of culture: Henderson [7] developed a multiple-culture model which demands instructional design to become eclectic. Hence, offering a diverse range of learners the freedom to choose which paradigm and learning style they prefer. Building upon Henderson's concept, Edmundson [27] develops a cultural adaptation process (CAP) model for e-Learning. Both models appear to be sound and claim to provide practical guidance in the domain. However, both models mainly address instructional designers. After applying the CAP-model [27], Tapanes [28] also criticizes that is difficult to understand even for knowledgeable peers. For both reasons the models are not suitable for open e-Learning platforms. More particularly, open[2] implies that also learners actively create and adapt Open Educational Resources for local means. In this regard, Pawlowski et al. [29] and Pawlowski and Richter [5] made initial steps to guide learners in contextualization processes. While these models are valuable to guide learners in comparison to Edmundson [27,28], they are weak in providing the analytical and theoretical background such as cultural dimensions to analyze and design contextualization processes. Taking the mentioned critique into account, models in the educational contexts may still provide some guidance in the aim to advance e-Learning in the public sector. So far no similarly elaborated models have evolved. Nevertheless, the use of models needs to be critically assessed to answer whether they can be adapted for the context of public administrations, not at last with regard to analyzed socio-cultural factors. The conceptualization of culture in the public sector is no understudied field, however, there is no consensus about the most important aspects [30]. Rutgers focuses on the recurrent elaboration on public sector values and outlines that there are conceptual ambiguities and conflicts how to define and order the factors [30, p.93]. In search of culture' [title of 31], Keraudren [31] and Jamil et al. [32] approach the role of conceptual frameworks as well. Jamil et al. outline from various definitions that "…*some core values and basic assumptions are fundamental and influence the way a group of people think, feel, and act, and distinguish them from another groups*" [32, p.900]. Among values also beliefs, attitudes and political subcultures are important to include, such as cohesiveness, responsiveness and authority and bureaucratic norms [33, p.901]. Bouckert [33] reviews various concepts, too, and acknowledges that conceptual frameworks are important. Particularly, however, the time needed to investigate factors as well as the nature of their influence needs to be outlined in research designs [33, p.42].

Overall, this brief outline emphasizes that various considerations about the range and conceptualization of public administrative culture can be included. So far, this step has not been made for the development and evaluation of e-Learning system. Comparing the cultural factors from studies [10,12] with those in higher educational models [27,34] indicates that there are crucial differences. Most analytical frames orient on cultural dimensions of Hofstede [34,35]. In the public sector domain this concept is not often used [33, p.47]. Furthermore, general pedagogical frameworks appear to miss barriers unique to socio-cultural contexts of public administrations [10]. As a result, a simple transfer of existing models to the domain of public administrations cannot be made.

[2] An elaboration on 'openness' can be found in Hilton et al. [4].

Instead, it needs to be clarified 'which influences of socio cultural contexts in public administrations shape open e-Learning systems'. Answering this question includes defining salient cultural factors and creating an explanatory model of the influence. The essence of this answer has implications for developing the contextualization process of the open e-Learning systems, too. The socio-cultural model informs which factors interventions need to target in order to facilitate contextualization processes in the development and use of the e-Learning system. Considerations of this point are further explained below.

## 2.3 Interventions to improve the development and use of open E-Learning Systems

Contextualization in the domain of e-Learning systems means to adapt technical and socio-cultural features according to contexts of learners [29,36]. The goal of contextualization is to make the learning experience meaningful and prevent that learning outcomes are biased due to insufficient inclusion of socio-cultural factors in a platform [7,37]. Thus, on the one hand, contextualization covers the adaptation of learning styles, figures as well as learning contents. On the other hand, contextualization refers to design decisions of developers how to structure and enable learning processes in the backend of the system. Existing models tend to focus on user activities and guide learners to conduct an effective adaptation. In empirical studies several process steps were identified [38,29,5]. They cover the search of OER, evaluation the OER, re-use/and adaptation, validation of the solution and re-publishing for this means [5, p.6]. To advance (and extend) the guidance in contextualization processes, interventions can be categorized into technical and interactional aspects along these steps. Technical aspects refer to a (semi-)automatic response of e-learning systems to user information: One example is to devise cultural and context metadata [38,5,37]. Attributes such as learning preferences (e.g. value of error) [38, p.7] can be defined in the user profile. But "[t]*he procedures which use the[se] metadata, can be divided into two categories. The one directly needs access to the database and the other uses the datasets which already have been collected and locally stored*" [38, p.8 also see p.9.]. Hence, a matching process of the preferences for each entity leads to a selective response to the user request [38]. The second aspect of interventions focuses on the interactional level. They address to the interaction between developers and users in public administrations. Developers (designer) can align diversified needs by generification [39,40,41]. They need to understand which factors in the socio-cultural contexts are salient and require unique metadata categories or can be served similar ones respectively [37,38,39,40].Users, in return, need to learn which factors (metadata) they can extract from the e-Learning system, which they use as an information to adapt the learning resources. Altogether, these considerations will lead to answer the research question: **which interventions suit best to achieve a contextualization process for open e-Learning systems in public administrations**? Answering this question will complete the insights of previous steps on the path to develop a best practices model. It will allow analyzing and intervening in the use and development of an integrated, open e-Learning System in the public sector.

To realize the goal of the doctoral study, the three steps (exploring barriers, conceptualizing a cultural contextualization models and intervening) need to build upon each other. The doctoral study will take existing reference models into consideration. Including theoretical considerations about public administrative socio-cultural contexts, as well as lessons learned will advance interventions and current approaches. The contextualization model shall inform both theory and practice to overcome latest difficulties in the public sector.

Not to anticipate the quality of results for means of generalization, it can be discussed whether findings have implications for e-Government projects, too. Ebrahim and Irani [42] have conducted a barrier study whose barriers resemble those challenges found for introducing open e-Learning. Also the study of Imran et al. [43] highlights the key role of learning to transfer knowledge and e-Government models between countries. 'How e-Learning and e-Government may benefit each other' is thus a promising research question for the future.

All in all, this brief outline shall indicate which relevant topics may benefit from the contextualization model which is the intended outcome of the doctoral study. In view of the state and barriers to the phenomenon, the most valuable contribution in theoretical and practical hindsight is to advance (develop) a model that explains which cultural factors in public administrative contexts shape the use and development of open e-Learning systems. The model shall go beyond descriptive insights and answer how a cultural context shapes and is re-shaped in e-Learning activities. Based on that, a concept for contextualizing the e-Learning system can be developed. To finally summarize the background of the doctoral study, guiding research questions for the future work are: **which factors in the socio-cultural context across public administrations shape the development and use of an open e-Learning system**? and **which interventions suit best to achieve a contextualization process for open e-Learning systems in public administrations**? The background for answering these points will be presented in the following.

# 3 Research Design

## 3.1 Research approach

The research paradigm of the doctoral study is interpretative and critical since the research challenges previous approaches [44]. I follow a socio-technical paradigm [45] which shapes the research steps of exploring, conceptualizing and intervening in empirical contexts. Against this background, a set of theoretical assumptions can be defined. Firstly, a core assumption is that factors of the socio-cultural context shape and are re-shaped in the development and use of the e-Learning system. 'Socio-cultural contexts' refer to a set of characteristics like values, artifacts, routines and attitudes in a particular context (national or regional level asf.). The study follows the meta-theoretical grid of culture from Richter [46] in this definition. The grid presents no theory itself but enables to compare and synthesize other theories along the dimensions context

(national, regional level asf.), cultural phenotype (value, norm, formal / informal artifacts) and persistence (visible, not-visible) [46, p.187]. The second core assumption is that contextualization is a process which embraces all steps of development and use of an e-Learning system. The term 'development and use' hereby outlines that either developers or users alone, or by interacting with each other shape the evolving system. The third assumption is that factors of socio-cultural contexts can be attuned in contextualization processes to enhance e-Learning for particular socio-cultural contexts. Contextualization means that e-Learning systems are adapted for local means and socio-cultural characteristics [36,39].

These core assumptions need to be considered, tested and refined throughout the steps exploring, conceptualizing and intervening. The research approach for this aim orients on Action Design Research [47]. Firstly, ADR is valuable because it combines considerations of action research [48] and design science research [49,50]. For researchers who are intertwined in the research context ADR offers guidance how to contribute both to theory and practice. AR brings in the focus on change and interaction between emerging artifacts and their context while DS brings in the rigor of steps and generation of design principles for higher class problems [48,51,47]. Secondly, ADR provides a specific structure for the research process by defining the stages: problem definition, building intervening and evaluating, reflecting and learning, and formalizing knowledge [47]. For each stage the progress of research can be traced on behalf of the resulting artifacts. They refer to concepts, methods and technical artifacts [47, pp.39-42] which represent the intended contributions of the doctoral study. The following table [Table 1] provides an overview of the research approach and artifacts in my proposed work.

**Table 1** Overview of the research approach

| | Description of steps | Artifact |
|---|---|---|
| **Stage 1: Problem Definition** | | |
| Principle 1: Practice-Inspired Research | Increasing interest in culture-sensitive e-Learning programs in the public sector while experiences are not systematically assessed. | Literature review: cBF for open e-Learning systems in public administrations [19] |
| Principle 2: Theory-Ingrained Artifact | Oriented on barrier frameworks and culturally sensitive contextualization models the theoretical cultural model for the public context is made. | Empirical results: results from the applied cBF in the project EAGLE<br><br>Theoretical model (1): factors of the socio-cultural context in public administrations |
| **Stage 2: Building, Intervening, Evaluation** | | |
| Principle 3: Reciprocal Shaping | Influences on the contextualization model are analyzed, questioned and discussed. | Theoretical model (2): model (1) is synthesized with contextualization models |

| | | |
|---|---|---|
| Principle 4: Mutually Influential Roles | On-going evaluation of shaping forces within the project team, and interaction of project team members and prospective user interactions | Empirical model (3): applied cultural contextualization model within the project context EAGLE |
| Principle 5: Authentic and Concurrent Evaluation | Internal project team discussion, expert validation and user feedback | |
| **Stage 3: Reflection and Learning** | | |
| Principle 6: Guided Emergence | Discussion about meaning of the artifact hardened to critical evaluation criteria such as use and functioning | Evaluation of the applied model (3) within the project context EAGLE |
| **Stage 4:Formalization of learning** | | |
| Principle 7: Generalized Outcomes | From evaluation and constant feedback a best practice model is built | Best practices model (4) of the previous ones for developing an integrated open e-Learning System |
| | | Oriented on Sein et al. [47, p.51] |

In line with a socio-technical paradigm [45] ADR encourages researchers to reflect on their influence and hidden assumptions in the development process. Concerning the development and research process, however, ADR emphasizes that stages 1-3 in the table [Table 1] are not linearly conducted. Throughout accumulating knowledge, insights of exploring, conceptualizing and intervening need to be reflected and connected among each to other. To facilitate the reading of research methods for each (iterative) stage, however, the following outline orients on the three-fold steps (exploring, conceptualizing, and intervening).

## 3.2 Research Method

Overall, the doctoral study will result of a mixed-method design [61]. So far, initial data gathering processes were of qualitative nature while later empirical assessments (and evaluations) are thought to include quantitative methods. Given the phase of the doctoral study and limited scope of the article, the report of methods will concentrate on the qualitative design.

**Exploration.** Exploring the state and barriers to open e-Learning in the public sector in theory and practices has been initiated by a systematic literature review [52,19] as well as a qualitative empirical fieldwork in the project context EAGLE. Public employees from four countries (Luxembourg, Ireland, Montenegro and Germany) have been invited to focus groups [53] and semi-structured interviews [54]. The author both acted as an interviewer (focus group leader) and observer of interacting designers and prospective users. Both the design and analysis of the overall sixteen focus group and interview sessions was guided by a pattern matching technique [55,56,62] and qualitative content analysis [57]. Due to the experience and insight of literature reviews, the Barrier Framework [20] has been chosen as conceptual framework for structuring the design.

The current state of the phase is still exploratory. There is no quantitative model yet, so that the nature of research is still explorative. Initial results of exploring the state are presented in the short summary of this article (chapter 2), the literature review [19] and evaluation of empirical results (forthcoming). In terms of the ADR-stages [47] two artifacts (literature review, empirical results) have been created.

**Conceptualization.** The conceptualizing of the cultural model was initiated by a systematic literature review [52]. The results represent and compare salient cultural dimensions to those in higher education. Firstly, this model will be conceptually validated by experts [54] between February and March this year. Secondly, refined model will be introduced in focus groups to prospective open e-Learning platform users in the participating countries [53]. One strength of the focus groups method is hereby to perceive the interaction of designers and users in making design decisions of the evolving system [53]. Apart from the observation, evaluative criteria will be integrated in the focus group session [5,53,57,58]. The results of the process so far include the literature review of cultural models and initial conduct of expert discussions.

**Intervention.** The design of interventions can be categorized into technical and interactional aspects. For the technical interventions a semi-automatic matching process of (user's and OER's) cultural metadata will be designed. Latest knowledge about theoretical metadata-modeling will be included [5,37,38]. The design and evaluation of the model will be subject to experts discussions [53,54] in the project context. The result will integrated and evaluated in the iterative focus group sessions (above). For interactional interventions, the insights and artifacts of the previous ADR stages will be analyzed by qualitative methods [57]. Hereby, insight about interaction and alignment strategies [39,40,41,58] in participatory design will be of concern. Throughout the ADR-stage, reflection and learning, the insights will be shared and discussed with involved participants.

## 3.3 Evaluating of findings

The important point 'evaluating the contribution of the doctoral study (and artifacts) to theory and practice' has been slightly touched upon above. Considerations in this respect are shaped by the research report of Frank [59]. He provides a set of principles for evaluating research and theory development in Information Systems Research. It includes principles for conceptualizing (expanding) and critiquing existing (contextualization) frameworks [59, pp.52,55]. They correspond to those of ADR to secure an "[]…*authentic and concurrent evaluation*" [47, p.43]. Depending on the respective method and artifact of inquiry, however, evaluative criteria will be more clearly defined. Another important evaluation is the role of research ethics. Following Guillemin and Gilliam [60] the reflexivity in observing both peers and self-behavior in user-interaction requires thorough planning and open disclosure to involved subjects. Informed consent to the meaning of this process on the side of prospective users, as well as the maintenance of anonymity and confidentiality among research peers is difficult to accomplish. It will be valuable to discuss with peers, which steps for establishing and

maintaining respective ethical principles are feasible and may be formalized for future projects.

# 4 Initial results and conclusion

## 4.1 Initial outcomes: Barriers and cultural models

The doctoral study aims at developing an integrated, open e-Learning System for public administrations. The intermediate steps are to explore and to conceptualize a cultural contextualization model as well as to design suitable interventions for the development and use of the system. The exploration of the state and barriers has fairly advanced. Based on the insights, the problem definition [47] of the doctoral study was précised. Firstly, a gap regarding collaborative e-Learning practices has been found both on the national and international level [10,11]. From systemized literature review it has then become clear that challenges related to collaborative activities are neglected so far. One example is the spatial distance among public administrations and employees. Empirical findings from the project EAGLE support that introducing cross-administrative collaboration in e-Learning programs has to take this point into account. Public employees in close municipalities seem to be more likely to exchange knowledge than municipalities in wider distance. More elaboration of this point will be discussed with the associated analysis. Another refinement of the study focus on behalf of the literature review hinted at the role of managerial policies and practices. Among others, the planning of training through e-Learning Systems needs to be coordinated. Objectives and goals seem to lack a thorough evaluation [8]. Interestingly, also the role of externals and developers in this respect is rarely reflected [22,23,25]. The empirical insights support, however, that early interactions between developers and users align divergent expectations. By developing providing metaphors or mitigating concerns, generification of diverging perspectives seems to be a naturally occurring intervention. This point requires further empirical observation and expert discussion in the project context. Still, the observation of early contextualization processes supports the goal of the study to develop an integrated open E–Learning system. It will guide the development and use of contextualized e-Learning and thus extend previous existing models in the field.

## 4.2 Future work and discussion points

The immediate future work is to integrate knowledge of factors in the -cultural contexts of public administrations into contextualization models. The expert reviews need to be planned and conducted in order to derive at a refined model, ready for the assessment and evaluation of prospective e-Learning users in the public sector.
Apart from the immediate steps, it is further to reflect whether the design for integrating stages and knowledge from artifacts is sufficiently realized. To conduct the scope of the study within a project frame of three years requires a thorough planning and realization of steps and ADR stages. As the accumulated knowledge during the doctoral study advances, it will have to be critically discussed whether it is feasible and valuable to focus on two aspects of interventions in the research project. This decision will have

to be made with regard to the quality and time permitting to integrate the points in a sound and integrated model for open e-Learning in the public sector.

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# Data Quality Management in Information Systems Security Documentation

Christian Sillaber
christian.sillaber@uibk.ac.at

Institute of Computer Science
University of Innsbruck

**Abstract.** Businesses are increasingly required to document, implement, improve and monitor IS security requirements derived from different sources to ensure proper implementation of controls, overall compliance and to support managerial decision making. However, the documentation of IS security is fraught with a variety of challenges, including missing tool support, low stakeholder awareness, different levels of formalization that lead to hardly maintainable documentation entities stored in different ISMS and GRC tools and productivity platforms. The goal of this PhD thesis is to create a data quality model and associated processes to help organizations overcome these challenges and to provide them with tool support that ensures a high level of data quality in the documentation of IS security at various organizational levels. We are the first to address these quality issues in a systematic way and to build a data quality model and tool support in empirically grounded research. The preliminary research results provide evidence that quality deficiencies in the documentation of business and IS security requirements are a relevant problem that justifies further examination. First research results were already transferred to industry and empirically validated.

## 1 Introduction

The advent and great success of cloud computing has paved the way towards global markets of decoupled, ubiquitously and dynamically available IT services. These emerging markets and the increased availability of dynamic hosting services pressures today's businesses more and more to rethink their business processes and to redesign their IT and IS landscape to employ outsourced services on the application as well as platform and infrastructure level while ensuring compliance to various laws, policies and contracts.

Therefore, businesses are increasingly required to document, implement, improve and monitor business security requirements derived from different sources to ensure proper implementation of controls, overall compliance and support managerial decision making.

However, the documentation of business security requirements is fraught with a variety of challenges, including missing tool support, low stakeholder awareness and unclear cost-benefit trade-offs (e.g. [1–4]). At the stakeholder level, the documentation of business security requirements often suffers from quality deficiencies that are predominantly due to negligence, manual resolution of security policy and configuration

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dependencies, unclear responsibilities and inappropriate languages and tools used [5]. These quality deficiencies often lead to improper system configurations, decreased or diminished maintainability of both the documentation and system [6, 7].

As a result, organizations often fail to continuously maintain, measure and improve the documentation quality of business- and derived IS security requirements. Since organizations are required to demonstrate compliance and are accountable for breaches of contractual or legal obligations, it is in the businesses' own interest to decrease the risk of potential financial losses and liabilities [5, 6] through not only adequate measures but also proper documentation of these measures including the business security requirements they are derived from.

IS security documents are called by various names in different organizations and contexts. Further, multiple types of security documents related to IS security may exist at different levels in a single organization, such as documents for high-level IS security strategies and more granular, operational-level guidelines. We focus on the hard-to-formalize security documents that contain high-level IS security information stored in GRC, ISMS and related tools where - due to their plain-text nature - automatic syntax and semantic checks fail.

To support businesses in the process of continuously improving the quality of their business and IS security requirements documentation entities that are currently stored in various tools, formats and locations, a combination of tool support and associated business processes are required that ensure stakeholders' participation and allow managerial decision based on objective measurements.

## 2 State of the Art

Current research on quality aspects of IS security documentation either focuses on specific IS standards, IS security economics research, acceptance and behavioral models, or stakeholder aspects:

**Information security management standards, tools and processes**: Information security management covers technical aspects of IS security as well as organizational and managerial issues such as risk management and the development of organizational policies [8]. In addition to already existing standards and best practices, existing work covers the areas of security requirements engineering [9–11], risk management [12, 13], security engineering processes [14] and process maturity models [15]. However, these approaches, while implicitly requiring a high quality of IS security documentation, fail to provide guidelines and quality measurements suitable for stakeholders and fail to provide analysis models to identify quality problems. Furthermore, they do not take the challenges of complex relationships between IS security documentation entities into account, such as inter-dependencies between different or conflicting standards. These approaches primarily provide documentation and evaluation models for security requirements from an abstract, managerial viewpoint without providing decision support for improving the documentation itself. Existing tool support in both industry and research is limited, and most available GRC tools provide no automatic quality checks or are limited to highly formalized quality checks [16–18]

**Information security economics**: Current research on information security economics studies the optimal level of information security investment based on mathematical calculations (e.g.[19]). Established evaluation tools from the domain of operations research such as ROI Return on Security Investment [20], Net Present Value [21], and IRR - Internal Rate of Return [22] have been adapted and extended. While these models address how to efficiently invest in security from a service provider point of view, they neither examine intangible factors that reflect customers' decision making processes nor take the challenges and associated costs of stakeholders maintaining business security requirements documentation entities into account.

**IS trust and security behavior models**: Existing research in the area of IS trust and IS acceptance has developed several models (e.g. [23–25]) that explain system use. However, most of these models aim at being as general as possible and do not focus on the specific problems of acceptance, usage, and trust related to the business security documentation.

While research in other areas, such as software development [26] has investigated the quality of (general) requirement documentation, research in the IS security domain is mostly limited to behavioral models which focus on the behavior of IS stakeholders that have to use IS security documentation without investigating the impact of the quality of the documentation artifacts. For instance, [27] investigates employees' compliance through IS security training without investing the impact of data quality. Similarly, [28] and [29] both acknowledge the importance of IS policy documentation, but do not investigate its impact in detail.

**Stakeholder participation**: Multiple studies have shown that the majority of incidents related to IS security can be traced back to internal stakeholders (e.g. [6, 30, 31]). IS security literature moved from portraying users as the weakest link in IS security (e.g. [32, 33]) to viewing them as the solution to multiple IS security issues in recent years (e.g. [34, 35]). However, literature is still lacking empirical studies that examine more closely how users' participation positively impacts IS security risk management processes that go beyond users being viewed as "mere" executors of IS security policies. Calls for more research in this area have been made repeatedly [27, 28, 35–37]. Following a synthesis of theories explaining user participation in IS security contexts, Spears et al. [35] define user participation in IS security risk management as the set of behaviors, activities, and assignments undertaken by business users during IS risk assessment and the design and implementation of IS security controls that is expected to add value to security risk management. While the value of stakeholder participation in general is backed by manifold studies, these approaches either do not address stakeholder involvement in the documentation, neglect IS security documentation at all, or "reduce" stakeholders to mere executors of business security requirements and their derived controls.

## 3 Problem Statement and Contributions

By developing quality measurement and improvement processes with associated tool support for stakeholders, this thesis will be the first approach to extend the available

toolset for IS security requirements management and to improve the IS security documentation organizations have to manage.
The first goal of this thesis is to investigate existing quality deficiencies in IS secu- rity requirement documentation entities, identify and categorize patterns of best practice to improve the end-to-end quality of the continuous IS security requirements documentation management process.
The second goal of this thesis is to build a comprehensive data quality model and associated quality assurance processes for business security requirement documentations. The creation of the data quality model will be supported by empirical research to obtain knowledge from best practices in industry. To ensure that the quality model and associated processes are usable in different industries, we plan to align the model with the industry independent security standard COBIT 5 and to include consistency checks with both the asset model as well as high level business security objectives. Coverage criteria should include existing stakeholder-, business process- and asset models.
The creation of semi-automatic tool support to implement the findings into already existing GRC tools is the third step of this thesis. We will integrate both, the data quality model and the quality assurance work-flow into the adamant[1] platform which has been developed and extended within several research projects. Tool support will include automatic quality assessment based on predefined heuristics, decision support for stakeholders by visualizing quality issues and support for quality assurance workflows.
This thesis will contribute to the existing body of knowledge in IS security management research by 1) investigating types and causes of existing quality deficiencies in the documentation of IS security requirements and 2) to develop a model to assess and measure the quality of IS security requirements documentation to support investment decisions and 3) investigating tool-supported mechanisms to (semi-) automatically identify such quality deficiencies.

## 4 Research Approach and Evaluation

Different research methodologies are appropriate to address the presented research contributions. To investigate types of existing quality deficiencies in the documentation of IS and business security requirements a mixed-methods research design has been deemed appropriate, that 1) identifies existing knowledge on quality deficiencies in an extensive literature review, 2) elicits stakeholder knowledge from relevant expert stakeholders, and 3) qualitatively analyses and categorizes existing quality deficiencies in real world datasets.
To address the third research problem (improved tool support), a design science approach has been chosen. Based on the resulting knowledge on existing quality deficiencies identified in the previous set of analysis steps, the iterative creation of a design science artifact will be conducted in close collaboration with expert stakeholders from a multinational organization developing distributed health-care IS as part of an ongoing research project. The goal of this research artifact is to incorporate methods and processes that address identified quality deficiencies and provides stakeholders with semi-automatic means of identifying and improving them.

[1] http://adamant.q-e.at

By investigating the usage of the proposed research artifact in an organization, it is expected to gain valuable insights into the organizational effects that contribute to the quality of the IS security documentation. Furthermore, the application of the proposed research artifact within the organization will provide insights into managerial decision making processes and associated investment decisions.

To show the economic benefit of addressing quality deficiencies in business security requirement documentation we plan to develop an economical model which, aside from organization-internal process improvements, considers factors such as reduced costs for executing external compliance processes and service creation across organizational boundaries.

In order to evaluate the proposed quality deficiency taxonomy with stakeholders from different backgrounds and to disseminate the gathered knowledge on security requirements documentation quality (and lack thereof) we are currently planning to develop a web based simulation game. The game will allow security management teams to collaboratively elicit, manage and virtually implement security requirements without verbally communicating. We expect that this gamified learning platform will teach security management teams to collaboratively create high quality business security requirement documentation and thus positively impact the quality of the business security requirements in their organization. Furthermore, this platform will be used to evaluate the developed tools and processes.

As research related to research problems 2) and 3) is currently ongoing, the evaluation strategy is not yet final. As of now, the evaluation strategy related to tool support will be several case study based approaches where the design artifact is evaluated in a non-healthcare area such as banking and finance. Similarly, the validity of the proposed quality model must be evaluated in other domains as well but due to the ongoing nature of this research venue, the final evaluation strategy is yet to be defined in detail.

# 5 Preliminary Results

In [38], we described the particular quality deficiencies organizations have to deal with when managing their complex business security requirement documentation. Our results indicate that current work practices and prevailing quality models used do not come close to satisfying the needs of service providers.

Based on expert interviews and several think-aloud sessions with professionals hav- ing long-standing experience with the management of business security requirements (including security managers and auditors), we introduced a taxonomy that describes and categorized common faults in the documentation of business security requirements. The taxonomy will form the basis for a quality assessment and analysis framework, which is currently under evaluation in a case study as part of an ongoing security analysis of an healthcare IS. A first proposal for this workflow was presented in [38].

The research results we described in [39], provide evidence that stakeholder participation in IS security risk management processes is not only desirable but also the potential contributions of different stakeholders can be predicted by their respective awareness of the business process under analysis.

An exploratory study was conducted to better understand the connection between business process model awareness and stakeholder participation in IS security risk management and to investigate its outcomes. The exploratory study was conducted during an ongoing action design science research project seeking to improve the IS security risk management process currently used by the organization. The organization under investigation is one local branch (≈ 100 employees) of a multinational engineering company, focusing on the development of distributed information systems within a highly regulated domain. Stakeholders' awareness of business process models was found to improve the elicited security requirements in both number and accuracy. Thus, stakeholder awareness of business process models was found to add value to an organization's IS security risk management process.

We identified a close connection between stakeholders' knowledge about documented business processes and their knowledge of applicable business security requirements. Contributing to research problems 2) and 3), the results can be utilized by IS security risk managers as well as automatic tools to prioritize the involvement of different stakeholders in the IS security risk management process without sacrificing quality of the resulting business security requirements documentation.

In [40], we investigated the connection between data quality of Information System Security Documentation and the quality of the Information System Security Risk Management process. The first phase of the exploratory study was also conducted during an ongoing research project that investigated the efficient management of security requirements at an organization. The organization under investigation is one local branch (Company A; ≈ 1200 employees) of a multinational IT service provider, providing various cloud services.

The second phase of the exploratory study, where the findings from the first phase were refined and extended, was conducted during an ongoing action design research project seeking to improve the IS security risk management process currently used by the organization. The organization under investigation is one local branch (Company B; ≈ 100 employees) of a multinational engineering company, focusing on the development of distributed information systems within a highly regulated domain.

We devised the measurement setting as shown in Figure 1 to validate the hypothe- ses in our confirmatory study (confer to [40] for more details, icons designed by freepik.com). The five step process was executed for each component of the IS under investigation:

- **Step 1 - Collection of IS security documentation:** In this step, we collected any available IS security documentation at the organization under analysis. We worked together with process owners and IS stakeholders to identify any written artifacts.
- **Step 2 - Creation of reference models:** In this step, we "sanitized" any IS security documentation identified in the previous step by converting all documents in a common format and simplifying terminology. We created aan IS security documentation reference model from the available documentation. This step required multiple rounds of feedback with stakeholders from the organization to clarify terminology and notations used.
- **Step 3 - Stakeholder interviews and model creation:** In this step, we asked stakeholders to elicit security requirements for the components of the IS under investi-

gation. This required stakeholders to recreate IS security documentation to a large degree. We collected both verbal statements from stakeholders as well as models and artifacts created on paper / whiteboard during multiple workshops.

- **Step 4 - Creation of models for comparison:** In this step, we again "sanitized" the IS security documentation created by stakeholders in the previous step. We created IS security documentation models describing the security aspects of the IS under investigation from the artifacts produced by stakeholders.
- **Step 4 - Identification of contradictions:** In the last step, we compared the models created in step 2 against the models created in step 4 and identified contradictions between them.

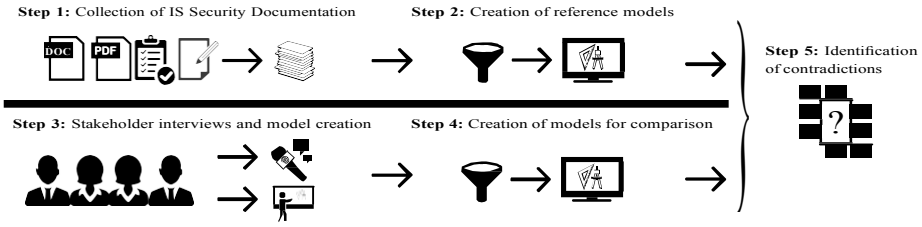


**Fig. 1.** Overview of the measurement setting.

We found that outdated security documentation best explained the contribution to the number of elicited security requirements, indicating that outdated IS security documentation is a major inhibitor to IS risk management processes. Stakeholders also agreed during the first exploratory study that outdated IS security documentation is an indicator for potential security issues. The more IS components were found that were not documented, the more potential security problems were identified.

# 6 Conclusion

The preliminary research results provide evidence that quality deficiencies in the documentation of business security requirements are a relevant problem that justifies further examination. Research activities and evaluation of intermediate results were conducted during the FP7 PoSecCo project and research activities are continued in the currently ongoing nationally funded research project QE LaB.

It is expected to achieve the goal of creating the first tool-supported solution for the continuous quality improvement of Business Security Documentation artifacts well within the timeframe of the current research project.

We could already show that stakeholder participation in IS security risk management processes is not only desirable but the potential contribution of different stakeholders to the overall quality of the resulting artifacts can be predicted by their respective awareness of the business process under analysis. The possibility of integrating

resulting research artifacts into existing IS security and risk management processes and associated Governance, Risk and Compliance management tools promises a quick utilization of the research results in industry.

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# The Human Side of Business Process Standardization

Janina Kettenbohrer[1]

[1] University of Bamberg, Department of Information Systems and Services,
Bamberg, Germany
janina.kettenbohrer@uni-bamberg.de

**Abstract.** Durch Standardisierung von Geschäftsprozessen streben Unternehmen eine einheitliche und durchgängige Prozesslandschaft an, was die Effektivität und Effizienz der Unternehmenstätigkeiten steigern soll. Zur Realisierung dieser Vorteile wurden in den letzten Jahren vorrangig die technischen Aspekte des Prozessmanagements fokussiert, ohne die dafür notwendigen organisationalen und mitarbeiterbezogenen Faktoren in ausreichender Form zu berücksichtigen. In meiner Dissertation werden diese Aspekte in den Mittelpunkt gerückt und dediziert untersucht.

**Keywords:** Business Process Standardization, BPS, People, Influencing Factors

## 1 Einleitung

Aktivitäten der Geschäftsprozessstandardisierung (BPS) stellen einen wichtigen Aspekt des Geschäftsprozessmanagement (BPM) dar [1]. Mit ihrer Hilfe soll eine einheitliche und durchgängige Prozesslandschaft geschaffen werden, um den Leistungsaustausch sowohl zwischen den einzelnen Geschäftseinheiten als auch mit externen Partnern transparenter und effizienter steuern zu können [2, 3]. Entsprechend investieren immer mehr Unternehmen in BPM sowie Prozessstandardisierung, um Effizienzvorteile zu heben [4–6]. Gleichwohl wird deutlich, dass viele Unternehmen in den letzten Jahren vor allem die Implementierung von unterstützenden IT-Systemen (wie ERP- oder Dokumentationssystemen) und somit lediglich die technischen Aspekte im Bereich des Geschäftsprozessmanagements im Allgemeinen und der BPS im Besonderen fokussiert haben. Dabei wurden jedoch häufig organisatorische Fragestellungen, wie die Bedeutung der Prozessverantwortlichen und -mitarbeiter oder die notwendigen Strukturen zur Etablierung und Festigung des Prozessgedankens sowie zur kontinuierlichen Verbesserung von Geschäftsprozessen nicht ausreichend berücksichtigt [4].

In meinem Dissertationsvorhaben soll untersucht werden, welche organisationalen und mitarbeiterbezogenen Faktoren in welcher Form für die erfolgreiche Standardisierung von Prozessen berücksichtigt werden müssen. Die Forschungsfrage lautet: *Welche organisationalen und mitarbeiterbezogenen Faktoren beeinflussen das Prozessmanagement und die Prozessstandardisierung in Unternehmen?*

Um die Forschungsfrage umfassend beantworten zu können, werden sowohl qualitative als auch quantitative Forschungsmethoden angewandt. Mithilfe von qualitativen

Forschungsansätzen (wie Fallstudien) werden die aus der Literatur identifizierten Einflussfaktoren sowie ihre Wirkweise und Kontextabhängigkeit detailliert analysiert. Ergänzend werden durch den Einsatz von quantitativen Forschungsmethoden (wie Umfragen) die Relationen zwischen den Einflussfaktoren und BPS statistisch evaluiert [7, 8].

# 2 Theoretische Grundlagen

## 2.1 Business Process Management und Business Process Standardization

An der Leistungserstellung für externe Kunden sind viele unterschiedliche Prozesse beteiligt, deren Koordination in der Praxis zu erheblichen Schwierigkeiten und Kosten führt. Um dieses Defizit zu beheben, wird das Konzept des Geschäftsprozessmanagements verwendet [3]. Dabei wird Geschäftsprozessmanagement als *„a collection of process improvement efforts that differ in mission, scope and approach"* verstanden [9]. Seit den ersten Forschungsarbeiten in diesem Bereich [10] hat sich das Verständnis über Geschäftsprozessmanagement stetig weiterentwickelt, was zu verschiedenen Definitionen führte.
Für Al-Mudimigh [11] stellt BPM *„a structured approach to understand, analyze, support and continously improve fundamental processes"* [11] dar, was sich auch mit den Ansichten von Elzinga et al. [12], Zairi [13] und van der Aalst et al. [14] deckt. Somit ist Geschäftsprozessmanagement ein *„integriertes Konzept von Führung, Organisation und Controlling […], das eine zielgerichtete Steuerung der Geschäftsprozesse ermöglicht. Es ist auf die Erfüllung der Bedürfnisse der Kunden und anderen Interessensgruppen (wie bspw. Mitarbeitern, Kapitalgebern, Eigentümer, Lieferanten, Partner und Gesellschaft) ausgerichtet und trägt wesentlich dazu bei, die strategischen und operativen Ziele des Unternehmens zu erreichen"* [3]. Des Weiteren ist BPM *„ein zentraler Bestandteil eines integrierten Konzepts für das Geschäfts- und Workflow-Management. Es dient dem Abgleich der Unternehmensstrategie, der organisatorischen Gestaltung von Prozessen sowie deren technischen Umsetzung mit geeigneten Kommunikations- und Informationssystemen"* [15].
Somit werden die Geschäftsstrategie und die Verbindung zu Kunden bzw. Stakeholdern zu den zwei wichtigsten Bezugspunkten zwischen Geschäftsprozessmanagement und den zugehörigen Geschäftsprozessen. Der Strategie- und Kundenbezug müssen dabei aufeinander abgestimmt werden, um einerseits den langfristigen Auf- und Ausbau von Erfolgspotenzialen und Kernkompetenzen des Unternehmens und somit langfristige Ziele und andererseits auch kurzfristige, operative Ziele zu erreichen [3, 15].
Einen wichtigen Bestandteil des Geschäftsprozessmanagements stellt die Geschäftsprozessstandardisierung dar [16, 17]. Mit ihrer Hilfe soll eine einheitliche und durchgängige Prozesslandschaft geschaffen werden, um den Leistungsaustausch sowohl zwischen Geschäftseinheiten als auch mit externen Kunden, Lieferanten oder Partnern transparenter und effizienter steuern zu können [2, 3].
Dabei werden unter Standards *„documents, established by consensus and approved by a recognized body that provides, for common and repeated use, rules, guidelines*

*or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context"* [18] verstanden. Demnach kann Standardisierung als die Tätigkeit zur Verbreitung und Annahme eines Standards angesehen werden [17].
Sánchez-Rodriguez et al. [19] verstehen unter Business Process Standards *„the best, easiest and safest way to do an activity"* [19]. Wüllenweber et al. [20] definieren des Weiteren *„the objective of [process] standardization […] [as] to make process activities transparent and achieve uniformity of process activities across value chain and across firm boundaries"* [20]. Demzufolge meint organisationsweite Prozessstandardisierung "*the development of a standard or best-practice process to be used as a template for all instances of the process throughout the organization"* [21].

## 2.2 Einflussfaktoren der Business Process Standardization

Der Erfolg Geschäftsprozessstandardisierung und der damit verbunden Prozessstandardisierungsinitiativen hängt von mehreren Faktoren (wie beispielsweise IT oder Top Management-Unterstützung) ab [22]. Durch umfassende Literaturrecherche konnten einige erste Erfolgsfaktoren identifiziert werden.
Im Folgenden wird kurz (in chronologischer Reihenfolge) auf den Inhalt der einzelnen Forschungsbeiträge eingegangen.

- Manrodt und Vitasek [23] untersuchten mittels einer explorativen Fallstudie wesentliche Aspekte eines Prozesses, welche lokal modifiziert werden können ohne dabei die Robustheit eines lokalen Prozesses negativ zu beeinflussen. Zudem betonten sie die Bedeutung eines Vorgehensmodells für die Prozessstandardisierung. Im Zuge dessen entwickelten sie ein Vorgehensmodell zur kontinuierlichen Prozessverbesserung und -standardisierung. Von der Fallstudie ausgehend leiteten Manrodt und Vitasek [23] sechs Schritte ab, mit deren Hilfe ein Prozess standardisiert werden kann.
- Ungan [24] betrachtet Prozessdokumentation als wichtigen Treiber für Prozessstandardisierung. Er kombinierte Literatur der Bereiche Prozesswissen, Wissensmanagement und Prozessdokumentation und entwickelte darauf aufbauend ein Vorgehensmodell zur Dokumentation und Prozessstandardisierung.
- Münstermann und Weitzel [25] formulierten eine detaillierte Definition für sowie ein Vorgehensmodell zur Prozessstandardisierung. Dabei unterschieden sie zwischen den beiden Schritten Prozesshomogenisierung und -standardisierung. Aus ihrer Sicht, stellen eine vorhandene Dokumentation sowie ein existierendes Vorgehensmodell wesentliche Faktoren zur Erreichung eines Standardprozesses dar.
- Hall und Johnson [26] entwickelten ein Framework, um Praktiker bei ihren Standardisierungsentscheidungen unterstützen zu können. Unter Zuhilfenahme eines dreistufigen Ansatzes sowie einer Prozessmatrix, können Prozesse bezüglich ihrer Eignung zur Standardisierung bewertet werden. Eins der wesentlichsten Kriterien ist dabei die Beschaffenheit des Prozesses.

- Eckhardt [27] untersuchte die Rolle der Prozessstandardisierung im Rahmen der Mitarbeiterrekrutierung. Er konnte mithilfe empirischer Daten den positiven Einfluss von IT-Nutzung auf BPS zeigen.
- Münstermann und Eckhardt [17] leiteten mittels einer explorativen Fallstudie drei Einflussfaktoren für BPS her: Top Management-Unterstützung, Involvierung der Personal-, Fach- und IT-Abteilungen sowie organisationale Struktur.
- Münstermann et al. [28] analysierten eine Fallstudie in einem führenden E-Business-Unternehmen und leiteten Maßnahmen zur erfolgreichen Prozessstandardisierung ab: Konfiguration des BPS-Teams, Involvierung der Mitarbeiter und Top Management-Unterstützung, Identifikation von Best-Practices und Definition eines Standardprozesses, Definition von Process Governance-Rollen und Schaffung von Anreizsystemen, Implementierung von angemessener IT.
- Rosenkranz et al. [22] diskutierten drei Fallstudien aus verschiedenen Industrien, um prozessinterne und -externe Einflussfaktoren für BPS zu identifizieren. Dabei stellten die Autoren fest, dass neben Top Management-Unterstützung, auch IT-Fähigkeiten, Standardisierungsvorgehensmodelle, Marktsituation und die Prozessbeschaffenheit Auswirkungen auf den Erfolg von Prozessstandardisierung hat.
- Beimborn et al. [29] entwickelten ein Forschungsmodell zur Untersuchung des Einflusses von SOA (Service-Oriented Architecture) auf Prozessstandardisierung.
- Schäfermeyer et al. [30] entwickelten ein Forschungsmodell, um die Beziehung zwischen Prozesskomplexität, Prozessstandardisierung und Standardisierungsaufwand zu erklären. Sie befragten 255 BPM-Experten und konnten somit zeigen, dass Prozesskomplexität einen signifikant positiven Einfluss auf Standardisierungsaufwand hat. Zudem wurde ein negativer und signifikanter Einfluss von Prozesskomplexität auf Prozessstandardisierung sichtbar. Jedoch konnte der unterstellte positive Effekt von Standardisierungsaufwand auf Prozessstandardisierung nicht gezeigt werden.
- Zellner [31] leitete mittels Literaturrecherche die folgenden acht Kriterien zur Bewertung von Prozessen beziehungsweise der Prozessbeschaffenheit hinsichtlich der Standardisierungseignung ab: Grad der Vorhersagbarkeit, Grad des taziten Wissens, Anzahl an involvierten Prozessbeteiligten, Grad der Komplexität, Grad der Umweltdynamik, Grad der ineffizienten Prozessvielfalt, strategische Bedeutung des Prozesses, Transaktionshäufigkeit
- Zellner und Laumann [32] entwickelten mittels Design Science ein Instrument, um Prozesse beziehungsweise Prozessbeschaffenheit hinsichtlich ihrer Eignung zur Standardisierung bewerten zu können. Das Instrument besteht aus einer Entscheidungsmatrix und acht Kriterien. Der zu bewertende Prozess wird anhand der acht Kriterien (Grad der Vorhersagbarkeit, Grad des taziten Wissens, Anzahl an involvierten Prozessbeteiligten, Grad der Komplexität, Grad der Umweltdynamik, Grad der ineffizienten Prozessvielfalt, strategische Bedeutung des Prozesses, Transaktionshäufigkeit) in die Matrix eingeordnet. Auf Grundlage dessen werden anschließend Empfehlungen zur Standardisierungseignung möglich.

In meiner Dissertation sollen vorrangig die organisationalen und mitarbeiterbezogenen Faktoren untersucht werden.

# 3 Bisherige Ergebnisse und weiteres Vorgehen

Im Folgenden wird die genaue Anwendung dieser Ansätze beschrieben, indem erste Ergebnisse sowie weitere Schritte meiner kumulativen Dissertation genauer erläutert werden.

## 3.1 Bisherige eigene Forschungsbeiträge

Die organisationale Steuerung (Governance) stellt neben der Unterstützung durch das Top Management und der Zusammenarbeit mit den beteiligten Abteilungen einen zentralen Treiber des Geschäftsprozessmanagements sowie unternehmensweiter Geschäftsprozessstandardisierungsmaßnahmen dar [17]. Als erstes Ergebnis meines Dissertationsprojekts wurde mithilfe eines Action-Design-Research-Ansatzes [33] der Einfluss eines organisationalen Rollenmodells auf die erfolgreiche Etablierung und Erhaltung von unternehmensweiten Prozessstandards untersucht. Mithilfe einer Fallstudie und ergänzenden Experteninterviews wurde gezeigt, dass ein Rollenkonzept mit klar definierten Verantwortlichkeiten als Teilaspekt einer organisationalen Steuerung notwendig ist, um eine Standardisierung der unternehmensweiten Prozesslandschaft zu erreichen und zudem sicherzustellen, dass einmal standardisierte Prozesse auch standardisiert bleiben [34].
Die erfolgreiche Einführung einer solchen Governance-Struktur wird mithilfe eines Vorgehensmodells unterstützt. Das im Rahmen meines Dissertationsvorhabens entwickelte Modell stellt einen ganzheitlichen Ansatz zur Vorgehensweise bei der Prozessstandardisierung dar, dessen Effektivität und Realisierbarkeit mithilfe eines Pilotprozesses und weiteren fünf laufenden Projekten evaluiert wurde [35].
Sowohl das beschriebene Rollenmodell als auch das erläuterte Vorgehensmodell zur Geschäftsprozessstandardisierung wurde innerhalb der Lufthansa Technik AG evaluiert. Durch den verwendeten Action-Design-Research-Ansatz und die damit verbundene enge Zusammenarbeit mit der Praxis erhöht sich die Relevanz der Beiträge sowohl für Forscher als auch für Praktiker.
Um nicht nur positive Einflussfaktoren zu beleuchten, wurde zur Identifikation von Inhibitoren der unternehmensweiten Geschäftsprozessstandardisierung eine weitere Fallstudie innerhalb eines international agierenden Wartungsbetriebs durchgeführt. Dabei konnten einige Inhibitoren (wie beispielsweise eine unklare und asymmetrische Kosten- und Nutzenverteilung) aufgezeigt werden, welche bei der Planung und Durchführung von Prozessstandardisierungsinitiativen berücksichtigt werden sollten. Auf Basis dieser Ergebnisse und durch eine Übertragung von Erkenntnissen aus anderen Forschungsbereichen im Kontext der Standardisierung werden gezielt Handlungsmöglichkeiten für das Management aufgezeigt [36].
In einem weiteren Schritt wurde die Einstellung von Mitarbeitern gegenüber den Prozessen, in denen sie tätig sind, beleuchtet. In dieser Betrachtung rückten die Managementrollen (wie beispielsweise Prozesseigner oder das Top Management) in den Hintergrund, während die operativen Prozessmitarbeiter in den Fokus gerückt wurden. Die Prozessmitarbeiter führen nicht nur Prozessaufgaben aus, sondern sie sind letztlich diejenigen, welche den Erfolg von Prozessmanagement [3] und -standardisierung

maßgeblich beeinflussen. So kann beobachtet werden, dass Standardisierungsinitiativen aufgrund vieler einhergehender organisationaler Veränderungen zu Widerständen seitens der Prozessmitarbeiter führen. In diesem Forschungsbeitrag wurde untersucht, welche Faktoren diese Reaktion maßgeblich beeinflussen. Dabei wurden vorranging die Rolle der Mitarbeiter, welche von Standardisierungsinitiativen betroffen sind, sowie ihre Wahrnehmung bezüglich der zu standardisierenden Prozesstätigkeiten analysiert. Basierend auf der Job Characteristics Theory [37, 38] sowie weiteren Konzepten wie Work-Role Fit [39–41] oder Co-Worker Relations [41] wurde ein Forschungsmodell konzipiert. Das Modell (Abbildung 1) geht davon aus, dass die Bedeutsamkeit, welche die Mitarbeiter ihren Tätigkeiten innerhalb eines Prozesses zusprechen, maßgeblich entscheidend für die Einstellung und letztlich für die Bereitschaft gegenüber Standardisierungsinitiativen ist. Dabei wird die Bedeutsamkeit der Tätigkeit von mehreren Faktoren wie beispielsweise den einzelnen Tätigkeitscharakteristika, der Übereinstimmung von Persönlichkeits- und Tätigkeitmerkmalen sowie dem Austausch mit Kollegen beeinflusst. Neben diesen internen (Prozess-) Aspekten muss jedoch auch die Wahrnehmung der Eingebundenheit als wesentlicher Einflussfaktor für die Bedeutung einer Tätigkeit in Betracht gezogen werden. Auf Grundlage der beiden Konstrukte Self-Construals (welches die Selbstwahrnehmung eines Individuums auf einem Kontinuum von ‘unabhängig‘ bis ‘mit anderen verbunden‘ beschreibt) [42, 43] und Task Interdependence [44] wurde ein Konstrukt namens Job Construals entwickelt. Job Construals beschreibt die Wahrnehmung eines Individuums bezüglich der Verbundenheit seiner Tätigkeit mit denen seiner Kollegen. Das Kontinuum reicht von ‚unabhängig‘ (im Sinne von lose gekoppelten Tätigkeiten mit hoher Autonomie und hohen Freiheitsgraden, welche als künstlerisch und intellektuell verstanden werden) bis ‚verbunden ‘ (im Sinne von Tätigkeiten, die gut eingebunden sind und eher ein kleines Rädchen im großen Ganzen darstellen).

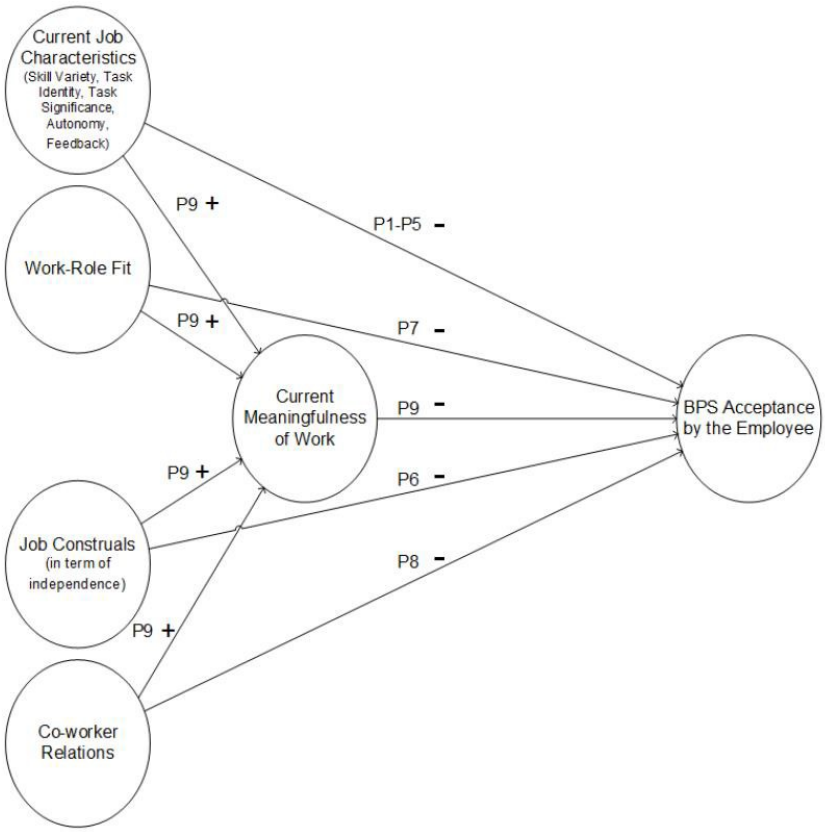


**Abbildung 1.** Forschungsmodell

### 3.2 Weiteres Vorgehen

Das weitere Vorgehen innerhalb der Dissertation fokussiert weiterhin die verschiedenen Einflussfaktoren der Prozessstandardisierung, wobei zunächst der Schwerpunkt auf der Analyse der Einstellung von Mitarbeitern gegenüber den Prozessen, in denen sie tätig sind, liegt. Dazu soll das eigens entwickelte Konstrukt Job Construals geschärft und ausgebaut werden. Dazu wird der Fragebogen für das Konstrukt erweitert. Zur detaillierten Analyse der Einflussfaktoren auf die Einstellung der Mitarbeiter gegenüber von Prozessen, werden zunächst Experteninterviews zum explorativen Erkenntnisgewinn [7] durchgeführt.

Darüber hinaus ist eine quantitative Studie geplant. Für das entwickelte Forschungsmodell (Abbildung 1) wurde bereits ein zugehöriger Fragebogen erstellt, welcher in einem Non-profit-Unternehmen validiert und aufgrund dessen überarbeitet wird.

In einem nächsten Schritt soll der überarbeitete Fragebogen in einem internationalen Unternehmen zum Einsatz kommen. Dieses Unternehmen befindet sich momentan kurz vor der Durchführung eines großen Prozessstandardisierungsprojekts, von dem ungefähr 600 Mitarbeiter betroffen sein werden. Um das gesamte Standardisierungs-

projekt begleiten zu können, sind mehrere Umfragerunden zu unterschiedlichen Zeitpunkten geplant. Zunächst werden die Mitarbeiter bezüglich ihrer Einstellung vor der Standardisierung befragt.
Anschließend wird die Umfrage während der Implementierung sowie nach Abschluss des Standardisierungsvorhabens durchgeführt. Die mithilfe dieser Umfrage erworbenen Daten sollen anschließend mithilfe von statistischen Verfahren (wie beispielsweise multipler Regressionsanalyse) ausgewertet werden. So sollen der Einfluss sowie die Einflussstärke der einzelnen Konstrukte auf die Einstellung von Mitarbeitern gegenüber Prozessstandardisierungsinitiativen genau analysiert werden. Beispielsweise ist zu vermuten, dass die Tätigkeitseigenschaft 'Autonomy' einen negativen Einfluss auf die Akzeptanz von Prozessstandardisierung hat.
Anschließend können dann gezielt Handlungsmöglichkeiten für das Management abgeleitet werden. Beispielsweise könnte der negative Einfluss von 'Autonomy' auf Prozessstandardisierung durch gezielte Einbeziehung der Mitarbeiter in die Entwicklung des neuen Standardprozesses [35] abgeschwächt oder eliminiert werden.
In einem nächsten Schritt soll die Top Management-Unterstützung genauer beleuchtet werden. In diesem Zusammenhang wäre es interessant zu untersuchen, ob und inwieweit sich die Einflussfaktoren auf die Einstellung gegenüber Prozessen von denen der Mitarbeiter unterscheiden. Dazu sind zunächst einzelne Interviews geplant, um ein erstes konzeptuelles Forschungsmodell erstellen zu können. Anschließend soll dieses Modell mithilfe einer Umfrage empirisch validiert werden. Auch hier soll mithilfe verschiedener statischer Verfahren der Einfluss der einzelnen Faktoren auf die Einstellung gegenüber Prozessstandardisierungsinitiativen analysiert werden.
Zudem sollen in der weiteren Forschung auch der Einfluss des entwickelten Rollenmodells sowie des Vorgehensmodells auf die Prozessstandardisierung empirisch untersucht werden. Dazu sind jeweils begleitende Fallstudien sowie Umfragen geplant.
Um die Forschungsfrage meiner Dissertation etwas zu erweitern, wäre in einem weiterführenden Schritt eine Betrachtung des Zusammenspiels zwischen IT und BPS interessant.

## 4 Fazit

Mein Dissertationsvorhaben leistet einen wichtigen Beitrag sowohl für die Wissenschaft als auch für die Praxis.
Zunächst wird die bestehende Prozessstandardisierungsliteratur mithilfe meiner Dissertation erweitert. Es werden nicht nur die einzelnen Einflussfaktoren der Prozessstandardisierung dediziert untersucht, sondern auch noch weitere beeinflussende Aspekte identifiziert und analysiert. So konnte bereits der Einfluss von Governance-Strukturen sowie von Vorgehensmodellen auf den Erfolg der Prozessstandardisierung gezeigt werden.
Darüber hinaus wurde die Job Characteristics Theory sowie die Konstrukte Work-Role-Fit und Co-Worker Relations auf den Prozessstandardisierungskontext übertragen und durch das neuentwickeltes Konstrukt Job Construals angereichert.

Neben dem wissenschaftlichen Beitrag, hat meine Dissertation aber auch wesentliche Implikationen auf die Praxis. Durch eine ganzheitliche Analyse von Erfolgsfaktoren der Prozessstandardisierung konnte eine Liste von Aspekten identifiziert werden. Dies kann als eine Art Checkliste für Praktiker verstanden werden. All diese Erfolgsfaktoren sollten bei möglichen Standardisierungsinitiativen berücksichtigt werden, um deren Erfolgswahrscheinlichkeit zu erhöhen.
Darüber hinaus kann mithilfe der Ergebnisse meiner Dissertation der Fokus des Geschäftsprozesses innerhalb von Unternehmen verändert werden. BPM wird zwar grundsätzlich als ganzheitlicher Ansatz verstanden, bei dem IT immer mehr in den Hintergrund rückt [45, 46], jedoch liegt der Fokus zu wenig auf den Prozessmitarbeitern, die letztendlich die Prozesse ausführen. Mit meiner Dissertation wird der Einfluss der Prozessmitarbeiter sowie der menschliche Aspekt des BPMs dediziert analysiert und gestärkt.
Zudem können durch den Erkenntnisgewinn, welcher sich durch die Analyse der Einstellung der Mitarbeiter gegenüber von Prozessen ergibt, Handlungsmöglichkeiten für die Praxis abgeleitet werden. Dadurch können das Prozessmanagement im Unternehmen gestärkt und damit verbundenen Vorteile realisiert werden.

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# On the Virtualizability of Retail Banking – An Empirical Examination

Enrico Graupner[1,2]

[1] University of Mannheim, Institute for Enterprise Systems, Mannheim, Germany
{graupner, maedche}@es.uni-mannheim.de
[2] Commerz Business Consulting GmbH, Frankfurt (Main), Germany
enrico.graupner@commerzbank.com

**Abstract.** The increasing digitization of retail banking is challenging for financial institutions. In particular, banks struggle to satisfy customers' channel preferences, as these can vary along transactions and their inherent phases. While existing research has focused on factors on the individual level, the process and its underlying characteristics has barely been considered. The proposed study adopts the Process Virtualization Theory (PVT) as theoretical lens to investigate the determinants of customers' channel choice on a more granular level. We intend to contribute with an empirical validation and extension of PVT. From a practitioners' perspective our results contribute to a deeper understanding how to enhance the level of virtualization in retail banking. In addition, we identify areas where interfaces with physical channels are needed to establish a customer-oriented multichannel strategy. The high practical relevance of our research is underlined by the cooperation with one of the largest German banks which supports a quantitative study with 2,000 bank customers.

**Keywords:** Process Virtualization Theory, Digitization, Channel Choice, Retail Banking.

## 1 Introduction

The virtualization increasingly impacts banking activities of private customers. The average Internet banking usage has reached 47 % in Germany in 2013 – a 6 percentage points increase compared to 2009 [1]. However, the digitization differs widely across the underlying banking transaction [2, 3]: For example, while 79% of the customers prefer the online channel to conduct a transferal of money, only 15% choose the online channel as preferred channel for the signing of a construction financing [4]. To effectively increase virtualization banks need to understand which determinants drive customers to conduct specific banking services virtually.

Extant literature has identified various determinants that influence the virtualizability of services in general [5, 6]. Prior research has adopted the Technology Acceptance Model [7–9], the Diffusion of Innovation Theory [10–12], and the Theory of Planned Behaviour [13–15] as theoretical lenses. Whereas previous lenses have been applied to the adoption of virtual activities for an individual level, the activity as such has barely

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been considered. The recently evolved Process Virtualization Theory (PVT) [16] closes this gap and investigates the determinants for virtualization from a process perspective. However, PVT has rarely been empirically tested. This leads to the research question:

*Which determinants influence the virtualizability of customer-facing retail banking processes and their inherent phases?*

As a result of the study we expect a thorough understanding of the PVT-related determinants that influence virtualizability in retail banking. We complement the above mentioned theories with a PVT-specific perspective and provide empirical evidence for a barely tested theory. We are the first to compare various retail banking processes in the evaluation. In addition, the sub-division of the entire process into distinct phases has not been incorporated as of now and provides more granular insights.
The remainder of the paper is structured as follows: Section 2 provides a description of the PVT. An outline of our research model and addressed research gaps is provided in section 3. Section 4 presents the research methodology and provides detailed information about the processes under investigation, the item development and survey pretesting as well as the planned large-scale data collection. Finally, Section 5 provides a conclusion for this doctoral consortium proposal.

## 2 Theoretical Background: Process Virtualization Theory

PVT provides a theoretical model that outlines factors that drive the process virtualization. A process is "a set of steps to achieve an objective" [16]. Based on Overby [16] this paper defines that a virtual process does not involve physical interaction between people or people and objects, as service delivery occurs through the Internet. Due to its novelty PVT has rarely been empirically tested [17]. Papers with empirical setup concentrate on process virtualization in public services [18, 19] and airport check-in [20, 21]. For the banking area only a short paper exists that pre-tests PVT with a student sample [22]. However, "there is a need to empirically test PVT with a sample that is closer to the real population of online banking users" [22]. The results of an initial prestudy indicate that customers' preference for virtualization differs widely across the underlying banking transaction (Figure 1). Accordingly, retail banking marks an appropriate and promising area for further PVT-related research. In particular, a PVT-based perspective can help to identify the underlying mechanisms that cause the variance in the channel preference. Banks can use these results to derive improvements that further increase virtual process conduction.

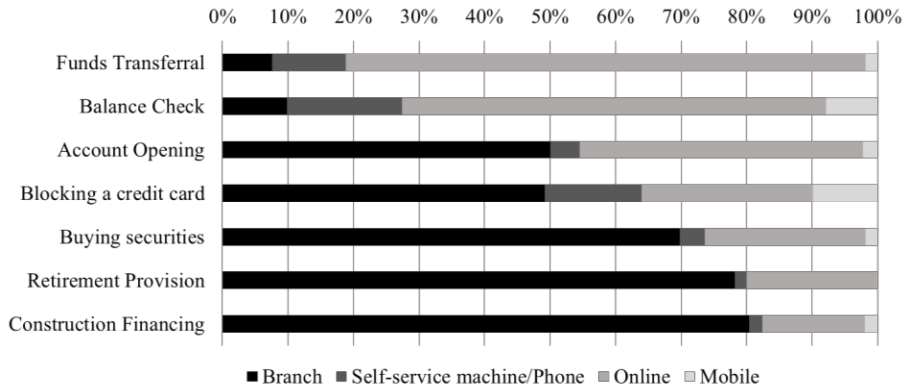


**Fig. 1.** Channel Preference for Various Banking Transactions [4]

PVT suggests four inhibitors (so-called requirements) that negatively impact the virtualizability of processes [16]: First, *sensory requirements* describe the degree to which process participants need a sensory experience including tasting, seeing, hearing, smelling and touching other participants or objects that are involved during process execution. Second, *relationship requirements* are another determinant and are considered as the degree to which process participants interact with others in a social or professional context. Third, *synchronism requirements* are suggested by PVT and refer to the degree to which process steps need to occur quickly and with minimal delay. Fourth, *identification and control requirements* also have a negative impact on process virtualizability and describe the degree to which the process requires the unique identification of process participants.

Finally, PVT proposes three IT-specific moderators with a positive impact on process virtualizability [16]: Representation, reach, and monitoring capabilities. *Representation* describes IT's capacity to show information that is relevant to a process. It includes simulations of persons and objects as well as their properties and characteristics, and how we interact with them. Representation facilitates to integrate sensory requirements and relationship requirements into virtual processes. Next, *reach* describes IT's capacity to overcome the limits of time and space to enable virtual process conduction. According to PVT, it is a positive moderator between relationship requirements as well as synchronism requirements and process virtualizability. Finally, *monitoring capabilities* refer to distinct IT capacities that enable the authentication of process participants and the tracking of activities. Monitoring capability facilitates the virtualization of processes with high identification and control requirements. Besides the moderation effect, other PVT-related sources [17] suggest a direct influencing relation between the three variables towards process virtualization.

## 3 Research Model

We adopt the PVT [16] as basis for our research model (Figure 2). In addition, we plan to incorporate various extensions: To establish constructs that are mutually exclusive and collectively exhaustive, we distinguish between identification and control requirements explicitly. Existing research has considered them as one construct. In addition, we add a construct 'information requirements', as banking products and services are based on the exchange of information [23]. We hypothesize an impact towards process virtualizability, as media channels vary in their capacity to exchange information [24]. Thus, virtualization may become less amenable with higher amounts of information to be exchanged. Finally, we are the first to test the moderators proposed by Overby [16].

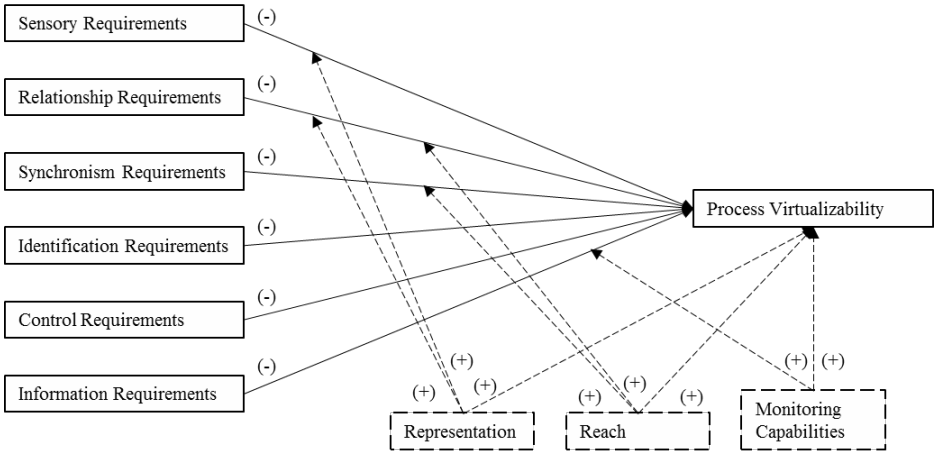


**Fig. 2.** Research Model (extended Process Virtualization Theory)

To understand the role of the underlying process in detail we have set up a comprehensive research design (Figure 3): First, we consider various retail banking products (e.g construction financing, retirement provision) and their underlying processes in the evaluation (cf. A). Comparisons between these processes shall detect variations and identify the underlying conceptual mechanisms that cause them. Second, we sub-divide each process into its respective process phases (cf. B). While PVT-related studies assume that entire processes are pursued either physically or virtually, literature indicates that customers switch between channels within transactions [25–28]. Our study shall investigate why virtualizability differs across process phases and considers PVT-related determinants for the explanation. Consequently, our research design distinguishes between four process phases that are derived from the consumer decision process [29]: Information, Advisory, Contract, and After Sales. Third, our study includes virtual and physical channels in the investigation (cf. C), as customers' preferred channel choice is expected to differ across processes and their phases. The results can help to establish a successful multichannel strategy and indicate where channel interfaces are required.

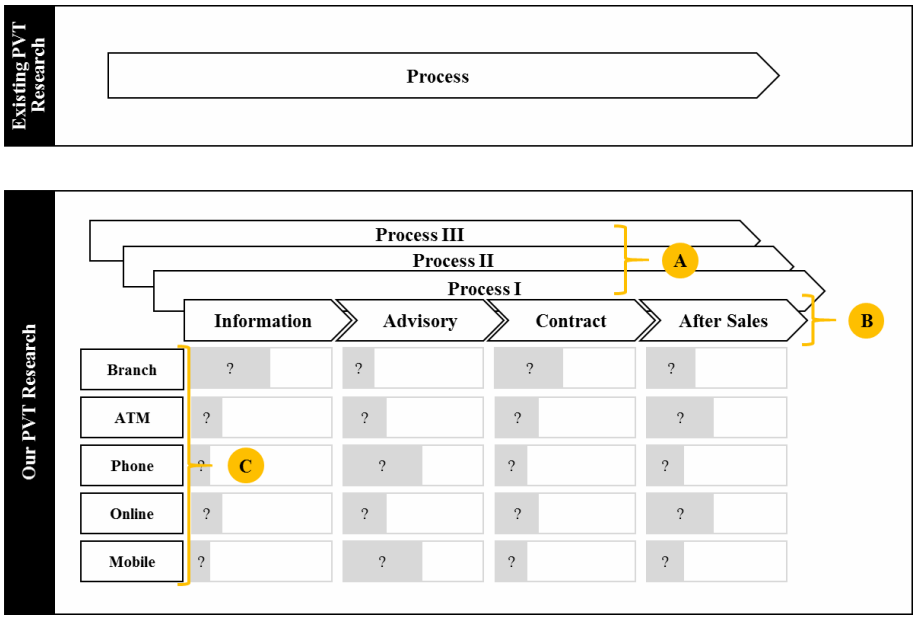


**Fig. 3.** Delineation between Existing PVT Research and Our PVT Research

## 4 Research Methodology

We plan to conduct a quantitative study to assess the research model. A market research firm that runs an online panel will engaged for data collection. This ensures a representative sample with more than 2,000 German retail banking customers across all banks. We plan to use a web-based survey assess five different processes in the area of retail banking. In the following, we introduce a detailed description of the planned research design.

### 4.1 Selection of Investigated Processes

The study considers five retail banking processes with varying process-specific characteristics in the investigation (Table 1). The process selection is on a selection of our practice partner and includes the most commonly used banking transactions. In addition, a comprehensive review of retail banking-specific reports underlined the process choice [2, 30–33]. This ensures that the most common retail banking transactions are included. All processes belong to the area of retail banking and focus on private customers. Other areas (e.g. wealth management for private customers or banking services for business clients) are not scope of the study and may require a collection of different processes.

**Table 1.** Retail Banking Processes under Investigation with Short Description

| *Process* | *Description* |
|---|---|
| Opening a bank account | The customer opens a new bank account. This includes the disclosure of personal information, the request of debit/credit cards, the setup of credit limits as well as the acceptance of the bank's terms and conditions. |
| Consumer credit | The customer signs a consumer credit to finance private consumption, generally up to 25,000 EUR. For the request, the customer discloses of personal information, provides income statements and agrees that the bank can obtain information from SCHUFA. |
| Savings account | The customer sets up a savings account. Therefore, the customer chooses between various conditions – in particular the duration of the financial investment has to be selected. To open the account the disclosure of personal information is needed and the bank's terms and conditions need to be accepted. |
| Securities deposit account | The customer sets up an account to deposit securities. Besides the disclosure of personal information and the acceptance of the bank's terms and conditions, various other pieces of information are needed. In this regard, the customer has to provide information about his experience with distinct asset classes to be able to trade the respective securities. |
| Retirement provision | The customer sets up a retirement provision. For an appropriate offer the current coverage is analyzed, the goals are set, and upcoming life events are anticipated. Next, the provision gap is calculated. The appropriate product is chosen and potential government funding requested. |

### 4.2 Item Development and Survey Pretesting

The preparation of the questionnaire used a comprehensive item development procedure. All measurement items of the constructs were based on existing literature that has been proven reliable. The items for sensory requirements, relationship requirements as well as synchronism requirements are adapted from Barth and Veit [18]. Measurement items for identification requirements and control requirements are based on Overby and Konsynski [34] and Overby et al. [35]. To derive the operationalization for information requirements we used the measurement items of Mani et al. [36] as a basis. The moderators were derived from Overby and Konsynski [34]. The items for virtual process use are adapted from Venkatesh et al. [37]. If necessary, a slight rewording was conducted to suit the study's retail banking context.

To ensure that the dependent variable is not influenced by further factors, our research included various control variables. In particular, socio-demographic characteristics were included such as age, gender and the educational level. Furthermore, Internet-specific measures were controlled, namely the Internet usage and trust in the Internet. Finally, we considered the trust in the bank, length of the bank relationship as well as the experience with the process as control variables.

Four further steps followed to ensure the validity and reliability of the measures: First, the operationalization of all constructs was translated into German, as the study will focus on Internet banking customers of German banks. Three researchers performed a back-translation [38] to ensure a correct and consistent understanding in both languages. Third, discussions with academic experts and practitioners from the financial services industry followed to examine the relevance of the survey, its comprehensibility and the consistency of the terminology used. Any ambiguity detected was resolved. Fourth, a draft questionnaire was prepared based on the established items. In this respect, all constructs were measured by closed-ended questions, where the respondents had to pick an answer from a given number of options on a 7-point Likert scale. In terms of an ordinal-polytomous response scale, the answer options were ordered from fully disagree (1) to fully agree (7). Finally, for each of the processes under investigation a separate survey version was set up. Items within the different versions only differ by the specific name of the process. A list with final measurement items is presented in Table 2.

**Table 2.** Measurement Items of Constructs

| *Construct [Source]* | *Measurement Items* |
|---|---|
| Sensory Requirements [18] | When conducting [the process phase] for the [process], I like to be able to see and touch the relevant documents. |
| | When conducting [the process phase] for the [process], I like to personally see and hear the responsible bank advisor. |
| Relationship Requirements [18] | The social interaction with the responsible bank advisor who is present is important to me when conducting [the process phase] for the [process], because I will thus be kept informed of current events. |
| | Personal contact and informal interaction with the responsible bank advisor is NOT important to me while conducting [the process phase] for the [process]. |
| | It is important to me, to establish a personal relationship with the responsible bank advisor when conducting [the process phase] for the [process]. |
| | I enjoy talking to the responsible bank advisor who is present during the different steps of [the process phase] for the [process]. |

| | |
|---|---|
| Synchronism Requirements [18] | It bothers me, if the processing does not directly start when my input is available. |
| | It bothers me, if I do not directly receive a confirmation but with delay via mail or e-mail. |
| Identification Requirements [34, 35] | When conducting [the process phase] for the [process], it is important to verify my identity. |
| | Personal identification mechanisms are crucial when conducting [the process phase] for the [process]. |
| | Authentication mechanisms are crucial when conducting [the process phase] for the [process]. |
| Control Requirements [34, 35] | When conducting [the process phase] for the [process] in the Internet it scares me to think that I could lose a lot of money by hitting the wrong key. |
| | While conducting [the process phase] for the [process] in the Internet, I have little control over my personal information and data. |
| Representation [34] | I can get the information I need when I am conducting [the process phase] for the [process] online. |
| | The information available online provide me with everything I need to know about the transaction. |
| | I do not need to personally visit a branch because I can get enough information online. |
| | The online channel provides me with everything I need to know about bank product. |
| Reach [34] | The Internet allows me to conduct transactions at any time. |
| | The Internet allows me to conduct transactions from any place. |
| Monitoring Capabilities [34] | Online Banking offers various ways to authenticate the bank customer. |
| | Online Banking offers various ways to track activity. |

| | |
|---|---|
| Virtual Process Use [37] | I expect that I would use the [channel] for [the process phase] in the [process] in the future. |
| | I intend to use the [channel] for [the process phase] in the [process] in the future. |
| | If possible, I would use the [channel] when conducting [the process phase] for the [process]. |
| | I would NOT use the [channel] for [the process phase] in the [process] (reverse). |
| Control Variables | Age |
| | Gender |
| | Educational level |
| | Internet Usage |
| | Trust in the Internet |
| | Trust in Bank |
| | Length of Bank Relationship |
| | Experience with Process |
| Legend | [channel] = to be replaced with the distinct channel under investigation |
| | [process phase] = to be replaced with the distinct process phase under investigation |
| | [process] = to be replaced with the distinct process under investigation |

The survey incorporates a respondent-friendly structure to achieve an appropriate respond rate: It starts with a short introduction with instructions, the retrieval of information for demographics and some further control variables. Next, participants have to select those processes that they already have conducted before to ensure minimal familiarity with the process. Subsequently, a process description is shown to set a common understanding of the process and its inherent steps for all participants. Next, the answers for all constructs are collected. All measurement items were retrieved in a format that it was easy to respond to, clear, and non-offensive [39].

Based on the developed questionnaire, two pre-tests were conducted to prepare the large-scale data collection. First, a student sample with 323 students was used to test the questionnaire. The students were between 18 and 38 years old. The gender was distributed approximately equally. Afterwards, we tested the survey with 368 German bank customers. Participants were recruited by a market research firm that operated an

online panel. The socio-demographic statistics indicate a well distributed sample of participants in the age between 30 and 65 years. While 30 percent of the respondents were in the 30 to 39 age range, 31 percent assign to the 40 to 49 age range and 39 percent are between 50 and 65 years old. 51 percent of the participants were female and 49 percent male. The results of both pre-tests provided initial evidence for the derived research model. Only minor improvements regarding the questionnaire and its appearance were made after the pre-tests.

### 4.3 Large-scale Data Collection and Analysis

A final large-scale quantitative study is planned to empirically assess the research model. Due to the high practical relevance the study is supported by one of Germany's largest banks. We aim to collect a sample with more than 2,000 German retail banking customers. To draw a representative picture of the German retail banking market the data collection is conducted by a professional market research firm and aims to represent the market characteristics drawn in Table 3. The research firm is certified with the ISO 26362 for access panels in market research.

**Table 3.** Overview of Planned Sample Characteristics (based on banks' annual reports)

| *Bank* | *Marketshare Private Customers* |
|---|---|
| Sparkassen | 36,39% |
| Volksbanken/Raiffeisenbanken | 21,83% |
| Postbank | 8,33% |
| Deutsche Bank | 6,55% |
| ING-Diba | 6,10% |
| Commerzbank | 5,74% |
| Sparda-Banken | 2,75% |
| Targobank | 2,59% |
| DKB | 2,35% |
| Santander | 2,26% |
| HypoVereinsbank | 1,62% |
| comdirect | 1,51% |
| PSD Bank | 0,89% |
| Consorsbank | 0,52% |
| Norisbank | 0,40% |

The market research firm uses a German panel of Internet users for the data collection. The approach is well-suited for the research at hand, as the Internet is a promising channeling medium for the survey and reaches a broad range of participants [40]. It is appropriate for the scope of the study, as individuals without access to the Internet shall be explicitly excluded from the population under investigation. Literature related to the digital divide [41] addresses how to include these persons into the digital society.

Each participant can take part in the survey once and with respect to only one of the previously outlined banking processes. Accordingly, the study at hand involves a random sample without replacement. The record of a participant's IP address and its blocking after the questionnaire completion helps to enforce the described design. To ensure response accuracy and integrity participants are only asked regarding processes that they have already conducted before. In this regard, participants are asked regarding their experience in the beginning of the survey. If participants select more than one process, they go through the evaluation for one process only. Participants who have never performed any of the predefined processes are screened out to ensure response accuracy and integrity.

The data collection is planned for a period of three weeks in summer 2015. Participants with incomplete answers are removed from the sample. To include only participants who read the questionnaire carefully, we will exclude participants that need less than half of the mean average survey duration. To exclude further unreliable responses, the answers were screened for unlikely patterns, such as alternating between two values or all maximum values despite reverse-measured items [42]. After the incorporation of these measures, we aim to obtain a response rate between 25 and 30% at minimum. This threshold is commonly expected for online surveys [43, 44].

As in both pre-studies, we use structural equation modelling with partial least squares (PLS) regression to evaluate the research model. SmartPLS 2.0 M3 [45] is used in this regard. PLS is recommended for exploratory research and theory development, as it concentrates on the prediction of data. Accordingly, it is appropriate for the study at hand, as PVT-related research is still in its early stages. For the use of PLS regression the sample size must be at least 10 times greater than the highest of either the block with the largest number of formative indicators or the largest block of independent variables impacting a single de-pendent variable [46]. With a planned sample of approximately 2,000 answers we exceed this threshold comfortably. As commonly recommended, we use a two-step analysis including the assessment of the measurement model and the structural model [47, 48].

## 5 Conclusion

The planned research project investigates the determinants that drive the virtualizability of customer-facing banking transactions. It uses the PVT as theoretical foundation and chooses a quantitative approach for the evaluation. Our study provides various theoretical contributions: First, while existing research has rarely tested the PVT, we provide an empirical evaluation and extension of the theory in retail banking. Second, we are the first who consider multiple processes in the investigation. Third, we incorporate a break-down of each process into distinct process phases to assess the impact of the process phase on process virtualizability. Practitioners can learn which process phases are amenable for virtualization and where an interface with physical channels is needed. Accordingly, the results help banks to build customer-oriented multichannel strategies. We believe that this basis enables an extensive exchange at the doctoral consortium that can be further enhanced by the incorporation of pre-test results. In return, we hope to

receive valuable suggestions regarding our theoretical foundation and research methodology to further improve the quality our research.

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# Situational Cost Allocation Method for Business Intelligence Systems

PhD candidate: Johannes Epple[1]

Supervisor: Prof. Dr. Robert Winter[2]

Institute of Information Management, University of St. Gallen, Mueller-Friedberg-Strasse 8, 9000 St. Gallen, Switzerland

[1]johannes.epple@student.unisg.ch
[2]robert.winter@unisg.ch

**Abstract.** Cost allocations for business intelligence (BI) are supposed to enhance transparency, create cost awareness and support the management of resources for the BI systems. Although cost allocation for BI is highly relevant for practice, the field is widely unexplored in current literature. The review of existing approaches applied to various domains of information systems (IS) revealed that there is no "one-size-fits-all" approach to cost allocations, but their design is highly dependent on the design situations consisting of management objectives and contextual factors. Therefore, the purpose of the dissertation is to design a method for the situational configuration of BI cost allocations.

**Keywords:** Cost allocation, business intelligence, cost accounting, BI management

## 1 Introduction

"Information is the oil of the 21st century, and analytics is the combustion engine." [1]. Along with the pervasion of transactional information systems (IS) in organizations, business intelligence (BI) technologies have developed which turn the vast amount of data into decision-supportive information. Today BI is acknowledged as an umbrella term for "technologies, applications and processes for gathering, storing, accessing and analyzing data to help its users make better decisions" [2, p. 14]. BI is thereby considered to be a prerequisite for organizational success [2].

Organizations of all sizes increasingly invest significant amounts into BI systems [3] – despite cost pressure and declining budgets in administrative departments. As a consequence, there is a high need within organizations to transparently present and justify the high expenses for BI. Costs of BI are mainly overhead costs, i.e., costs that are not directly attributable to a product or service sold. In other instances information delivered through BI services increasingly become market offerings by their selves or part of such, but the costs still remain as overheads and are added as an overhead surcharge

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to the direct costs in the product calculation, due to the missing capability of transparently analyzing and presenting those costs. In any case, there is a high need to internally allocate the costs of BI further, either to the cost object that is sold to an external customer or to the internal organizational unit that caused the costs.

Cost allocations are supposed to fulfil various purposes e.g., to enhance transparency about the costs, to provide the correct basis for calculation, to create cost awareness, to uncover inefficiencies in the use of resources, or to induce desired effects for the management of the resources whose costs are allocated to other units [4]. Therefore, cost allocation for BI costs is an appropriate means to enhance transparency and contain desired control effects for the management of the growing portion of BI costs.

The topic of BI cost allocations is located at the interface between cost accounting and IS research, and moreover, BI services [5] appear to be of particular interest to cost accounting and IS research, due to a BI system's nature. First, the output of a BI system is information for which traditional cost-oriented internal pricing mechanisms for goods and services do not apply. Second, due to the delayed value generation through BI – in contrast to the value-in-use – the intention of BI cost allocation should not be the restriction of use of resources, but needs to encourage users to use the system to the best of its capabilities. Thus, BI cost allocation should contribute to promoting the use of the BI system and not distract users from the system use. Further, the aspect of not distracting BI users is also important in the light of the voluntariness of use of a BI system. Third, the operation of BI systems involve a large monolithic cost block [6] that cannot be managed without transparency about the causes of the costs.

While research on cost allocations to various sub-domains of IS can be found in scientific literature, the instantiation to BI is missing (see chapter 3). However, existing cost allocation approaches are not easily transferrable and applicable to BI, which is characterized by its special nature in regard to cost allocations. Thus, the proposed dissertation project aims at contributing to the knowledge base of BI and BI cost management by closing the research gap through providing a comprehensive work on BI cost allocations. The results shall also deliver compelling answers to practitioners regarding the existing real-world design problems related to BI cost allocations, and provide assistance to BI managers and management accountants.

The paper at hand is structured as follows: chapter 2 introduces the conceptual foundations of cost allocation methods from an accounting perspective and of BI from an IS perspective. Chapter 3 presents a comprehensive overview of the state of the art of BI cost allocation found in an extensive literature review. Chapter 4 outlines the approach of the proposed dissertation.

## 2 Conceptual Foundations

This chapter provides the conceptual foundations relevant for the dissertation proposal. First, cost allocations commonly recognized in accounting literature are introduced. Due to the reason that BI cost allocations are conceptually located at the inter-

face between accounting and IS, the introduction of cost allocations is built upon definitions from accounting literature. Afterwards, the concept of BI is outlined, since it is the domain to which cost allocation is applied in the dissertation.

### 2.1 Cost allocation methods in cost accounting

A cost allocation refers to the concept of internally charging costs for the internal consumption of goods or services from one organizational unit (e.g., a cost center) to another organizational unit or to a cost object (e.g., a production order). The rationale behind is that the consumers should "pay" the price for receiving internally provided goods or services, and the provider should "earn" for the supply of goods or services. Therefore, a cost allocation sends costs by crediting the provider and debiting the consumer with a certain amount of costs. The costs credited and debited in the course of a cost allocation are also known as secondary costs. Cost allocations are supposed to fulfil various purposes, e.g., to enhance transparency about the costs, to provide the correct basis for calculation, to create cost awareness, or to uncover inefficiencies in the use of resources. Hence, they are designed to have a certain impact for business decisions.

A cost allocation method refers to the underlying mechanism to transfer costs from sender(s) to the receiver(s) (from BI provider to BI consumer). The differentiation of cost allocation methods is crucial at this point because it needs to be considered in the configuration of BI cost allocations. The following general cost allocation methods need to be distinguished:

1. No cost allocation [7]:
   The costs (e.g., of BI) are not further allocated, but remain with the providing unit.
2. Overhead rates [7-9]:
   A key (e.g., number of users, CPU-usage) is used as a rate to distribute the costs for to the users – *Synonym: assessment.*
3. Internal activity allocation [7-9]:
   Prices for activities are defined. The users are debited with price * used quantity – *Synonyms: billing, internal cost allocation, (internal) pricing, charging, charge-back.*
4. Activity based costing (ABC) [10]:
   Process costs and cost drivers for the processes (e.g., creation of a report) are defined. Upon use, the users are debited with the costs.
5. Relative single cost calculation [11]:
   Riebel's relative single cost calculation a decision-oriented approach offers "a conceptually consistent and appealing way of thinking of relevant costs for decision-making." [11, p. 1051] – *Synonym: relative direct cost calculation.*

It can be stated that if a cost allocation is applied, it can be either be a portioned distribution by certain keys, an allocation model with prices, an ABC system or a rather special case like relative single cost calculation. In the design of a cost allocation according to the above described mechanisms further considerations regarding the detailed configuration of single components need to be made. This includes the decision

on which basis the cost allocation is executed (e.g., on planned, actual, or market values). Further, it is crucial to define which part of the costs – in our case of the BI costs – should be allocated to the internal consumers. This could include e.g., full costs or only variable costs.

To sum up, the basic mechanisms of how costs are allocated from sender to receiver, and are archetypes of mechanisms that need further adaptation to be applicable to BI. Moreover, further considerations regarding the management impact, the configurable components, and the requirements for BI cost allocations need to be made.

### 2.2 Business Intelligence

In the year 1958 Hans Peter Luhn first mentioned the term BI and business intelligence system (BIS) respectively as a system to *"accommodate all information problems of an organization"* [12, p. 314]. Ever since, various concepts with slightly altering scopes have been developed for IS enabled decision support. The most commonly known among them are management information systems, decision support systems and executive information systems. While in the early development stages the IS for decision support had rather narrow perspectives, the concept of BI is widely understood in a broader sense, since it encompasses all components of an integrated decision support infrastructure [13]. This includes the technological as well as the sociotechnical components, or as Herschel [14, p. i] puts it "Today, the practice of BI clearly employs technology. However, it is prudent to remember that BI is also about organizational decision-making, analytics, information and knowledge management, decision flows and processes, and human interaction." Other definitions with a narrower scope restrict BI to a collection of methods and tools to exploit multidimensional data [15].

Today a plethora of definitions exist, but "there is no universally-accepted definition of BI" [2, p. 14]. In the context of the proposed dissertation, also a more holistic definition of BI is adhered following the understanding of Wixom and Watson [2, p. 14] who define BI as a "broad category of technologies, applications, and processes for gathering, storing, accessing, and analyzing data to help its users make better decisions." The comprehension of BI in this proposal includes the technological aspect of an IS landscape with analytical front-end applications, a data warehouse (DWH) and the interfaces to operational data sources. Further, it encompasses the technological process view "getting data in […] and getting data out" [2, p. 14] as well as the organizational process view including the sociotechnical perspective.

Pursuant to the above presented understanding of BI in the proposed dissertation, not only the costs of the technological components of BI are subject to the cost allocation for BI, but also the costs incurring the execution of the related processes and the sociotechnical interaction. Therefore, the proposed cost allocation shall not only consider hardware and software costs, but the full costs for BI including e.g., labor costs and external and internal services for BI. According to Bischoff et al. [6] the operation of BI involves a large monolithic cost block which cannot be managed without transparency about the costs. However, for the purpose of this dissertation proposal the costs

of BI operations and BI investments are distinguished. Since investment costs for development or enhancement projects be easily assigned to the causer, the focus of the dissertation lies on the operating costs of BI.

## 3 State of the Art

To identify the relevant publications regarding BI cost allocations an extensive literature review has been conducted consisting of a systematic literature review according to Rowe [16] as well as a hermeneutic literature review according to Boell & Cecez-Kecmanovic [17]. The literature review comprises four iterations with ever broadened and altered search terms and databases. Details on the literature review are documented in the first publication (see section 4.3).

The need for future research on BI cost management is discussed in various publications, e.g., in order to foster executive and user commitment to BI [18]. Schieder and Gluchowski [19] constitute that future research efforts are justified "to bring us closer to a long sought after means to assess and compare cost and benefit aspects of BI solutions" [19, p. 12]. The review of prior work uncovered that in practice-oriented journals scattered publications on the application of certain BI cost allocation approaches can be found [e.g., 20]. In addition, consulting companies publish papers stating the maturity of the topic of IT cost allocation [21] and BI cost allocation in particular [22] is still low. Consequently, we derive that there is a relevance of future research from the scientific community as well as from practice.

The basis for BI cost allocation can be found in accounting literature. One common characteristic observed in the several use cases is, that the applied cost allocation approaches heavily depend on the situational contexts of the use cases. Further sources [23-25] also indicate that environmental factors influence the design of cost allocations, e.g., the system maturity, form of organization, or the type of services to be allocated. Thus, there is no "one size fits all" approach neither to IS cost allocation in general, nor to BI cost allocation in particular. Therefore, a BI cost allocation approach has to be discretely designed for the specific situation.

A BI cost allocation serves specific purposes and is no end in itself. The rationale behind a BI cost allocation is to achieve desired management impact in order to accomplish certain management objectives in specific situations. Existing literature partially provides conceptions about the underlying objectives of a BI cost allocation. Klesse [4] describes the goals of a cost allocation for DWH services, Ross et al. [26] describe conditions and implications of IT cost allocations, and Müller et al. [27] build a matrix of appropriate allocation approaches and goals of lean management, but no research on the objectives of BI cost allocation can be found in literature so far.

The review of prior work revealed that only few sources give specific recommendations or guidelines on what to consider in the design of a cost allocation for BI or IS, respectively. Verner et al. [7] provide an overview of the different cost allocation methods for IS. Various sources give examples for the implementation of a specific cost allocation method in a given situational context [e.g., 20, 28-30]. Klesse [4] as well as Bär and Purtschert [31] describe basic requirements and prerequisites for the design of

a cost allocation for DWH services and IT services, e.g., cost effectiveness, exactness and practicability of the cost allocation. Several sources contribute aspects to consider in the design of a BI cost allocation, but a comprehensive work on BI cost allocation is missing in literature. Further, the literature review clearly revealed the lack of substantial groundwork generally applicable to BI cost allocations.

# 4 Dissertation Approach

This chapter specifically presents the research problems leading to the research questions (RQ). Further, the overall research method, an overview and further details of the single publications are provided.

## 4.1 Research Problem and Research Questions

The state of the art in scientific literature regarding BI cost allocations reveals that on one hand there is a high need for proper cost management, cost transparency, and cost-value considerations in the domain of BI. On the other hand, no research-based publications deal with the topic of BI cost allocations in a comprehensive and compelling way. The practical relevance of the topic is derived from existing practitioner-oriented publications as well as from the contact to industry partners (cf., exploratory focus group in publication 2). The motivation shown in the previous chapters leads to the assumption *that BI is a special case for cost allocations which is of high practical relevance. The topic is a rather unexplored field in research why further research on this topic is justified.*

From the literature review it came out that many antecedents and interdependencies need to be considered in the selection of an appropriate BI cost allocation method. Further, it is shown in the use cases of cost allocations for IS in research publications that the solution approaches vary depending on the characteristics of the use situation affecting the design and the desired management impacts. Thus, in the proposed dissertation the design situation of BI cost allocations is composed of the contextual factors influencing the BI cost allocation in combination with intended management objectives. Therefore, another underlying assumptions of the PhD thesis is *that there is no "one size fits all" solution for this topic, but they must be configurable according to individual design situations.* Further, no substantial groundwork and no generally applicable principles for BI cost allocations have been discovered in the conducted literature review. Consequently, the purpose of the proposed dissertation is manifold. Verbalized in a nutshell, the overall goal of the dissertation is…:

> *… to design a method for the configuration of BI cost allocations that incorporates the specific design situation consisting of management goals and contextual factors, in order to close the existing research gap and to support practitioners with the purposeful design of a BI cost allocation.*

This leads to the first research question of the proposed dissertation:

*RQ 1: What are the design principles for BI cost allocations applied in practice?*

The first RQ specifically targets the prevailing real-world problem and the identified research gap between the relevance of BI cost allocations and existing solution approaches and artifacts. On one hand, publications in scientific outlets highlight the need of future research, practitioner-oriented publications do not deliver compelling answers from practice, but stating that the maturity of the topic is still low, and BI experts from industry partners face challenges related to the topic and call for guidance. RQ 1 results from this dilemma and aims at providing research and practice with design principles for BI cost allocation yet independent from the specific situational context. To pursue this goal certain principles that are universally valid for BI cost allocations shall constitute a solid groundwork on which a BI cost allocation can be built in different situational contexts. The understanding of design principles in the proposed dissertation adheres to the definition according to Gregor et. al [32] differentiating principles of form, function, and implementation. Generally speaking, design principles shall give advice for the effective design and implementation of a solution in a specific context. Due to missing prior work in the field of BI cost allocations the foundations are the first step of the dissertation project.

*RQ 2: What are the design situations for BI cost allocations?*

The second RQ refers to the assumption that there is no "one size fits all" standard solution for the design of a BI cost allocation method, but that every cost allocation is designed for a specific purpose (the management objectives) and in a given situational context. The second RQ aims at identifying the different design situations in which a BI cost allocation can be designed. Therefore, this RQ is composed of two sub-RQs in order to identify the goals and contextual factor in order to define the use situations for which the situational BI cost allocation shall be designed. The results of the two sub-RQs are merged in RQ 2 leading to a multidimensional matrix describing design situations that consist of management objectives and influencing contextual factors.

*RQ 2.1: What are the management objectives of BI cost allocations?*

A cost allocation method is not an end in itself, but employed for a certain purpose, i.e., to achieve or fulfil management objectives. Hence, the objectives of management for BI cost allocations is subject to this RQ. The management objectives represent an important component for the purposeful design of a BI cost allocation in order to identify how the desired management impacts of BI cost allocations can be realized. The management objectives are one dimension of the design situation, since the objectives are the motivation and justification for designing BI cost allocations.

*RQ 2.2: Which contextual factors characterize the design situations of BI cost allocations?*

The design situations of BI cost allocations can be characterized by different contextual factors, e.g., the BI system maturity or the status of acceptance of the BI services which are subject to the allocation. Thus, the contextual factors are beside the management objectives the major component of the design situation of BI cost allocations. The purpose of RQ 2.2 is to identify and evaluate the different situational contexts that need to be incorporated in BI cost allocations. The supposed outcome of this RQ is to define a set of contextual factors that influence the design of BI cost allocations.

*RQ 3: How should BI cost allocations be designed in the identified design situations?*

The third RQ aims at the actual design of a method for BI cost allocations under consideration of the different design situations defined in RQ 2. In addition to the considerations of the identified design situations, the design principles resulting from RQ 1 need to be integrated in the solution artifact – a method for the situational configuration of a BI cost allocation – as the common ground on which the situational BI cost allocation is built. The result of this RQ is supposed to be a method that contributes to closing the identified research gap regarding BI cost allocations by providing insights on the necessary procedures of how to solve existing real-world design problem. Further, the derived method shall support practitioner (especially BI managers and cost accountants) in the purposeful design of a BI cost allocation.
In *Figure 1* the interrelation between the RQs is visualized.

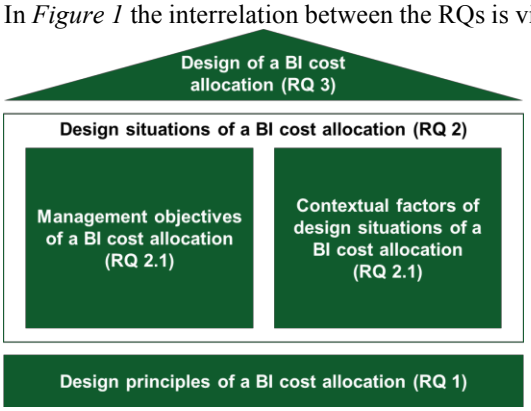


*Figure 1: Interrelation of research questions*

### 4.2 Research Method

The overall research method of the proposed dissertation follows the DSR paradigm according to Peffers et al. [33]. In contrast to behavioral research which purposes on exploratory and descriptive learning [34], DSR aims at "prescriptive learning, i.e. the design and evaluation of innovative, useful, generic problem solutions to important and relevant design problems in organizations" [34, p. 269]. Therefore, DSR intends to solve existing real-world problems through the design of useful artifacts, instead of understanding existing phenomena [35]. Different artifact types need to be distinguished in DSR: constructs, models, methods, and instantiations [36, 37]. Gregor and Hevner [38] add further artifact types, namely: design theories, design principles, and technological rules. The overall goal of the proposed dissertation is to design a method for the situational configuration of BI cost allocation. Baumöl [39] shows that there is no unified method definition in IS research. According to Winter [37, p. 471f] "methods describe processes which provide guidance on how to solve problems" and "focus on procedural aspects – and imply results". Winter [40] states that a method is composed of the following components: activity model, procedural model, solution model, role model, and information model. As described in prior sections the research problem resulting from the analysis is that currently there is a lack in research and missing support on how to achieve the desired management impacts effectively and efficiently and how

to cope with the real-world design problems regarding BI cost allocations. Therefore, the suitable solution artifact of the proposed dissertation is a method according to the above described understanding. This method shall provide guidance and support the process of purposefully designing BI cost allocations.

Peffers et al. [33] propose a methodology for DSR comprising the six activities identify problem & motivate, define objectives of a solution, design & development, demonstration, evaluation, and communication. These six activities should not be understood as a pure linear process, but in an iterative manner especially from the activities evaluation and communication back to the activities define objectives of a solution and design & development. Sonnenberg and vom Brocke [41] stress the iterative manner of the DSR process, and propose a design process consisting of several build-evaluate circles with four intermediate evaluations. During the course of the proposed dissertation, design and evaluation activities shall alternate according to Sonnenberg and vom Brocke [41], although the proposed research project does not stick to exactly four intermediate evaluations.

In order to take the specific design situations of BI cost allocations into account, and not to design a "one size fits all" method for BI cost allocations, the conception of SME is partially applied in the dissertation. The proposed dissertation follows the differentiation made by Bucher et al. [42] who characterize "design situations" and "method fragments" as the central components of SME. On one hand, the design of BI cost allocations is highly dependent on the situational context in which the allocation should be designed, e.g., the system maturity. On the other hand, in every BI cost allocation method various components have to be configured (the method fragments) according to the situational context, e.g., the applied allocation mechanisms or the cost types to be allocated.

Bucher et al. [42] propose to conduct three phases in SME comprising *(1) identifying situational characteristics*, *(2) decomposing generic artifacts into artifact fragments*, and *(3) composing artifact fragments into a situational method*. The proposed dissertation particularly focuses on the first phase of SME with RQ 2, by identifying situational characteristics. For the decomposition of generic artifacts, the existing general understanding of cost allocation methods is applied, since the purpose of the dissertation is not to design a new type of cost allocation method, but to design a method for configuration of BI cost allocations under consideration of the specific design situation. The third phase of SME is conducted in RQ 3 by providing a method for situationally recomposing cost allocation fragments depending of the identified design situations. Therefore, the identification of the design situations (phase 1 of SME – RQ 2) as well as the method for the situational configuration of BI cost allocation (phase 3 of SME – RQ 3) are the most crucial in the proposed dissertation.

Summing up, the overall research paradigm applied in the proposed dissertation is DSR. Due to the cumulative nature the single fragments of the dissertation, i.e. the individual research papers, cannot be clearly assigned to the phases of the presented approach. In fact, the single publications are small projects applying the introduced research paradigm to a certain extent in themselves by working out and evaluating results that are presented in autonomous publications. SME provides a suitable approach for understanding and elaborating a theoretically founded procedure for the design of

the solution in the proposed dissertation. However, the results of the dissertation are not derived in a pure SME project, but rather SME enriches the research process of the proposed dissertation with valuable conceptions and insights for target-oriented efforts towards the desired results.

### 4.3 Solution Components of the Dissertation

Answering the RQs constitutes the single solution components of the dissertation. These solution components are operationalized in terms of five individual research papers published as journal or conference papers.

In Figure 2 the coverage of the RQs in the planned publications is illustrated. The first publication is intended to identify the research problem and motivate. Therefore, the first publication partially addresses all of the RQs, since it presents an extensive review of existing literature on the topic and motivates the dissertation project. The second publication is intended to deliver a solid basis – the design principles (RQ 1) – for BI cost allocations and to identify the management objectives for BI cost allocations (RQ 2.1). In the third publication detailed insights on the status of acceptance as a crucial contextual factor of the design situations is provided, but the entire conglomerate of existing contextual factors is not yet presented, why the third publication only partially addresses RQ 2.2. The fourth publication fully addresses RQ 2.2 and delivers a comprehensive set of the contextual factors characterizing the design situations of BI cost allocations. In the fifth publication the single components of the method for the situational configuration of BI cost allocations are derived and evaluated.

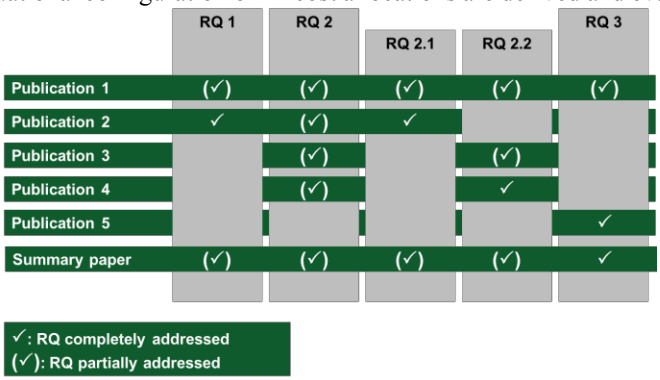


*Figure 2: Coverage of research questions in planned publications*

***Publication 1 (status: submitted).*** "A review of prior, relevant literature is an essential feature of any academic project" [43, p. 13]. This publication is not intended to answer any of the RQs of the overall dissertation project, but the results are supposed to deliver insights which are used for the subsequent publications and to motivate future research on BI cost allocations. However, due to the autonomous character of each publication further reviews of prior work on specific topics might be necessary.

The literature review yields a total of 31 relevant results that are considered in the literature synthesis. The main outcome is that cost allocation methods for BI are not yet sufficiently covered by existing literature, but several findings provide a basis for BI cost allocations. In consequence from the obtained insights areas of future research are derived. Especially, substantial research on a situational BI cost allocations that incorporate foundations, the different use situations, contextual factors, and the configuration components is proposed.

A systematic literature review according to Rowe [16] in four iterations enriched by elements of the hermeneutic approach according to Boell & Cecez-Kecmanovic [17] is conducted. A large number of search results stemming from the four iterations are analyzed and synthesized, e.g., 1,716 publication were reviewed only in the first iteration. Predefined search terms are used for each iteration and refined after the analysis of the results to be used in the subsequent iteration.

***Publication 2 (status: submitted).*** This publication is built upon the findings of the extensive literature review presented in the first publication and is intended to deliver a basis for BI cost allocations independent from the specific design situations as well as on identifying the management objectives for BI cost allocations. Therefore, the second publication addresses RQ 1 and RQ 2.1 of the proposed dissertation.

The contribution of this paper is solid basis for the design of a BI cost allocation method containing an exploration and evaluation of objectives and design principles for a purposeful design of a BI cost allocation method. The publication presents seven management objectives, three principles of form and three principles of function for BI cost allocations. Further, certain generally valid design principles provide guidance for the design and application of cost allocations even in other (IS) domains than BI.

The design principles constitute an DSR artifact [32, 44]. The findings regarding the design principles and management objectives are based on empirical data of an exploratory focus group (EFG) according to Tremblay et al. [45] conducted with BI specialists from five major banks. The findings of the EFG are evaluated in a confirmative focus group with a different group of BI managers and BI specialists testing the findings' validity.

***Publication 3 (status: submitted).*** This publication represents the first effort towards a comprehensive set of contextual factors influencing BI cost allocations. The literature review in the first publication revealed that research on several factors influencing the design of (IS) cost allocations already exists, e.g., on cost allocations depending on the maturity of the IS [24] or organizational environments [23]. The status of acceptance of BIS is considered to be another crucial contextual factor for the design of BI cost allocations. While various IS research contributions address questions regarding the phases of acceptance and continuous system use [e.g., 46], up to now, no comprehensive work in the specific context of BI exists. However, due to the fact that BI system acceptance is supposed to be an important contextual factor for BI cost allocations, the different phases of acceptance need to be identified by certain antecedents. Therefore, this publication partially addresses RQ 2.2 of the proposed dissertation by providing insights on one specific contextual factors of BI cost allocations.

This paper contributes to the knowledge base on continuous use of BI systems by presenting and evaluating six internal (attitude, cognition, behavior, affect, beliefs, and type of motivation) and three external (BI system use, learning curve, and extent of social influence) antecedents for the identification of phases of acceptance. The feasibility of operationalization is evaluated in a case study leading to the elimination of three antecedents (beliefs, type of motivation, and extent of social influence). The results of the research provide guidance for a purposeful management of BI systems.

Based on a literature review this paper contributes a comprehensive overview of antecedents for the phases of acceptance found in scientific literature. The validity of these antecedents is tested and empirical evidence on how they can be employed in practice is provided through a confirmatory case study according to Yin [47].

***Publication 4 (status: planned).*** The fourth publication of the proposed dissertation is aimed at completing the picture about design situations for BI cost allocations by presenting a comprehensive set of contextual factors influencing BI management and BI cost allocations in particular. The literature review in publication 1 uncovered that cost allocations are highly dependent on the specific design situations, but still a lack of research on the contextual factors of the design situations exists. Therefore, this publication fully addresses RQ 2.2 of the proposed dissertation.

The results of this paper enhances the knowledge base on BI management by providing a set of contextual factors (e.g., system maturity, status of acceptance, legal structure, or degree of centralization) and their type of influence on BI cost allocations. The set of relevant contextual factors is derived from an extensive review of prior work on contextual factors influencing IS cost allocations as well as on factors influencing (cost) management of IS and in particular of BI. The identified factors are validated and their type of influence is derived with industry partners.

In the first step a systematic literature review according to Rowe [16] is conducted in order to identify existing work on relevant contextual factors. A synthesis of the publications found is reflected against data obtained from a qualitative exploration according to Tremblay et al. [45]. In in-depth interviews followed by critical reasoning and analysis of existing literature the type of influence on BI cost management is derived for each of the identified factors.

***Publication 5 (status: planned).*** The fifth publication relates the findings of the prior publications in order to design certain method components providing guidance for the design of BI cost allocations in specific design situations. This paper fully addresses RQ 3 and constitutes the essential element of the solution artifact of the dissertation.

The expected results of this publication are partially depending on the outcomes of the fourth publication. In the present stage of the dissertation project the results are presumed to contain decision guidance in terms of a procedural model and an activity model. In addition, the target-oriented process of designing BI cost allocations should presumably be supported by identifying the different roles in the process and generically depicting the solution model and the different method fragments BI cost allocations are composed of.

The concept of SME [42] is applied to a certain extent, since single SME activities are used to develop the design situations and to re-construct the method fragments. In addition, a case study according to Yin [47] serves as the basis for the purposeful design and evaluation of the single components, e.g., the procedural and the activity model.

## 5 Points for Discussion

I would be interested in discussing several points on the doctoral consortium, especially my ideas to the potential solution artifact. I would further like to discuss the appropriateness of the chosen research methods, and whether they address the research question of my dissertation and current paper projects adequately. Finally, I suppose that the discussion on the platform of the doctoral consortium adds value to my work by identifying further potential kernel theories and giving suggestions on further literature and fields of research that should be considered.

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# Analysing Enterprise Social Network Data to Facilitate Knowledge Identification

Janine Viol[1,*]

[1] Institute of Information Systems, University of Erlangen-Nürnberg, Nürnberg, Germany
janine.viol@au.de

**Abstract.** Companies are often unaware of the knowledge that exists or lacks within their organisation. Embedded in the social context of a company's employees, knowledge is difficult to detect and internally available expertise cannot readily be accessed.
Enterprise Social Networks are increasingly used in companies to support collaboration and knowledge sharing. Enabling the exchange of messages and documents, they provide a rich record of the interactions happening between a company's employees.
This dissertation aims to identify key knowledge actors by analysing the data accumulated in Enterprise Social Networks. Transferring concepts and methods of organisational science to the context of Enterprise Social Networks, this research develops an alternative approach to knowledge identification. The results may support companies in designing more target-oriented and sustainable knowledge management initiatives.

**Keywords:** Enterprise Social Network, knowledge identification, social network analysis

## 1 Motivation and Objectives

The effective management of knowledge in an organisation is necessary to secure competitive advantage [1]. Knowledge management includes the processes of identifying, retaining, utilising, sharing, developing and acquiring knowledge [2, pp. 27]. In this connection, knowledge identification is an important prerequisite to know on the one hand which knowledge should be acquired and on the other hand which knowledge should be retained. However, many organisations skip the step of knowledge identification and thus, are unaware of the knowledge that exists or lacks within their organisation [2, 3].
One key obstacle to knowledge identification lies in the very nature of knowledge as a resource in the organisation. According to the knowledge-in-practice view, knowledge is embedded in the social context that organisational members interact in and cannot be separated from them [4–6]. If employees decide to leave the organisation, the knowledge stored in their informal networks, e.g. knowledge about how work gets done in an organisation and about who knows what [7], is easily lost. To

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make knowledge management initiatives more targeted and sustainable, there is a need to extend existing or create new knowledge identification strategies.
In the last years, companies have started to use internal online social networks in order to improve knowledge sharing and collaboration among employees. Belonging to the category of Enterprise 2.0 applications [8], well-known examples of these so-called Enterprise Social Networks (ESN) include IBM Connections, Jive and Yammer [9]. Compared to public and open social networking sites, such as Facebook or the professional network LinkedIn, ESN are closed applications within a company's intranet. Including features such as a profile page, a newsfeed, search options and different communication channels [10, 11], ESN enable a digitisation of social relations and communication within the company.

Research in the area of ESN has considered the (1) opportunities and risks of introducing ESN [12, 13], explored (2) how employees use these new media [14, 15], looked into (3) the potential benefits of organisational social networking from a knowledge management perspective [16, 17] and sought to analyse (4) the patterns of relationships in ESN [18, 19]. Bridging areas 4 and 3, the overarching goal of this research project is to analyse ESN data to support knowledge identification. In particular, it seeks to gain a better understanding of the social roles that can be distinguished based on the analysis of ESN data and aims to identify key actors – a topic that has already received a lot of attention with regards to online social media but is not yet sufficiently studied in an ESN and knowledge management context [20, 21]. Determining key knowledge actors in an organisation is an essential step in identifying knowledge loss risks and to create strategies for their mitigation.

## 2 Research Questions

To achieve the above objective, my dissertation project pursues the following main research question: How can key knowledge actors be identified based on the analysis of Enterprise Social Network data?
The main research question can be broken down into several sub-questions:

1. What are characteristics of key knowledge actors?
2. Which existing strategies facilitate the identification of key knowledge actors?
3. Which metrics enable the identification of key knowledge actors based on ESN data?
4. How do the developed metrics compare with existing methods to identify key knowledge actors?
5. How can knowledge retention be reinforced based on the identified key knowledge actors?

# 3 Theoretical Foundations

My doctoral research draws on insights in knowledge management, organisational science, network science and social network analysis to answer the above research questions. Informing the theoretical background of my research, the following sections introduce relevant concepts in the areas of knowledge management and organisational social network science.

## 3.1 Knowledge and knowledge identification

Scholars considering knowledge as a commodity [5] distinguish between explicit and tacit knowledge. Explicit or codified knowledge can be transmitted in formal and systematic language, e.g. through documents such as reports or guidelines [22]. On the contrary, tacit knowledge is acquired through personal experience and is difficult to formalise and to communicate. Another research stream adopts a knowledge-in-practice perspective that focuses on organisational *knowing* rather than organisational *knowledge* [4, 5, 23]. Instead of considering knowledge as an object, these researchers argue knowing to be an action or process of organisational members that cannot be separated from them [6]. Hence, knowledge is represented, created and transferred through the work practices and the social context that individuals interact in [5]. In this connection, a practice is "the way in which work gets done" [6] and knowing how to do it [5]. The knowledge-in-practice view emphasises the importance of communities and networks in reinforcing knowledge sharing and network-centric mechanism in promoting the knowledge flow [4].

However, many organisations do not know which practices are important for knowledge sharing processes nor do they have an overview of who knows what. As a knowledge management task, knowledge identification aims to increase the transparency about the knowledge that exists or lacks within an organisation by using methods such as knowledge mapping or business process analysis [3]. In this regard, the creation of knowledge maps is very time-consuming and their currentness is difficult to maintain [24]. Methods that enable the detection of the knowledge embedded in the relationships of organisational members are lacking.

Considering organisations as social networks with interdependent actors, this research adopts a knowledge-in-practice perspective and focuses on the identification of individuals who take up an active role in the organisational practice. These individuals may e.g. actively take part in sharing knowledge, helping others to do their work or being consulted frequently with specific questions. They could also assume critical positions in the knowledge flow of the organisation.

## 3.2 Organisation social networks and social network analysis

A social network "consists of a finite set or sets of actors and the relation or relations defined on them" [25, p. 20]. Nodes, i.e. actors, are described as social entities, e.g. individual, corporate, or collective social units. The transfer of immaterial or material resources, such as information and knowledge between them happens along relational

ties (called edges) that can be directed or undirected. In a directed network an arrow pointing from person A to person B would mean that person A asked person B for advice. Undirected relationships between employees, that is a line without arrows, might show that A and B are associated, e.g. they work in the same department.
From a social network perspective, organisations can then be considered as a web of formal and informal linkages between employees. While formal social networks are typically prescribed by management and represent the organisational structure of a corporation, informal social networks are emergent and connect groups of individuals across organisation [26].
Social network analysis (SNA) offers readily developed measures to characterise formal and informal networks. To characterise entire networks, measures such as the network density or network centralisation enable conclusions about the overall connectivity and the extent to which a network is centralised around a few actors [25]. The most common measures to characterise individual nodes in the network include degree centrality, betweenness centrality and closeness centrality [27]. Degree centrality considers the number of connections of an individual actor with in-degree and out-degree determining the number of incoming or outgoing links in directed networks. Betweenness centrality measures the number of times a node acts as a bridge along the shortest path between two other nodes and closeness centrality focuses on how close an actor is to all other actors in the network. Having been used to study informal organisational networks in the past [7, 28, 29], SNA will be part of the approach to analyse ESN data taken in this study.

# 4 Related Work

Existing taxonomies of knowledge workers often treat knowledge as an object and therefore focus on the activities that knowledge workers would perform, e.g. *knowledge finder* or *knowledge packager*, rather than a role they could take up [30]. However, this research considers knowledge as embedded in organisational structure [5, 6]. It requires a knowledge identification method that unveils knowledge and the associated key individuals by considering the social context employees interact in.

In the following, selected works regarding approaches and methods used to identify social roles and key actors in organisational "offline" settings and online social media will be discussed.

## 4.1 Approaches to identify key individuals in organisations generally

In the past decade, a number of studies have analysed informal social networks in organisations, e.g. investigating the social aspects of knowledge sharing and development [31, 32], forms of knowledge exchange in R&D teams [26] or detecting influential members in organisations [29]. The results of these analyses were used to inform structural or organisational interventions [33] or to create knowledge retention strategies [34]. All studies have in common that they calculate SNA metrics to systematically identify knowledge and knowledge flows within organisations (Chan and Liebowitz 2006). In doing so, the data to construct the network is collected from employees using questionnaires. Depending on the focus of the questionnaire, different

kinds of networks can be identified, such as communication, information, problem-solving, or knowledge networks (Cross et al. 2002).

The relations in the resulting social network graph reflect the interactions between employees (**Fig. 1**). Calculating the above mentioned centrality measures, the following four key roles can be identified in an information network [7, 29]:

- *Central connectors* are go-to-persons that connect many people in an informal network. Due to their technical expertise and knowledge about "who knows what", they are central to the knowledge flow of the organisation.
- *Boundary spanners* connect an informal network to other groups or people outside of the observed network, e.g. people in other departments within the company. The boundary spanner in **Fig. 1** connects the offices in Boston and Chicago with the New York office.
- *Information brokers* support the information exchange among groups within the observed informal network. They are thus able to control the knowledge flow in the network. The information brokers in **Fig. 1** connect division 1, 2 and 3 within the New York office.
- *Peripheral specialists* hold specific expertise, but are peripheral in terms of their network location.

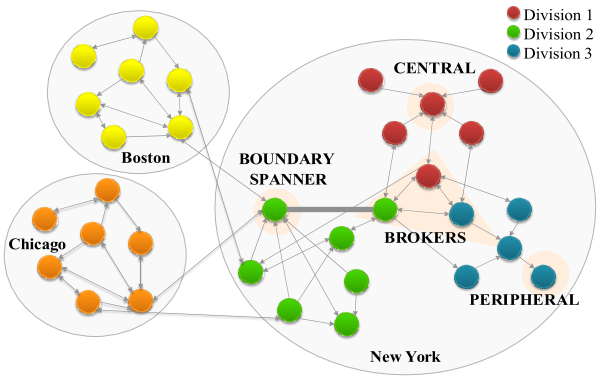


**Fig. 1.** Example of an organisational social network with key network roles [7]

Extending organisational SNA, Helms and Buijsrogge [36, 37] developed an approach called knowledge network analysis. The approach of knowledge network analysis includes (1) the identification of knowledge areas in the organisation, (2) the identification of the main actors for each area and their levels of expertise and (3) the participation of all members of the organisation in a questionnaire to identify existing knowledge flows. Helms and Buijsrogge [36, 37] differentiate between different roles such as knowledge creators, knowledge sharers and knowledge users. Visualised in a knowledge network graph, knowledge creators will have many outgoing links as they provide others with knowledge. Acting as intermediaries, knowledge sharers have both ingoing and outgoing links. Knowledge users can be recognised by having ingoing links only.

Both organisational SNA and knowledge network analysis are feasible to provide valuable insights into the knowledge flows in a company's informal network and to identify employees taking up important organisational roles behind the scenes. However, the manual collection of social network data is time-consuming, may be biased and cannot be applied to analyse large datasets [38].

### 4.2 Approaches to identify key individuals in social media

The identification of different social roles and particularly key players in social media has been studied in many different contexts with marketing being a major area of application. These studies aimed at unearthing influential users, e.g. opinion leaders or early adopters, in order to inform viral marketing efforts or improve seeding strategies [39].

While the data collection requires less manual effort than the collection in "offline settings", the interpretation of the network graph and the calculated metrics is a challenging task. Being formed with a single click, a friendship tie between two people on Facebook exists regardless of how close the two people are [40]. The mere existence of a link does not allow for conclusions about the quality and strength of the relationship. Similarly, key players cannot be identified by considering their structural position only [41, 42].

The literature reviews by Forestier and Stavrianou [43] and Probst et al. [42] provide an overview of how the identification of social roles and key individuals has been approached in the existing literature. Forestier and Stavrianou [43] distinguish between the discovery of non-explicit and explicit roles. While non-explicit roles are discovered using unsupervised machine learning techniques in order to group the data into (non-predefined) categories of roles, explicit roles are defined upfront and then identified in an online social network based on a set of criteria. Focusing on the identification of influential users in their literature review, Probst et al. [42] argue that the influence of an individual should be measured based on "who one is", "what one knows", "whom one knows" and "how active one is". They further differentiate between studies focusing on the strategic position of users and studies investigating the "influence maximization problem". Whereas the former identify key players based on social network metrics and activity measures, the latter use approximation algorithms to figure out which users can maximise the spread of information in an online social network.

In the existing literature, social roles and key players have been studied in forum-like applications, on Wikipedia, social networking sites and, more recently, in ESN. The identified roles and kinds of key players reflect different types of media users, communication types and knowledge roles. Most studies identify roles or key individuals based on predefined behaviours or attributes or they rely on explicitly defined roles. For instance, Welser et al. [44] base their roles on official Wikipedia user roles (e.g. technical editor). In an ESN context, value adding users are characterised as those who contribute and share their knowledge in order to help others to work more successfully and efficiently [21]. Only few studies came up with new (non-predefined) role categories by clustering users [45] or classifying them based on the prior nomination as a leader by a domain expert [46]. SNA is an important method

across almost all studies. Depending on the analysed platform, edges are conceptualised based on reply relationships, edits, common participation in topic groups and name quotations, to name a few. Metrics regarding participation behaviour, e.g. the number of initiated threads or created replies in an internet forum, are commonly employed. Furthermore, some studies analyse the content of messages created by the users [46, 47]. Relying on a partly automated approach, Burns and Kotval [48] distinguish questions from non-questions by scanning discussion entries in Alcatel-Lucent's ESN "Engage" for question marks and question words like "who", "what", "when" and "where". In conclusion, most studies use a combination of social network metrics and measures characterising the participation behaviour to identify social roles.

# 5 Research Design and Progress to Date

**Fig. 2** provides an overview of the process steps and working packages to be completed in the course of my dissertation project.
The following paragraphs provide information for each phase. Currently in progress, phase 3 is described in more detail than the other phases.

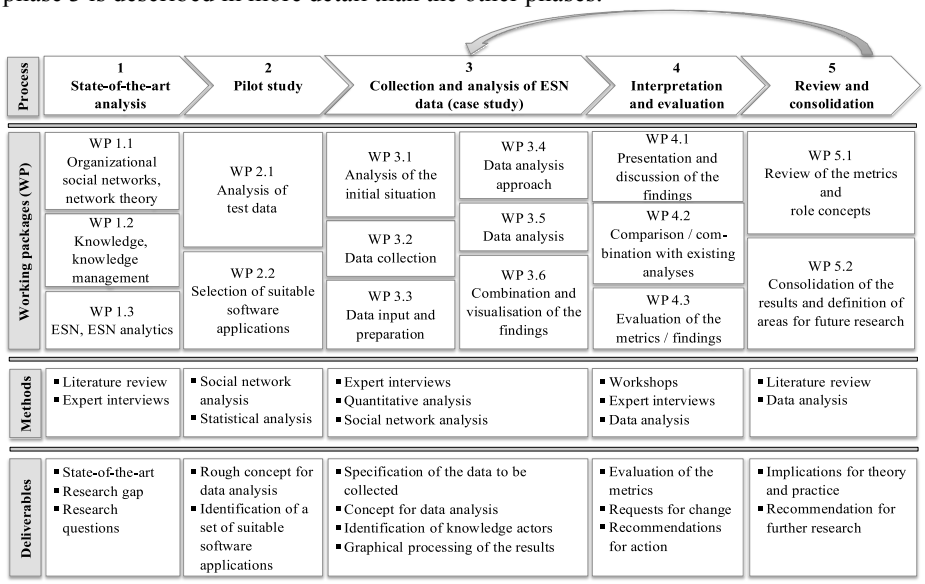


**Fig. 2.** Research Design

**Phase 1: State-of-the-art analysis (completed)**

Informing the theoretical background of my research, the first step involved a literature review on organisational networks, network theory and knowledge management. Moreover, literature specifically addressing the mining of social network data and ESN data was reviewed. The results of phase 1 are documented in a research proposal that was successfully presented at the Doctoral Consortium of the Australasian Conference on Information Systems in December 2013.

**Phase 2: Pilot study (completed)**

Within the second stage, a number of test datasets were generated and analysed using different applications to identify the best suited solution for the social network analysis of ESN data provided by an industry partner in phase 3. The first dataset was generated based on a questionnaire in a department of a medium-sized German company and analysed using the SNA software UCINET and Netdraw. Besides identifying knowledge actors, scenarios for their departure as well as succession rules were created. The second dataset was generated based on communication data on a specifically installed ESN platform. Considering user interactions, experts were identified by combining text analysis and the analysis of the user's structural position. The third dataset contains test data extracted from the ESN used by the industry partner (see below). Different SNA software solutions, such as Gephi, NodeXL, UCINET and Pajek were used to calculate social network measures and to visualise the data in a social network graph. A comparison of the solutions showed that UCINET and Pajek were most feasible to calculate the metrics. As to the visualisation of the data, Gephi and NodeXL performed best.

**Phase 3: Collection and analysis of ESN data (in progress)**

This study is done in cooperation with the Australian partnership, in the following called PSF, of a globally operating professional services firm. PSF has 6,000 employees located in 14 offices in Australia and provides audit, economics, financial advisory, human capital, tax and technology services.

The ESN used by PSF is a browser based platform that offers a company-wide newsfeed, allows users to create a profile, the creation of public or private groups, the sharing of updates and files as well as communicating with others by commenting on their updates or writing private messages.

Two research periods at the University of Sydney in March and September 2014 provided the starting point for the data collection and analysis.

**WP 3.1 Analysis of the initial situation.** This working package started with a detailed introduction of the research project at PSF's offices in Sydney, Australia. Next, expert interviews were done in order to identify current knowledge management – and in particular, knowledge identification – processes at PSF. Moreover, the interviews sought to find out what constitutes key knowledge actors from the viewpoint of PSF. The identification of key personnel can be considered as a task at the intersection of knowledge management, human resources management and performance management. Hence, employees of the departments of Knowledge Management, Talent Management, Operations Excellence and Talent Development were questioned within six expert interviews. Amongst others, the interview guideline included the following questions:

— What knowledge and which knowledge actors represent critical resources for PSF?
— Which traits and skills characterise important knowledge actors?

— Which existing processes support knowledge identification and knowledge retention? Which challenges exist concerning these knowledge management tasks?
— Are the data accumulated in the ESN already being analysed? If so, how and for which purpose?
— Which metrics could be used to identify important knowledge actors on the ESN?

The interviews with employees in the area of knowledge management pointed to processes focusing on the identification, the acquisition as well as the storing and distribution of formal and explicit knowledge. The knowledge of employees who occupy a higher level in the hierarchy is considered as particularly valuable as they possess substantial experience, networks and informal knowledge, e.g. with respect to a specific industry. An internally used Yellow Pages application allows employees to create a profile and to search for people who have certain expertise or skills.
As many professional services firms PSF has a fluctuation rate of approximately 30%. Hence, knowledge loss risk are due to a high turnover rate rather than due to demographic reasons. The recruitment of new staff is an ongoing task. PSF requires efficient and effective processes in the areas of recruitment, talent management and performance management in order to figure out who should be hired, promoted and retained.

As to the ESN, the data has been analysed in the past to, e.g. investigate the relationship between ESN engagement and performance. The behaviour and activities on the ESN are currently not reflected in the performance measurement of the employees. However, the consideration of ESN interactions, e.g. question asking and answering - could lead to valuable insights concerning the employees' social behaviours. Thus, it could help detect important knowledge actors who cannot be identified based on the existing very much results-oriented performance metrics. With regard to the analysis of the ESN data it would therefore be interesting to identify individuals who e.g. often initiate discussions, create high quality answers, provide others with advice, share documents and other content or act according to the company's values. Based on the insights from the interviews, the necessary data for the analysis were specified. The interviews also inform the data analysis approach (WP 3.4).

**WP 3.2 Data collection.** The ESN dataset of PSF spans the period of 10 September 2008 – 06 April 2014. It includes 268,196 messages that were posted by 6,911 users. Message and user related data has been exported from the backend of the ESN and been provided as a .csv file. The messages file includes messages posted in the main message stream, private messages as well as messages exchanged in private and public groups. Public groups can be viewed and joined by all network members whereas private groups are only visible to invited group members. Based on different IDs, the messages file allows the identification of the messages belonging to one thread, the users receiving replies, and the author of a message. It also contains information as to whether a message was posted in the main stream, in a private conversation or in a public or private group and indicates if the message had an attachment. Due to privacy reasons, PSF did not provide the content of the messages. However, they extracted meta information, such as the number of words and characters of the message, the

tagged users or topics as well as information on the appearance of different question words, e.g. “how” or “why”, and words indicating users praising and thanking each other, e.g. “well done” or “thanks”. As to the user data, the export contains the information as stated on the profile page of each user, e.g. job title and location. Moreover, additional information was exported from PSF’s HR system including e.g. gender, nationality, and tenure as well as performance ratings for the years 2009 – 2012 for a subset of the users.

**WP 3.3 Data input and preparation**. This step involves the import of the data into a MySQL database as well as the cleansing of the data. Issues regarding the dataset, such as inconsistent or implausible records, were clarified together with PSF.

**WP 3.4 Data analysis approach.** This research project seeks to gain a better understanding of the social roles that can be distinguished based on the analysis of ESN data and aims to identify key actors. According to these objectives, the data analysis will follow the approach of explicit role discovery [43], i.e. the roles will be predefined and identified based on a set of criteria.

The predefinition of roles is done based on the literature review (chapter 3 and chapter 4) and the interviews with PSF (WP 3.1).

- According to the *knowledge-in-practice* view, individuals playing an active role in the social practice of a company can be considered as important. The associated roles are related to behaviours such as initiating, developing, sharing and exchanging knowledge. An exemplary role could be a *content originator*.
- Based on the *organisational SNA* literature, individuals asking for, giving and receiving advice would assume important positions. In this regard, the roles of *central connectors*, *boundary spanners*, *information brokers* and *peripheral specialists* are predefined.
- Moreover, roles specifically important from the point of view of *PSF* are determined based on the interviews and secondary research. For instance, requirements specified in job offers and information related to the company’s culture can inform the role definition. PSF encourages a culture of diversity, continuous learning as well as pride in own achievements and the success of others. Further, teamwork and collaboration are important aspects. Hence, a *team worker* or a *diversity person* could be exemplary roles.

To create the criteria for the role identification, a set of 40-50 metrics is developed. The metrics describe the behaviours of the different roles with respect to the following dimensions:

1. Participation in general: e.g. number of messages, number of active days
2. Replying and initiating: e.g. number of replies, number of initial messages
3. Receiving feedback: e.g. number of received replies, initial messages replied to ratio
4. Content: e.g. number of attachments posted, number of received / given “thanks”

5. Structural position: e.g. in-degree / out-degree, betweenness centrality

The metrics should take different values depending on the respective role. For instance, a *content originator* may have high scores for degree, in-degree, number of threads started and number of active days. Compared to that, a *discussion person's* value for threads started may be lower whereas the number of reply messages will be higher [19].

Having the predefined roles and metrics, selected experts from PSF participate in a questionnaire that contains a short description of the different roles. The questionnaire participants are asked to assess the behaviours of the roles with regard to the above dimensions, e.g. in terms of *replying and initiating*. They are also asked to identify missing roles and to state how valuable they perceive each role. Based on the results of the questionnaire, the behaviour of each role is described using a subset of all metrics. The subset of metrics is due to the fact that not all metrics are applicable to each role. The results of this step are filled in a template similar to **Table 1**.

**Table 1.** Roles and metrics

| | Role 1 | Role 2 | Role 3 | Role 4 | Role 5 | Role n | … |
|---|---|---|---|---|---|---|---|
| Metric 1 | High | Medium | High | Low | Medium | Medium | |
| Metric 2 | Medium | - | Low | High | High | Low | |
| Metric 3 | - | Medium to high | Medium | Low | Low | - | |
| Metric 4 | Low | - | High | High | Medium | - | |
| Metric 5 | Low | High | - | - | Medium | Low | |
| Metric n | Low | Medium | Low | Low | - | - | |
| … | | | | | | | |

**WP 3.5 Data analysis.** This working package includes the implementation of the metrics as well as a classification.

*Implementation of the metrics.* The metrics are implemented and calculated per user for a subset of the data. As the performance ratings are related to the metrics later on (see phase 4), the subset spans the year prior to the 2012 rating, which is the latest one of the provided. For the metrics characterising the user's communication behaviour (dimensions 1-3, WP 3.4) as well as the content of their messages the implementation and calculation are done in a database using SQL statements. As to the user's structural position, different social networks, e.g. with edges based on replies, user tags, common topic participation or question asking and answering, are to be constructed. PHP scripts are used to extract these different types of relationships from the data and to create files that allow for the processing in an SNA software. The social network metrics, i.e. centrality measures, are then calculated for the different networks using UCINET. Once all the metrics are calculated, a correlation matrix is created using the data mining software RapidMiner in order to measure the strength of the relationships between the different measures and to get an idea of potentially redundant metrics.

*Classification*. Based on the criteria defined in WP 3.4 one or several roles are assigned to each user. In this regard, one user may be member of more than one role category since the metrics are expected to correlate. On the basis of this training set of data, an individual decision tree with the label attributes "role_1" / "not_role_1" for each role category is run in RapidMiner. Using decision trees [49] is advantageous since they can handle multidimensional data and allow for the detection of new patterns with regard to the metrics without a predefined range (WP 3.4). Moreover, decision trees help figure out redundant metrics, are easy to interpret and enable the prediction of roles in future data sets.

**WP 3.6 Combination and visualisation of the findings.** The last working package of phase 3 compares and combines the findings of the data analysis in order to detect new patterns and correlations. For instance, strongly correlating role categories could be merged into one category within this step. The results of the analyses will be visualised using diagrams and social network graphs. These graphs will help understand how different roles interact with each other, how they are spread across the network and allow for comparisons regarding their sociodemographic attributes.

**Phase 4: Interpretation and evaluation (planned)**

Phase 4 includes the presentation and the discussion of the findings with experts from PSF. They will be asked for feedback and input for the refinement of the metrics in the following phase.

Moreover, the performance ratings provided by PSF will be related to the role categories. Employees with ratings that are above or significantly higher than average have been very successful in meeting the set targets and are hence, considered as very valuable from PSF's point of view. However, how do the performance ratings correlate with the employees' role on the ESN? It will be very interesting to see to what extent behaviour on the ESN and performance correlate and which role is most associated with performance.

**Phase 5: Review and consolidation (planned)**

Based on the feedback received in the previous phase, the metrics and role concepts are refined and the respective steps of the data analysis are repeated as indicated by the arrow from phase 5 to phase 3. Once the data analysis is completed, suggestions for the transferability of the concept to other ESN applications and companies in other branches will be created. Moreover, different scenarios regarding the use of the concept in practice, e.g. in the area of retention management or succession planning, will be created. Finally, areas for future research at the intersection between ESN and knowledge management will be defined.

## 6 Expected Contributions

My dissertation topic is of interest to researchers in the fields of knowledge management, organisational science and enterprise social media. As to knowledge management, it provides a novel approach to knowledge identification. The transfer of concepts and methods of organisational science to the context of ESN may be of interest to scholars in this discipline. For researchers in the area of enterprise social media it provides starting points for the design of new features, e.g. social recommendations.
The very nature of knowledge, decentralised organisational structures and the increasing information overload make it difficult for organisations to achieve knowledge transparency. While many companies are introducing or are about to introduce ESN, it does not seem to be very clear how these applications can be used in a systematic way and how to obtain a measurable benefit. In this regard, my research can help run knowledge management processes, e.g. knowledge retention efforts, in a more target-oriented and sustainable way.

## 7 Expectations from the WI 2015 Doctoral Consortium

The WI 2015 Doctoral Consortium will provide me with an excellent opportunity to discuss my current state, next steps and potential problems with researchers and Ph.D. students with different backgrounds and hence, different perspectives. Having started the ESN data analysis, I would like to receive feedback regarding my approach and the scope of the analysis as well as discuss different options to evaluate the results in the subsequent stage. Moreover, I am curious to get to know and talk about the research projects of other Ph.D. students to help them move forward.

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# Peer-to-Peer-Geschäftsmodelle zur Absicherung privater Risiken

Thomas Zwack[1]

[1] HHL Graduate School of Management, Center for Leading Innovation and Cooperation, Leipzig, Germany
thomas.zwack@hhl.de

**Abstract.** Peer-to-Peer (P2P) beschreibt seit einiger Zeit nicht mehr nur Netzwerkstrukturen im Sinne der Informatik, sondern auch den Austausch von materiellen Gütern oder Dienstleistungen zwischen Privatpersonen. In den vergangenen Jahren wurde eine Vielzahl von Unternehmen u.a. in den Bereichen Wohnraumvermittlung (z.B. Airbnb), Car-Sharing (z.B. Uber) und Kreditvergabe (z.B. Auxmoney) gegründet, die Dienstleistungen direkt zwischen Privatpersonen sehr erfolgreich vermitteln. Im Bereich der Versicherungswirtschaft sind derzeit noch keine P2P-Ansätze auszumachen. In dieser Arbeit wird die Vorgehensweise zur Entwicklung und Evaluierung eines P2P-Geschäftsmodells für die Versicherungswirtschaft beschrieben.

**Keywords:** *Peer-to-Peer, P2P, Geschäftsmodell, Versicherung, DSR*

## 1 Problemstellung und Zielsetzung

Der Begriff Peer-to-Peer (P2P) bzw. P2P-System wurde Ende der 90er Jahre vor allem durch den Erfolg der Musiktauschbörse Napster geprägt. "*Peer-to-peer 'year zero' can effectively be set to Napster*." [1] In den letzten 10 Jahren wurden immer mehr Unternehmen gegründet, die das eigentlich technisch besetzte Akronym P2P nutzen, um die Vermittlung von Dienstleistungen zwischen Privatpersonen in ihrem Unternehmen zu umschreiben. „Peer-to-Peer" beschreibt also seit einiger Zeit nicht nur Netzwerkstrukturen im Sinne der Informatik, sondern auch den Austausch von materiellen Gütern oder Dienstleistungen unter gleichgestellten Partnern – „Peer-to-Peer" wird damit nach Plouffe [2] zu „Person zu Person". *„In broader terms, P2P exchanges are a form of what has occasionally been labeled "consumer-to-consumer" (C2C) exchange."* Ein Peer-to-Peer Geschäftsmodell unterscheidet sich von klassischen Geschäftsmodellen im Wesentlichen also dadurch, dass Angebot und Nachfrage ausschließlich von Privatpersonen ausgehen und nicht das Leistungsangebot durch ein Unternehmen erstellt und von Endkonsumenten nachgefragt wird. Ein

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Intermediär stellt hier lediglich eine Verbindung zwischen Anbieter und Nachfrager her.

Die disruptiven Auswirkungen der P2P-Modelle innerhalb einer Branche lassen sich derzeit eindrucksvoll am Beispiel der Reise- und Hotelbranche beobachten [3]. Das 2008 in den USA gegründete Unternehmen Airbnb (Airbed and breakfast) ist in kürzester Zeit zum weltweit größten P2P-Anbieter für Unterkünfte aufgestiegen und stellt mittlerweile eine existentielle Bedrohung für viele Unternehmen der Hotel- und Beherbergungsbranche, insbesondere für Hotels der unteren Preisklasse, dar [4]. Seit seiner Gründung verzeichnet Airbnb nach eigenen Angaben 11 Millionen Gäste weltweit (Stand: Juni 2014). Heute kann aus über 600.000 Unterkünften in 34.000 Städten eine Auswahl getroffen werden [5].

Im Bereich der Versicherungswirtschaft sind derzeit noch keine P2P-Ansätze auszumachen, die Defizite, wie bspw. fehlende Individualisierungsmöglichkeiten von Produkten oder niedrigere Absicherungskosten, beheben könnten. Es gibt zwar neuerdings einige Ansätze, sich von Privat zu Privat zu versichern, hierbei handelt es sich aber nicht um P2P-Modelle im engeren Sinne, sondern um Solidargemeinschaften aus Mitgliedern einer vordefinierten Gruppe. Friendsurance [6] (Deutschland) etwa überträgt das Risiko von Kleinschäden bei Standardversicherungsprodukten auf Privatpersonen [7], Glaubensmitglieder der Christian Care Ministry (USA) teilen sich die Kosten ihrer Arztrechnungen [8] und in deutschen Solidargemeinschaften (Artabana [9], BASSG [10]) unterstützt man sich gegenseitig bei der persönlichen Gesunderhaltung. Privatpersonen können also heute noch nicht durch andere Privatpersonen vollständig abgesichert werden. Einzig bei Guevara [11] (Neugründung UK) sollen sich noch in diesem Jahr Gruppen von Privatpersonen fast vollständig gegenseitig absichern. Diese Arbeit wird deshalb von folgender Forschungsfrage geleitet:

**Lässt sich die Absicherung von privaten Risiken in einem Peer-to-Peer-Geschäftsmodell realisieren?**

Um diese Frage zu beantworten, wird in einem ersten Schritt der aktuelle Stand der Forschung zu diesem Thema skizziert (vgl. Kapitel 2). Ein gestaltungsorientierter Forschungsansatz (Design Science Research) nach Hevner et al. [12], [13] bildet das methodische Fundament der Forschungsarbeit (vgl. Kapitel 3). Die Designtheorie von Gregor und Jones [14] (vgl. Kapitel 4) dient der theoretischen Fundierung der in dieser Arbeit getroffenen Aussagen. Ein zusammenfassender Überblick über das Forschungsdesign sowie eine vorläufige Gliederung der Arbeit findet man in Kapitel 5.

## 2 Stand der Forschung

In der Literatur findet man zunächst eine große Vielfalt an technischen Definitionen für den P2P-Begriff. Vielfach wird hier Peer-to-Peer bzw. P2P-System mittels einer Negativabgrenzung zum Client/Server-Paradigma definiert. In diesem Sinne be-

schreibt Singh [15] P2P wie folgt: *"P2P can be defined most easily in terms of what it is not: the client-server model."* Eine der ersten konkreten Definitionen des Begriffs P2P, die auf große Akzeptanz gestoßen ist, wurde von Shirky [16] eingeführt: *"Peer-to-peer is a class of applications that takes advantages of resources, storage, cycles, content, human presence, available at the edges of the Internet. Because accessing these decentralized resources means operating in an environment of unstable connectivity and unpredictable IP addresses, peer-to-peer nodes must operate outside DNS and have significant or total autonomy from central servers."* Die Arbeiten von Crowcroft / Pratt [17] und Kubiatowicz [18] bauen auf der Definition von Shirky auf und fokussieren sich auf vier wesentlichen charakteristischen Eigenschaften von P2P-Systemen: Dezentralisierung, Selbstorganisation, Autonomie und Verfügbarkeit.

Eine Vielzahl von Unternehmen haben in den letzten 10 Jahren die technisch besetzte Begrifflichkeit P2P übernommen, um damit nun den Austausch von materiellen Gütern oder Dienstleistungen unter gleichgestellten Partnern zu umschreiben – „Peer-to-Peer" wird damit nach Plouffe [2] zu „Person zu Person". Diese neuen P2P-Geschäftsmodelle bieten seit wenigen Jahren Privatpersonen die Möglichkeit, Dienstleistungen untereinander und ohne Einbindung traditioneller Akteure anzubieten. Ein klarer wissenschaftlicher Schwerpunkt liegt im Bereich der Kreditvergabe und dabei auf der Datenanalyse des US-amerikanischen P2P-Kreditmarkts Prosper [19], während sich explizite Analysen der deutschen P2P-Kreditmärkte auf smava [20] beschränken. Um den derzeitigen Stand der wissenschaftlichen Forschung wiederzugeben, wird daher hier der Ansatz verfolgt, die, gemessen an ihrer Bedeutung und an der Häufigkeit ihrer Zitierung, wichtigsten Arbeiten über P2P-Kreditplattformen zu identifizieren [21-30]. Neben der P2P-Kreditvergabe findet man in der wissenschaftlichen Literatur aber auch zahlreiche Analysen zu P2P-Geschäftsmodellen anderer Branchen, wie etwa Wohnraumvermittlung oder Car Sharing [31-33]. Die P2P Foundation [34] bietet zusätzlich eine sehr umfangreiche Zusammenstellung wichtiger Texte zum Thema P2P. *„The P2P Foundation is an international organization focused on studying, researching, documenting and promoting peer to peer practices in a very broad sense."*

Eigene langjährige berufliche Erfahrungen in der Finanzwirtschaft (Banken und Versicherungen) lassen vermuten, dass eine wissenschaftliche Untersuchung der Möglichkeiten zur Übertragung der mittlerweile sehr erfolgreichen P2P-Geschäftsmodelle vom Kreditgeschäft auf die Versicherungswirtschaft einen zusätzlichen Erkenntnisgewinn liefern kann. Eine aktuelle empirische Studie aus dem Jahr 2014 für den Versicherungsbereich zeigt, dass keine großen Vorbehalte bei den Verbrauchern gegen einen Markteintritt von alternativen Versicherungsgeschäftsmodellen bestehen. In dieser wurden Versicherungsnehmer aus elf unterschiedlichen Ländern befragt: 67% der Befragten gaben an, sie können sich vorstellen, zukünftig eine Absicherung auch über Nicht-Versicherungsunternehmen abzuschießen [35]. Seitens der Verbraucher gibt es gegenüber neuen Versicherungsgeschäftsmodellen erst einmal keine Vorbehalte.

# 3 Methodik

Der Methodenbegriff in der Wirtschaftsinformatik kann in Entwicklungsmethoden und in Forschungsmethoden als Instrument der Erkenntnisgewinnung unterschieden werden [36]. Erkenntnistheoretische Methoden unterteilen sich wiederum in designwissenschaftliche und verhaltenswissenschaftliche Forschungsparadigmen. Diese Forschungsarbeit ordnet sich klar ein in den Designforschungsansatz (Design Science Research) nach Hevner et al. [12], [13].

Dieser orientiert sich an sieben Richtlinien (guidelines), die einen Verfahrensvorschlag für das Forschungsprojekt bilden. Diese Arbeit berücksichtigt diese Richtlinien und ordnet sie im folgenden den entsprechenden Erkenntnisphasen zur gestaltungsorientierten Wirtschaftsinformatik nach Österle et al. [37] zu (i.e.: A: Analyse, B: Entwurf, C: Evaluation und D: Diffusion). Im folgenden werden die für diese Arbeit notwendigen Ausprägungen dieser Richtlinien beschrieben.

## 3.1 ERKENNTNISPHASE A: Analyse

### 3.1.1 RICHTLINIE: Problemrelevanz

Ausgangspunkt des designorientierten Ansatzes ist nach Hevner [12], [13] die Wahrnehmung des Problems. Bei traditionellen Versicherern wurden zum Zwecke dieser Arbeit drei Hauptproblempunkte identifiziert, die im folgenden beschrieben werden.

#### 3.1.1.1 Fehlendes Kundenvertrauen gegenüber Versicherungsunternehmen

In einer im Oktober 2014 veröffentlichten repräsentativen Studie [38] wird der sogenannte Kundenvertrauensindex (KVI) ermittelt. Er wird aus den Antworten auf die Frage, ob der Kunde den Leistungen eines bestimmten Unternehmens oder eine Marke vertraut oder nicht, generiert. So steht ein KVI von 70 dafür, dass 70 Prozent der Kunden, die schon Erfahrungen mit dem jeweiligen Unternehmen gemacht haben, Vertrauen in die Leistungen des Unternehmens haben. Es wurden 54 Branchen untersucht. Die Versicherungsbranche wurde dabei nochmals in die Kategorien Online, Multikanalvertrieb, Exklusivvertrieb sowie Makler unterteilt.

Mit einem KVI von 47,33 Prozent landeten die Online-Versicherer auf Platz 36 von 54 Branchen. Der Multikanalvertrieb (46,10 Prozent) und der Exklusivvertrieb (45,58 Prozent) liegen knapp dahinter auf den Plätzen 38 und 39. Am geringsten ist das Kundenvertrauen in die Versicherungsmaklerbranche. Diese landete mit einem KVI von 30,85 Prozent auf dem 52. Platz (von 54) des Rankings, nur noch unterboten vom Vertrauen in Finanzvertriebe und Privatbanken. Die Studie zeigt deutlich, dass Versicherungsnehmer der Assekuranz wenig Vertrauen schenken.

Bei P2P-Unternehmen sind in puncto Vertrauen natürlich auch Grenzen gesetzt, denn ein Geschäft mit anderen Privatpersonen verlangt Vertrauen als konstituierendes Element. Grenzen des Vertrauens bilden damit auch Grenzen der Kooperation in P2P-Netzwerken [39]. Unter Vertrauen wird hier in Anlehnung an Ripperger [40] die „freiwillige Erbringung einer riskanten Vorleistung unter Verzicht auf explizite rechtliche Sicherungs- und Kontrollmaßnahmen gegen opportunistisches Verhalten" verstanden. Dies geschieht auf Basis der Erwartung, dass „der Vertrauensnehmer freiwillig auf opportunistisches Verhalten verzichtet". Dies ist jedoch aus heutiger Sicht in der Realität kaum vorstellbar. Man benötigt demzufolge Konzepte, welche die Ausbildung von Vertrauen zwischen Kommunikationspartnern ermöglichen. Geeignet erscheinen hierfür Sicherheits- und Reputationsmechanismen, die in bereits existierenden P2P-Geschäftsmodellen anderer Branchen sehr wirksam eingesetzt werden.

Das P2P-Kreditvergabeunternehmen Auxmoney verwendet beispielsweise eine Vielzahl dieser Mechanismen zur Vertrauensbildung (Nutzerbewertungen, Zertifikate, Freitextfelder zur Vorstellung der eigenen Person, etc.). Für den Zeitraum vom 01. Januar 2009 bis zum 16. November 2012 nennt Auxmoney eine Ausfallquote von 3,11% des Kreditvolumens. Damit ist die Quote nur unwesentlich höher, als die von der Schufa für das Jahr 2011 genannten 2,5% [41].

#### 3.1.1.2 Eingeschränkte Produktvielfalt

Der deutsche Versicherungsmarkt war bis 1994 Jahre staatlich reguliert und damit geprägt durch wenige gleichartige und preislich nahezu identische Produkte. Das Inkrafttreten der Dritten Richtliniengeneration zur EG-rechtlichen Umsetzung eines europäischen Binnenmarktes für den Finanzsektor seit dem 1. Juli 1994 sollte das Bild der Wirtschaftsbranche eigentlich grundlegend ändern. Aufgrund der gemilderten Intensität der aufsichtsrechtlichen Genehmigungspflichten konnten nun Versicherungsunternehmen weitgehend autonom entscheiden. 2005, also 11 Jahre nach Inkrafttreten der Dritten Richtliniengeneration, wurde mit einer empirischen Untersuchung qualitativ nachgewiesen [42], dass auch im Zeitraum nach der Deregulierung Produktinnovationen und -modifikationen bei Erstversicherern wider Erwarten nicht angestiegen sind. Die Deregulierung hat die Rolle von Produktneuerungen und Innovationen in der Versicherungswirtschaft also kaum verändert.

Der Versicherungsnehmer kann heute also weiterhin nur aus einer limitierten Produktpalette seines Versicherers seinen bestmöglichen Risikoschutz wählen. Oft sind bei diesen Standardprodukten zudem Risiken mitversichert, für die kein Bedarf besteht, für die man aber einen entsprechenden Risikozuschlag entrichtet, der die Gesamtprämie insgesamt wieder erhöht (Beispiel: „Anprall oder Absturz eines bemannten Flugkörpers" bei der Wohngebäudeversicherung). Auch die Absicherung von einzelnen oder sehr individuellen Risiken, die einem persönlich von besonderem Wert sind, werden heute bei Erstversicherungsunternehmen kaum angeboten (Beispiel: Reisrücktrittskosten bei chronischen Erkrankungen, Absicherung von Wildschäden).

**Der Fokus dieser Arbeit liegt auf der Absicherung von Wildschäden.**

Mit Wildschaden wird der durch Wild verursachte Schaden in der Land-, Forst- und Fischereiwirtschaft bezeichnet (z.B. Wühlschäden, Wildverbiss, etc.). Bisher existieren in Deutschland kaum Möglichkeiten, um sich effizient gegen die finanziellen Auswirkungen von Wildschäden abzusichern. Nach Schätzungen der TU München verursacht Wild jedes Jahr einen Schaden in Deutschland in Höhe von mehreren hundert Millionen Euro [43]. Der Jagdpächter ist laut Bundesjagdgesetz gesetzlich verpflichtet, den Schaden der Forst- oder Landwirte zu ersetzen. Traditionelle Versicherungsunternehmen bieten in Deutschland dafür keinen Versicherungsschutz an. Abhilfe könnte hier wieder ein versicherungsähnliches Konstrukt auf Basis eines P2P-Geschäftsmodells schaffen, bei dem Privatpersonen anstelle eines Versicherers das Risiko übernehmen.

#### 3.1.1.3 Hohe Verwaltungskosten der Assekuranz

Die Kostenquote, also die Brutto-Aufwendungen für den Versicherungsbetrieb eines Versicherungsunternehmens in einem Geschäftsjahr in Relation zu den verdienten Brutto-Beiträgen betrug 2013 für die Sachversicherung der deutschen Versicherungswirtschaft 25,4 Prozent [44]. Dies bedeutet, dass ca. 25 Prozent der Prämieneinnahmen eines Versicherers in dieser Sparte für die Verwaltung (Personal, Gebäude, etc.) aufgewendet wurde.

Die Combined Ratio, also die Schaden-Kostenquote nach Abwicklung in Relation zu den verdienten Brutto-Beiträgen, lag im selben Zeitraum bei 116,2 Prozent. Dies bedeutet, dass für 100 Euro eingenommene Prämie Aufwendungen in Höhe von 116,20 Euro dem Versicherungsunternehmen im Sachversicherungsgeschäft entstanden sind. Das Geschäft der Versicherer war damit defizitär.

## 3.2 ERKENNTNISPHASE B: Entwurf

### 3.2.1 RICHTLINIE: Artefakt als Designergebnis

Gestaltungsorientierte Forschung will ein Artefakt (vereinfacht gesprochen: eine Lösung) hervorbringen, das vorher unbekannt war bzw. nicht in der Form existierte. Als Ergebnis gestaltungsorientierter Forschung definieren March und Smith vier Artefakttypen: Konstrukte, Modelle, Methoden und Instanzen [45]. In der Wirtschaftsinformatik kann ein derartiges Artefakt ein Softwareprogramm, eine darauf aufbauende ökonomische Lösung, eine Methode zur Entwicklung von Softwareprogrammen sein. Entscheidend ist, dass das Artefakt etwas verbessert und in diesem Sinne normativ ist. Als elementare Prinzipen gestaltungsorientierter Forschung gelten die Originalität des Artefakts, dessen Anwendbarkeit auf eine ganze Klasse von Problemen und dessen nachvollziehbare Begründung und Validierung [46]. In dieser Forschungsarbeit wird sich für das Modell als Artefakttyp entschieden, da die Entwicklung eines P2P-

Geschäftsmodells zur Absicherung privater Risiken primäres Ziel dieser Arbeit ist. Die Designtheorie (vgl. Kapitel 4) enthält dabei Anweisungen, wie das Artefakt zu konstruieren ist.

### 3.2.2 RICHTLINIE: Forschungsbeitrag

In einem DSR Knowledge Contribution Framework ordnen Gregor und Hevner [47] den Forschungsbeitrag einem Quadranten in Abhängigkeit der Ausprägung bereits bekannter Lösungen bzw. bekannter Probleme zu. Da bereits erfolgreich P2P-Geschäftsmodelle in anderen Branchen entwickelt wurden (z.B. P2P-Kredite) und diese Lösungen nun auf ein neues Problem übertragen werden können (Versicherungen), befinden wir uns in dieser Arbeit im rechten unteren Quadranten. Gregor und Hevner sprechen hier von Exaptation, also der Übertragung von Lösungen. Für diese Klasse weisen Gregor und Hevner einen klaren Forschungsbeitrag aus.

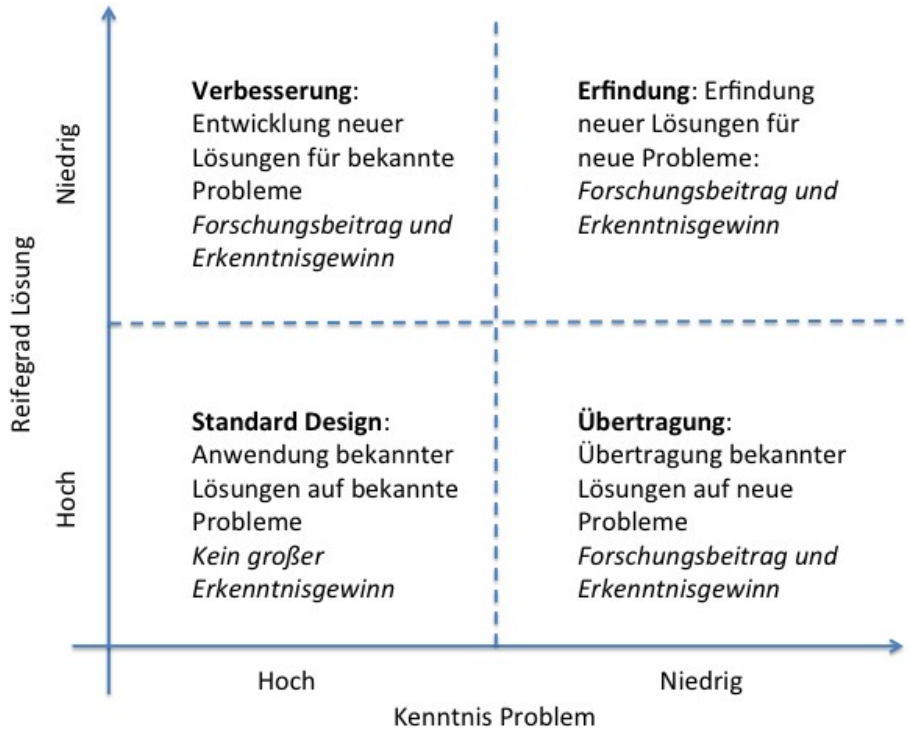


**Abb. 1.** Forschungsbeitragsrahmen (nach Gregor und Hevner [47])

### 3.2.3 RICHTLINIE: Stringenz in den Forschungsmethoden

Die Wirtschaftsinformatik hat sich in den letzten Jahren recht intensiv mit dem Vorgehen bei der Entwicklung von Artefakten beschäftigt. Ergebnis sind eine Reihe standardisierter Verfahren, die vorschlagen, wie gestaltungsorientierte Forschung und die Veröffentlichung der Ergebnisse vom Prozess her aussehen sollte [47], [45]. Betont wird dabei immer wieder die Anforderung, sowohl wissenschaftlicher Stringenz („Rigor“) als auch praktischer Bedeutsamkeit („Relevance“) Genüge zu tun (vgl. Abb. 2). Die Qualität des Ergebnisses bemisst sich in der Regel allein an der Nützlichkeit zu einer Zielerreichung des Artefakts.

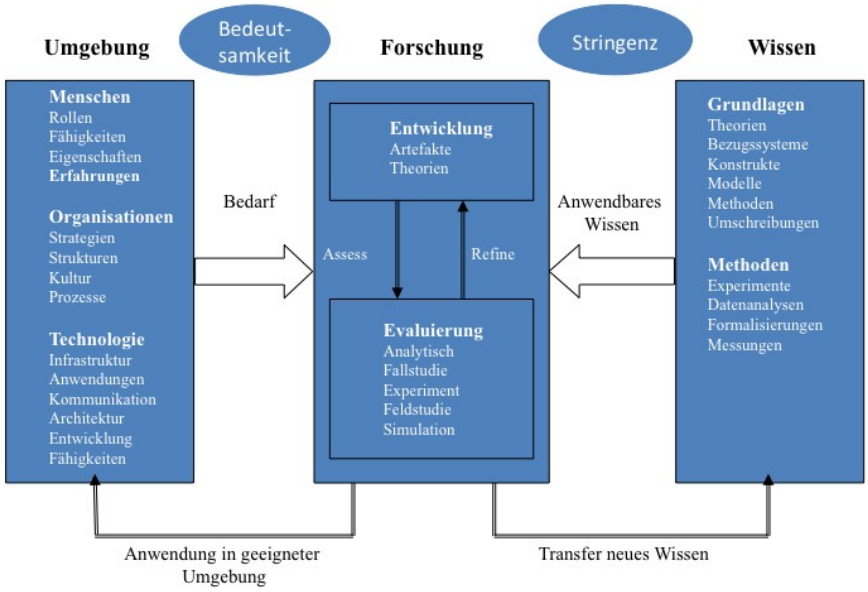


**Abb. 2.** Forschungsrahmenwerk (nach Gregor und Hevner [13])

### 3.2.4 RICHTLINIE: Design als Suchprozess

Der Designprozess beschreibt die Abfolge von Aktivitäten, die zur Lösung des Problems durchlaufen werden. Am Ende entsteht ein innovatives Ergebnis, also ein Artefakt, das eine Lösung zur Absicherung von Wildschäden repräsentiert. Die Forschungsarbeit hat den Artefakttyp Modell zum Ziel. Es folgt konsequent dem wiederverwendungsorientierten Paradigma und soll als Ausgangsbasis für den Aufbau weiterer Geschäftsmodelle oder Versicherungsprodukte verwendet werden können [48] [49]. Das Artefakt wird anschließend prototypisch angewendet (vgl. dazu auch 3.3) und evaluiert.

### 3.3 ERKENNTNISPHASE C: Evaluation

#### 3.3.1 RICHTLINIE: Evaluation

Die Konstruktion des Artefaktes demonstriert die Machbarkeit der Erstellung. Während der Evaluation wird der durch ein Artefakt erreichte Fortschritt anhand entwickelter Kriterien geprüft. Die Ergebnisse der Evaluation werden theoretisch behandelt und die Begründungen zur Funktionsweise von Artefakten werden schließlich gerechtfertigt [45]. Hevner [12] fordert, dass gestaltete Artefakte wissenschaftlichen Theorien und Methoden oder praktischer Expertise entspringen müssen. Ebenfalls sollten Artefakte wissenschaftlichen und praktischen Anforderungen in der betroffenen Domäne genügen. Es ist daher sinnvoll, Artefakte unter realen Bedingungen (Feldexperiment) zu instanziieren und zu testen.

Fischer [50] bewertet unterschiedliche Forschungsmethoden in Abhängigkeit zu den Voraussetzungen des Artefakts und gibt Empfehlungen zur Wahl einer bestimmten Forschungsmethode. Im Rahmen der Arbeit kann auf eine große Gruppe von Experten zurückgegriffen werden, die befragt werden. Aus diesem Grunde bietet sich zur Erstellung des Artefakts eine Expertenbefragung oder Fokusgruppe an [51], [52]. Die zu erwartende Stabilität des Artefakts hängt stark von der Erfahrung der Befragten und von der Qualität der Rahmenbedingungen des Diskurses ab. Aus diesem Grunde werden ausschließlich aktive Jagdscheininhaber und Berufsjäger befragt. Die Zeitschrift „Wild und Hund“ (www.wildundhund.de) unterstützt bei der Mobilisierung des Panels. Das Artefakt wird anschließend durch einen Prototypen instanziiert und in einem Feldexperiment evaluiert.

### 3.4 ERKENNTNISPHASE D: Diffusion

#### 3.4.1 RICHTLINIE: Kommunikation Forschungsergebnisse

Die Konzeption, die prototypische Implementierung mit der Evaluation bildet den angestrebten Forschungsbeitrag. Dabei gliedert sich die Arbeit in zwei wesentliche Teile:

I: Design Science-basierte Entwicklung eines Artefakts zur Absicherung privater Risiken
II: Evaluierung des P2P-Geschäftsmodells im Feldexperiment

Die Erkenntnisse dienen als Grundlage zur Übertragung der Erkenntnisse auf weitere Risikoarten der Versicherungswirtschaft.

## 4 Theorie

Die Designtheorie stellt das „stärkste“ Ergebnis („Level 3“) gestaltungsorientierter Forschung auf einer dreistufigen Skala von Gregor und Hevner [47] dar. Stringenz

und Relevanz einer Problemlösung können zwar anhand einzelner Instanziierungen ebenfalls gezeigt werden – aber eben nur in Einzelfällen („Level 1“). Auf der „Glaubwürdigkeitsskala“ zwischen Instanziierungen und Designtheorien („Level 2“) liegen als sog. „im Entstehen begriffene“ (nascent) Designtheorien, Methoden, Modellen, Prinzipien, „technological rules“ etc., die einen beschränkteren Geltungsbereich haben als ausgereifte, vollständige Designtheorien. Die Forschungsarbeitet kann dem Level 2 zugeordnet werden.

Die Designtheorie beantwortet zum einen die Frage, wie etwas zu tun ist. Die Theorie enthält Anweisungen, wie das Artefakt, also die Lösung für den Versicherungsbereich, zu konstruieren ist (vgl. dazu auch Kapitel 3.2.1). Beispiele sind Methoden, Techniken oder Gestaltungsprinzipien, für die gezeigt werden kann, dass ihre Anwendung eine bestimmte Klasse von Problemen löst. Diese wurden in Abschnitt 3.1.1 bereits skizziert. Gregor und Jones [14] spezifizieren in ihrer „Anatomy of a Design Theory“ dazu Problem- und Lösungsbeschreibung, Geltungsbereich und Anpassungsmöglichkeiten, Begründungszusammenhang, Umsetzungshinweise und andere Komponenten. Diese Komponenten werden im folgenden kurz beschrieben:

1. Problembeschreibung („purpose and scope“): Generalisierte Anforderungen oder Ziele, die mit dem zu konstruierenden Artefakt erfüllt werden sollen und die gleichzeitig den Anwendungsbereich der Designtheorie definieren (Problemklasse).

2. Informationsmodell („Constructs“): Beschreibung der für die Problem- oder Lösungsbeschreibung relevanten Objekte, über welche die Designtheorie Aussagen macht.

3. Lösungsarchitektur („Principles of form and function“): Wesentliche Komponenten des Lösungsartefakts (Modell oder Methode) und deren Zusammenwirken.

4. Anpassungsfähigkeit der Lösung („Artifact mutability“): Beschreibung der unterschiedlichen Kontext-, Ziel- und Wirkungsvarianten des Artefakts sowie der entsprechenden Anpassungsmechanismen (z. B. Konfiguration), um verschiedene Problemsituationen abzudecken.

5. Wirkungsnachweis („Testable propositions“): Prüfung der Problemlösungskraft der Designtheorie.

6. Begründung („Justificatory knowledge“): Erklärungswissen, auf dessen Grundlage die Designtheorie konstruiert wurde.

Zusätzliche Komponenten
7. Umsetzungsvorschrift („Principles of implementation“): Hinweise zur Anwendung der Designtheorie für konkrete Problemstellungen.

8. Illustratives Umsetzungsbeispiel („Expository instantiation“): Beschreibung tatsächlicher Instanziierungen der Designtheorie.

# 5 Aufbau der Arbeit

Das dieser Arbeit zugrundeliegende Forschungsdesign ist zusammenfassend in Abbildung 3 dargestellt.

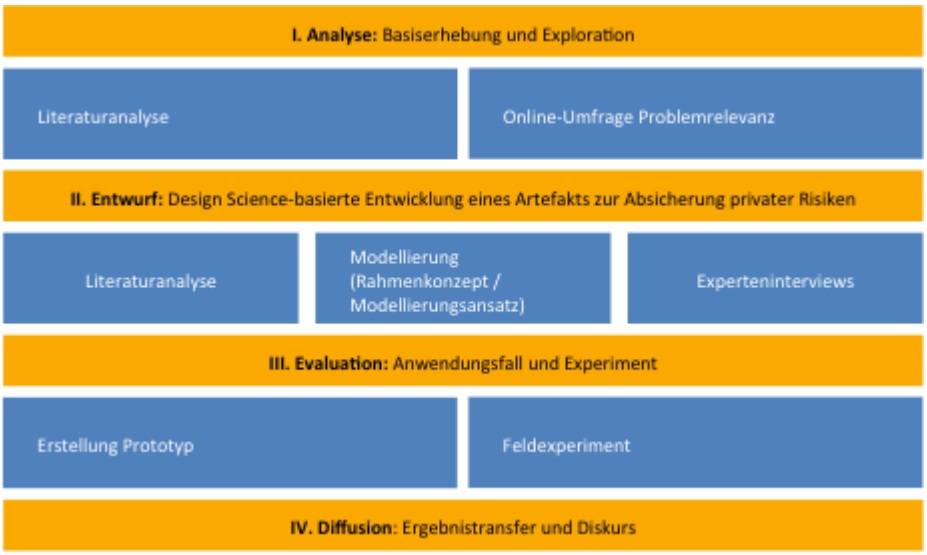


**Abb. 3.** Überblick Forschungsdesign

Der Aufbau der Forschungsarbeit orientiert sich am Aufbau vergleichbarer DSR Arbeiten und wird wie folgt gegliedert:

A. Einführung
B. Stand der Forschung
C. Studie I: Design Science-basierte Entwicklung eines Artefakts zur Absicherung privater Risiken
D. Studie II: Evaluierung des P2P-Geschäftsmodells im Feldexperiment
E. Diskussion
F. Zusammenfassung und Ausblick

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# Experimental Research on the Influence of Informational Triggers on Driving Behavior

Matthias Gottlieb[1]*

[1]Technische Universität München, Chair for Information Systems, Munich, Germany
{gottlieb}@in.tum.de

**Abstract.** Energy consumption displays in cars are used to influence driving behavior. These displays are used as part of the human machine interface to indicate the energy consumption. This paper analyzes which triggers might lead to a more efficient energy usage. Energy consumption displays are informational triggers (ITR). However, cars are designed to drive safely from A to B with energy efficiency being a secondary or tertiary priority. This thesis does a two-step approach, (1) a literature review to identify a research gap on ITRs and (2) two experiments on the found gap on ITRs, more specific two ITRs for motivated and non-motivated users to drive energy efficiently. This contributes to theory by findings about ITRs which influence the driving behavior. Practitioners can implement more specific ITRs for motivated and non-motivated users that might have an impact on the energy consumption caused while driving.

**Keywords:** informational triggers, driving behavior, human computer interaction, energy efficiency

## 1 Motivation

Energy is a limited resource in a car. Hence the driver is informed about the energy consumption via display. This provides the driver with feedback such as when the resource of energy has to be refilled or about the current energy consumption. This feedback triggers the driver to react or not to react.

Stern [1] depicts that information is a complex and important factor to affect behavioral change. Behavioral change can be triggered by in-car displays. In-car displays illustrate information about different data, which can be internal or external such as fuel indication, or radio signals. Further this data can have an influence on driving behavior (DB). The influence on DB can be triggered by in-car information systems. Software that interacts with the driver is a growing topic in human computer interaction [2].

[1] Advisor Univ.-Prof. Dr. Helmut Krcmar, Technische Universität München, Chair for Information Systems, Munich, Germany

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The tasks of a driver are categorized by primary, secondary and tertiary tasks [3, 4]. The primary task of a driver is to drive the car safely from point A to B [3-5]. Secondary tasks increase the safety for the driver, the car, and the environment such as collision warning signals, turning on dimmed headlights when it is getting dark, or energy warning signals [3, 4]. Tertiary tasks are all further functions such as entertainment and information systems use [3, 4]. It is important to note that Trushin et al. state that in-car services in tertiary tasks "gain increasingly in importance" [6]. For energy consumption to become a secondary task, it has to directly influence the safety of the driver, the car, or the environment. This can happen when the car runs out of energy and as a result e.g. generator, brake booster, or steering booster fall off, but in general it is a tertiary task.

This thesis focuses on reducing energy consumption with the help of informational displays that influence the DB. Energy consumption displays are informational triggers (ITR). ITRs are essential for the influence on driving behavior, because of the limited resource of energy in cars. Nowadays one or more displays inform the driver about the energy consumption and thus influence DB. It is known that Volkswagen was one of the first companies to introduce a fuel indicator in one of its cars, which is the VW 1200, in the sixties [7, 8]. Today in-car displays have the possibility to illustrate and analyze sensor data such as average consumption, consumption per hour, consumption per 100 km, and current fuel consumption. This data can be used as a trigger for influencing the driver to change the behavior and drive more energy efficiently by providing feedback through a software system, which is also known as eco-feedback technology [9].

Findings are added to the eco-feedback technology theory with experimental research on the influence of ITRs on DB. The literature describes different systems which are categorized by (i) visual, (ii) haptic, (iii) auditive, or (iv) combinations of (i), (ii), or (iii), that raise for instance the acceptance of in-car interfaces to improve economic driving behavior [10, 11]. These findings are useful, but have a different point of view and concentrate on high intentions [10], acceleration and gear shift [11], or focuses on households [12, 13].

In a first step, this thesis focuses on visual ITRs. In further steps the remaining types of displays in the categories (ii) – (iv) might be explored. Persuasive designs of technology and the influence of human factors have been looked at by Fogg and Nass [14-16]. They [16] have focused on reciprocity to change human behavior and found that social rules and dynamics can explain the behavioral change.

This knowledge is extended by the findings of which ITR has a higher impact on motivated or non-motivated users and shows the influence on DB. As the above mentioned literature shows there are a lot of human computer interaction and psychology papers that deal with ecological driving, acceptance of systems, changing human behavior, or how systems should be designed, but a combination of compared ITRs and motivation is not yet found.

The result of this first step is a research agenda. Out of this research agenda this thesis contributes in the first research question (RQ) a list of ITRs influencing DB. In the next step, two of these ITRs from RQ1 are used. In this step this thesis looks at their influence on driving behavior. Therefore motivation (intention) and ability are the main influencing factors for behavior and have been studied over decades in psychology [17-19]. Fogg [14] developed the Fogg Behavior Model (FBM) where he bundles a lot of concepts, models, and theories and applies the FBM to computer systems to reduce complexity. This thesis concentrates on the dimension of motivation and assumes that the ability is given, since Fogg [14] states that the ability has to be mandatorily given to affect the behavior with a trigger.

## 2 Terminology

Before the purpose and research design of this thesis are specified the keywords of this thesis are defined to achieve a deeper understanding of the meaning of ITRs and DB.

Wehmeier and Hornby [20] define ITR as a trigger for "something that is the cause of a particular reaction or development." This thesis uses the naming of ITR because it is a combination of information, in form of energy consumption illustrated to the driver via display, and trigger. Energy consumption displays are ITRs.

The understanding for driving is "the way that sb drives a vehicle" [20]. Driving is the gerund of drive and is defined as "to make a car […] move and control where it goes" [21]. Behavior is defined as "the way a person […] behaves or functions in particular situation" [20]. The American definition is slightly different, behavior is defined as "the way that a person […] does or say things" [21].

## 3 Purpose

The overall purpose of this thesis is to analyze which triggers lead to a better energy usage. More specific the influence of ITRs for motivated and non-motivated users on the DB to reduce energy consumption.

Therefore this thesis attempts to answer the following three research questions:

- RQ1: What is the state-of-the-art of informational triggers on driving behavior?
- RQ2: What is the influence of informational triggers on driving behavior for motivated users?
- RQ3: What is the influence of informational triggers on driving behavior for non-motivated users?

# 4 Research Design

This thesis uses a two-step approach, by analyzing the influence of ITRs on DB. In the first step this thesis conducts a literature review to identify ITRs in the area of human computer interaction, more specific in-car displays influencing the DB on the energy consumption. In the second step this thesis conducts a laboratory experiment on motivated and non-motivated users and measures the energy consumption caused by them. This shows the influence of ITRs on DB and gives an answer to which triggers lead to a more efficient energy consumption. Therefore this thesis compares ITR1 with ITR2 in each scenario RQ2 and RQ3. Fig. 1 illustrates this research design in total.

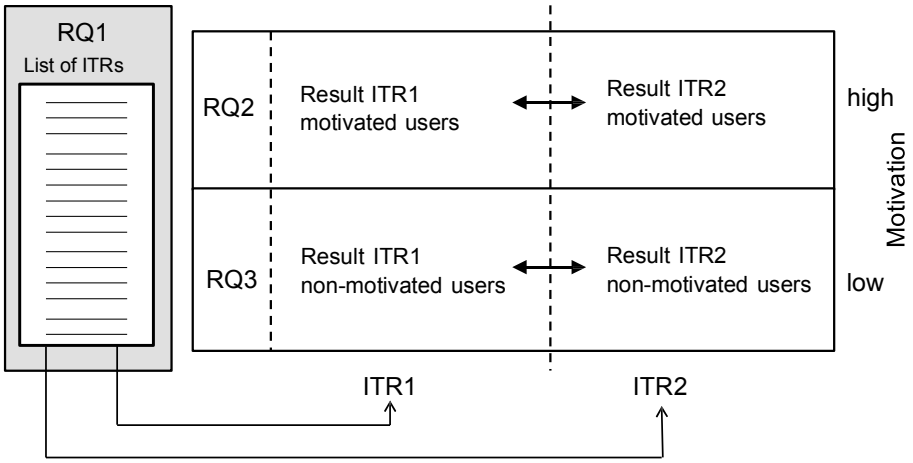


**Fig. 1.** Research Design (own illustration)

## 4.1 RQ1: What is the state-of-the-art of informational triggers on driving behavior?

In order to answer the RQ1, the frameworks of Brocke et al. [22], Webster and Watson [23] and Onwuegbuzie, Leech and Collins [24] are used to develop a deeper understanding of ITRs and to find a gap of unsolved ITRs. This thesis follows the five steps of Brocke et al. [22]:

1. Definition of review scope
2. Conceptualization of topic
3. Literature search
4. Literature analysis and synthesis
5. Research agenda

To get a state-of-the-art in theory and practice the literature review scope in this thesis focuses on research outcomes and practical/applications from researchers and used by car manufactures. The goal of the literature review is to give a "broad conception of what is known" [25] and to identify central issues within the research field of the influence of ITRs on DB. Thereby this review identifies relevant work and pays attention to different solutions and open issues of ITRs and their influence on DB. Further the integrative literature review generates findings about the topic itself and a research agenda. This thesis uses the research agenda to have a look at the influence of ITRs on DB for motivated and non-motivated users. The literature review covers the literature in a way that the reader is able to conduct his own evaluation with the presented documentation to get an exhaustive with selective citation coverage. This thesis follows the approach of Webster and Watson [23] which takes in a first step highly ranked journals, and articles, which are described in detail after the conceptualization step. In a second step analyzes the second and third literature. Furthermore practical magazines and papers by car manufactures are used to cover an exhaustive overview with specific selected literature. This thesis focuses on historical and conceptual organization of literature to look at the development of ITRs over the last decades to finally achieve the state-of-the-art in research and practice. Further the review looks at conceptual frameworks and applications to implement ITRs which influence DB. The literature review is written for specialized researchers. Fig. 2 illustrates the review scope in total.

| Charateristic | | Categories | | | |
|---|---|---|---|---|---|
| (1) | focus | research outcomes | research methods | theories | pratices/applications |
| (2) | goal | integration | criticism | identification of central issues | |
| (3) | perspective | neutral representation | espousal of position | | |
| (4) | coverage | exhaustive | exhaustive with selective citation | representative | central/pivotal |
| (5) | organization | historical | conceptual | methodological | |
| (6) | audience | specialized scholars | general scholars | practitioners/ policy makers | general public |

**Fig. 2.** Taxonomy of literature reviews (following Cooper [26])

Following the approach of Brocke et al. [22] this thesis conceptualizes the topic to give a broad overview and identify the keywords. In the middle node the topic ITR for the influence on DB is illustrated. On the left side of Fig. 3 (1) keywords are presented, that define the topic of ITRs for the influence on DB. On the right side (2) the two main research fields human computer interaction (HCI) and psychology with the concerns of interests are illustrated. Watson et al. [27] identified with their "RQ9: What information do consumers need about the usage of the objects they own or

manage to increase their energy efficiency?" an open research gap in information systems. This thesis looks at ITRs, information that is displayed to users to influence their DB. According to that, this thesis addresses the RQ of Watson et al. [27] partly by comparing ITRs which influence DB. ITRs can be (i) visual, (ii) haptic, (iii) auditive, or (iv) combinations of (i) - (iii) [10, 11]. Those ITRs (4) are types of displays (3). Displays and their interaction with humans are part of the research field of HCI (2). Further to contribute the information to the needs of their users and to use energy more efficiently, a feedback (3) has to be given [28]. Therefore the users are provided with data from sensors, which monitor their driving style and thus can be used to persuade the driver to be more energy efficient. Further, information technology supports the driver to be energy efficient such as eco driving [29]. This feedback is an essential part of HCI, because this data is necessary to provide the user with an illustration. This feedback might lead to a 10% increase of fuel efficiency [30]. Furthermore influence on DB is part of the research field of psychology (2). As mentioned in the first section motivation (intention) and ability are the main influence factors for behavior [17-19]. Those factors are reviewed and considered in Psychology (2). Fig. 3 thus illustrates a broad overview of the conceptualization of the influence of ITRs on DB.

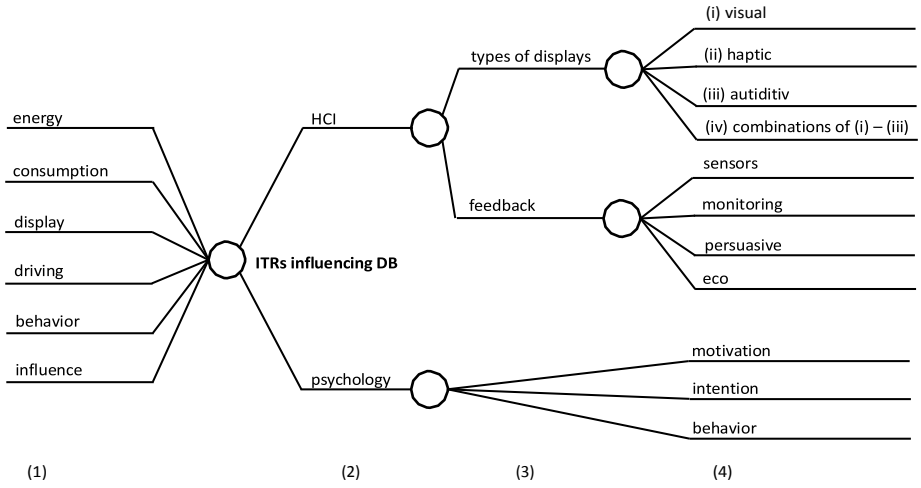


**Fig. 3.** Conceptualization of the influencing ITRs on DB (own illustration)

There are a lot of different ITRs Meschtscherjakov et al. [10], Staubach et al. [11], and Birrell and Young [31] show. In addition the causes that change the behavior may be greatly different [32]. To identify relevant literature in the field of information systems, this thesis looks at the "Senior Scholars' Basket of Journals" [33] to assure high quality of knowledge is considered. In addition and due to the found literature this review is based on other disciplines such as psychology, marketing, economic

sciences, and further information systems specific literature presented on conferences such as human computer interaction: *CHI*, *SIGCHI* and the design of computer systems *AutomotiveUI* [1, 3, 32, 34, 35]. To address these disciplines the A+ ranked Journals in VHB-JOURQUAL2 [36] which have the words marketing, economic or information systems in its titles are selected: *American Economic Review (AER)*, *Journal of Marketing (JM)*, *Journal of Financial Economics (JFE)*, *ISR*, *Journal of Marketing Research (JMR)*, and *Marketing Science (MktSci)*. The journal ISR is highly ranked in both rankings: "Senior Scholars' Basket of Journals" [33] and VHB-JOURQUAL [36], because of the coverage in the field of information systems and economic sciences it might be of special interests. Moreover for psychology the top three ranked peer reviewed journals from the SCImago Ranking of Psychology journals [37] are selected: *Psychological Bulletin (PB)*, *Trends in Cognitive Sciences (TiCS)*, and *American Psychologist (AP)*. Additionally the area of transportation research, seems to be suitable [11]. Therefore the following journals are selected: *Transportation Research Part D: Transport and Environment (TR Part D)* and *Transportation Research Part F: Traffic Psychology and Behaviour (TR Part F)*, and of course the area of automotive research such as *Automobiltechnische Zeitschrift (ATZ)* and practice such as a selection of catalogues of car manufactures are added.

The following databases are used in this thesis *EBSCOhost*, *CiteSeerX*, *IEEE Xplore*, *ACM Digital Library*, *Scopus*, *Lecture Notes on Computer Science*, *scholar.google*, and *SpringerLink*. So far from the conceptualization of the influencing ITRs on DB identified search words are *energy*, *driving*, *behavior*, *trigger*, *eco*, *motivation*, *motivated*, *non-motivated*, *intention*, *persuasive*, *display*, *feedback*, *monitoring*, *driving assistant*, and *consumption*. In addition this thesis considers also combinations of these search words. The literature search will use these keywords in British English, American English, and German. At first this thesis searches in *title*, *abstract*, and *keywords* to identify relevant literature, except for scholar.google, because of the limitations of the search engine which only provides an *all fields* search. Second, this thesis conducts a forward and backward search according to Webster and Watson [23]. This literature review starts with papers published since 1960. As mentioned above this was the time when the first fuel indicator was introduced. Table 1 illustrates an overview of the literature search.

**Table 1.** Overview of the literature search (own illustration)

| Journal/Conference | Search words | Database | Search fields | Coverage |
|---|---|---|---|---|
| MISQ | energy, driving, behavior, trigger, eco, motivation, motivated, non-motivated, intention, persuasive, display, feedback, monitoring, driving assistant, consumption and combinations of these search words | EBSCOhost, CiteSeerX, IEEE Xplore, ACM Digital Library, Scopus, Lecture Notes on Computer Science, scholar.google | title, abstract, keywords | since 1960 |
| ISR | | | | |
| JMIS | | | | |
| JAIS | | | | |
| EJIS | | | | |
| ISJ | | | | |
| JSIS | | | | |
| JIT | | | | |
| AER | | | | |
| JM | | | | |
| JFE | | | | |
| JMR | | | | |
| MktSci | | | | |
| TR Part D | | | | |
| TR Part F | | | | |
| CHI | | | | |
| SIGCHI | | | | |
| Automotive UI | | | | |
| ATZ | | SpringerLink | | |

This thesis uses the concept matrix of Webster and Watson [23] to analyze and synthesize the findings more specific.

The result of RQ1 is a research agenda including a list of potential ITRs which might influence DB.

### 4.2 Preparation for RQ2 and RQ3

In order to answer the following RQ2 and RQ3 Runco and Sakamoto [38] illustrate that a laboratory experiment is suitable for evaluating the change in human behavior. Moreover, to control the experiments the human test subjects are separated into two groups which are motivated and non-motivated drivers. Motivated drivers want to consciously reduce their energy consumption while driving. In contrast, non-motivated drivers are unaware of the consumed energy while driving. Drivers are human test subjects that use the ITR. Therefore this thesis conducts a survey with the human test subjects which are users of the ITR to find out to which group the user belongs to. To control the independency the human test subjects are not told for what the survey is used for. In addition this thesis collects demographical data such as sex and age. Besides that the human test subjects have to have a valid driving license.

For the laboratory experiments a suitable driving simulation has to be found. The solution of Poitschke et al. to use the Unreal Engine in the version 2.0 in a multifunctional virtual reality simulator to test user interfaces seems to be suitable [5]. They presented a driving simulation on a car, more specifically a BMW 318i with the possibility to add additional displays [5]. On these additional displays the ITR can be displayed to illustrate the ITR to the human test subject.

The two ITRs that seem to have suitable and applicable criteria are selected for the laboratory experiment for RQ2 and RQ3. The laboratory experiment enables to control the surrounding conditions such as attitudes and subjective norms. These conditions are part of the model chosen by Loock et al. [39]. They chose the extended model of goal-directed behavior (EMGB) by Perugini and Conner [40]. The EMGB from Perugini and Conner is a combination of the Theory of Planned Behavior (TPB) [19] and the Model of Goal-directed behavior (MGB) [41]. Further in this theoretical context Loock et al. [39] focus on the causal chain of goal desire, behavioral desire, intention, and behavior. Thereby the first part describes the decision-making process including goal desire, behavioral desire, intention, and further objects such as attitudes, subjective norms. The second part illustrates the influence of the decision-making process on the behavior. This measured behavior is given to an energy consumption platform to generate feedback to the user. This thesis focuses on the last part of this chain on motivation (intention) and DB (behavior) and looks at the influence of ITRs on DB. Fogg looks at triggers which influence non-motivated users to change their behavior to become motivated users [14]. Instead of having a vertical view on the motivation such as Fogg [14], this thesis looks at a horizontal view by comparing ITRs for motivated users in RQ2 and for non-motivated users in RQ3. Fig. 4 illustrates the theoretical focus of this research for a deeper understand for the following experiments.

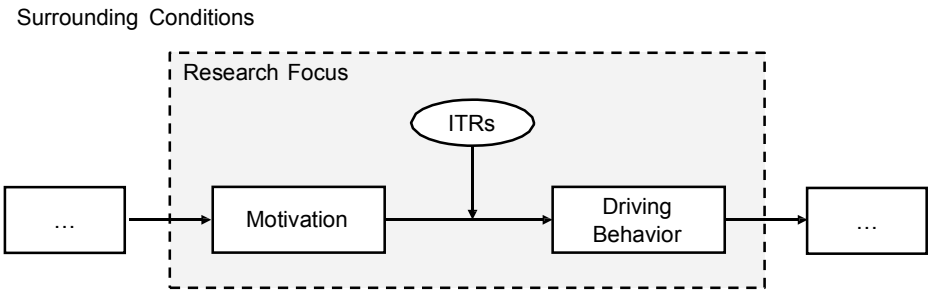


**Fig. 4.** Research Focus (own illustration)

### 4.3 RQ2: What is the influence of informational triggers on driving behavior for motivated users?

In order to answer RQ2 this thesis conducts a laboratory experiment within the motivated group of users. Two ITRs, identified in RQ1, are depicted iteratively to the users while driving. Therefore this thesis is using a driving simulation where a specific type of car and a specific road can be simulated such as Poitschke et al. [5] illustrated. Besides a simple car view with in-car information for the driving simulation the ITR are depicted to the human test subject on an additional display. Further a suitable driving scenario to test the ITR for the motivated test group has to be implemented. This driving scenario could for example be driving a specific car from point A to B on a specific road and under specific circumstances within a driving simulation. Furthermore to have an independently measured object the surrounding conditions have to be the same for every human test subject. It is essential to note that the surrounding conditions might have an effect on the motivation of human test subject. This can be used to ensure the human test subject is motivated to consume less energy while driving, e.g. the energy indication might be used to move the attention of the driver from a tertiary task to a secondary task. Because the knowledge about having "few" energy left to reach the destination can motivate the driver to change the DB. The measured object is energy consumption c per distance d. In the experiments the distance is set constant.

To ensure that the human test subjects had the ability to interact with the ITR, which this thesis sets as given, a post survey is conducted with the human test subjects. Moreover, the survey collects data about the DB from the human test subject for decreasing possible interferences.

The result is a comparison of ITRs which influence the DB of motivated drivers.

### 4.4 RQ3: What is the influence of informational triggers on driving behavior for non-motivated users?

In order to answer RQ3 this thesis conducts a laboratory experiment and selects the non-motivated group of users. Again the same two ITRs used in RQ2 are depicted to the users while driving. Further the same driving simulation of RQ2 with the same surrounding conditions is conducted, but the scenario of RQ2 might have to be changed to ensure the human test subject is non-motivated while using the ITRs. For example this can be done by surrounding conditions such as time pressure, or a traffic jam.

Again, to ensure that the human test subject had the ability to interact with the ITR the same post survey from RQ2 is conducted on the human test subjects.

The result is a comparison of ITRs which influence the DB of non-motivated drivers.

## 5 Implications for Research and Practice

From a theoretical perspective, this thesis depicts a research gap of ITRs with influence on DB. In addition experimental research adds, firstly, to theory, findings about ITRs which influence DB for motivated users. Secondly, experimental research adds findings about ITRs which influence DB for non-motivated users. This yields experimental research on the influence of ITRs on DB.

The result of this thesis provides practitioners with specific ITRs for motivated and non-motivated users in order to implement ITRs for the analyzed groups. This might lead to a more energy efficient DB.

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# Entwicklung von Smart Glass Service Support Systemen

# Prozessunterstützung des Technischen Kundendienstes durch mobile Assistenzsysteme im Maschinen- und Anlagenbau

Christina Niemöller

Universität Osnabrück
christina.niemoeller@universitaet-osnabrueck.de

**Abstract.** Smartphones und Tablets sind nicht das Ende der mobilen Innovationswelle. Durch die Ankündigung sogenannter Smart Glasses ergeben sich neue Möglichkeiten zur Unterstützung von Dienstleistungen am Point of Service. Vor allem der Technische Kundendienst kann von den neuen Technologien profitieren, die nun auch für kleine und mittelständische Unternehmen erschwinglich werden. Im hier vorzustellenden Forschungsvorhaben soll untersucht werden, wie mobile Assistenzsysteme für Smart Glasses konzipiert werden müssen, um eine Prozessunterstützung am Point of Service zu ermöglichen. Zur Konzeption, Implementierung und Evaluation wird ein Design Science-orientiertes Forschungsvorhaben in der Agrartechnik und dem Heizungs- und Klimabau durchgeführt. Die Ergebnisse sollen abschließend mit den Erkenntnissen aus einem Forschungsprojekt zu Handheld-Assistenzsystemen in der Flurfördertechnik in Bezug auf die Fachanforderungen, Design-Prinzipien und die Anwendbarkeit von Handheld- und Smart Glass-Assistenzsystemen verglichen werden.

**Keywords:** Service Support Systems, Mobile Assistenzsysteme, Smart Glasses, Augmented Reality

## 1 Motivation und verwandte Arbeiten

Dienstleistungen werden zunehmend zum zentralen Katalysator innovativer Geschäftsmodelle. Vor allem an der Schnittstelle zur industriellen Produktion in Form sogenannter Produkt-Service Systeme (PSS) werden Dienstleistungsmodelle zum Dreh- und Angelpunkt für betriebswirtschaftliche Investitionsentscheidungen, ingenieurwissenschaftliche Produktinnovationen und informationstechnische Umsetzungen. Allein das Potenzial in den After-Sales-Bereichen des Maschinenbaus ermöglicht neue Wertschöpfungskonzepte und -partnerschaften an der Markt- und Kundenschnittstelle [1, 2].
Durch die fortwährende Digitalisierung durch mobile Endgeräte bieten sich neue Möglichkeiten, diese informationstechnische Unterstützung am Ort der Dienstleistungserbringung (Point of Service) zu gestalten [3]. Dies ist vor allem für wissensin-

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tensive und modulare Dienstleistungen erforderlich. Servicetechniker müssen eine Fülle verschiedener Aktivitäten beherrschen, um die immer komplexer werdenden Maschinen zu warten, instand zu halten und zu reparieren [4, 5].
Bisher wurden mobile Assistenzsysteme vor allem in Form von Handheld-Geräten implementiert; aber diese sind nicht das Ende der Innovationswelle [6]. Nach dem stark gestiegenen Smartphone Markt wird eine ähnliche Entwicklung für tragbare Endgeräte (Wearables) erwartet [7]. Vor allem im Geschäftsumfeld, in dem Dienstleister am Ort der Dienstleistungserbringung keine Geräte in der Hand halten können, da sie bspw. freie oder sauberer Hände benötigen, versprechen Wearables einen hohen Nutzen [8]. Diese tragbaren Geräte sind beispielsweise Smart Glasses in Kombination mit Augmented Reality-Anwendungen (AR), deren Anwendung viel natürlicher ist als die Nutzung von AR-Anwendungen auf einem Handheld-Endgerät während der auszuführendem Tätigkeit [7].
Obwohl das Thema Augmented Reality nicht neu ist, wird durch die Ankündigung beispielsweise der Google Glass eine neue Verbreitung der erschwinglichen Smart Glasses erwartet: die weltweite Auslieferung soll von 2,13 Mio in 2014 auf 10,57 Mio. in 2015 steigen [9]. Diese Entwicklung spiegelt sich auch in der Wissenschaft wider: In den letzten Jahren wurden zahlreiche Publikationen zu Augmented Reality-Anwendungen vor allem im Bereich Handheld aber auch Wearables publiziert. Die meisten Konzepte beziehen sich dabei auf den medizinischen Sektor, aber auch im Bereich Maschinen- und Anlagenbau wurden Augmented Reality-Anwendungen diskutiert (vgl. [8-13]). Nachdem verschiedene Anwendungsfälle von Augmented Reality publiziert wurden (vgl. [10–12]), wurde zuletzt besonders der Nutzen von Head-Up-Displays untersucht: Hierzu zählen u.a. schnelleres Auffinden von Informationen für den Arbeitsablauf auf dem Endgerät, als auch ergonomische Vorteile [13], sowie schnellere Arbeitsvorgänge, da der Prozess nicht unterbrochen werden muss [14].

## 2 Zielsetzung und forschungsleitende Fragestellungen

Obwohl die Diskussion um den Einsatz von Augmented Reality-Applikationen und Head-Up-Displays nicht neu ist, wurde bisher noch keine wissenschaftliche Beurteilung des Nutzens der neuen, erschwinglichen Smart Glasses als Service Support Systems für den Technischen Kundendienst publiziert. Hier soll das Forschungsvorhaben ansetzen. Ziel des Vorhabens ist die Beantwortung der zentralen Frage:

> *F: Wie sind Assistenzsysteme für Smart Glasses zu konzipieren, um eine Prozessunterstützung am Point of Service zu ermöglichen und warum?*

Zur Erforschung der zentralen Frage sind u. a. zwei Teilfragen zu klären:

> *TF1: Was sind die zentralen Bedarfe für ein mobiles prozessorientiertes Informationssystem zur Unterstützung des technischen Kundendienstes?*

Diese Frage wurde bereits im Rahmen eines Forschungsprojektes für den Technischen Kundendienst im Bereich Flurförderzeuge beantwortet. Im nächsten Schritt sollen die Anforderungen im Bereich Agrar-und Klimatechnik erhoben werden. Hier-

bei sollen sowohl technologieunabhängige (Fokus aus Prozessunterstützung) als auch technologieabhängige (Smart Phone vs. Smart Glasses) Bedarfe untersucht werden.

*TF2: Wie müssen die Design Prinzipien für die Entwicklung von Smart Glass Service Support Systemen gestaltet sein und warum?*

Im zweiten Schritt sollen Prinzipien zum Design von Smart Glass Support Systemen aus den Anforderungen abgeleitet werden.

*TF3: Wie beurteilen die Nutzer Smart Glass Service Support Systeme und warum?*

Nach der Konzeption und Implementierung der Applikation soll das System evaluiert werden in Bezug auf die Akzeptanz der Nutzer.

Weitere Teilfragen zum Design-Prozess sowie zur Implementierung und Nutzung von Smart Glass Service Support Systemen, die im weiteren Forschungsverlauf näher spezifiziert werden sollen sind bspw. *Welche speziellen Usability-Anforderungen sind bei Smart Glass Applikationen zu beachten? Welche der erhobenen Daten durch Smart Glasses am Point of Service haben Implikationen auf die Produktentwicklung und wie können diese in die Entwicklung zurückfließen? Welche Datenschutzaspekte müssen zum Schutz der Techniker und Kunden beachtet werden? Inwiefern unterscheiden sich Smart Glass Applikationen zu Handheld-Applikationen und welche Vor- und Nachteile liefern diese in Bezug auf Unterstützung bei der Prozessausführung, Datengenerierung und Anwendbarkeit? Inwiefern unterscheiden sich die neuen Smart Glasses von den bisher untersuchten Head-Up Displays und welche neuen Möglichkeiten und Marktsegmente ergeben sich?* und *Wie lassen sich die Erkenntnisse auf weitere Branchen und Anwendungsszenarien wie bspw. dem Gesundheitswesen übertragen?*

## 3 Forschungsmethode

Zur Erarbeitung der zentralen Forschungsfrage mit ihren Teilfragen kommen individuelle Forschungsmethoden zum Einsatz, da je nach untersuchtem Teilbereich spezifische Verfahrensweisen erforderlich sind [15]. Zur Konzeption, Implementierung und Evaluation des Smart Glass Service Systems wird ein gestaltungsorientierter Ansatz gewählt. Dabei wird nach dem Design Science Paradigma (DSR) nach HEVNER ET AL. [16, 17] und dem DSR-Prozess nach PEFFER ET AL. vorgegangen [18]. In Kombination mit dem DSR-Ansatz werden zusätzlich verhaltensorientierte Methoden eingesetzt. Zur Anforderungsanalyse werden beispielsweise qualitative Forschungsmethoden [19] wie Shadowing, leitfadengestützte Experteninterviews und Literaturrecherchen in einer Triangulation angewendet. Die Auswahl weiterer geeigneter Forschungsmethoden zur Beantwortung der Forschungsteilfragen, wie bspw. Laborexperimente für den Vergleich zur Nutzung des Handheld-Systems mit dem Smart-Glass-System, soll im Verlauf erfolgen.

Das Forschungsvorgehen und die Einordnung der entwickelten Forschungsfragen ist in Fig. 1 dargestellt.

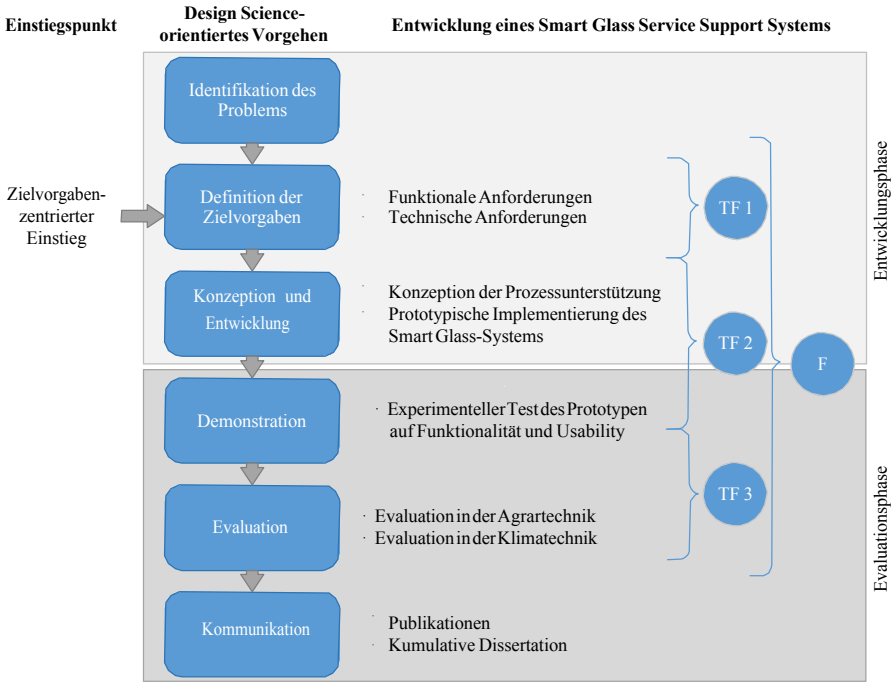


**Fig. 1.** Design Science-orientiertes Forschungsvorgehen

# 4 Bisherige Ergebnisse und nächste Forschungsschritte

## 4.1 Identifikation des Problems und des Einstiegspunktes

Über die Notwendigkeit der Unterstützung von modularen und wissensintensiven Dienstleistungen an immer komplexer werdenden Maschinen herrscht in Wissenschaft und Praxis weitestgehend Einigkeit (vgl. [4, 5, 20, 21]). Das Problem wurde bereits in einem vorangehenden Forschungsprojekt und Literaturstudien belegt. Innovativ an der zu entwickelnden Lösung ist die Verwendung der neu auf dem Markt erschienenen Smart Glasses, die u.a., dadurch dass sie freihändig bedient werden können, einen Mehrwert zur Unterstützung während des Service-Prozesses bieten. Daher wird ein zielvorgaben-zentrierter Einstiegspunkt gewählt. Die Forschungslücke wurde dabei durch eine Literaturanalyse (Schritt 1, Fig. 2) und eine Analyse existierender Smart Glass-Projekte (Schritt 2) aufgedeckt.

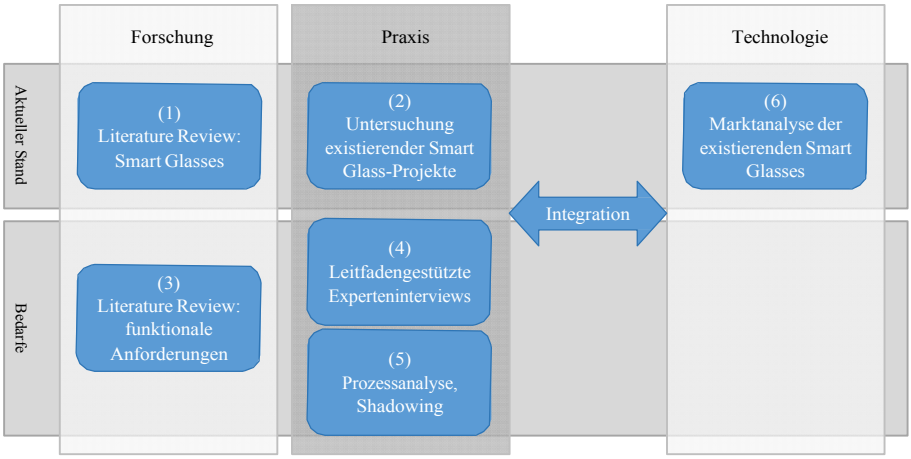


**Fig. 2.** Methodenbaukasten zur Analyse des aktuellen Stands der Forschung, Praxis und Technologie sowie der Bedarfe an ein mobiles Assistenzsystem für den TKD

## 4.2 Definition der Zielvorgaben

Zur Definition des Ziels des zu entwickelnden Prototyps sollen sowohl die funktionalen (Fokus aus Prozessunterstützung) als auch die technischen Bedarfe analysiert werden. Die funktionalen Anforderungen an mobile Assistenzsysteme zur Unterstützung des Technischen Kundendienstes wurden in einem vorausgehenden Forschungsprojekt in einer Triangulation (Schritt 3-5) erhoben (vgl. [22]). Ein Auszug der 10 am häufigsten genannten funktionalen Anforderungen sind in Fig. 3 abgebildet.

| | | Shadowing | | Interview | | Literatur | |
|---|---|---|---|---|---|---|---|
| | Funktionale Anforderungen | Absolute und relative Häufigkeit | | | | | |
| 1 | Vernetzung von Informationsobjekten | 197 | 0,1812 | 5 | 0,0595 | 0 | 0 |
| 2 | Messung dienstleistungsbezogener Key Performance Indicator | 80 | 0,0736 | 12 | 0,1429 | 0 | 0 |
| 3 | Intelligente Disposition | 25 | 0,023 | 12 | 0,1429 | 0 | 0 |
| 4 | Proaktive Informationsbereitstellung | 26 | 0,0239 | 7 | 0,0833 | 3 | 0,0462 |
| 5 | (Teil-) automatisierte Dokumentenerstellung | 81 | 0,0745 | 5 | 0,0595 | 0 | 0 |
| 6 | Ausfüllhilfe für Formulare und Reports | 86 | 0,0791 | 3 | 0,0357 | 1 | 0,0154 |
| 7 | Echtzeit-Kommunikation mit int. und ext. Akteure | 3 | 0,0028 | 3 | 0,0357 | 5 | 0,0769 |
| 8 | Aktualisierung der Servicehistorie | 101 | 0,0929 | 0 | 0 | 1 | 0,0154 |
| 9 | Suche und Abruf strukturierter und unstrukturierter Daten | 54 | 0,0497 | 2 | 0,0238 | 2 | 0,0308 |
| 10 | Plausibilitätsprüfung für Datenerfassung | 112 | 0,103 | 0 | 0 | 0 | 0 |
| | Kummulierte Häufigkeit der aufgeführten Anforderungen | | 70,37% | | 60,00% | | 18,47% |

**Fig. 3.** Die Top 10 der genannten funktionalen Anforderungen an mobile Assistenzsysteme im TKD [22, 23]

Zusätzlich zu den funktionalen Anforderungen wurden Informationsbedarfe, die während des Serviceprozesses auftreten, definiert. Das Ergebnis ist in Table 1 dargestellt. Eine Konsolidierung der aus der Literatur abgeleiteten Informationsbedarfe (T: Theorie) mit der praktischen Erhebung (P: Praxis) aus dem Anwendungsfall im Bereich Flurförderzeuge ergab, dass der größte Informationsbedarf im Bereich Vorbereitung, Durchführung und Controlling auftrat. Bezogen auf die Informationsbedarfe selbst, wurden am häufigsten Informationen zum Informationsobjekt (N3) und Informationen zur Terminplanung (N11) benötigt. Hierbei wurde die absolute Häufigkeit der abgefragten Informationen während der 77 Prozessausführungen gemessen.

**Table 1.** Informationsbedarfe im Instandhaltungsprozess [3, 24]

| | | ***Phase des generalisierten Instandhaltungsprozesses*** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *Initiierung* | | *Problem / Leistungsklärung* | | *Planung* | | *Vorbereitung* | | *Durchführung* | | *Controlling* | | *∑ Informationsbedarfe* |
| | ***Informationsbedarf*** | *T* | *P* | *T* | *P* | *T* | *P* | *T* | *P* | *T* | *P* | *T* | *P* | |
| N1 | Informationen des Herstellers | ✓ | 0 | ✓ | 0 | ✓ | 0 | ✓ | 1 | ✓ | 37 | ✓ | 21 | 59 |
| N2 | Auftragsanfragen | ✓ | 4 | ✓ | 2 | ✓ | 0 | ✓ | 34 | ✓ | 38 | ✓ | 171 | 249 |
| N3 | Informationen des Serviceobjekts | ✓ | 4 | ✓ | 1 | ✓ | 0 | ✓ | 35 | ✓ | 87 | ✓ | 173 | 300 |
| N4 | Informationen zum Instandhaltungsvertrag | ✓ | 1 | ✓ | 1 | ✓ | 0 | ✓ | 34 | ✓ | 38 | ✓ | 171 | 245 |
| N5 | Informationen zur Vorgehensweise | | 0 | | 0 | ✓ | 0 | ✓ | 24 | ✓ | 43 | ✓ | 17 | 84 |
| N6 | Ressourceninformationen | | 0 | | 0 | ✓ | 0 | ✓ | 34 | ✓ | 38 | ✓ | 171 | 243 |
| N7 | Werkzeuginformationen | | 0 | | 0 | ✓ | 0 | ✓ | 1 | ✓ | 9 | ✓ | 0 | 10 |
| N8 | Ersatzteilinformationen | | 0 | | 0 | ✓ | 0 | ✓ | 0 | ✓ | 35 | ✓ | 21 | 56 |
| N9 | Informationen zu Gesetzen und Regelungen | | 0 | | 0 | ✓ | 0 | ✓ | 1 | ✓ | 1 | ✓ | 6 | 8 |
| N10 | Planungsinformationen | | 0 | | 0 | ✓ | 0 | ✓ | 34 | ✓ | 38 | ✓ | 171 | 243 |
| N11 | Informationen zur Terminplanung | | 0 | | 0 | ✓ | 0 | ✓ | 57 | ✓ | 72 | ✓ | 188 | 317 |
| N12 | Auftragsinformationen | | 0 | | 0 | | 0 | ✓ | 34 | ✓ | 38 | ✓ | 171 | 243 |
| N13 | Feedbackinformationen | | 0 | | 0 | | 0 | | 0 | ✓ | 8 | ✓ | 6 | 14 |
| | ∑ Informationsbedarfe pro Phase | | 9 | | 4 | | 0 | | 289 | | 482 | | 1287 | 2071 |

Aufbauend auf den Prozessbeobachtungen und einer Literaturstudie zu Prozessen im Technischen Kundendienst wurden Use Cases entwickelt, die durch Informationstechnologie unterstützt werden sollten. Das Interdependenzmodell der Use Cases in Fig. 4 abgebildet. Die Use Cases, die durch den Kundendiensttechniker ausgeführt werden (Use Cases 5-12), liefern die einzelnen Einsatzszenarien des zu entwickelnden Smart Glass-Assistenzsystems.

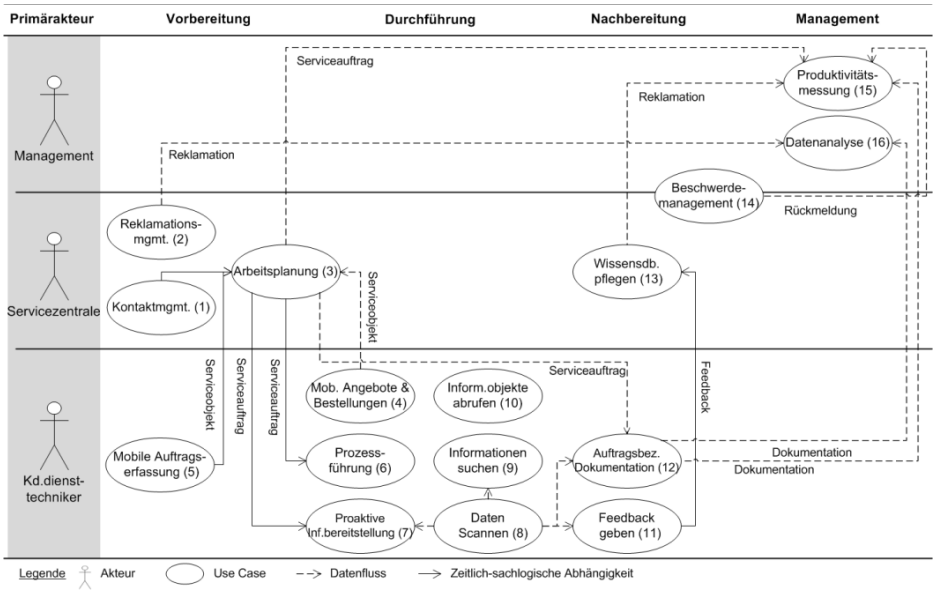


**Fig. 4.** Use Cases im Technischen Kundendienst [25–27]

Da bei der Triangulation in Bezug auf die Prozesserhebung bisher nur ein Anwendungsfall im Bereich Flurförderzeuge betrachtet wurde, sollen im nächsten Schritt zwei weitere Anwendungsfälle (Agrartechnik und Klimatechnik) analysiert werden. Dabei werden methodisch sowohl das Shadowing (vgl. [19]) der Kundendienstprozesse am Point of Service (Schritt 4) als auch leitfadengestützte Experteninterviews (Schritt 5) der Kundendiensttechniker und des Managements durchgeführt.

## 4.3 Konzeption und Entwicklung

Für die Konzeption und Entwicklung müssen die aufgenommen Anforderungen und Ziele mit den technischen Möglichkeiten der sich am Markt befindlichen Technologien integriert werden. Zur Analyse der existierenden Smart Glasses und deren Funktionalitäten wurde eine Marktanalyse (Schritt 6) durchgeführt. Dabei wurden mehr als 30 Modelle identifiziert, die zum Teil schon verfügbar sind (u.a. Google Glass, Vuzix M100, *Pivothead Smart Glasses*) oder sich noch in der Entwicklung

(GlassUp Eyeglasses, Sony Smart Eyeglass Attach, *WeON Smart Glasses*) befinden. Aufbauend auf der Marktanalyse wurden Eigenschaften und besondere Funktionalitäten untersucht.
Im zweiten Schritt wurden die Funktionalitäten mit den bereits erhobenen Anforderungen abgeglichen. Ein Auszug ist in Table 2 abgebildet. Diese Integration wurde zunächst durch 4 Forscher auf dem Gebiet Service-Engineering unabhängig voneinander durchgeführt und konsolidiert und muss in einem zweiten Schritt durch Experteninterviews aus der Praxis validiert werden.

**Table 2.** Abdeckung der formalen Anforderungen durch die Smart Glass-Funktionalitäten

| *Anforderung (vgl. Fig. 3)* | *Funktionalität* | *Natürliche Integration* | *Freihändige Interaktion* | *Objekterkennung* | *Integration in die Umwelt* | *Proaktive Infobereitstellung* | *Videokonferenz* | Gesamt |
|---|---|---|---|---|---|---|---|---|
| 1. Vernetzung von Informationsobjekten | | x | | x | x | x | | 4 |
| 2. Messung dienstleistungsbezogener KPIs | | | | x | | x | | 2 |
| 3. Intelligente Disposition | | | | x | | x | | 2 |
| 4. Proactive Informationsbereitstellung | | x | x | | x | x | | 4 |
| 5. (Teil-)automatisierte Dokumentenerstellung | | | | x | | | | 1 |
| 6. Ausfüllhilfe für Formulare und Reports | | | | | | | | 0 |
| 7. Echtzeit-Kommunikation mit int. und ext. Akteuren | | | x | | | | x | 2 |
| 8. Aktualisierung der Servicehistorie | | | x | | x | x | | 3 |
| 9. Suche und Abruf strukturierter und unstrukturierter Daten | | | | x | x | x | | 3 |
| 10. Plausibilitätsprüfung für Datenerfassung | | | | x | | | | 1 |
| Gesamt | | 2 | 3 | 6 | 4 | 6 | 1 | |

Bei der Abdeckung zeigt sich, dass bspw. die am häufigsten genannte Anforderung *Vernetzung der Informationsobjekten* durch den Einsatz von Smart Glasses zusätzlich unterstützt werden kann. Dadurch, dass Objekte direkt erkannt, Informationen proaktiv zu den Objekten bereitgestellt werden, kann eine Integration dieser Information in die Umwelt erfolgen und durch die Einblendung der Information in das natürliche Sichtfeld eine natürliche Integration in den Arbeitsablauf ermöglichen. Somit kann ein Kundendiensttechniker beispielsweise durch die ständige Verfügbarkeit der Smart Glass (kein aktivieren eines Handheld-Gerätes) eine Maschine identifizieren, sobald er diese ansieht, sich Anweisungen zur Reparatur eingebettet in die Umwelt (Schraube an der Maschine wird markiert) anzeigen lassen und somit freihändig und natürlich seine Arbeit verfolgen ohne auf ein Gerät blicken zu müssen.

In der Konzeptionsphase sollen weitere aufkommende Fragen wie bspw. *Welche Datenschutzaspekte müssen zum Schutz der Techniker und Kunden beachtet werden? Inwiefern unterscheiden sich die neuen Smart Glasses von den bisher untersuchten*

*Head-Up Displays und welche neuen Möglichkeiten und Marktsegmente ergeben sich?* geklärt werden.

### 4.4 Evaluationsphase

Nach der Fertigstellung eines ersten Prototyps soll dieser in einer *Demonstrationsphase* getestet werden. Hier sind Methoden wie ein Laborexperiment in einem iterativen Verfahren zur Anpassung des Prototyps denkbar. Dabei sollen u. a. erste Hinweise zu den Forschungsfragen *Welche speziellen Usability-Anforderungen sind bei Smart Glass Applikationen zu beachten? Wie beurteilen die Nutzer eine mobile prozessorientierte Smart-Glass-Applikation?* ermittelt werden.
Anschließend soll in der *Evaluationsphase* der Prototyp eingesetzt werden, um die Effektivität und Effizienz in realen Szenarien zu erproben. Dazu wird der Prototyp zum einem während des Service-Prozesses in der Agrartechnik und zum anderem im Klima und Heizungsbau eingesetzt.
Abschließend soll eine Einschätzung dazu gegeben werden, *Wie sich die Erkenntnisse auf weitere Branchen und Anwendungsszenarien wie bspw. dem Gesundheitswesen übertragen lassen* (Analogiekonstruktion TKD und Pflege vgl. [28]).
In Bezug auf die Methodik wird parallel untersucht inwiefern DSR-Ansätze Wissenschaftlern und Unternehmen helfen können, Produkt-Service Systeme wie beispielsweise den produktbegleitenden Technischen Kundendienst zu konzipieren (vgl. [24]). Der DSR-orientierte Produkt-Service-Engineering-Prozess soll während des Projekts erprobt werden.
Die *Kommunikation* erfolgt durch Publikationen und einer abschließenden kumulativen Dissertationsschrift.

## 5 Beitrag für Wissenschaft und Praxis

**Beitrag zur Wissenschaft.** Die in der Praxis entwickelten und zukünftig auch für den Privatkundenmarkt erschwinglichen Datenbrillen können mit dem Forschungsvorhaben frühzeitig auf Ihre Anwendbarkeit zur Lösung des komplexen Service-Prozesses des Technischen Kundendiensts übertragen werden. Die Literaturstudie zeigte, dass bisher in der Wissenschaft wenig Informationen zum Einsatz der Smart Glasses zur Prozessunterstützung im TKD verfügbar sind, sodass mit dem Vorhaben die Forschungslücke geschlossen werden soll. Dabei wird ausgehend von den funktionalen Anforderungen, sowohl aus wissenschaftlicher Perspektive (Literature Review) als auch aus praktischer Perspektive (drei Anwendungsfälle), überprüft werden, inwieweit Smart Glasses die Prozessunterstützung am Point of Service ermöglichen. Hierbei ist es wichtig, frühzeitig aus der Perspektive eines Wissenschaftlers der Wirtschaftsinformatik herstellerunabhängig zu ermitteln, welche Anforderungen an Usability, Datenschutz und Integration in den Unternehmenskontext (Informationsbedarfe im Service-Prozess) gestellt werden müssen und welchen Mehrwert die Brillen gegenüber dem papierbasierten und dem Handheld-unterstützen Prozess erbringen. Das Forschungsvorhaben soll einen grundsätzlichen Anwendungsfall-basierten Einsatz

von Smart-Glasses im Unternehmenskontext aufzeigen und die Basis für weitere Forschungsfragen wie *Welche der erhobenen Daten durch Smart Glasses am Point of Service haben Implikationen auf die Produktentwicklung und wie können diese in die Entwicklung zurückfließen?* bilden.

**Beitrag zur Praxis.** Das protypisch zu entwickelnde System kann in der Praxis eingesetzt werden, um die komplexen Tätigkeiten des TKD zu unterstützen sowie Implikationen für weitere Einsatzszenarien bspw. im Gesundheitswesen zu liefern.

Die entwickelten generischen Use Cases für den Einsatz mobiler Assistenzsysteme können als Ansatzpunkt dienen, eigene Einsatzmöglichkeiten im Unternehmen zu identifizieren.

Der Einsatz in der Praxis kann die Effektivität, Effizienz und Qualität der zu erbringenden Dienstleistung steigern, was in der Evaluation in zwei Anwendungsfällen erprobt werden soll. Für Unternehmen bietet sich die Möglichkeit, auch an Standpunkten, in denen die Kundendiensttechniker geringere Schulungsstandards erfüllen, die Qualität der Dienstleistungen durch systembasierte oder Videokonferenz-geführte Prozesse am Point of Service zu erhöhen. Folglich kann das anwendungsfallbasierte Vorhaben ebenso Implikationen liefern für mögliche Geschäftsmodelle im Bereich Product-Service-Systems für Maschinen- und Anlagenbauer.

## 6 Fazit und Ausblick

Im Rahmen dieses Beitrags wurde das kumulative Dissertationsvorhaben vorgestellt. Das Vorhaben befindet sich in einer frühen Phase. Bisher wurden die formalen Anforderungen in einer Triangulation für einen Anwendungsfall (Hersteller von Flurförderern) aufgenommen und die Informationsbedarfe im Service-Prozess des Technischen Kundendienstes identifiziert. Um die Unterstützungsmöglichkeiten im Technischen Kundendienst aufzuzeigen, wurden Use Cases des TKD definiert. Daraus wurde ein Prototyp implementiert (vgl. [26]). Aktuell wird eine Evaluation der erstellten Use Cases mithilfe von Experteninterviews aus der Praxis (Technischer Kundendienst) und Wissenschaftlern (Service Science) durchgeführt.

Parallel dazu wurden bereits erste Implikationen der Einführung von Smart Glasses für den technischen Kundendienst untersucht (vgl. [29]). Anfang 2015 werden die funktionalen Anforderungen des technischen Kundendienstes an ein Smart Glass Service Support System bei einem Großunternehmen in der Agrartechnik und einem mittelständischen Unternehmen im Klima- und Heizungsbau erhoben.

Die neuen Anforderungen sollen im nächsten Schritt mit der Marktanalyse der verfügbaren Smart Glasses abgeglichen und darauf aufbauend ein Konzept entwickelt und prototypisch umgesetzt werden. Die Evaluation erfolgt ebenfalls in den zwei Anwendungsszenarien.

Aufbauend auf den Erkenntnissen des Dissertationsvorhabens können sich zukünftig weitere Fragestellungen in Bezug auf den Einsatz von Produkt-Service-Systemen - im speziellen im Maschinen- und Anlagenbau – ergeben. Das Dissertationsvorhaben fokussiert dabei zunächst vor allem die Unterstützung des Technikers während der Serviceerbringung durch die Bereitstellung von Informationen. Im Gegensatz hierzu

könnte bspw. der Rückfluss von Informationen, die mit Smart Glasses während des Service-Prozesses generiert werden, in den Entwicklungszyklus des Produktes untersucht werden.

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# Advancing Mobile Support Systems in the Area of Technical Customer Service – Requirement Analysis, Artifact Design and Evaluation

Gerald Daeuble

University of Hamburg, Dept. Information Systems, Hamburg, Germany
gerald.daeuble@wiso.uni-hamburg.de

**Abstract.** Information can be declared as fundamental component for the performance of service processes. Especially for the service provision of Technical Customer Services (TCS), information is a key driver for productivity. Information systems (IS) are a critical success factor to provide the TCS employees with needed information for a high-quality service delivery to gain service improvement. Especially in the service sector information provision through mobile IS represents a key competitive factor leading to information needs of the TCS that require the integration of appropriate IS to support the operation and staff efficiently and effectively. Before such a service support system can be designed purposefully information needs of the TCS need to be identified first. Therefor in this research the information needs for mobile TCS are investigated by applying a multi-method approach.

## 1 Motivation and Research Question

Over the past decades, the service sector is continually growing and has fundamental share on the gross domestic product (GDP) in leading industrialized nations [1, 2]. Manufacturing industry is undergoing a transition from the traditional production of products towards the integration of services and providing Product-Service Systems (PSS). Eminently, the addition of lifecycle services to traditional product concepts is a major characteristic of PSS providers. In this context, for many manufacturers the Technical Customer Service (TCS) became a major value-adding resource. Through service provision a value co-creation process is originated, caused by growing customer needs [3]. In machinery and plant engineering, lifecycle extending services such as supply of spare, repairs and maintenance are part of a companies' portfolio complementing their business by additional mobile business processes. The TCS focuses the service maintenance of different products which may come from different manufacturers and perform his tasks at different locations [4]. While a service is the application of resources including competences, knowledge and skills [5], product-related information is also required during service processing.

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The variety and complexity of the products and their appropriate service activities make the management of the field service a more difficult tasks [6]. Existing and within a service process generated data is both provided and accessed by a heterogeneous group of users, such as service engineers, service technicians, back-office, and management, pursuing different purposes [7]. A service process of the TCS is not only a collection of related and structured activities or tasks, organized with the aim to meet a particular need, but it can be also recursively decomposed into sub-processes, in which each process has its clearly defined inputs, outputs, dependencies, and communication channels [8]. Furthermore, providing both "hard" technical variables of a product and "soft" variables of services regarding their reciprocal influence on each other implies barriers for the development of PSS and the appropriate service systems, since the innovation of a system is a complex task [9].

Most industrial companies already tend to use established information technology (IT) solutions for the transfer of information, data, and for the offerings of services [7] in which service systems represent a configuration of resources [10]. Due to the mobility of the field service, mobile technology is needed to enhance business efficiency by distributing information to the workforce at the point of service and making the same corporate data available to employees working inside in the company's back-office [11]. Though, the difference is the user's need is of rather time-critical nature compared to stationary desktop computing [12]. This makes flexible and mobile support for communication and coordination among involved actors in the field of the TCS inevitable in order to enter valid input and to retrieve appropriate information in real-time. However, designing such a mobile solution is a complex task considering the high number and variety of components required and the complexity perceived by the actors in the mobile field [11]. The overriding objective is the development of an adequate intelligent mobile service support system for the Technical Customer Service in the field of the machinery and plant engineering. This aims at providing functionalities of storing, retrieving and distributing service related information and knowledge at the point of service. In order to enhance TCS processes following research questions arise:

**RQ1:** Is there a generalizable service process for Technical Customer Services (TCS) suiting multiple (real world) TCS scenarios?

**RQ2:** What information needs arise in TCS processes (along the TCS process, identified in RQ1)?

**RQ3:** How can identified information needs (identified in RQ2) be structured in order to design and development IT artefacts (mobile support system) of use and utility?

## 2 Related Work (in extracts)

Due to the large variety of information, a proactive information provision especially in TCS processes is important [13, 14]. However, it must be considered that not all organ-

izations and persons do have the same service requirements for which appropriate information is needed [14]. Most notably in knowledge intensive maintenance and repair work, a diverse expertise of actors with different experiences and backgrounds is needed [15]. Even though responsible actors may be equipped with a great amount of required knowledge and expertise, service-specific information needs still emerge during work. This is due to the increasing complexity of high-tech products being subject to their work. Hence there is a demand for enhanced support by appropriate information systems. Based on existing information needs of the service technicians, information systems can be designed according to the necessity. Nevertheless, a purposeful design of such information systems requires a careful analysis and documentation of the particular information requirements [16]. Since current research in the academic discipline of Service Science, Management and Engineering tends to focus on the basis of creating value in service economics or on service marketing and the inclusion of the customer, little research on information needs in the field of TCS has been conducted to date [17]. Fellmann et al. (2011) proposed an integrated IS architecture that directs the integration of data from different specialized systems to cover the aforementioned information needs of the TCS [18]. Their architecture reflects both – the information supply of the service technicians when they are on-site at the customer's facility and the information production by the service technicians captured by collaboration services – to satisfy the information needs of the TCS as well as other enterprise departments. However, focusing on the IS architecture their research obtains no indication on characteristics of existing information needs. Conducting a case study, the authors Becker et al. (2011) have analyzed information needs within service and manufacturing business processes of a milling/turning machine producer [17]. Nevertheless, their focus on how an integration of services and manufacturing can be accomplished by sharing information in service systems differs to this research approach: Their investigation results in certain information needs, which were detected in the case study, make no point to the frequency of the appearance of the information needs, and their significance nor to the information needs from literature such as the official standards. The research of Matijacic et al. (2013) deals with the elicitation and consolidation of service technician's requirements for mobile TCS support systems where 55 requirements were detected [19]. Those requirements will be integrated into the process of purposefully designing IT artefacts in order to support daily operation on technical customer service staff. However, no regard to the characteristics of the service technicians' information needs is given.

Based on the lack of related work, the need for research, focusing on the elicitation of information needs seems beneficial from a scholar's and practitioner's point of view.

**Table 1.** Functional requirements of TCS – multi-method approach [19]

| | | Shadowing | | Interview | | Literature | |
|---|---|---|---|---|---|---|---|
| | **Functional Requirement** | **Absolute and Relative Frequency of Mention** | | | | | |
| 1 | Linked information objects | 197 | 0,1812 | 5 | 0,0595 | 0 | 0 |
| 2 | Service-related Key Performance Indicator measurement | 80 | 0,0736 | 12 | 0,1429 | 0 | 0 |
| 3 | "Intelligent" disposition | 25 | 0,0230 | 12 | 0,1429 | 0 | 0 |
| 4 | Proactive information provision | 26 | 0,0239 | 7 | 0,0833 | 3 | 0,0462 |
| 5 | (Partially) automated document creation | 81 | 0,0745 | 5 | 0,0595 | 0 | 0 |
| 6 | Filling-out assistant for forms and reports | 86 | 0,0791 | 3 | 0,0357 | 1 | 0,0154 |
| 7 | Real-time communication with int. and ext. actors | 3 | 0,0028 | 3 | 0,0357 | 5 | 0,0769 |
| 8 | Updating of the service history | 101 | 0,0929 | 0 | 0 | 1 | 0,0154 |
| 9 | Search and call of structured and unstructured data | 54 | 0,0497 | 2 | 0,0238 | 2 | 0,0308 |
| 10 | Plausibility check for data collection | 112 | 0,1030 | 0 | 0 | 0 | 0 |
| | *Cumulated freq. of the above requirements in %* | | 70,37 | | 58,33 | | 18,47 |
| | **Non-Functional Requirement** | **Absolute and Relative Frequency of Mention** | | | | | |
| 1 | Centring the user | 0 | 0 | 0 | 0 | 10 | 0,1538 |
| 2 | Data protection | 0 | 0 | 0 | 0 | 3 | 0,0462 |
| 3 | Flexibility | 0 | 0 | 0 | 0 | 3 | 0,0462 |
| 4 | Usability | 0 | 0 | 0 | 0 | 3 | 0,0462 |
| | *Cumulated freq. of the above requirements in %* | | 0 | | 0 | | 29,24 |

## 3 Research Design and Methodology

From a methodological point of view "(…) adopting a particular paradigm is like viewing the world through a particular instrument such as a telescope, and x-ray, machine, or an electron microscope. Each reveals different aspects but each is blind to others" [20]. In regards to specific research methods, this research plans to employ a multi-method research design using both qualitative and quantitative methods [22]. This should help considering the research question from different angles and ensure its relevance.

The research project presented here follows the design science paradigm. Design science aims at creating artefacts that serve human purposes and is technology oriented [21]. Hence, it is problem-driven and leads to an artefact that solves an addressed problem, when it is introduced into the environment. Framing research activities to tackle "real world" problems assures the relevance of the research [22]. In this research project the relevance is addressed by integrating main stakeholders of the technical customer service domain early in the research process. In general, design science consists of two main activities: build and evaluate [21]. Building is the process of constructing an artefact for a special purpose; evaluation is the process of determining how well the artefact supports a solution to the problem [23]. March and Smith (1995) identify four types of design artefacts: constructs, models, methods, and instantiations [21].

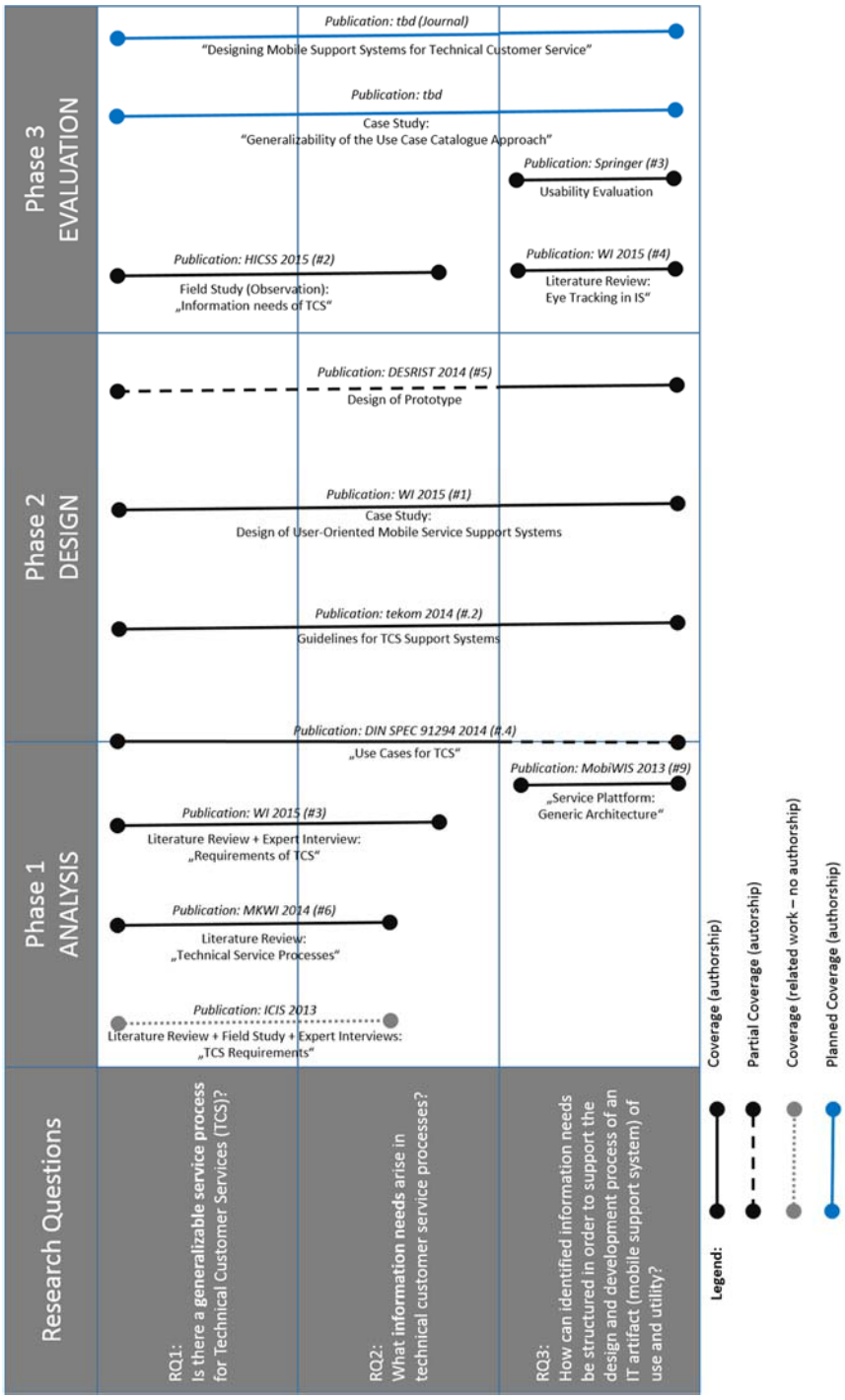


**Fig. 1.** Research Design

High quality design science research (DSR) has to be not only relevant but rigorous [24]. In order to assure methodological rigor, several models exist for carrying out design science research ([22][25][23][26]). Hevner et al. (2007) describes design science as a cyclic process comprised of the relevance, design and rigor cycle [25]. Peffers et al. (2007) divides the research process into six phases: identify problem and motivation, define objectives of a solution, design and develop, demonstration, evaluation, and communication [23]. According to Österle et al. (2010), the design science process consists of four steps: analysis, design and development, evaluation, and diffusion [26]. This research project follows the approach of Österle et al. (2010) as it subsumes the activities recommended by Peffers et al (2007).

Combining different research methods is meaningful for the complex topic under research as the "(…) collection of different kinds of data by different methods from different sources provides a wider range of coverage that may result in a fuller picture (…)" [27]. In order to do so, the following research design is applied (cf. **Fig. 1**). Combining the phases of the research process [26] with the actual research questions provides an overview, how these questions are intended to be answered. The diffusion phase [26] is not illustrated explicitly since (existing and planned) publications are integrated in the phases analysis, design and evaluation. The vertical bars represent the thematic coverage of current and planned publications.

# 4 Addressing RQ1 and RQ2

## 4.1 Generalized Use Cases of TCS

The overriding objective is the development of an adequate intelligent mobile service support system for the Technical Customer Service in the field of the machinery and plant engineering. This aims at providing functionalities of storing, retrieving and distributing service related information and knowledge at the point of service. Before this can be realized, requirements of the users need to be considered for system specification. Based on former research [28], a Use Case Catalog (UCC) following the requirements engineering process has been derived in order to identify necessary system functionalities as a basis for system specification [29].

The development of a mobile service support system is a very complex task since diverse requirements have to be considered spanning professional and technical aspects such as interfaces or integration technology [29]. For harnessing the complexity, the concept of use cases after Cockburn have been used, as it is a common technique for describing functional requirements of systems [30]. With the help of use cases a complete course of interaction between an actor and the appropriate system can be specified [31] as well as the basis for precise requirement documents [32].

The UCC has been documented using a template based on Cockburn [30]. The template comprises e.g. a brief description of the use case, the primary actor and further participants, the pre- and post-condition as well as input and output data and the data sources [29]. Beyond that, during the specification and standardization process, an interdependency model of the use cases was derived (cf. **Fig.** 2).

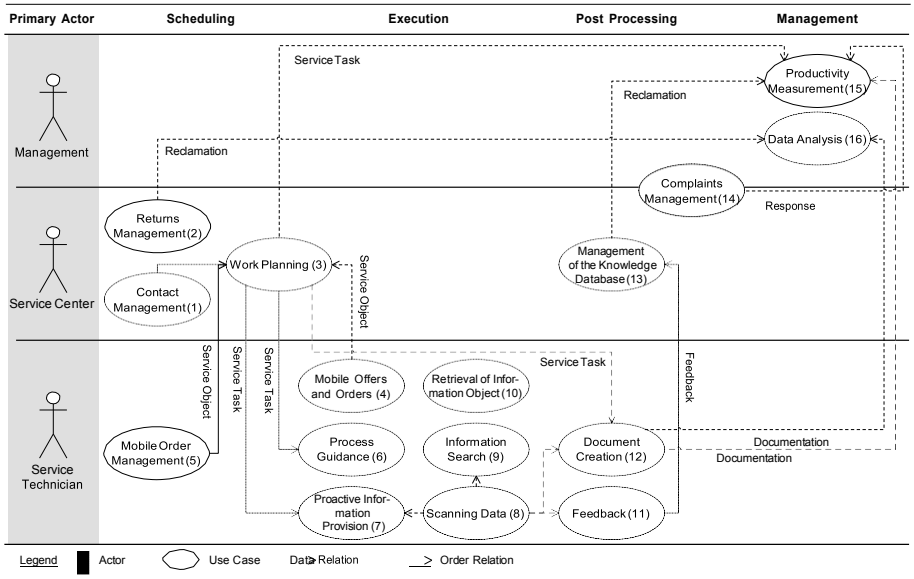


**Fig. 2.** Use Case Catalog – Interdependency Model [33]

## 4.2 Theoretical Framework

While the four phases of the UCC do not provide a lot of detail from a service technician's perspective, a more granular process for TCS had to be found. In addition the service process should allow division of labour – e.g. between a back-office and the field-service. A literature review was conducted to identify processes suitable for conducting technical customer service (TCS). Several processes were found – but none incorporated the concept of the other processes completely. Accordingly, a generalized service process was compiled (cf. RQ1). This service process endorses

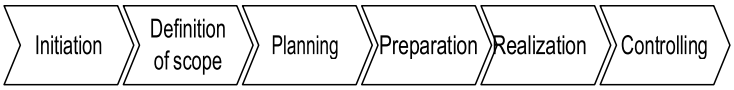


**Fig. 3.** Generalized maintenance process [34]

Having this consolidated process at hand, information needs occurring within the daily operation of TCS staff can be structured and arranged along a generalized service process (cf. RQ2). While identified requirements [28] does not provide enough detail to design IS (e.g. "proactive information provision" [28]), more precise and tangible information needs are required. In order to analyse information needs in more detail a DIN specification describing maintenance of technical products is integrated [35, 36]. While this – among practitioners widely accepted – specification contains *documents and templates*, the actual *information* has to be extracted. The specification over all contains 55 types of documents not consistent in terms of overlapping and degree of

abstraction. In a next step the documents are transformed into information needs, enabling the integration into IS artefacts (e.g. mobile support systems). Transferring the documents into information needs was conducted through several researchers to ensure intracoder reliability. Three researchers in parallel executed this task independently and the results were discussed afterwards extensively. A consensus has been reached that is resulting in overall 13 information needs (cf. **Table 2**).

**Table 2.** Information needs along the generalized maintenance processes [34]

| | Phase of the generalized maintenance process | | | | | |
|---|---|---|---|---|---|---|
| **Information need** | Initiation | Def. of Scope | Plan Work | Prepare Work | Realization | Controlling |
| N 1 Information from the manufacturer | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| N 2 Work order request information | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| N 3 Service item information | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| N 4 Maintenance contract information | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| N 5 Procedure information | | | ✓ | ✓ | ✓ | ✓ |
| N 6 Resource information | | | ✓ | ✓ | ✓ | ✓ |
| N 7 Tool information | | | ✓ | ✓ | ✓ | ✓ |
| N 8 Spare part information | | | ✓ | ✓ | ✓ | ✓ |
| N 9 Law and regulation information | | | ✓ | ✓ | ✓ | ✓ |
| N 10 Planning information | | | ✓ | ✓ | ✓ | ✓ |
| N 11 Scheduling information | | | ✓ | ✓ | ✓ | ✓ |
| N 12 Work order information | | | | ✓ | ✓ | ✓ |
| N 13 Feedback information | | | | | ✓ | ✓ |

### 4.3 Empirical Validation

For the elicitation of the TCS information needs (cf. **Table 2**) a qualitative research design based on a case study [37, 38] in the field of the machinery and plant engineering was chosen. More precisely a leading company of the intralogistics sector providing both, a wide range of products (e.g. forklift and lifting cart) and services in more than 100 countries, embracing over 10,000 employees, was accompanied. The particular focus was set on services regarding maintenance and repair of products manufactured by this company itself. Applying the qualitative method of *shadowing* [39] service technicians were observed in their day-to-day operation. Data has been collected through observations and "thinking aloud" [40] of the TCS technicians during their work. During the shadowing process, the researchers kept in the background minimizing any way of influencing the situation. "Interference should only occur when the subject stops talking" [40]. The service technicians were asked to "think aloud" in order to also capture tacit information that would not be obvious by only observing his work. Since some technicians forgot to comment on their work after a while, researchers asked some open questions (e.g. "what are you doing now?") to provide a continuous stimuli for the verbal description of the current work being executed. Comfort of the one being observed was the key in order to gain valid information. Therefor it was assured that no personal data is passed along – e.g. into the direction of his supervisor. It was recognizable that trust and comfort increased after the first day of observation. Besides apparent actions,

the researchers were able to keep record of actual requirements and subjective impressions and reflections about the situation [39]. Five researchers in two different European countries have conducted the observation in cooperation with the before mentioned company. During the shadowing process, the service technicians were observed by researchers during the whole workday for overall two weeks at several customer locations in order to document actions concerning the TCS processes (in this context, "process" is used as a shorthand synonym for a work order at a customer location). Special attention was paid to the information needs of technicians as well as the context and chronology in which this information is required. Over all 13 service technicians have been observed where each one has been with the company for at least three years in order to capture "best practice procedures".

The empirical validation was conducted by contrasting the conceptualized information needs (cf. **Table 2**) to empirical data gathered during the shadowing process. The numbers in **Table 3.** Consolidation of theoretical investigation and empirical evidence [41] constitute how often an information need occurred in a particular phase in the real-world scenario of the TCS.

Altogether 2071 information needs have been recorded within 77 processes containing sub-steps. This equals averaged 27 information needs per process. In average each process consists of 15 sub-steps (like disassembling of machinery, measuring, inspection, assembling of spare parts, etc.). Among the recorded processes, the shortest process took 15 minutes to complete containing three sub-steps while the longest process lasts 14 hours and 47 minutes containing 75 sub-steps due to its scope and complexity. The shadowing process has shown that a service technician is working at machinery approximately 30 % of the time. The remaining time consists of administration (like paperwork or ordering spare parts), search for information as well as communication with central departments and travelling time. The empirical validation of the concept showed that all required information is covered by the here presented information needs. Obviously, information of some categories is used more frequently than others. One reason is that some (administrative) information is declared mandatory by the organization – like work order information, service item information or spare part information and has to be updated until closing the service order. [41]

As a main result, most information needs have been recorded in the *Controlling* phase in which, compared with the other phases, almost each type of the 13 defined information needs has been gathered. While the first half of the phases from the maintenance process is characterized by the processing executed by the back office, the last three phases are predominantly executed by the service technician being at the point of service. In conclusion, analysis tools should be integrated into service support systems. Second, most information needs occurred during *Realization* in which primarily information concerning machinery, scheduling and procedure were captured while fulfilling their service duty. This underlines that procedural information concerning the execution of service activities is important and should not be neglected when implementing mobile TCS support systems. [41]

In order to provide a more generalizable view on information needs in the area of TCS this framework will be validated conducting another case study in a different industry. (Currently I am working with a company installing and maintaining technical

products onboard cruise vessels.) From a methodological perspective this research will be carried out equivalent to the here presented intralogistics case in order to provide a valid comparison and derive valid results.

**Table 3.** Consolidation of theoretical investigation and empirical evidence [41]

| Information need | Phase of the generalized maintenance process | | | | | | | | | | | | ∑ Information needs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Initiation | | Def. of Scope | | Plan Work | | Prepare Work | | Realization | | Controlling | | |
| | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | |
| N 1 Information from the manufacturer | ✓ | 0 | ✓ | 0 | ✓ | 0 | ✓ | 1 | ✓ | 37 | ✓ | 21 | 59 |
| N 2 Work order request information | ✓ | 4 | ✓ | 2 | ✓ | 0 | ✓ | 34 | ✓ | 38 | ✓ | 171 | 249 |
| N 3 Service item information | ✓ | 4 | ✓ | 1 | ✓ | 0 | ✓ | 35 | ✓ | 87 | ✓ | 173 | 300 |
| N 4 Maintenance contract information | ✓ | 1 | ✓ | 1 | ✓ | 0 | ✓ | 34 | ✓ | 38 | ✓ | 171 | 245 |
| N 5 Procedure information | | 0 | | 0 | ✓ | 0 | ✓ | 24 | ✓ | 43 | ✓ | 17 | 84 |
| N 6 Resource information | | 0 | | 0 | ✓ | 0 | ✓ | 34 | ✓ | 38 | ✓ | 171 | 243 |
| N 7 Tool information | | 0 | | 0 | ✓ | 0 | ✓ | 1 | ✓ | 9 | ✓ | 0 | 10 |
| N 8 Spare part information | | 0 | | 0 | ✓ | 0 | ✓ | 0 | ✓ | 35 | ✓ | 21 | 56 |
| N 9 Law and regulation information | | 0 | | 0 | ✓ | 0 | ✓ | 1 | ✓ | 1 | ✓ | 6 | 8 |
| N 10 Planning information | | 0 | | 0 | ✓ | 0 | ✓ | 34 | ✓ | 38 | ✓ | 171 | 243 |
| N 11 Scheduling information | | 0 | | 0 | ✓ | 0 | ✓ | 57 | ✓ | 72 | ✓ | 188 | 317 |
| N 12 Work order information | | 0 | | 0 | | 0 | ✓ | 34 | ✓ | 38 | ✓ | 171 | 243 |
| N 13 Feedback information | | 0 | | 0 | | 0 | | 0 | ✓ | 8 | ✓ | 6 | 14 |
| ∑ Information needs per phase | | 9 | | 4 | | 0 | | 289 | | 482 | | 1287 | 2071 |

# 5 Addressing RQ3

RQ3 focusses on the actual implementation of IS artefacts. To address RQ3 the conceptualized requirements are transferred into an artifact of use and utility in terms of an app for technical staff performing TCS processes. Currently, the results of RQ1 and RQ2 were incorporated into a prototype on a mobile support system for TCS. To gain relevance in an iterative research process the project is performed in a user-centered design (UCD) approach. A user-centered method for product development describing a process of four iterative steps is used as follows: 1. Specify context of use, 2. Specify requirements, 3. Produce design solutions and 4. Evaluate designs [42]. In an iterative approach, starting from use cases and information needs, the prototyping started with first scribbles and was developed towards a functional prototype. The prototype (cf. **Fig. 4**) is set up on a ruggedized iPad for field and laboratory testing. At the moment the prototype is integrated into the companies IT system. A (field-) evaluation was not possible as of today – but will be conducted in near future. While the service processes haven't changed, a second field study observing TCS staff allow direct contrasting the results in the given structure (former system compared to the system developed within this research approach). These combined results are used for a quantitative analysis (e.g. time spent per service process over all, time spent interacting with the IT system, etc., time spent for per use case, etc.). Besides the field test an eye-tracking study will be conducted as soon as the prototype is incorporated in the current version of the company's software. Comparing laboratory and field tests hopefully provide insights into generalizable use cases and their implementation in mobile support systems.

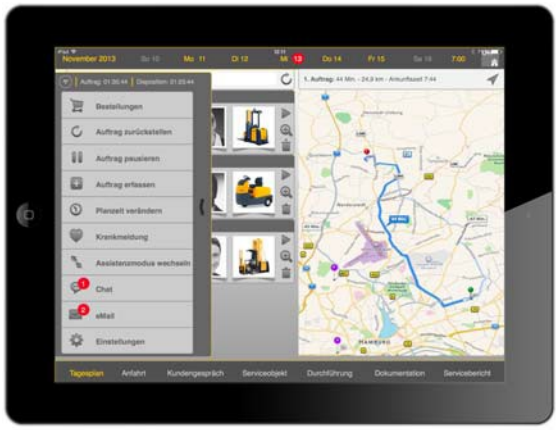

**Fig. 4.** Prototype – mobile support system for TCS [43]

## 6 Contribution to research

Since the literature review pointed out, that little research about information needs in TCS exist so far, it is aspired filling this research gap. Heretofore, information requirements have not been compared to the certain phases of a TCS process. So far, the information needs were ascertained on a document-basis with a practical orientation. This approach goes back where service processes were solely paper-based. Widely used documents in the area of TCS have been analyzed from a requirements perspective to identify information needs in order to design IS supporting technical service processes. In addition, those information needs have been structured along a generalized service process. This concept has been validated by contrasting it to real-world processes (empirical data from extensive observations). Other scholars can benefit from those results integrating or extending the conceptualized information needs into the design and implementation of (mobile) support systems in the area of TCS. Besides that a use case catalog was developed – and will be evaluated conducting another case study. The IT artefact (mobile support system for TCS) translates the conceptual framework into an information system of use and utility (evaluation outstanding). Relying on the compiled framework the application is not limited to certain hardware like tablets. Other scholars can apply these concepts to develop IS using other form factors like smart watches or augmented reality or virtual reality.

## 7 Practical implications

The frameworks of conceptualized information needs as well as the use case catalog can be beneficial to practitioners giving a structured overview of information needs and their occurrence in the service process. The framework provides a condensed view to identify and structure requirements prior to “make or buy” TCS support systems. It can

be used as a starting point to set priorities for further steps. Also the framework can be used to review existing solutions and help to identify potentials for improvement.

## 8 Limitations

Finally, the investigation – as of today – was limited due to the following circumstances. The empirical research within this case study is restricted to only one company and one industry (intralogistics). If the scope of the investigation would be extended to additional companies and sectors, more generalizable results could be achieved. While this research was conducted in the area of intralogistics, basically technical service processes like maintenance and repair were of main interest. Hence, the results can be generalized to industries having similar TCS requirements such as the agricultural machinery industry or construction machinery industry. In the most abstract sense, they are applicable for TCS work engaged with complex engine-powered movable capital goods requiring on-site repair and maintenance work. The outcome of further cases will enhance the generalizability of the here presented results. Due to the fact that the empirical investigation was limited to the observation of the TCS technicians only, it is difficult to make a point about the information need in the early phases of the TCS process or in the back office. In order to gain information needs in those phases, an observation of the TCS employees working in the back office ought to be conducted.

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# An Adaptive Case Management approach for supporting the Incident Management process in data centers

Robert Meyer[1]

[1] Technische Universität München, Chair for Information Systems I17, Garching, Germany
robert.meyer@in.tum.de

**Abstract.** As data centers continue to grow in complexity and size, the management of IT services hosted in them becomes an increasingly complex task. While a lot of research still focuses on fully automating data center operations up to the point of full "lights-out" some processes seem less suitable for automation due to their unstructured, ad-hoc character, frequently called "knowledge(-intensive) work". Following a Design Science approach, the goal of the proposed thesis is to elicit requirements by means of case studies and a literature review for knowledge-intensive activities of the Incident Management (IM) process in data centers. Based on these findings, a prototypical implementation of such a tool based on the Adaptive Case Management (ACM) paradigm shall be developed. The prototype will afterwards be evaluated by means of a theoretical evaluation, questionnaires and a case study.

**Keywords:** Incident Management, Adaptive Case Management, Data Center, Knowledge-intensive, Knowledge work.

## 1 Introduction

The growing need for more powerful and sophisticated IT services is fueling a constant increase of data center size and complexity. In fact, today's data centers do not only grow horizontally but also vertically by running more machines in parallel, which in turn also host higher "stacks", i.e. services that host other services [1, 2]. The advent of cloud computing has further aggravated this trend, also leading to high ownership heterogeneity, meaning that different parts of an infrastructure landscape can belong to different parties and stakeholders. These trends are leading to a rise in management complexity, making it harder to keep a holistic view of what is going on in the data center landscape on different infrastructure layers and correspondingly fulfill SLA agreements [1, 2].

Approaches found throughout the literature dealing with the subject matter traditionally propose automation techniques as possible solutions to regain control over data center processes while at the same time minimizing human error (e.g. Isard [3]). While these approaches do help in alleviating management complexity, they tend to only cover parts of a data center's management processes while completely leaving out others. In fact, it seems that some data center processes seem to be more eligible for

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automation than others. A possible reason for this diversity lies in the various degrees of knowledge-intensity (as defined by e.g. Eppler, Seifried and Röpnack [4]) a respective process in a data center exhibits. Knowledge-intensive work in general is harder if not wholly impossible to automate by traditional methods like workflow, straight-through processes or software due to its "late-structured nature" [5], where late-structured means that the process is not defined in advance but rather emerges during its execution flow. One of these hard to automate processes is the Incident Management (IM) process, whose goal it is to bring data center operations back to normal operation levels as quick as possible according to e.g. given SLAs when disturbances, so called "incidents" occur [6].

In order to deal with such hard to automate, knowledge-intensive, late structured processes the so called Adaptive Case Management (ACM) methodology [7] has emerged. Adaptive Case Management has its roots in the Case Management methodology, which first appeared in the Health Care sector. Case Management treats single process instances as so called "Cases", which have a clear starting and end point but leave it to the process participant(s) to figure out the best way to the solution. Furthermore, cases organize all data and activities related to the solution of the case. Adaptive Case Management takes this concept one step further by incorporating mechanisms, which allow a process participant to gain insight into the steps taken in former case instances to successfully reach the same case goal and thereby helping the process participant to reach his goal faster and more efficiently [7].

## 2 Research objective

The aim of this thesis is to connect the ideas of ACM with the Incident Management process in data centers. In order to attain this goal, the following research questions shall be answered:

- **RQ1: What are requirements for an ACM-based tool supporting knowledge-intensive Incident Management tasks in data centers?**

The first research question aims at eliciting the requirements for an ACM-based tool for supporting knowledge-intensive tasks in the Incident Management process in data centers. This shall be done by first off by conducting two literature reviews (following the guidelines of [8]), one on the current state of the art of research aiming at supporting the Incident Management process in data centers and the other on the current state of research in the Adaptive Case Management domain. Furthermore, in order to evaluate the IM process' suitability for a BPM methodology developed for supporting knowledge-intensive processes, its knowledge-intensity shall be examined at three different data centers by means of case studies according to [9]. The case studies should collect the various tasks involved in the examined organizations' Incident Management processes and classify them according to their knowledge-intensity. Furthermore, the case studies shall elicit the requirements for a tool supporting these tasks, which will

subsequently be mapped on the capabilities an ACM-tool can provide according to the aforementioned literature study.

- **RQ2: How can the Adaptive Case Management paradigm be applied to the Incident Management process with regard to its knowledge intensity?**

Building on the findings of RQ1, the second research question shall examine how a tool following the ACM paradigm should be designed to support knowledge-intensive Incident Management tasks. In order to do this two case studies on the requirements for supporting knowledge-intensive processes in general shall be conducted and its results – combined with those from the literature review on ACM performed as part of RQ1 – shall then be refined into a general model for an ACM platform. The specific requirements for an ACM tool supporting the Incident Management process in data centers are then mapped onto this general ACM platform model in order to create the concept for an ACM Incident Management tool, which is then subsequently implemented via prototyping.

- **RQ3: Which benefits can be achieved by adopting the adaptive case management paradigm in the Incident Management process?**

Within this research phase the prototypical implementation of the previously built Adaptive Case Management tool for supporting the Incident Management in data centers shall be evaluated. The evaluation will be executed in three iterations: At first, the prototype will be theoretically evaluated against the requirements established in RQ1. Secondly, the tool will be assessed by professionals in the field using a questionnaire-based evaluation. Finally, the tool will be deployed within the Incident Management of an organization using a case study. Based on this case study, benefits achieved through the tool are identified.

## 3 Research Design

The proposed research endeavor is geared towards a design science-oriented approach, which aims at creating and evaluating "IT artifacts intended to solve identified organizational problems" [10]. Possible outcomes of a design-science oriented research encompass models, methods, constructs and instantiations thereof [11]. The concept and implementation of an Adaptive Case Management prototype for supporting the Incident Management process in data centers constitutes a combination of models describing the general architecture and layout of an Adaptive Case Management platform as well as methods for realizing its proposed features and an instantiation as proof of concept. Building on the general design science process model described by Peffers, Tuunanen, Rothenberger and Chatterjee [12], the proposed research will be structured in five distinct phases: *Problem identification and motivation*, *Definition of solution objectives*, *Design and development*, *Demonstration and evaluation* and *Communication*. In the following, the research design already laid out in the previous

chapter is compartmentalized according to the chosen research methodology and described in detail.

### 3.1 Problem identification and motivation

First off, the domains of Incident Management in data centers is described in detail with regard to its respective current status of research. Also, the Incident Management process in data centers is examined with regard to its knowledge-intensive tasks by means of case studies as well as the capabilities a tool for supporting the Incident Management should offer according to the literature.

### 3.2 Definition of solution objectives

After the initial problem identification and motivation the objectives and requirements as well as a general model for the proposed ACM tool for the IM process in data centers are defined. This also includes the elaboration of parts, which the first prototype should feature by conducting interviews with experts in the field.

As a first step, the current state of research on Adaptive Case Management is reviewed based on a comprehensive literature review with a focus on existing ACM frameworks as well as the general capabilities an ACM tool should offer. Additionally, in order to better grasp the general demands for supporting knowledge-intensive processes, two cases studies on processes with strong knowledge-intensive characteristics will be performed. The results of these former steps will then be molded into a general model of the architectural parts an ACM platform should consist of.

In a second step, requirements for a tool supporting the IM process in data centers will be elicited from the literature (e.g. [13]) and subsequently assessed with regard to their importance by means of an expert survey among practitioners.

The outcome of this phase will be a general model for an ACM platform based on a study of the current literature and case studies as well as a mapping of the found and assessed requirements on this model.

### 3.3 Design and development

During this phase, the general ACM platform model with the mapped requirements will be further detailed and elaborated by on the one hand defining the right software platform to build the proposed solution upon (e.g. an in-memory database like SAP HANA as ACM implies dealing with a Big Data problem [14]). Furthermore, a data model as well as a technical software architecture and suitable testing methodologies will be defined in this step. The prototype of the proposed ACM tool will afterwards be implemented according to the laid out planning.

### 3.4 Demonstration and evaluation

The "Demonstration and evaluation" phase will encompass the development of an evaluation model for the developed prototype's effectiveness and efficiency with which the prototype will be assessed. The evaluation will be executed in three iterations: First off, the prototype will be theoretically evaluated under the terms of the found requirements. Subsequently, the tool will be assessed by professionals in the field using a questionnaire-based evaluation. Finally, the tool will be deployed within the incident management of an organization using a case study to evaluate its utility. Based on this case study, benefits achieved through the tool will be identified.

The last phase's result will be the evaluated ACM-based tool for supporting the incident management process in data centers.

### 3.5 Communication

Finally, the developed prototype as well as all accompanying artifacts will be presented to the scientific community.

## 4 Contribution

The contributions of the thesis' proposed outcomes are as follows: On the one hand the thesis would provide a step into analyzing and properly classifying the operations done in a data center with regard to the nature of work being conducted. This could pose as a foundation for other researchers to better understand and support operations in data centers through their results.

Furthermore, data center operations seem to be something that has not experienced a lot of attention by the information systems research community so far. In fact the author to date has not seen any contributions dealing explicitly with knowledge-intensive processes in data centers in particular. On the other hand, introducing Adaptive Case Management to the field of IT service management (ITSM) with a focus on Incident Management so far seems a novel approach in the scientific Adaptive Case Management community, only covered by Motahari-Nezhad and Bartolini [15] (who do not call it Adaptive Case Management though) and to some extent Gupta, Prasad, Luan, Rosu and Ward [16] (who do not follow the Adaptive Case Management paradigm as their work emerged prior to its advent). Additional to this, the thesis would provide a foundation for building ACM-based tools by offering a general platform design model.

## 5 Limitations

Boundaries of the proposed thesis include the strong focusing on the Incident Management process as well as the dedicated utilization of the Adaptive Case Management methodology. While the Incident Management seems to bear strong knowledge-intensive characteristics, there might be more knowledge-intensive ITSM

processes that the proposed thesis does not cover. Own research results suggest that with Problem Management and Information Security Management two additional processes commonly found in ITSM show a high grade of knowledge-intensity.

Moreover, Adaptive Case Management is not the only methodology for supporting knowledge-intensive processes. Other methodologies might be suitable for the same task as well but are not in the scope of this thesis.

## 6 Research Results so far

First examinations of the pertinent literature on data center operations revealed knowledge-intensive characteristics in the Incident Management process as well as in the Problem Management and Information Security Management process (all three according to ITIL [6]).

In addition to this, a literature review on the current state of research in the field of ACM has already been performed. Furthermore, the two planned case studies for better understanding the nature and demands of knowledge-intensive processes in general have already been conducted as well. Additionally, the proposed general model for an ACM platform has been synthesized from the already existing frameworks and capabilities ACM should offer, which have been found in the literature as well as the case study findings.

## 7 Submission Date

I plan on submitting the proposed dissertation in Q1 2017.

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# Dissertation Proposal: A Framework and Design Patterns for Gamified Collaborative Open Innovation

Martin Boeckle[1]

[1] EIPCM, European Institute for Participatory Media, Berlin, Germany
m.boeckle@eipcm.org

**Abstract.** *This dissertation proposal investigates the application of gamification in the domain of collaborative open innovation. The problem statement underlines the limited scope of exploiting external knowledge since no possibilities for cooperative knowledge creation are provided. Additionally the incentive models of current open innovation platforms are more oriented towards stimulating individual participation, such as price or a portion of revenue share for the one solution selected for implementation. In order to use collective intelligence more effectively, different motivational structures and tools to better support the cooperation and knowledge exchange between the participants are necessary. The proposed research questions address the design of collaborative visual annotations and the application of gamification for effectively supporting collaborative open innovation. Accordingly, a design science approach shall be adopted in order to develop a framework and design patterns for gamified collaborative knowledge creation in open innovation as a novel research contribution in the field of information systems.*

**Keywords:** *Gamification, Open Innovation, Visual Annotation, Design Patterns*

## 1 Introduction

The processes of product and service development are undergoing major changes as a result of new models of collaborative innovation. Many established companies, such as Procter & Gamble, LG Electronics, Kraft Foods, Unilever or IBM to name but a few, are rethinking their innovation processes and replacing their standard (vertical) integration with an open innovation approach [12]. Chesbrough (2003) defines the concept of "Open Innovation" as a paradigm, describing how firms can open up their innovation process to more effectively integrate external knowledge through an open model, where ideas and solutions for new or improved products, processes or services come from a variety of external actors, such as customers, suppliers, business partners or the general public. This can happen through a range of models from open idea competitions, through customer innovation forums to online innovation jams. Compared to a closed innovation approach, the open innovation model presents a more dynamic way of innovation management where companies look inside out and outside

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in. The associated model by Chesbrough (figure one) marks the firm boundaries and shows the possible emergence of new markets outside of them.

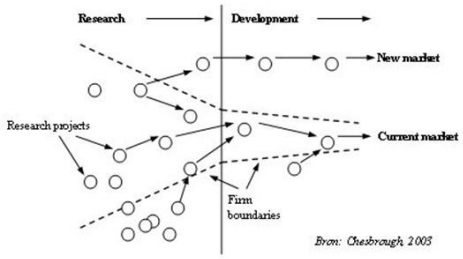


**Fig. 1.** *Open Innovation Model (Chesbrough 2003)*

Recent research has shown how such involvement of outsiders can indeed speed up processes, reduce costs, introduce more innovative ideas and reduce time to market [13]. A critical issue in open innovation is ensuring active participation of a wide variety of external participants, e.g. experts from different areas [2]. This requires scale and outreach as well as appropriate incentive models for engaging not only a few but a large number of active contributors; a requirement which is feasible only for global, large companies. At the same time, it is the small and medium-sized companies (SMEs, startups) that could benefit from open innovation the most. In order to overcome such problems of scale and asymmetry of participation (i.e. the "lurker" problem [8], current research is increasingly investigating the use of gamification i.e. "the use of game design elements in non-game contexts"[5]. The importance of gamification is also becoming visible in a variety of forms in practice, ranging from customer engagement and innovation management to training and education. According to Gartner (2011), by 2015 more than 50% of the organizations, which are dealing with innovation processes will gamify them. Similarly, the use of gamification in the design of engaging business software has also been investigated recently, with the notion of player-centered design extending the "traditional" user-centered design [7][11].

## 2 Problem Statement

Current open innovation platforms (e.g. atizio[1], innocentive[2]) typically connect solution seekers (companies) with problem solvers (individuals), but mainly support individual contributions of single users (e.g. submitting one's own solution idea to a given problem). This results on one hand in a limited scope of exploiting external knowledge since no (or little) possibilities for cooperative knowledge creation are provided. On the other hand, the incentive model itself is oriented towards stimulating

[1] http://atizio.com
[2] http//innocentive.com

individual participation, such as a prize or a portion of revenue share for the one solution selected for implementation. Table one reflects current open innovation platforms and their degree of collaboration and what kinds of incentive systems they are using.

| Platform | Collaboration and incentive Models |
|---|---|
| One Billion Minds (http://www.onebillionminds.com) | Brainstorm functionality which is connected to Facebook, simple comment and like function; Top responses can achieve a special award; Individual awards are created by the solution seekers; |
| Atizio (http://atizio.com) | Top inventors are ranked by reputation points, quality and efficiency; Collaborative functions are limited to idea submissions and include a simple image upload function, comments and keywords; Atizio also includes monetary rates; |
| Quirky (http://quirky.com) | Quirky offers community feedback through user comments and has a internal score system based on idea influence; Inventors can influence other projects by "price project", "tagline project" or "name project"; Images and videos can be attached to the submission; Quirky includes a monetary model to motivate the innovation community; |
| NineSights (http://ninesights.ninesigma.com) | The community includes innovation contests (e.g. by GE) and NineSigma requests, where innovators can respond via comments and attachments; The award amount is often announced as "to be determined" (TBD). |
| InnoCentive (http://innocentive.com) | InnoCentive offers open innovation challenges on a professional level; They include premium challenges for different types (e.g. ideation stage) with huge monetary awards; Comments and attachments can be applied when users submit a solution; |

**Table 1.** Open Innovation Platforms

But research has shown that the users incentive to participate in cooperative knowledge creation and exchange is rarely based on monetary incentives but on a range of other motivating factors (e.g. Wikipedia as the most prominent example) [15]. Recent work by Shen et al. [19] compared both, the "i-mode" and "we-mode" collective intention to understand online social behavior in crowdsourcing communities. The findings indicated, that the "we-mode" intention had a greater impact on users behavior. In order to make effective use of collective intelligence in open innovation we thus need different motivational structures and tools to better support the cooperation and knowledge exchange between the participants. The use of gamification has already proven it's worth as a method to motivate large groups of participants (in games-with-a-purpose such as EyeWire more than 100.000 participants engage in

solving scientific tasks without monetary reward [14]), but the integration of such game mechanics haven't yet been systematically investigated in the context of open innovation. An advantage of gamification is that it provides tangible benefits for a large group of users (fun, joy of use, scores, badges, leader boards), whereby traditional open innovation platforms use "winners take all" incentive models (e.g. prize money, revenue sharing). There is also a close link to social reputation where users can prove themselves with their status against others, which has been shown to be a major driver of participation in successful online communities [10]. Yet, a systematic analysis of how gamification can be used to design for and support cooperative open innovation still hasn't been addressed. Results from literature indicate that if game mechanics are applied inadequately, they are not able to unfold their full potential. At the same time literature [20] also reveals, that there is only little research on the boundaries between play and idea management.

## 3 Research Question and Approach

Accordingly, the main research question that I intend to address is: How can we systematically support cooperative knowledge creation in open innovation through the use of gamification and collaboration tools? The main idea is to analyze best practices from current gamification approaches and from cooperative knowledge creation in online exchanges and develop a model of how they could be transferred and applied to open innovation. More specifically, the goal is to redesign current tools for the creation of online contributions in open innovation so that they can be used by the participants a more collaborative manner. Such tools should support easy use and could be implemented as a lightweight version into the collaborative innovation platform. Current modalities such as classical user comments could be enriched to better support collaborative knowledge creation. Some results from CSCW research [16] and my previous work [1][21] suggest that one possibility could be the use of collaborative visual annotations, which could be connected with the elements of gamification. It has been shown that the use of annotations in a collaborative environment can have a positive influence on user participation [3] and that annotation-based discussion environments may lead to higher quality discussions [17]. Both are issues of critical importance for collaborative open innovation.

This leads to two specific questions:

- RQ1: How to design collaborative visual annotation tools to effectively support open innovation processes?
- RQ2: How to systematically use and design gamification elements for such cooperative open innovation?

Accordingly, the expected research contribution is the development and evaluation of a framework and design patterns for gamified cooperative knowledge creation in the domain of open innovation.

# 4 Methodology

In addressing these research questions I will adopt the design science approach which aims at solving theoretical and practical problems by creating new innovative artifacts [9]. In addition to behavioral science, which puts the focus on the development and verification of theories explaining human and organizational phenomena in the use and development of information systems, the main goal of design science research is the development of "technology-based" solutions to important and relevant business problems [9]. The creation of new innovative artifacts (new constructs, models, methods or prototype systems) provides a contribution to further state-of-the-art scientific knowledge in the area of information systems. At the same time, this kind of design science research allows organizations to apply this knowledge to act in new ways in solving problems more effectively and achieving their goals. The complete design process is thereby based on existing theories, which are applied and extended through problem solving and the creativity of the researcher and extended through the creation and validation of novel IT artifacts.

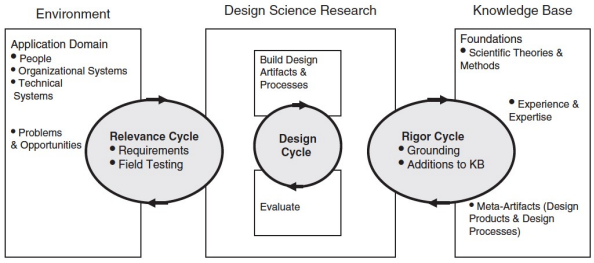


**Fig. 2.** *Design science research cycles [11]*

In this research proposal, the initial design of the framework and of the design patterns will be based on the theoretical analysis of existing work (case studies) on the application of gamification to selected business domains that are going to be transferred to meet the requirements of open innovation processes. The result will be validated and improved through implementing a prototype that will be evaluated in laboratory studies and in a pilot field test with a selected company. Based on the insights from this theoretical analysis and from the design and evaluation cycle, a new framework with associated design patterns will be defined. In this way, a theoretically grounded and empirically verified framework and design patterns for gamified cooperative knowledge creation in open innovation will be provided as a novel research contribution in the field of information systems. All the developed artifacts (framework, prototypes, design patterns) including the insights from the evaluation, will contribute to advancing existing state-of-the art on this topic. The application of the design science methodology ensures that the developed insights are not only methodologically sound but also have both scientific and practical relevance – an important goal in information systems research.

## 5 Previous Work

In my recent work I have investigated the use of collaborative visual annotations to support work-related knowledge exchange in general medicine. The developed solution and the study were part of the KOLEGEA (http://kolegea.de, https://beta.kolegea.org/kolegea/) platform that supports the creation and sharing of medical patient cases from everyday practice. This was accompanied with experiments investigating the use of cooperative visual annotations for enhancing knowledge exchange between general users in online forums. First results indicate that the use of collaborative visual annotations could provide important support for making online knowledge exchange more effective both for professionals (physicians) [1] and general users (publication in preparation). In addition to that I have conducted an explorative evaluation of a proof-of-concept prototype (figure3) in a setting simulating an online discussion for knowledge exchange in the ideation of products and services [21].

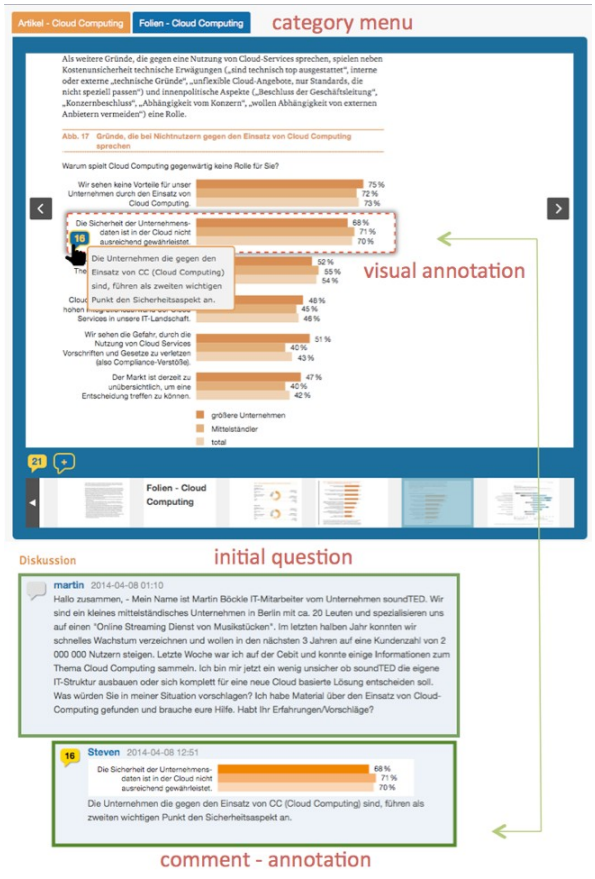


**Fig. 3.** *Proof-of-Concept Prototype*

Results reveal a high level of use of collaborative visual annotations and supporting functionalities, a high quality of discussion and a clear preference of the participants for this solution compared to traditional online forums. This underlines the potential of applying enhanced online discussions to support knowledge exchange in the ideation stage of design processes.
Recently I developed a mobile Application exploring gamification elements for cooperative innovation between SMEs and customers in fashion. The application has been evaluated within the EU research project CUbRIK with a Berlin-based fashion crowdsourcing startup.
This work has been done as a preparation for my thesis proposal, in order to verify the relevance and feasibility of the main research idea. It suggests both a practical need and research potential in investigating the proposed research questions.

## 6 Workplan

The diagram below outlines the main phases of my workplan.

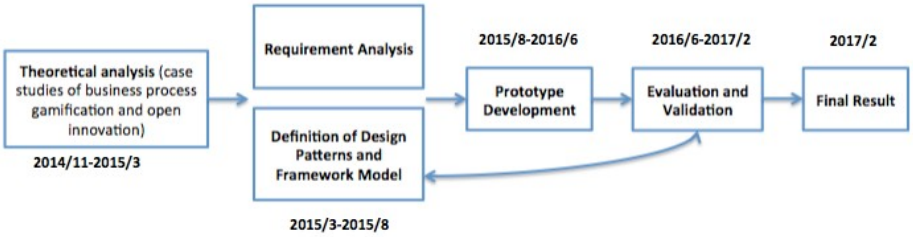


**Fig. 4.** *Workplan*

The workplan includes the development of collaborative tools to support collaboration in open innovation. Antikainen et al. [18] describes toolkits for collaboration as configurators, choice boards, design systems, co-design platforms which provides the customer with sufficient "manufacturing related" information and guide the user through the co-design process of expression their needs and wishes. A crucial aspect is how well they are able to communicate the knowledge of different stakeholders [18]. To verify the viability of our approach we identify appropriate test companies. This will be done with the assistance of Redstone Digital GmbH, a Venture Capital Management Company in Berlin.

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# Komplexitätsschätzung und Folgewirkungsbetrachtung der Integration in betriebswirtschaftlichen Anwendungssystemen

Sebastian Göhrig

Julius-Maximilians-Universität, Würzburg, Germany
{sebastian.goehrig}@uni-wuerzburg.com

**Abstract.** Angesichts der Tatsache, dass das Thema Integration seit über vier Jahrzehnten diskutiert wird (Heilmann 1962; Mertens 1966; Grochla 1974), besteht in der einschlägigen Literatur diesbezüglich erstaunlich wenig Konformität (Yu & Li 2007; Fischer 2008; Chowanetz et al. 2012; Klima et al. 2014). Ein Integrationsverständnis über betriebswirtschaftliche Anwendungssysteme stellt für Unternehmen dabei vor allem im Hinblick auf kontinuierliche Flexibilitätsanforderungen eine langfristige Herausforderung dar. Spezifische Integrationsanalysen sollen dabei sicherstellen, dass Aufwände und Kosten kontinuierlicher Systemanpassungen frühzeitig offen gelegt und Integrationsbeziehungen greifbar und messbar werden. In diesem Forschungsvorhaben wird daher ein Vorgehensmodell entwickelt, das ermöglichen soll, Integrationsgegenstände sowie deren Abhängigkeiten zueinander aus betriebswirtschaftlicher Standardsoftware abzuleiten. Die auf ERP-Systemen basierende Datengrundlage dient letztlich der Erstellung eines referenziellen Modells zur Visualisierung und Bestimmung des Integrationsgrades. Im Rahmen der Design-Science-Forschung wird das entwickelte Vorgehens- und Referenzmodell anhand realer Anwendungsfälle demonstriert und evaluiert.

**Keywords:** Integration, Integrationswirkung, Integrationsgrad, ERP-Systeme, Design Science, Graphentheorie

## 1 Forschungsbereich

Seit Beginn der Entwicklung der Wirtschaftsinformatik gilt die Analyse, Beschreibung und Gestaltung der Integration von Informationssystemen als eines ihrer zentralen Forschungsgebiete (Heilmann 1962; Scheer 1990; Mertens 2010). Integrationsbetrachtungen wurden seitdem kontinuierlich erweitert um die steigende Komplexität und Reichweite betriebswirtschaftlicher Anwendungssysteme beherrschbar zu machen (Rosemann 1999). Eine elementare Zielsetzung der Wirtschaftsinformatik besteht folglich darin, bei der Gestaltung und Nutzung von integrierten Informationssystemen einen möglichst „optimalen“ Integrationsgrad anzustreben (Scheer 1990; Rosemann 1999). Da weder eine eindeutige Definition des Integrationsgrades, noch eine einheitliche Methode um diesen zu bestimmen existieren, ist eine allgemeingültige

Bewertung der Integration sowie ihrer Wirkungsbetrachtung kaum möglich (Singletary et al. 2003; Klima et al. 2014).

Gegenstand dieser Arbeit ist demzufolge die Entwicklung eines Verfahrens, welches Integrationsabhängigkeiten aus betriebswirtschaftlichen Anwendungssystemen möglichst allgemeingültig sowie nachvollziehbar ableitet und somit langfristig die Bestimmung eines Integrationsgrades erlaubt.

### 1.1 Integration und Subsysteme

Grundsätzlich besteht das Ziel der Integration in der Schaffung einer Gesamtheit aus Einzelteilen, um einen größeren Nutzen zu stiften als einzelne Elemente (Linß 1995). Integration kann dabei als Tätigkeit oder erreichter Zustand verstanden werden (Grochla 1974; Lehmann 1980). Aus systemtheoretischer Perspektive wird Integration als Verknüpfung von Subsystemen zu einem System definiert (Lehmann 1980; Thränert 2005). Die einzelnen Subsysteme sind zusammen auf einen gemeinsamen integrierten Systemzweck ausgerichtet indem sie miteinander verbunden werden (Rautenstrauch 1993). Veränderungen in bestimmten Subsystemen wirken sich auf andere Subsysteme aus und beeinflussen somit das gesamte System (Heinrich et al. 2004). Innerhalb der Organisationstheorie können diese Subsysteme beispielsweise mit betrieblichen Aufgaben, Fachbereichen oder Organisationseinheiten gleichgesetzt werden (Lawrence et al. 1989). Integrationsrelevante Gegenstände in der Informatik dagegen sind Daten, Funktionen oder Benutzerschnittstellen (Ruh et al. 2001). Entsprechend sind Systemkomponenten in Softwaresystemen in sich geschlossene Gebilde, die Daten und Funktionen kapseln und somit voneinander abgrenzbar sind (Griffel 2001). Der betriebswirtschaftliche Bezug wird durch die den Komponenten zugordnete Aufgabenverteilung hergestellt. Je nach Umfang einer Aufgabe müssen die einzelnen Komponenten aufeinander abgestimmt bzw. zusammengeführt werden (Griffel 2001). Bezogen auf ein Referenzmodell ergeben sich allerdings Probleme einer einheitlichen Festlegung der Schnittstellen zwischen zwei (oder mehr) unmittelbar zusammenhängenden Aufgaben bzw. Subsystemen. Besteht ein Aufgabenkomplex etwa aus mehreren Teilen, ergeben sich unterschiedliche Möglichkeiten der Darstellung. Je nach Zuordnung der Teilaufgaben und Abgrenzung der Aufgaben innerhalb des Modells können sich Wirkung und Komplexität der Informationsabhängigkeiten ändern (Grochla 1974). Folglich besteht intensiver Untersuchungsbedarf darin, referenzielle Modellkriterien zu identifizieren, welche zum einen die Relevanz des Forschungsvorhabens unterstützen (Bestimmung eines Integrationsgrades) und zum anderen die Rigorosität der Datenerhebung gewährleisten (Ableitung von Subsystemen und Integrationsabhängigkeiten aus versch. Systemen).

### 1.2 Eingrenzung der Untersuchung

Trotz der logischen Zusammenhänge konnte sich ein einheitliches Begriffsverständnis zur Integration bislang nicht etablieren (Krcmar 1991; Rosemann 1999). Dies liegt mitunter an einer Vielzahl theoretischer Integrationsrahmenwerke und praktischer Anwendungssysteme, welche auf unterschiedliche Weise versuchen, Integrati-

onsgegenstände zu etablieren (Thränert 2005). Weiterhin muss zwischen den Betrachtungsweisen der organisatorischen und informationstechnischen Integration differenziert werden (Rosemann 1999). Ein weiteres Unterscheidungsmerkmal stellt die Integrationsreichweite dar. Es wird dabei zwischen inner- und zwischenbetrieblicher Integration unterschieden (Heilmann 1989; Krcmar 1991). Für das Vorhaben wird eine unternehmensübergreifende Betrachtung der Integrationswirkungen anfangs nicht berücksichtigt. Stattdessen soll der Fokus aufgrund der systemanalytischen Vorgehensweise auf unternehmensweite Integrationswirkungen gelegt werden.

Eine weitere Differenzierung des Integrationsgrades wird mithilfe der Dimension Integrationsrichtung charakterisiert und beschreibt die Positionierung der Integration in Bezug auf Unternehmensebenen (Scheer 1993). Dabei kann grundsätzlich zwischen horizontaler und vertikaler Integrationsrichtung unterschieden werden (Mertens 2010). Innerhalb dieser Arbeit beschränkt sich die Untersuchung auf den horizontalen Integrationsansatz innerhalb der operativen Systemebene.

## 2 Identifikation der Forschungslücke

Bei der Aufarbeitung bisheriger Ansätze zur Messung der Integrationsfolgewirkung lassen sich in Theorie und Praxis unterschiedliche Ansätze identifizieren, welche sich in ihrer Tiefe und Abstraktion der Integrationsfolgewirkungsbetrachtung unterscheiden. Die Betrachtung der Integrationswirkung ausgehend von unmittelbar betroffenen Informationsobjekten bzw. Unternehmensbereichen hin zu allen und damit auch mittelbar, d.h. indirekt betroffenen Objekten, wird in der Literatur sehr differenziert gehandhabt. Zudem unterscheiden sich die Ansätze in ihrem Integrationsgrad. Eine Skalierung von abstrakt bis spezifisch basiert demnach auf der tatsächlichen Bezugnahme zu realen Unternehmensobjekten, weshalb Software-Werkzeuge eher im spezifischen Raum zu finden sind und allgemeine Integrationstheorien eher einen abstrakten Charakter haben (vgl. Abbildung 1). Während das Ziel dieser Dissertation in der Betrachtung unmittelbarer und mittelbarer Integrationsfolgewirkungen spezifischer betriebswirtschaftlicher Objekte liegt, können abstrakte theoretische Betrachtungen von IO nicht alle Integrationsfolgewirkungen miteinbeziehen, weil die betriebswirtschaftliche Spezifität fehlt. Aus diesem Grund finden sich keine Ansätze für den Teilbereich „unten rechts“. Die Größe der Kreise in Abbildung 1 symbolisiert die Breite der Integrationsbetrachtung als dritte Dimension.

Zahlreiche Ansätze betrachten die Integrationswirkung eher direkt und abstrakt. Vor allem theoretische Frameworks lassen sich in diesem Bereich ausmachen. Beispielsweise erörtert Sherman (2004) einen direkten Zusammenhang zwischen Koordinationsanforderungen und Integration (vgl. Abb. 1, Kreis 5), während Browning (2001) eine Design-Structure-Matrix (Kreis 6) anbietet um auf abstraktem Niveau eine Datenintegration zu ermöglichen. Bevernik et al. (2006) zeigen ein weiteres Modell zur Anwendungsintegration (Kreis 7), welches deutlich komplexer ausfällt als die beiden zuvor genannten Arbeiten, aber dennoch in der Tiefe der Integrationsbetrachtung relativ einfach ist. Weitere ähnlich abstrakte Integrationsbetrachtungen finden sich auch bei deutschen Autoren wie Mertens (1966) (Kreis 11), Holten (2003) (Kreis

12), Scheckenbach (1997) (Kreis 13), Teubner (1999) (Kreis 14) oder Kurbel (2011) (Kreis 16). Mertens (2010) (Kreis 15) zeigt einen höheren Grad an Spezifität.

Aus der Praxis existiert eine Vielzahl von als Softwaretools implementierten Auswahl- und Integrationslisten. Software-Auswahl-Plattformen wie Softselect (Softselect 2013) (Kreis 8) oder IT-Matchmaker (IT-Matchmaker 2013) (Kreis 9) zeigen anwendungsorientierte Werkzeuge zur Bewertung der Integration und Funktionalität von Unternehmenssoftware. Ähnliche Ansätze finden sich z.B. in Büchern von Schütte und Vering (2011), Becker et al. (2007) oder Fandel und Gubitz (2008). Auch Gronau (2012) (Kreis 10) ist hier beispielhaft zu nennen.

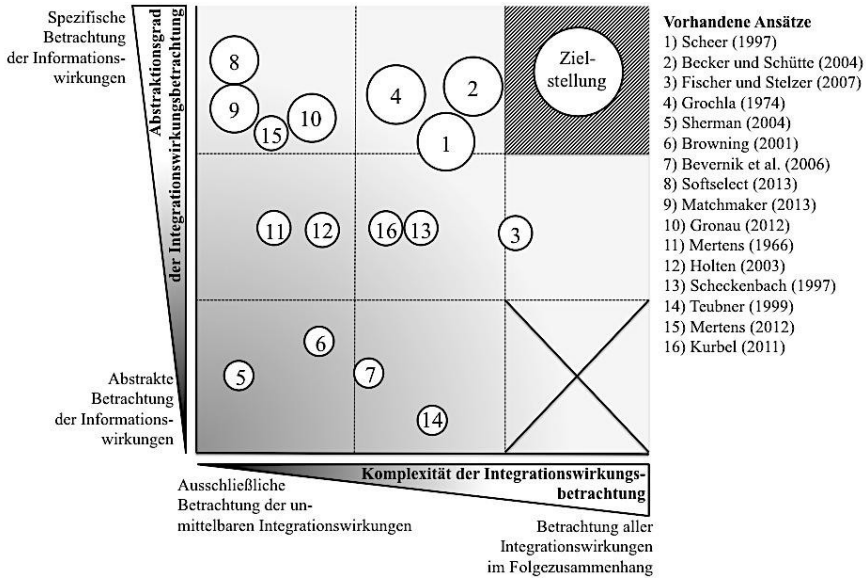


**Abb. 1.** Klassifizierung bestehender Integrationswirkungsbetrachtungen

Des Weiteren finden sich in der Forschung zahlreiche gestaltungsorientierte Integrationsmodelle, von denen hier exemplarisch häufig genannte hervorgehoben werden: Das Y-CIM-Modell (Kreis 1) strebt nach einer Verknüpfung der operativen Informationssysteme mit dem Fokus der Zusammenführung technischer und betriebswirtschaftlicher Aspekte (Scheer 1997). Das Handels-H (Kreis 2), als Modell zur Verknüpfung von Funktionsbereichen im Unternehmen durch Handelsprozesse (Becker und Schütte, 2004), zeigt tiefere Integrationsbetrachtungen als Y-CIM und liegt auf einem ähnlichen Abstraktionsniveau. Das von Fischer und Stelzer (2003) gezeigte Illmenauer Integrationsmodell (Kreis 3) zeigt einen Einbezug unternehmensübergreifender Integration, weshalb hier von einer erhöhten Tiefe (Komplexität) gesprochen werden kann. Das Kölner Integrationsmodell (Kreis 4) zeigt eine Betrachtung der durch Datenverarbeitung lösbaren Aufgaben und deren Informationsbeziehungen (knapp 1500 Stück) zueinander (Grochla 1974). Hier ist eine deutlich spezifischere

Ausprägung zu erkennen, die jedoch auf unternehmensinterne Themen in der Komplexität der Betrachtung beschränkt ist. Den genannten Modellen ist gemein, dass sie zwar bis zu einem gewissen Grad eine spezifische und komplexe Integrationsbetrachtung erlauben, jedoch keinerlei Möglichkeiten zur Analyse von mittelbaren Integrationswirkungen als Ansatzpunkt zur Bewertung der Komplexität bieten.

Keiner der identi i ierten Integrationsans t e eist gleichermaßen eine on rete Spezifität durch realen Bezug zu Informationsobjekten in Systemen und ein hohes Maß an Integrationsfolgewirkungsbetrachtungen auf. Das Dissertationsvorhaben positioniert sich exakt in diesem Bereich (Zielstellung), indem durch Identifikation, Extraktion sowie Modularisierung integrativer Abhängigkeiten aus betriebswirtschaftlichen Anwendungssystemen um einen olge ir ungen bei ystemanpassungen und um anderen Komple it tsgrade dieser Änderungen vorab bestimmbar werden. Letztlich lassen sich bezüglich des Vorhabens zwei zentrale Forschungsfragen ableiten:

(FF1) In welchem unmittelbaren und mittelbaren integrativen Wirkungszusammenhang stehen betriebswirtschaftliche Informationsobjekte?

(FF2) Auf welche Weise werden Objekte und Beziehungen einheitlich aus betriebswirtschaftlichen Anwendungssystemen extrahiert?

(FF3) Wie muss ein Modell zur Darstellung und Analyse der Integrationsfolgewirkung von Informationsobjekten gestaltet sein?

## 3 Methodik und Vorgehensweise

Das wissenschaftliche Vorhaben basiert auf entsprechend den Teilaspekten zugeordneten methodischen Vorgehensweisen, welche im Rahmen eines Design-Science-Ansatzes strukturiert werden. Nachfolgend werden die einzelnen Teilschritte erläutert und in Abbildung 2 den entsprechenden Methoden zugeordnet.

Ergänzend zur Sequenzierung des DSRM-Ansatzes, der die Phasen der Entwicklung und Evaluation des Artefakts deutlich separiert, wird bei der hier vorgestellten Methodik ein wesentlich iterativeres Vorgehen angestrebt. In Anlehnung an das Action-Design-Research-Paradigma nach Sein et al. (2011) wird vor allem durch regelmäßige Evaluation im frühen Entwicklungsstadium die Relevanz und Anwendbarkeit des Artefakts sichergestellt. Um dies zu bewerkstelligen, müssen bereits frühzeitig entsprechende auswertbare Lösungsszenarien entworfen werden. Entsprechend der Anwendbarkeit und Tauglichkeit des Artefakts wird dessen grundlegende Struktur angepasst und iterativ weiterentwickelt.

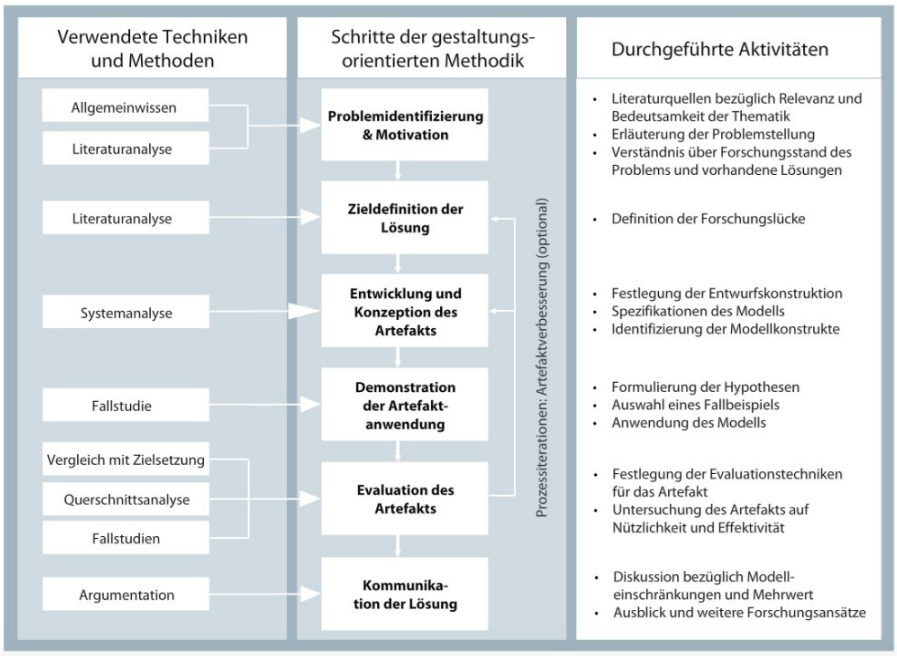


**Abb. 2.** Angewandte Forschungsmethodik in Anlehnung an Peffers et al. (2007)

### 3.1 Literaturanalyse

Zu Beginn eignet sich eine Literaturanalyse nach vom Brocke et al. (2009), welche vorab eine systematische Analyse und Aufarbeitung der entsprechenden Literaturbasis sicherstellt. Einerseits soll somit ein Überblick über den aktuellen Stand der Forschung bezüglich Integrationsanalysen gegeben werden. Andererseits sollen darin enthaltene Erkenntnisse bezogen auf Integrationsbeziehungen (Wirkungstypen) und Objekte identifiziert werden. Die Vorgehensweise der Literaturanalyse ist in Abbildung 3 illustriert und wird wie folgt durchgeführt. Zu Beginn der Analyse (I) soll sowohl der Umfang, als auch der Anwendungsbereich der weiteren Untersuchung definiert werden. Dies erfolgt unter Berücksichtigung der Taxonomie von Cooper, welche insgesamt aus sechs konstituierenden Merkmalen mit zugehörigen Kategorien besteht (Cooper 1988). Nachdem Umfang und Anwendungsbereich der Literatursuche definiert wurden, werden in einem nächsten Schritt (II) neben einer groben thematischen Einführung gängige Suchbegriffe in der einführenden Literatur identifiziert (Vom Brocke et al. 2009). Die eigentliche Durchführung der Suche stellt einen wichtigen zu dokumentierender Teil der Literaturanalyse dar (III). Innerhalb dieser Phase wird festgelegt, welche Ressourcen mithilfe welcher Datenbanken durchsucht werden, welcher Zeitraum für die Suche ausgewählt wird und ob lediglich der Titel, der Abstract oder der gesamte Text einer Ressource analysiert wird (Vom Brocke et al. 2009). Im Anschluss an den Suchvorgang wird die Literatur synthetisiert (IV), um

zweckmäßige Aussagen bezüglich der untersuchten Thematik treffen zu können (Vom Brocke et al. 2009). Das Rahmenwerk der Literaturanalyse wird letztlich durch eine Forschungsagenda abgeschlossen (V). Hierbei werden die Ergebnisse bewertet und gezielte Fragestellungen für zukünftige Forschungsvorhaben dargelegt.

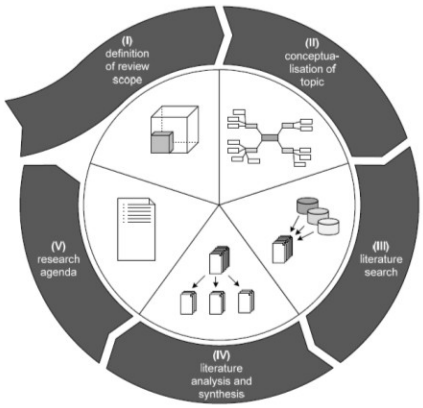


**Abb. 3.** Rahmenwerk der Literaturanalyse (Vom Brocke et al. 2009)

### 3.2 Entwicklung des Vorgehensmodells

Um ein systematisches Vorgehensmodell entwickeln zu können, welches Informationsobjekte sowie deren Abhängigkeiten zueinander eindeutig und nachvollziehbar aus betriebswirtschaftlichen Anwendungssystemen extrahierbar macht, muss zuvor eine definitorische Abgrenzung der Integrationsgegenstände auf unterschiedlichen Granularitätsstufen erfolgen. Auch im Hinblick auf Modellerstellung und Durchführung der späteren Integrationsanalyse ist diese Voraussetzung notwendig. Folglich determinieren angestrebte Systemanalyse und beabsichtigte Analyseergebnisse diejenigen Merkmale, welche verwendet werden können, um Objekte und deren Beziehungen eindeutig voneinander abzugrenzen. Dies muss ebenfalls vertikal auf sämtlichen Granularitätsstufen gewährleistet sein. Da angestrebt wird, spezifische integrative Folgewirkungen auf operativer Ebene abzuleiten, befindet sich beispielsweise die Auswirkung eines einzelnen Datums auf ein Datum oder eine Funktion eines weiter entfernten Unternehmensbereichs auf der untersten Granularitätsstufe. Sollen allerdings Integrationsbeziehungen möglichst abstrakt zwischen unterschiedlichen Unternehmensbereichen oder Abteilungen dargestellt werden, müssen diese Bereiche bzw. Subsysteme auf einer höheren Granularitätsstufe ebenfalls voneinander abgrenzbar sein. Bei der Abgrenzung der Integrationsobjekte auf operativer, feingranularer Ebene muss demnach stets eine Möglichkeit der Abgrenzung auf höherer Abstraktionsstufe berücksichtigt werden.

Um Grenzen zwischen unterschiedlichen Integrationsbereichen fixieren zu können, muss eine Abgrenzung anhand unterschiedlicher Kriterien erfolgen (Grochla 1974). Hierbei kann zwischen einer merkmals- und relationsorientierten Strategie zur Subsystembildung unterschieden werden (Gagsch 1971). Wird bei der Subsystembil-

dung merkmalsorientiert vorgegangen, erfolgt eine Zusammenfassung von Aufgaben gleicher Merkmalsausprägung in unterschiedlichen Bereichen, etwa der Beschaffung, der Produktion, des Vertriebs oder der Finanzen (Gagsch 1971). Hierbei müssen die Eigenschaften der Systeme wie beispielsweise deren Architektur, modularisierter Aufbau, GUI-Darstellung oder Datenmodell beachtet werden, welche die Datengrundlage des Modells darstellen. Zur strukturellen Abgrenzung können ferner vorhandene Referenzmodelle verwendet werden. Eine Aufarbeitung bisheriger Vorarbeiten ist dabei Aufgabe der Literaturanalyse.

Im Vergleich zu dieser Art der qualitativ-orientierten Abgrenzung und Synthese legt die relationsorientierte Vorgehensweise zugrunde, Kriterien wie Beziehungsdichte oder Beziehungsintensität als Determinanten der Abgrenzung von Subsystemen zu verwenden (Gagsch 1971). Dies entspricht zwar dem Zweck, Integrationsbeziehungen innerhalb der Merkmalsdetermination zu berücksichtigen, setzt allerdings voraus, dass eine grundsätzliche Objektabgrenzung bereits merkmalsorientiert vorliegt. Zwar könnte dabei die einem System zugrundeliegende Struktur der Subsysteme verwendet werden, allerdings ist damit zu rechnen, dass aufgrund der heterogenen Systemlandschaften eine Vergleichbarkeit der Subsysteme nicht a priori gegeben sein wird. Folglich stellt die relationsorientierte Identifikation im Rahmen des Forschungsvorhabens eine zukünftige und optionale, der merkmalsorientierten Vorgehensweise nachgelagerte Abgrenzungsdetermination dar. Mögliche relationsorientierte Merkmale in einem Integrationsanalysemodell wären bspw. die Anzahl übereinstimmender Datenfelder zweier Objekte, die Anzahl der Vorgänger- oder Nachfolgeobjekte oder die Wirkungsart eines Objektes auf ein anderes (vorhandene Daten einer Aufgabe sind zur weiteren Verarbeitung einer nachgelagerten Aufgabe zwingend notwendig).

### 3.3 Darstellung des Vorgehensmodells

Das zu entwickelnde gestaltungsorientierte Artefakt in Form eines Integrationsanalysemodells soll möglichst allgemeingültigen Charakter besitzen sowie relevante Hilfestellungen in der Praxis ermöglichen. Da für das zu entwerfende Modell Integrationsobjekte und Abhängigkeiten aus realen betriebswirtschaftlichen Anwendungssystemen abgeleitet werden, müssen die strukturellen Gegebenheiten der Systeme bei der Modellerstellung beachtet werden. Die Abgrenzung einzelner Integrationsobjekte in unterschiedlichen ERP-Systemen muss aufgrund der strukturellen und funktionalen Systemheterogenität stets iterativ innerhalb der einzelnen Systeme überprüft werden. Zu Beginn empfiehlt es sich deshalb aus der wissenschaftlichen Literatur abgeleitete Abgrenzungsmerkmale festzulegen (I). Hierbei wird entschieden, welche Merkmale notwendige- bzw. hinreichende Bedingungen der Abgrenzung darstellen.

Sind die Merkmale identifiziert, werden diese in Form von Merkmalsanforderungen formuliert (II). Dieses Vorgehen muss sowohl auf feingranularer Ebene sowie grobgranular durchgeführt werden. Beispielsweise müssen Merkmale zur Unterscheidung von Teilaufgaben innerhalb eines Aufgabenbereiches determiniert sein. Ebenso muss eine Determination zwischen Aufgabenbereichen stattfinden. Einige beispielhafte Anforderungen werden im Folgenden aufgeführt:

1. *Objekte müssen systemübergreifend eindeutig voneinander abgrenzbar sein*
2. *Objekte müssen eindeutig aus unterschiedlichen Systemen ableitbar sein*
3. *Objekte müssen mind. ein Vorgänger- oder Nachfolgeobjekt besitzen*
4. *Objekte müssen Daten mit mind. einem weiteren Objekt gemein haben*
5. *Es müssen Beziehungen zwischen den Objekten vorhanden sein, welche Aussagen über integrative Abhängigkeit und Wirkung zulassen*

Im nächsten Schritt werden innerhalb der Anwendungssysteme Objekte identifiziert, welche den Anforderungen entsprechen. Dabei wird mithilfe einer Maskenanalyse ein eingeschränkter Bereich, z.B. der im System abgebildete OTC-Prozess, über mehrere Systeme hinweg analysiert (III). Unterschiedliche Objekte sollten dabei möglichst eindeutig und zwischen den Systemen vergleichbar identifizierbar sein. Um eine möglichst objektivierbare Analyse zu gewährleisten, beteiligen sich mind. zwei Experten am Prozess der Datenanalyse und Konzeption. Dadurch wird eine reziproke Überprüfbarkeit sichergestellt und durchgeführte Interpretationen bekräftigt. Dieses Verfahren ermöglicht letztlich, widersprüchliche individuelle Interpretationen der Daten zu vergleichen, in Frage zu stellen und entsprechend zu bereinigen (Klein & Myers 1999).

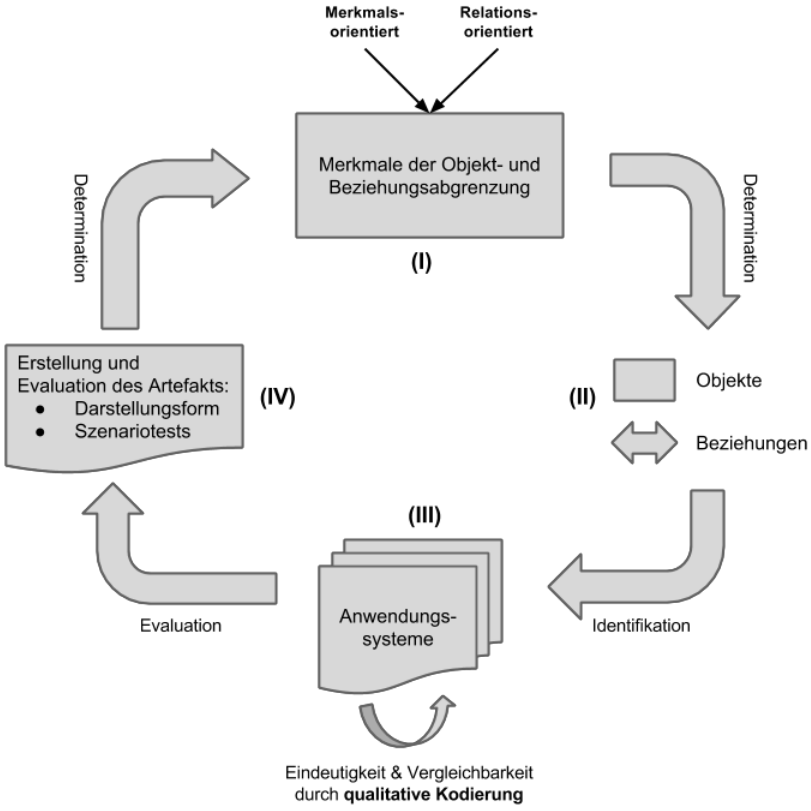


**Abb. 4.** Vorgehensweise der Artefakterstellung

In diesem Schritt ist außerdem die Entwicklung und Durchführung eines qualitativen Kodierungsverfahrens sicherzustellen um die Vorgehensweise der Identifikation und Abgrenzung einheitlich dokumentieren zu können. Dies geschieht iterativ, basierend auf den analysierten Systemen, welche die zu kodierende Datengrundlage darstellen (Glaser & Strauss 1976).

Abschließend werden die identifizierten Objekte entsprechend ihrer Granularitätsstufe in das Modell überführt (IV). In diesem Schritt muss eine Darstellungsform gewählt werden, welche sowohl Objekte als auch Beziehungen sowie deren Abgrenzung untereinander verdeutlicht. Langfristig wird eine Graphentheoretische Darstellungsform angestrebt um einerseits netzwerkartige Integrationsbeziehungen veranschaulichen zu können und andererseits eine relationsorientierte Synthese der Abgrenzung zu ermöglichen. Allerdings muss hierbei evaluiert werden, inwieweit feingranulare Interdependenzen (z.B. Datenabhängigkeiten) abgebildet werden können. Mithilfe praxisrelevanter Integrationsszenarien wird das Modell abschließend auf dessen Anwendbarkeit untersucht. Die Szenarien sind dabei so zu wählen, dass mittelbare Integrationseffekte enthalten sind.

Abbildung 4 fasst den iterativen Zyklus der Modellerstellung in einem Phasenmodell nochmals zusammen. Sämtliche Erkenntnisse aus den Phasen (II) bis (IV) fließen wiederum in die Determination der Objekt- und Beziehungsmerkmale ein. Iterative Anpassungen werden solange vorgenommen, bis sämtliche Phasen komplikationsfrei durchlaufen werden können.

## 4 Fazit und Limitationen

In diesem Dissertationsvorhaben wird das Problem fehlender Messmethoden für die Bewertung des Integrationsgrades adressiert. Das Forschungsdesign beruht auf dem Paradigma des Design-Science-Ansatzes bzw. der gestaltungsorientierten Wirtschaftsinformatik und hat zum Ziel, eine generelle Methode zur Ableitung von Integrationswirkungen aus betriebswirtschaftlichen Anwendungssystemen zu entwickeln, diese in ein Modell zu überführen und somit eine Bestimmung des Integrationsgrades zu gestatten.

Einerseits muss während der Entwicklung der Extraktionsmethode und Modellerstellung stets der langfristige Nutzen sowie die Anwendbarkeit im organisatorischen Umfeld berücksichtigt werden. Andererseits muss die Zusammenführung einer relativ heterogenen Datenbasis möglichst stringent und eindeutig erfolgen. Aus diesen Gründen erweist sich ein evaluierungsgetriebenes Vorgehen als folgerichtig.

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# Managing Heterogeneity in the IT Service Value Network: Guidelines for IT Service Management

Robert Heininger[1]

Technische Universität München, Chair for Information Systems, Munich, Germany
robert.heininger@in.tum.de

**Abstract.** Cloud computing supports specialization and modularization of service providers and involves the trend towards distributed service generation. Therefore, multi-vendor networks arise and IT departments have to handle heterogeneous IT service value networks (ITSVN). This thesis will first identify the main factors influencing heterogeneity in ITSVN. Secondly, approaches to manage heterogeneity in the ITSVN will be identified. Finally guidelines for managing heterogeneity in the IT service value network will be developed and evaluated. These guidelines will support IT departments in becoming service integrators/aggregators, and in aligning the common IT service management methods and standards to the special needs of heterogeneous ITSVN.

**Keywords:** Cloud computing, IT service, value network, heterogeneity

## 1 Introduction

Heterogeneity has been widely discussed in the IT literature [1] and is a topic of highly practical relevance. However, there is only little research about heterogeneity in IT service value networks (ITSVN). ITSVN can be defined as a multi-staged construct of networked but autonomous service suppliers whose delivery relies on information systems which generate a tangible and intangible value for an IT service consumer through complex dynamic exchanges between all participants of the network [2].

### 1.1 Situation

By becoming in-house IT service providers, IT departments have to manage the change towards IT service orientation, IT process orientation, and IT architecture orientation [3]. The growing requirements from business functions and the growing

[1] This dissertation is supervised by Prof. Dr. Helmut Krcmar, Technische Universität München, email: krcmar@in.tum.de.

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number of specialized IT solutions make the IT environment more and more heterogeneous. On the other hand, new provisioning models like IT outsourcing and cloud computing increase the complexity of the management of IT [4]. The complexity of a system can be defined as the number and the heterogeneity of components and relations [5]. Heterogeneity is related to the variety of IT elements [1]. Cloud computing leads to more modularization in the IT industry [6]. Modularization comprises the decomposition of one object into decoupled single components [7] and enables the creation of new service offerings. Also, cloud computing "[…] transforms IT services from vertically integrated [services] to an IT supply cloud chain model" [8] and induces the emergence of multi-stage supply relationships and IT value networks [6]. These multi customer-supplier relationships result in heterogeneous IT service landscapes [9], whose impact on the value creation process has not been researched yet [4]. Thus, cloud computing is one big driver of heterogeneity. IT solutions are offered from different providers in different levels of provisioning and with different qualities of service [10]. Thereby, provisioning IT services nowadays includes the orchestration of several vendors and therefore leads to supply chain management problems in the field of IT service management (ITSM) [8]. The management of in-house development and provisioning of IT services becomes less important and the usage of service supply chains increases [11].

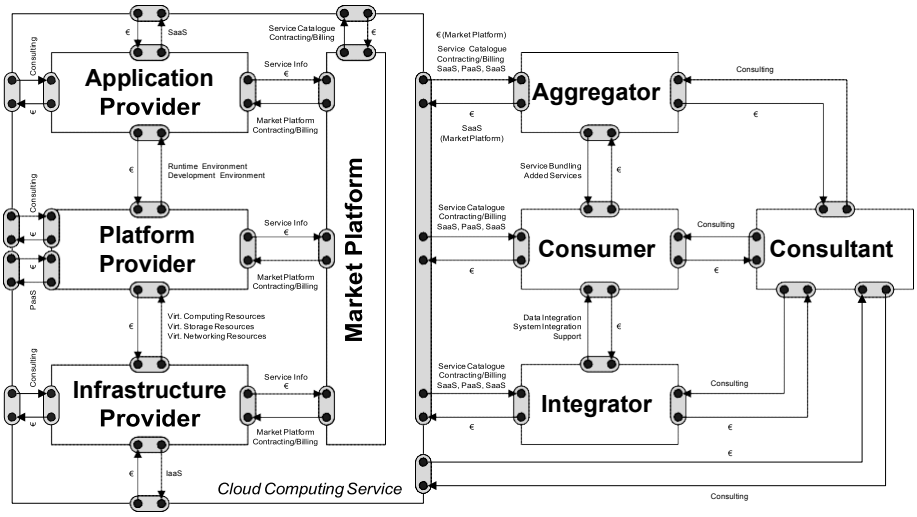



**Fig. 1.** A generic value network of cloud computing [12]

Fig. 1 shows a generic value network of cloud computing according to Böhm, et al. [12]. The network was derived by analyzing a dataset of 2628 cloud services and presents a business perspective on cloud computing. The authors identified eight generic actors and arranged them into a value network using the e³value method [13]. This thesis focuses on the role of IT departments. Therefore aggregators and integrators are relevant for this thesis. Aggregators combine existing services created

by various providers into service bundles and offer them to service customers. Integrators focus on integrating cloud services into existing IT landscapes including technical, data, process, and governance issues [12]. Both, aggregators and integrators have to address the challenges caused by heterogeneity to offer their value-added service to the consumer. Other works define deviating and additional actors, e.g. cloud auditor, cloud carrier, and cloud broker [14].

### 1.2 Complication

With cloud computing the way of generating and delivering IT services changes fundamentally towards ITSVN [6, 15]. IT departments are facing the challenge of managing heterogeneous IT landscapes alongside with progressively distributed service generation. On the one hand heterogeneity leads to an increase of complexity and thus makes the management of ITSVN difficult. On the other hand, heterogeneity may result in higher flexibility of the ITSVN and thus leads to an increased sustainability. "Flexibility is typically associated with the ability to respond to some kind of uncertainty or change" [16] and gaining an optimal degree of flexibility can lead to significant competitive advantages. Therefore, the relevance of heterogeneity increases when more flexibility in the information systems of the organizations is required [1].

It should be noted, that there are two effects of an increase in heterogeneity. On the one side, increasing heterogeneity will lead to increasing complexity and thus also to a rising effort in managing IT. On the other side, increasing heterogeneity comes along with an increase in flexibility and thus brings sustainability. It means that heterogeneity in an ITSVN has both a positive and negative aspect. Therefore, the IT management must try to find the optimal degree of heterogeneity [1] and must handle the tradeoff between increasing complexity and flexibility.

ITSM is acknowledged as an important element to handle cloud based service delivery [17] and adapted ITSM methods for managing heterogeneity in ITSVN are needed. Against this background, ITSM is facing the challenge of coping with growing heterogeneity in IT landscapes, which creates a need for models, methods, tools and best practices supporting this endeavor. Therefore, common ITSM standards, for example the Information Technology Infrastructure Library (ITIL) should be reviewed and extended to address the challenges of ITSVN [15].

Actually, the increase in heterogeneity due to cloud computing and the impact on ITSM on methods to manage heterogeneity in ITSVN have not been often on the focus of past research [4]. In practice, IT departments are facing the problems results from increasing heterogeneity in the ITSVN. By becoming service aggregators, the IT departments of tomorrow will have to aggregate the modularized services into value-added, complex solutions [12]. By using ITSM methods, they are able to standardize and to provide high quality services. Therefore there is a need to improve the adoption of ITSM to manage ITSVN.

## 1.3 Resolution

This thesis addresses both the challenges heterogeneity induces on ITSM and approaches to manage heterogeneity in an ITSVN. Managing heterogeneity in an ITSVN means to find the optimal degree of heterogeneity and to handle the tradeoff between increasing complexity and flexibility. By identifying the main factors influencing heterogeneity, approaches from literature and practice will be analyzed in order to develop guidelines (implementation strategies, action plans, methods, KPIs, etc.) for managing heterogeneity using ITSM methods. However, methods for managing a heterogeneous ITSVN are currently not well researched. Also, there is no description of factors influencing heterogeneity in ITSVN. Therefore, this thesis strives to answer the following research questions (RQs):

**RQ 1:** What are the main factors influencing heterogeneity in an ITSVN?

**RQ 2:** Which effects of heterogeneity are described in theory and practice and what are suitable approaches to manage heterogeneity in ITSVN?

**RQ 3:** What are suitable guidelines for managing heterogeneity in ITSVN?

Fig. 2 shows a research model referencing the RQs. By answering the first RQ, the main factors influencing heterogeneity in the ITSVN will be identified and rated. As a result of answering RQ 2, approaches for managing heterogeneity will be identified. Also, the implications of heterogeneity will be determined and the causal relationship between influence factors and their impact on heterogeneity are researched. Finally, as a result of the third RQ, guidelines for managing heterogeneity in an ITSVN will be developed and evaluated.

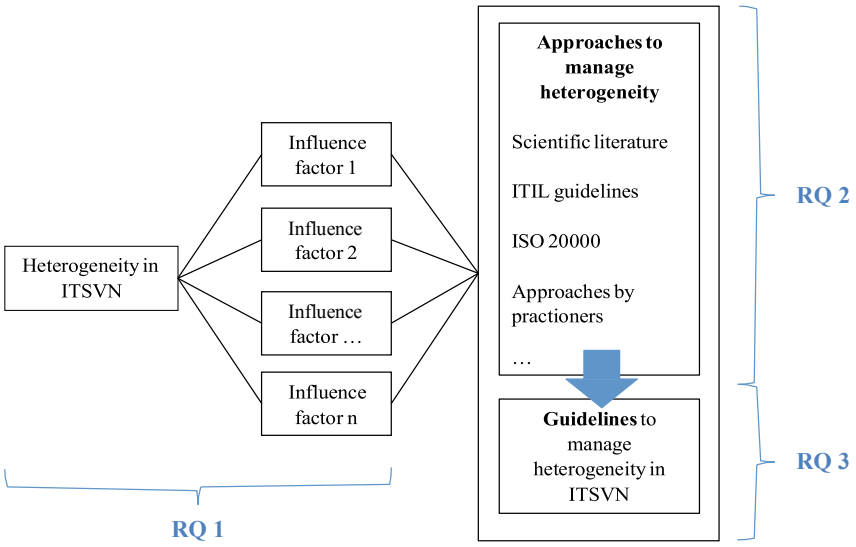



**Fig. 2.** Research model (own illustration)

## 2 Research Design

In order to answer the three research questions, several research methods are used. The output from one application of methodology will be the input of the application of the next methodology. Fig. 3 shows the three research questions, the corresponding research methods and the expected results of their application. Additionally, a time planning and the planned publications are presented.

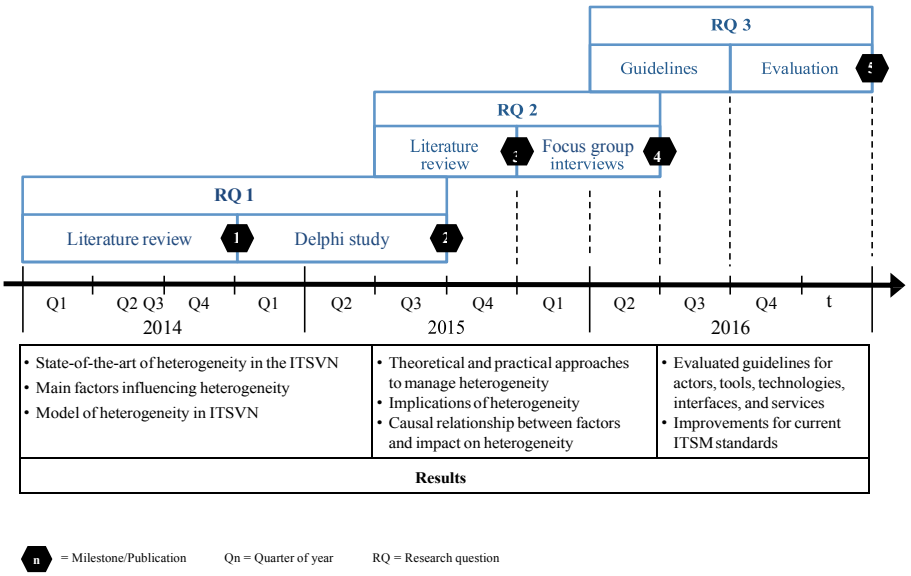



**Fig. 3.** Research schedule (own illustration)

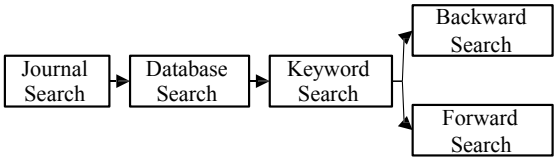
In the following, both the approach for conducting this research and the expected results are described in detail.

### 2.1 RQ 1: What are the Main Factors Influencing Heterogeneity in an IT Service Value Network?

#### 2.1.1 Literature Review

As a first step of this research a literature review will be conducted. Table 1 shows the structure of the literature review according to vom Brocke, et al. [18]. At first, a definition of the taxonomy of the literature review as recommended by Cooper [19] will be done. To conceptualize the topic of the literature review and to identify the search terms, a preliminary literature search will be conducted [18]. The results will be used to identify relevant literature in 22 A-ranked journals [20] and the six major databases (IEEE Explorer, Science Direct, ACM Digital Library, EBSCO Host, Emeralds, and AIS Electronic Library).

**Table 1.** Structure of literature review according to vom Brocke, et al. [18]

| Actions |
|---|
| **1. Definition of the review scope** following Cooper [19]<br>Draw a taxonomy of the literature review |
| **2. Conceptualization of the topic**<br>Preliminary literature review in order to define heterogeneity in general and identify concepts related to heterogeneity |
| **3. Literature search** following Webster and Watson [21]<br>  |
| **4. Literature analysis and synthesis**<br>Analyzing and synthesizing the relevant publications; developing a model for heterogeneity in ITSVN |
| **5. Research Agenda**<br>Identification of research gaps and under-researched areas |

Finally, a backward and forward search will be conducted [21]. As a result the main factors influencing heterogeneity in the ITSVN will be identified and a model of heterogeneity in ITSVN will be developed. Also, the state-of-the-art of heterogeneity in the ITSVN will be noted.

### 2.1.2 Delphi Study

In a second step, the model of heterogeneity in ITSVN and the main factors influencing heterogeneity in the ITSVN will be prioritized by conducting a Delphi Study [22] and a set of the most important influence factors will be derived. Also, the model of heterogeneity in ITSVN will be reviewed and, if necessary, adjusted. The first version of the model of heterogeneity in ITSVN was built based on a review of the scientific literature. In order to verify and review the model, it will be assessed by a group of experts. To do so, it is important to initiate a cognitive process by using the Delphi study method [23]. Häder [23] defines four types, respectively objectives, of Delphi studies. One of them is the determination and qualification of expert opinions. For this purpose a group of ITSM experts and cloud computing experts will be assembled. The ITSM experts should possess common ITSM certifications, for example *ITIL Expert*. The cloud computing experts should possess longstanding expertise in providing, aggregating or integrating cloud services. The anonymous survey will be conducted by using a universal computer-based questionnaire system,

for example LimeSurvey[2]. The questions of the questionnaire will be derived from the model of heterogeneity in ITSVN. However, before the first round of the Delphi study can be started, the questionnaire will be checked by performing a pretest as desired by Häder [23].

In the first round the expert are asked to evaluate the impact, respectively the relevance, of the different influence factors on heterogeneity in ITSVN. In order to achieve durable results, the Delphi study shall continue either (a) until the expert opinions matches to each other to a large extend or (b) until stable clusters emerged. To archive this, the answers of the former round will always be analyzed and prepared for the next round. By doing cluster analysis, the potential context factors may be identified. For all rounds the same group of experts will be accessed. Thus, the experts will be able to rethink their answers and appraisals.

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 will be derived.

## 2.2 RQ 2: Which Effects of Heterogeneity are Described in Theory and Practice and what are Suitable Approaches to Manage Heterogeneity in IT Service Value Networks?

### 2.2.1 Literature Review

In order to identify approaches to manage heterogeneity in ITSVN, established ITSM frameworks, for example ITIL, will be analyzed. Also the scientific literature will be reviewed by conducting a literature review according to vom Brocke, et al. [18] and Webster and Watson [21]. The literature review process corresponds to the process as shown in Table 1. In a first step, the ITSM models and standards, in particular the ISO/IEC 20000, ITIL, COBIT[3], and eTOM[4], will be analyzed. In a second step, the scientific literature will be reviewed and analyzed. To identify relevant literature, a search in 22 A-ranked journals [20] and the six major databases (IEEE Explorer, Science Direct, ACM Digital Library, EBSCO Host, Emeralds, and AIS Electronic Library) will be performed. Additionally, a backward and forward search will be conducted [21]. Both steps, the analysis of the ITSM standards and the review of the scientific literature, should provide knowledge about approaches to manage heterogeneity in the ITSVN, implications of heterogeneity, and the causal relationship between the influence factors of heterogeneity (as identified in RQ 1) and the impact of heterogeneity on these factors.

[2] https://www.limesurvey.org

[3] Control Objectives for Information and Related Technology

[4] enhanced Telecom Operations Map

### 2.2.2 Focus Group Interviews.

Next, focus group interviews according to Schulz [24] and Stahl, et al. [25] will be performed. Thereby, approaches derived from the literature will be verified and, if applicable, additional approaches will be derived from practice. Fig. 4 shows a three-phase approach including nine steps to conduct focus group interviews according to Bürki [26] c.f. [24]. The interview guide will be developed by using the recommendations of Gläser and Laudel [27]. As described in chapter 2.1.2, ITSM experts and cloud computing experts will be assembled. At this point the same group of experts as involved in the Delphi study (chapter 2.1.2) could be invited.

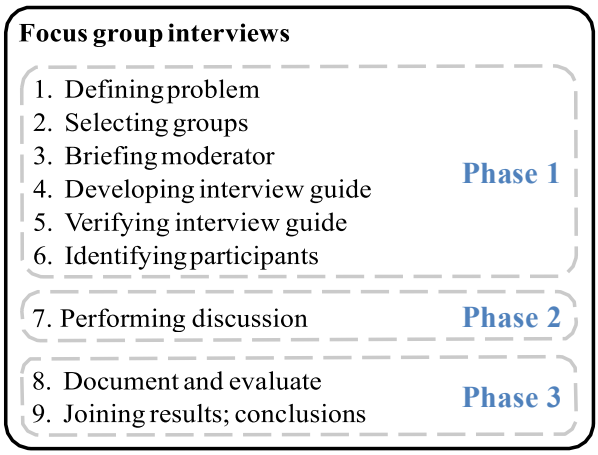



**Fig. 4.** Phases and steps of a focus group interviews according to Bürki [26] c.f. [24]

Doing so, additional knowledge about approaches to manage heterogeneity in the ITSVN, implications of heterogeneity, and the causal relationship between the influence factors of heterogeneity (as identified in RQ 1) and the impact of heterogeneity on these factors will be derived.

## 2.3 RQ 3: What are Suitable Guidelines for Managing Heterogeneity in IT Service Value Networks?

Based on the findings of RQ 1 and RQ 2, guidelines for managing heterogeneity in the ITSVN will be developed. According to the seven elements as shown in the model of heterogeneity in ITSVN (Fig. 6), these guidelines will be structured and dedicated to their corresponding elements.

Next, these guidelines will be evaluated based on a multi-perspective evaluation as recommended by Fettke and Loos [28]. In this way, current ITSM standards and methods will be improved and suited to the special needs of ITSVN. Fettke and Loos [28] define 15 perspectives for evaluating reference models. ITIL is a reference model for ITSM processes respectively for the IT service lifecycle. The guidelines for

managing heterogeneity in the ITSVN focus on a detailed level of the vertical process decomposition according to Krcmar [29]. However, a multi-perspective evaluation provide seems to achieve a particularly good result. Therefore, descriptive perspectives and an empirical perspective will be used. For the descriptive perspectives the natural language approach and, in order to determine the quality of the guidelines, the feature-based evaluation method will be used. On the one hand both are easy to carry out but, on the other hand, they are both methods with a subjective manner [28]. To compensate this, expert surveys for the empirical perspective will be applied according to Gläser and Laudel [27]. For this purpose a group of ITSM experts will be assembled. By using a semi structured questionnaire [27], the guidelines for managing heterogeneity in the ITSVN will be assessed and evaluated. Doing so, an evaluated set of guidelines for managing heterogeneity in the ITSVN as a complement to the common ITSM standards will be achieved.

# 3 Structure and Progress of the Thesis

## 3.1 Structure of the Thesis

Fig. 5 shows the planned structure of the thesis. The black circles denote the main chapters. The blue rhombuses represent the three RQs. Also the different research methods and steps as introduced in chapter 2 are shown including their main results and contributions to the thesis.

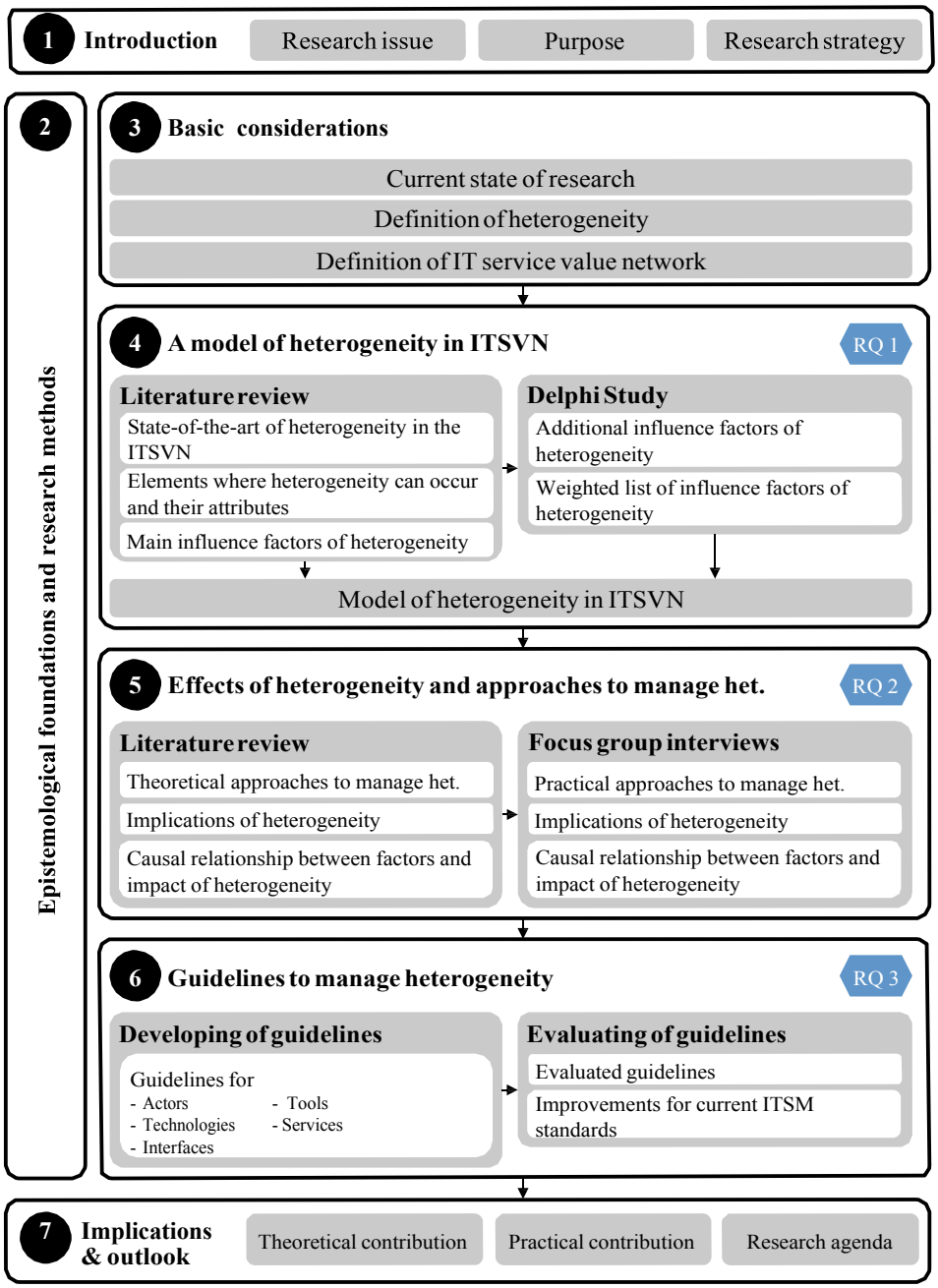



**Fig. 5.** Structure of the thesis (own illustration)

### 3.2 Current State of the Thesis

As a first result, a literature review yet to be published [2], proposes a model for heterogeneity in ITSVN consisting of seven elements and their attributes. The model was derived by conducting a systematic literature review as described in chapter 2.1.1. Based on the results of this literature review the main influence factors of heterogeneity in the ITSVN were extracted. Additionally, a model for heterogeneity in ITSVN consisting of seven elements where heterogeneity can occur is proposed. Several attributes were assigned to these elements.

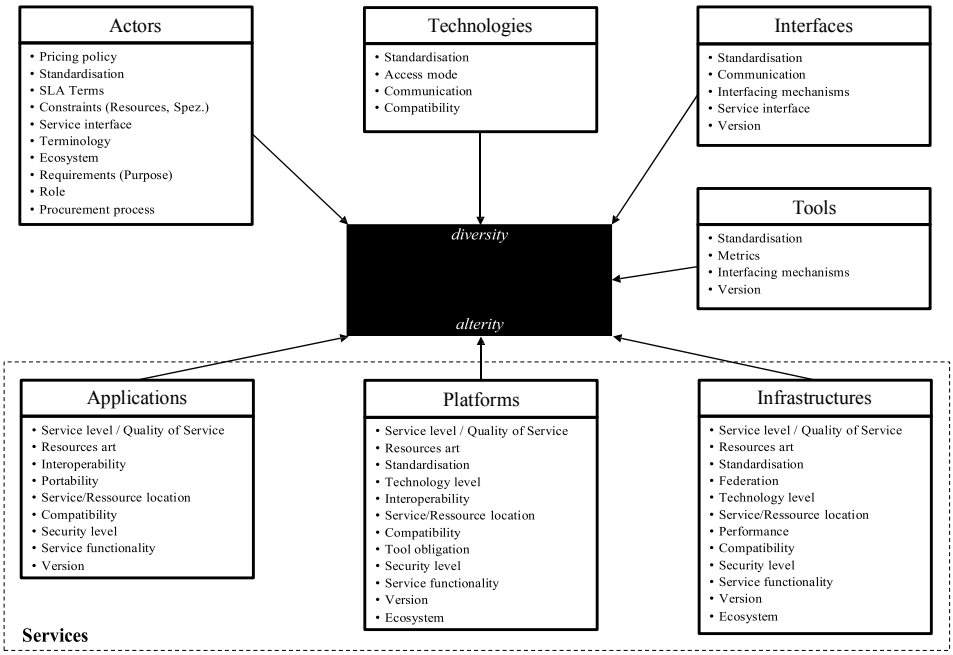



**Fig. 6.** Model with elements and attributes of heterogeneity in the ITSVN [2]

Fig. 6 shows a first version of the model of heterogeneity in ITSVN consisting of the seven elements and their attributes representing the influencing factors. *Applications* are all the software components that are part of the ITSVN, whereas *platforms* comprise the entire environment in which applications can run, including hardware infrastructure, operating systems and also different libraries. In an ITSVN the *infrastructure* includes the whole hardware ecosystem that supports the service delivery. *Applications*, *platforms*, and *infrastructure* can be summarized as *services*. *Actors* are all the interacting members of the ITSVN as shown before in Fig. 1. *Technologies* include all the used capabilities and communication and exchange methods that are used from the ITSVN actors like communication technologies etc. The term *interfaces* in the ITSVN describes all access possibilities to the service. Finally, *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.

In addition to the model for heterogeneity in ITSVN the literature review provide a definition of heterogeneity in ITSVN: *heterogeneity in an ITSVN is defined as the diversity or alterity of the attributes of the summed applications, platforms, infrastructures, actors, technologies, interfaces, and tools of the ITSVN* [2].

The next step will be the design and planning of the Delphi study as described in chapter 2.1.2.

# 4 Contribution and Originality

## 4.1 Expected Results

The impact of heterogeneity in heterogeneous IT landscapes and the moderating effect of ITSM has not been examined until today [4]. Therefore, by presenting the state-of-the-art of heterogeneity in ITSVN, this thesis aims to identify the main factors influencing heterogeneity. By identifying these factors, a model to illustrate heterogeneity in ITSVN will be derived. This model can be used to structure further research and to gain a deeper understanding of this topic. Next, approaches to manage heterogeneity in ITSVN will be identified by reviewing the literature and surveying practitioners. In the same stage, the implications of heterogeneity and the causal relationship between the main factors influencing heterogeneity in ITSVN and their impact on heterogeneity in ITSVN will be researched. Finally, guidelines for managing heterogeneity in the ITSVN will be developed and evaluated. Doing so, improvements for current ITSM standards will be achieved.

## 4.2 Implications to Theory

By providing a state-of-the-art of heterogeneity in the ITSVN derived from a literature review, the thesis 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 causal relationship between the influence factors and their impact on heterogeneity "*... provides an explanation of how, why, and when things happened ...*" [30]. Thus, a greater understanding and insight by others into heterogeneity in ITSVN will be promoted. According to Gregor [30], this thesis complies with the explanation goal of theory.

## 4.3 Implications to Practice

In this way, IT departments will be supported in becoming service integrators and service aggregators [12]. Thereby IT departments will be able to fit the requirements of the business units in a better way. Also, current ITSM methods and standards will

be improved and suited to fit the special needs of ITSVN. Thus, IT departments will be enabled to master heterogeneity in the ITSVN.

### 4.4 Limitations and Additional Research

However, there are some limitations which should be mentioned. At first, at the present time, there are no practical implementations of the guidelines to manage heterogeneity. Therefore, this thesis includes no case study research in the evaluation section. Basically, case study research seems to be a suitable method to obtain empirical data from the practice. However, the implementation of the guideline to manage heterogeneity and an evaluation of the success of such an implementation would take too long. Additionally, it would be very difficult to find a sufficiently large number of IT departments participating in such a study.

Second, this thesis only considers IT services. However, service value networks are a widespread phenomenon in many different industries. Therefore it would be valuable to research heterogeneity in service value networks in general. Doing so, a common understanding of heterogeneity in service value networks could be derived and general approaches to manage heterogeneity in service value networks could be developed.

Finally, in order to understand heterogeneity in ITSVN in more deeper way and to provide an input to empirical based research, suitable metrics to measure and quantify heterogeneity in ITSVN respectively in service value networks could be developed [4].

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# Issues in involving online consumers in value co-creation processes – a framework for designing online product configurators and recommendation systems

Veronika Schuhbeck
veronikaschuhbeck@yahoo.de
Accenture GmbH, München, Germany

**Abstract.** Companies increasingly involve consumers in product design and development, e.g. through built-to-order and mass customization or by integrating data generated at the point of sale into product development and production processes. The latter approach requires that companies provide online tools and interfaces like product configurators for consumer participation in value co-creation. This research addresses the question how to design such tools to i) obtain reliable data and ii) keep customers happy with both products and value co-creation processes. Furthermore data analysis guidelines will be developed to reuse the generated data for e.g. value co-creation.

## 1 Introduction

Digitalization is steadily increasing the variety of online shops in which consumers can chose from a wide range of products [1]. Specifically, the number of shops offering individualized products has been growing along with consumer demand for products, which precisely fit their requirements [2]. The drawback of the individualization "trend" for business is the fact that it becomes quite difficult for companies to differentiate their products from their competitors' [1]. As a solution to consumers' individualization requirements and companies' differentiation requirements, many companies integrate the consumer in the value creation process, e.g. through mass customization or built-to-order services [3-4]. One of the most common types of online interfaces provided for creating individualized products is the product configurator [5].

Product configurators, and similar tools like recommendation systems, collect large quantities of data on consumer preferences, which can be used in product development and production processes, marketing and customer relationship management [1]. Companies who transform such data to business insights per-form better than those who do not [6]. Feeding data into core business processes, however, requires a high level of data quality. In our case, this concerns the accuracy of consumer preference estimates. These depend on the design of the product configurators' interface [7]. Prior research has shown that interface design elements like the default product, i.e. the product shown to the consumer as the "baseline" product as a starting point for configuration, can have large effects on consumer preferences and, finally, purchase decisions [8]. Companies need to be aware of the potential implications of design

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decisions regarding product configuration interfaces because they can affect business performance both directly (purchase decisions and turnover) and indirectly (quality of data integrated in core business processes).

In my research, I propose to build a framework for designing product configurators and recommendation systems that i) describes design elements that affect cognitive processes (and therefore preferences) and ii) makes these effects on data quality transparent. Based on this framework, companies can design better configuration and recommendation tools, both in the sense of providing consumers with better fitting products and of understanding better which implications can be drawn from the data for future business decisions, e.g. product design.

The first step in my research is a review of prior studies on (consumers') decision processes, and factors that affect these processes. Specifically, I draw on the work of Johnson et al. [9] who describe the elements of a "choice architecture", to identify relevant design elements in product configurator and recommender interfaces. The second step is experimentally testing the effects of these design elements on consumer decision processes. The third step is developing design guidelines and data analysis guidelines to avoid or correct for preference distortion effects.

## 2 Outline of dissertation

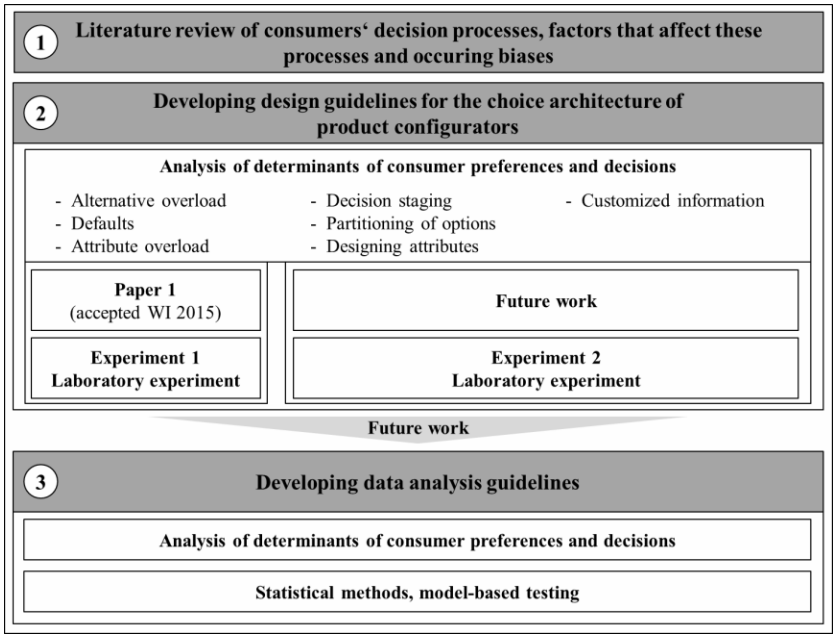


**Fig. 1.** Outline of dissertation

With my dissertation, I contribute to two issues in product configuration regarding the usability of generated data from product configurators for value co-creation and future product development. One important issue is leveraging insights from research

on consumer decision-making and decision biases to improve the design of product configurators and similar online tools. Understanding this process is a prerequisite for addressing the second issue: generating valid preference data and / or correcting for preference distortion effects before utilizing the data in business (decision) processes. Figure one presents the outline and structure of my dissertation.

### 2.1 Literature review

Decision making is a cognitive process with the aim to choose between several alternatives. The decision maker identifies alternatives and decides based on her preferences which alternative to choose. This process and the decision maker's underlying preferences are influenced by a number of factors endogenous to the decision maker, like emotions and the usage of heuristics [10]. This can lead to cognitive biases which can be grouped in the following subcategories: 1) decision making, belief and behavioral biases 2) social biases 3) memory errors and biases. In addition, factors exogenous to the decision maker influence decisions. Which factors come into play depends on the presentation of the decision task [9].

Our research focuses on a specific decision setting; online product configuration. We investigate the effects of decision task presentation on the decision process, i.e. how different design elements of a decision task influence the decision maker. Table 1 gives an overview about nine essential design elements which are often referred to as "tools of the choice architecture" [9].

In summary, prior research strongly suggests that the quality of data generated with product configurators is dependent on how the interface and the configuration process are designed [4]. My research aims at identifying those elements of the configuration process which influence consumer preferences and decisions systematically, and to determine their effects on data quality to help companies design better configuration processes and systems.

Based on the description of choice architectures by Johnson et al. [9], a number of important design elements of product configurator interfaces must be considered (Table 1).

Dealing with **alternative overload**, i.e. the number of available product alternatives, is precisely the problem that product configurators are designed to address. They are supposed to help consumers cope with (too) many purchase options [11]. Product configurators can make the decision process less effortful. Consumers change one attribute level at a time, which means that they effectively compare two products (pre-change and post-change) that differ in only two attribute dimensions, assuming that the price also changes. Changes in one attribute level (e.g. higher processor speed) can make some other attributes' levels unavailable (e.g. low prices): consumers also need to remember trade-off relationships between attributes during configuration. The level of cognitive effort during product configuration thus depends mainly on three factors: the number of attributes, the number of levels per attribute and the number of trade-off relationships between attributes.

The second factor in complex decision situations is **decision inertia**, i.e. decision makers abstaining from making a decision. This can be addressed by setting decision defaults, i.e. presetting initial configurations (attribute level combinations) for products [8], [12-13], which reduce the need to decide, or at least the number of decisions.

Defaults can affect purchase decisions because consumers often use them as reference points to compare other product configurations with [7]. Defaults can thus push consumers not only towards making a decision at all but also towards a certain decision (in our case, a certain product).

Often, product **search and decision time** is an important factor of decision [9]; if it takes too long, consumers may abandon the decision process altogether. Among neglected decision aspects, future outcomes are particularly prominent. Since consumers tend to be myopic and prefer early positive outcomes, they frequently neglect future outcomes [14]; products are often evaluated largely based on short-term benefits rather than long-term costs. This tendency is reinforced in cases where uncertainty about future developments is high, e.g. with regard to technological developments in the product context. Consumers thus tend to focus on the short-term desired outcomes and not on the long-term commitment and therefore overestimate the benefit of the product [15-16]. The way how decisions are structured can reduce the required time to make a decision and alert decision makers to aspects of their decision that they had not taken into account before.

**Decision staging** – structuring and formatting the decision task – affects the likelihood with which a particular piece of information will be noticed and processed or ignored and neglected [9]. Consumers typically screen alternatives first, based on a subset of attributes, and then make detailed (compensatory) comparisons between alternatives. If the screening stage is deliberately structured to facilitate comparison on one particular attribute, consumers will focus on it and likely express a preference for alternatives that perform well in this attribute [3]. Decision structuring and staging can lead to reduced search costs, it [17] but it can also affect preference building.

**Partitioning of options** refers to grouping or categorizing options or attributes which also influences consumers decision. Consumers allocate limited resources, e.g. money or attention, to each group or category that has been identified. Decision makers are biased toward assigning equal importance weights to each attribute that is explicitly identified [18]. By splitting one category of attributes into two, a decision maker will spend more time and attention on them than if they had been grouped in one category. At the same time, partitioning of options provides opportunities to (re-)direct consumer attention to specific attribute categories.

Finally, **attribute design** can be used to make specific attributes more or less salient. Consumers are generally assumed to have individual importance weights, e.g. for one consumer product performance may be the most important attribute, and for another product price. Attribute design can influence these weights. It may be implemented in four different fashions: parsimony, linearity, comparability, and evaluability [9]. Parsimony aims to reduce cognitive effort: only the most important attributes are presented to the decision maker. The main challenge is finding the right balance between reducing the number of attributes and providing sufficient information to the consumer to make a decision. Linearity refers to the relation-ship between attribute and a fundamental objective. An example for a non-linear relationship is fuel consumption of a car which is higher for short distances than for long distances. To constitute linearity it is sensible to show the fuel consumption for 100 miles which prevent consumer from misinterpretation of information. Comparability refers to the requirement that attributes be expressed on the same scale, e.g. a time period of a year or month or a weight of 1 kg. Evaluability is important for attributes which are diffi-

cult to process. Additional information in form of evaluative labels, e.g. labelling the salt content of food "good" or "bad" for health, is provided with the aim of making the processing of this information easier.

| *Interface design elements* | *Potential impact on consumer decision* | *Theory / theoretical foundation* | *Results \| Suppositions* | *Paper* |
|---|---|---|---|---|
| Number of available product alternatives | Use simplification strategies to reduce cognitive effort | Humans are limited in the amount of information they are able to process at any one time | Task difficulty (higher number of available alternatives and attributes) does not affect product satisfaction and satisfaction with the configuration process | Paper 1 |
| Number of available attributes | | | | |
| Default values | Focus on satisficing decisions | Prospect theory | Setting the right default increases product satisfaction but not satisfaction with the configuration process | |
| Search / decision time | Tendency to myopia and preference for early positive outcomes | Myopic behavior | Tendency to configure higher-quality products | Future work |
| Decision staging | Influence which data is examined / ignored | Heuristics in judgment and decision-making | Cognitive biases | |
| Partitioning of options | Focus attention on specific categories | Heuristics in judgment and decision-making | Change in importance weights | |
| Designing attributes | Influence assessment of attribute | Heuristics in judgment and decision-making | Cognitive biases | |
| Customized information | Increase information utility | Individual cognition | Reducing cognitive effort / improving decision quality | |

**Table 1.** Overview interface design elements

### 2.2 Developing design guidelines for the choice architecture of product configurators

**Research Paper 1.** In the first paper we focus on two basic design elements of a product configurator, default product configurations and task difficulty. Higher task difficulty, displaying greater numbers of attributes and attribute combinations, makes

the configuration and selection task more complex, thus potentially frustrating or confusing consumers [19-20]. Product configurators typically start with a default product configuration (i.e. at- tribute combination) and let consumers change attribute levels one at a time, informing them about corresponding changes in price and the availability of other attribute levels [8]. Prospect theory tells us that consumer preferences are influenced by reference points like default configurations [21]. Specifically, consumer preferences and their satisfaction with different products depend on whether they perceive these products as gains or losses relative to their reference points [22]. We therefore use a model of multi-attribute reference points [23] to explain why consumers react differently to configurators that transport identical marketplace information (in terms of attribute availability, prices etc.) but start the configuration process with different default configurations.

For practitioners, our results are of interest because they show how consumer decision predictions can be improved without requiring additional consumer input and shed light on the influence of decision aid design on consumer decision. Our research helps retailers and product manufacturers understand the implications of certain design decisions, thus helping them to design better interfaces and to interpret the data generated during product configuration. If data are to be used in product development, being able to assess the reliability and validity of these data is particularly important [24].

The theoretical background supposed the following argumentation of derivation of the hypotheses. Default configurations can act as a reference point for consumers. High-utility default values (i.e. set to attribute levels which yield high utility) require that the consumer initially accept a loss in at least one attribute if she wishes to change the default value. The more attributes are set to high-utility default values, the greater the chance is that changing them will lead to a number of losses. We call this case “loss-inducing default”.

Low-utility default values (i.e. set to attribute levels which yield low utility) initially permit consumers to realize gains by changing the default value to a higher-utility level. We call this case “gain-inducing default”. Because reference points are less likely to be (fully) adapted after losses than after gains [22] consecutive losses will be felt less acutely or, in other words, will register on a less steep part of the loss curve than a loss following a gain. Assuming that the consumer had already updated her reference point to reflect a gain in one attribute, changing this attribute level downwards (because she realizes that in another attribute dimension higher-utility levels have become unavailable) will cause her a greater loss than be-fore the update. We therefore suggest that consumers will be more satisfied with the configured product in the presence of loss-inducing defaults.

Consumers judge decision aids based on the effort they save in the decision process [25]. Because different default configurations do not affect effort levels, we do not expect that consumer satisfaction with the configuration process will be affected by them.

H1: Consumer product satisfaction will be higher in the presence of loss-inducing defaults (high-utility default values).

H2: Consumer satisfaction with the configuration process will not vary de-pending on gain-inducing and loss-inducing defaults.

Product satisfaction depends on the fit between consumer preferences and configured (i.e. available) products. If products are evaluated on the same attributes, and those attributes only, that were used for product configuration, we would not expect the number of attributes to affect product satisfaction.

The greater the number of configurable attributes, the higher the cognitive demand that the configuration process imposes on consumers [26], particularly if the number of trade-offs also rises [11]. Therefore we suggest that satisfaction with the configuration process will decrease with the number of configurable attributes.

H3: Consumer product satisfaction will not vary with greater numbers of configurable attributes.

H4: Consumer satisfaction with the configuration process will be lower for greater numbers of configurable attributes.

Our results show that product satisfaction was higher for loss-inducing defaults, i.e. high-utility attribute levels, and did not change with task difficulty. Satisfaction with the configuration process was not affected by the default con- figuration or by task difficulty. Experience with product configurators had a negative effect on both product satisfaction and satisfaction with the configuration process; product experience had a positive effect on satisfaction with the configuration process but no effect on product satisfaction. Gender and price sensitivity had no significant effects on either dependent variable.

We contribute to recent research on the role of defaults in consumer decision processes. Our findings support the suggestion that, during product configuration, consumers use default configurations as reference points and therefore feel consecutive losses less acutely than a loss following a gain: reference points are less likely to be (fully) adapted after losses than after gains [22].

Some practical implications of our study are that the configuration process appears to be particularly difficult for consumers with little prior experience. This suggests that offering “beginner’” and “expert” configurators is advisable. Setting default values to higher rather than lower attribute levels increases not only sales but also product satisfaction. However, this effect may not be persistent over time. If products can be returned, it may “wear off” and lead to higher return rates, suggesting that default configurations distort consumer preferences in the short run. In this case, basing co-creation or sales process on data generated from product configurators will have adverse effects unless interface design-related effects are accounted for.

**Future work.** Study one shows that that defaults and task difficulty affect consumers’ decision processes in product configuration. In other words, these two choice tools [9] are relevant for decision making with product configurators. In our future

work, we propose to investigate the effects of the remaining choice tools on decision processes in product configuration and to develop design guidelines based on this knowledge.

Besides the already expounded design elements search and decision time is also playing an important role in mostly long term decisions. In the context of product configurators this design element becomes especially important for products and services which are binding over time, e.g. insurances or credits. The factor time plays a role in two regards at product configurators, once if the consumer is put under pressure because of a limited edition product which means the consumer has to decide quickly to buy the product or not as otherwise it may not be available anymore. The second aspect is to use the facts of this design element as a control variable. As explained in the literature review consumers are myopic and prefer to receive positive outcomes early [9]. Furthermore uncertainty and optimism about the future are two factors that affect their decisions. Concluding the strength of those characteristics could influence the decision process during a configuration. We will examine the aspects of uncertainty and optimism in future work.

Consumer with strong optimism may buy more expensive products and therefore configure products with better attribute combinations as they don´t mind the higher costs. Uncertainty is a variable which is worth to examine more closely, especially product uncertainty which is highly prevalent in online markets as the user can not touch the product [27]. Product uncertainty can be split in two facets: description uncertainty and performance uncertainty. Description uncertainty often depends on the inability of the seller or the characteristic of a product it is difficult to describe a product in a perfect way for the consumer. Performance uncertainty relies often on the question if the product has indeed all characteristics a consumer needs. Both are relevant in the context of product configurators. Through the design of a product configurator the product uncertainty may be reduced, e.g. through decision staging, partitioning of options and designing of attributes product relevant information is presented in a more structured way thus the consumers information uncertainty may be reduced. Furthermore customized information will focus on the information a consumer is asking for respectively needs for her purpose of product purchase which may reduce performance uncertainty.

A further group of design elements constitute all elements regarding structure and arrangement of the available attributes. This includes the design elements **decision staging, partitioning of options and designing attributes**. Roughly outlined those three design elements affect in different ways which information the consumer processes and which one she ignores or neglect.

Decision staging enables the consumer to process her decision with low effort. Thus formatting information or add additional information facilitate the consumer in her decision. Therefore it is expected to increase consumer satisfaction with the configuration process. As through the simplification the consumer is expected to be better able to configure her desired product, product satisfaction is also expected to increase.

Partitioning of options leads the consumer to spend more attention on putatively more important attributes. This works in the following way in the example of an automotive configuration: Important attributes are divided into subcategories such as

safety, performance, warranty and less important attributes into one subcategory such as stylishness. But an important fact to consider is task difficulty as a too high number of categories and therefore attributes may be counterproductive regarding mental overload. The expected outcome would be, that consumer spend in sum more attention on the important attributes because consumer configure one category at a time.

The third design element in the group of structuring the configuration process is designing attributes. Within this design elements a choice architect different methods namely parsimony, linearity, comparability and evaluability. Parsimony of attributes is already covered with the design element of number of available attributes within our first paper. In the field of product configurators linearity refers to comparability, as linear representation makes it easier to compare two different products. Comparability and evaluability ensures that the customer can easily process the attribute information especially for highly quantitative information. One possibility is to highlight endpoints which represents the maximum and minimum as best and worst reachable facility.

Altogether structuring the decision task on the above mentioned design elements we expect that the consumer will be more satisfied with the configuration process as it is easier for her to maintain an overview especially in configuring complex products such as cars.

We will examine this group of design elements in a laboratory experiment. Decision staging will be operationalized by providing additional information such as "market leader" or "best in class" for individual attributes. This additional information helps inexperienced customer in particular since it reduces their need to search for information outside the configurator, thus increasing their satisfaction with the configuration process. Also it is expected that the average product quality increases through this information as more consumer would use the market leader part or at least the second best version. Thus consumer satisfaction is expected to increase as more valuable information is given and qualitative better products are configured.

The second design element in this part, partitioning of options is operationalized through segment attribute as described above. We represent supposedly important attributes divided in categories and all other ones in one category. We expect that this increases satisfaction with the configuration process since it reduces the cognitive effort while subconscious indicating which attributes needs more attention and which ones less. Thus the consumer will also get the feeling that she spent the effort in the configuration on the right part of the product which leads to a higher satisfaction with the product.

In our paper one we suggested as a result of our research to offer a "beginner" and a "expert" product configurator as it appeared to be particularly difficult for consumer with little prior experience to configure a product. Thus the design element **customized information** is an interesting follow up of paper one. To investigate the influence of individual information for consumer is already widely examined. As other researchers found a positive impact on consumer satisfaction in the online environment [28] we believe it is an important factor for product configurators as well.

### 2.3 Developing data analysis guidelines

The data generated during the product configuration process is used to translate consumer requirements into product information [4]. However, product configuration can be a complex procedure, which requires considerable cognitive effort on part of the consumer [17]. Data generated during the configuration process is quite noisy and the accuracy of elicited preferences likely to be low, which raises serious questions regarding the reliability and validity of insights derived from such data. Based on the results of the first part of my dissertation, in which I analyze the effects of certain important design decisions on consumer decision processes, I will develop guidelines that help researchers and practitioners analyze and interpret data derived from tools like product configurators.

**Biases.** Biases induced by the choice architecture are falsifying data analysis if not considered. The study in paper one already showed design elements used for choice architecture influence the decision process. But effects may "wear off" for example through the return of products. If those biases are not considered and corrected, data analysis will be distorted and the interpretation results of data will be biased too. Thus it is an essential part of our data analysis guidelines to regard biases induced by the choice architecture.

**Noisy data.** Noisy data is a problem and hinders most types of data analysis. Therefore removing noisy objects is an important goal of data cleaning [29]. There are two main issues that cause noisy data: 1) noise that is caused through low-level data errors that result from an imperfect data collection process and 2) data objects that are irrelevant or only weakly relevant.

In the field of product configurations, imperfect data sets can be the result of two behavioral patterns. First there are data sets which are basically fully configured, but there is no purchase done after configuration. And second there are data sets which are not fully configured, e.g. the user abandoned the configuration process. Important for data analysis is, that we do not eliminate noisy data as those data contains important information, e.g. information or even reasons for discontinuing the configuration process.

## 3 Summary

In our research we analyze the decision process while using a product configurator based on the outlined design elements of Johnson et al. [9]. We examine the effects of those design elements on product satisfaction and satisfaction with the con-figuration process. For the two design elements, default and task difficulty we found already implications. Further design elements are examined in a future series of laboratory experiments. We use the results to develop design guidelines for the choice architecture of product configurators which help practitioners to design their product configurators in a way to increase consumer satisfaction.

Based on the results of the first part of our research we will develop data analysis guidelines with the aim to make this data more usable, e.g. for value co-creation. The

guidelines will help practitioners to interpret data correctly and beware from biases and noisy data.

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# Proaktive Geschäftsprozesssteuerung mittels ereignisbasierten Prognosen: Referenzmodell und prototypische Implementierung

Julian Krumeich
Betreuender Hochschullehrer: Prof. Dr. Peter Loos

Institut für Wirtschaftsinformatik (IWi) im Deutschen Forschungszentrum für Künstliche Intelligenz (DFKI GmbH) und Universität des Saarlandes, Saarbrücken, Deutschland
julian.krumeich@iwi.dfki.de

**Abstract.** Das vorzustellende Dissertationsvorhaben entwickelt ein Referenzmodell eines Systems zur proaktiven Steuerung von Geschäftsprozessen, das auf Basis ereignisbasierter Prognosen agiert, und implementiert dieses als Proof-of-Concept. Basierend auf der Analyse gesammelter Prozessdaten als auch der Auswertung aktueller Kontextinformationen, kann so der weitere (optimale) Prozessablauf prognostiziert und dieses Wissen zur proaktiven Steuerung von Geschäftsprozessen unter dedizierter Berücksichtigen der aktuell vorliegenden Kontextsituation verwendet werden.

**Keywords:** Event-driven Business Process Management, Predictive Analytics, Complex Event Processing, Prescriptive Analytics, Geschäftsprozessprognose.

# 1 Motivation

## 1.1 Ausgangssituation und Vision

Unternehmen sind in der heutigen globalisierten Marktwirtschaft einer hochdynamischen und zunehmend komplexeren Geschäftswelt ausgesetzt. Unlängst stellt die frühzeitige Erkennung und Kompensation veränderter Rahmenbedingungen einen strategischen Erfolgsfaktor dar. Als zentrale Geschäftsgrundlage müssen Unternehmen ihre Geschäftsprozesse daher kontinuierlich überwachen und stets individuell an die aktuelle Geschäftssituation anpassen. Die steigende Digitalisierung der realen Welt, im Zeitalter von Big Data und Industrie 4.0, ermöglicht eine zunehmend feingranulare Erfassung von Geschäftssituationen [1] und die Nutzung dieser Wissensbasis bei der Steuerung von Unternehmensabläufen.

Unternehmen, denen es zukünftig gelingt, ihre Geschäftsabläufe basierend auf dieser steigenden Masse an Daten zu analysieren, den weiteren Prozessablauf zu prognostizieren und mit diesem Wissen proaktiv ihre Prozesse zu steuern, werden ihrer Konkurrenz einen bedeutenden Schritt voraus sein. Ein solches Unternehmen zeichnet die Vision einer „Predictive Enterprise“ im Zeitalter von Daten als wettbewerbsentscheidendes Wirtschaftsgut [2].

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### 1.2 Problemstellung

Von dieser Vision ist die heutige Unternehmenspraxis noch weit entfernt. Das Potenzial der Daten, die in Unternehmen bereits gesammelt werden, wird unzureichend zur deskriptiven, prädiktiven und insbesondere präskriptiven Analyse von Unternehmensabläufen eingesetzt. Es fehlt oftmals an fundierten Konzepten und Technologien, um diese Daten zeitnah zu analysieren und die richtigen Schlüsse daraus zu ziehen. Aktuelle Ansätze im Bereich „Business (Process) Intelligence“ (BI bzw. BPI) verfügen zwar über hinreichende analytische Fähigkeiten, sind jedoch auf die Ex-Post-Analyse historischer Datenbestände ausgelegt [3]. Klassische Ansätze des „Business Activity Monitoring“ (BAM) ermöglichen die aktuelle Prozessüberwachung. Meist sind diese jedoch ungeeignet zur Identifikation komplexer Zusammenhänge, die erst durch Korrelation mehrerer Geschäftsereignisse über einen längeren Zeitraum ersichtlich werden [3 - 5].

Mit „Complex Event Processing“ (CEP) wird seit einer Dekade eine Technik zur Identifikation und Korrelation sogenannter komplexer Ereignisse erforscht. Zunehmend wird CEP mit dem Geschäftsprozessmanagement (GPM) verknüpft, was den Forschungsbereich des „Event-driven Business Process Management“ (ED-BPM) begründete 6. Diese Verknüpfung weist insbesondere für BPI erhebliches Potenzial auf. Basierend auf historischen Ereignissen, können Prognosemodelle erstellt werden, die präzise und durch die Korrelation mit aktuell vorliegenden Ereignissen „rechtzeitige“ Vorhersagen über den weiteren Prozessverlauf ermöglichen [5, 7]. Solche als “Event-driven Predictive Analytics” (EDPA) bezeichneten Ansätze werden aktuell jedoch fast ausschließlich zu Zwecken des Prozessmonitorings eingesetzt; Forschungsbedarf besteht daher insbesondere in der Nutzung deren Potenziale zur tatsächlichen Steuerung von Geschäftsprozessen [6].

## 2 Zielsetzung und adressierte Forschungsfragen

Dieser Forschungsbedarf ist motivierend für das Dissertationsvorhaben. Ziel ist die Konzeption eines Referenzmodells eines Systems zur Entscheidungsunterstützung, das auf Basis ereignisbasierter Prognosen, eine proaktive Steuerung von Geschäftsprozessen ermöglicht [8]. Damit soll eine möglichst frühe Handlungsfähigkeit auf eingetretene bzw. sich abzeichnende komplexe Ereignisse erzielt werden. Je früher auf erkannte Ereignisse reagiert wird bzw. je eher potenziell eintretende vorhergesagt werden, desto höher ist der Wert über die Kenntnis solcher Ereignisse zu bewerten. Man vergleiche hier eine Tsunami-Warnung eine Woche mit einer Minute vor Eintreten dieses katastrophalen Ereignisses [9]. Abb. 1 illustriert diesen Sachverhalt aus betriebswirtschaftlicher Perspektive.

Es zeigt sich somit, dass sich eine Verknüpfung von CEP mit Predictive Analytics (PA) zum einen für die instantane Erkennung von Ereignismustern im laufenden Event-Stream-Betrieb eignet, wodurch bestimmte Aktionen, wie Echtzeit-Prognoseberechnungen, angestoßen werden können. Zum anderen versprechen ereignisbasierte Prognosen einen stärkeren Kontextbezug und somit eine potenziell höhere Prognosegüte.

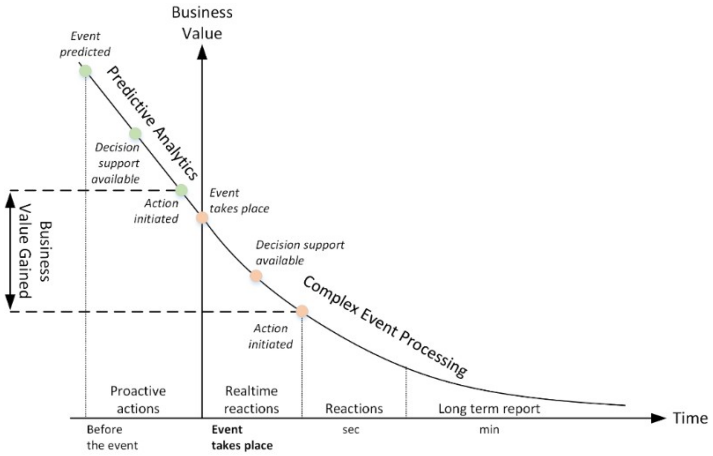


**Abb. 1.** Darstellung des betrieblichen Mehrwerts einer antizipativen gegenüber einer reaktiven Ereignisbehandlung (in Anlehnung an [3, 9])

Das zu entwickelnde Referenzmodell soll im Rahmen des Dissertationsvorhabens ferner in einen Prototyp – im Sinne eines Proof-of-Concepts – instanziiert werden.

Das Dissertationsvorhaben adressiert grundsätzlich folgende Forschungsfragen:

1. Wie lässt sich proaktives Handeln aus betriebswirtschaftlicher Sicht charakterisieren? In welcher Form können Informationssysteme dies bereits unterstützen?
2. Wie stellt sich der aktuelle Stand der Forschung im Bereich des ED-BPM dar? Inwiefern manifestiert sich die Zielsetzung einer proaktiven Prozesssteuerung im Kontext ED-BPM als Forschungsdefizit?
3. Welche Anforderungen sind an Informationssysteme, im speziellen an Systeme zur Entscheidungsunterstützung, zu stellen, die eine proaktive Prozesssteuerung im Wirkungsgefüge des ED-BPM realisieren?
4. Aus welchen Komponenten soll ein derartiges System bestehen? Wie sind diese aus fachkonzeptioneller Sicht auszugestalten?
5. Wie sieht eine prototypische Instanziierung des zu entwickelnde Referenzmodells aus und wie lässt eine exemplarische Anwendung charakterisieren? Wie ist das Referenzmodell zu evaluieren und welche Implikationen ergeben sich für das traditionelle GPM?

# 3 Forschungsstrategie und -methode

In der Forschungsdomäne der Wirtschaftsinformatik lassen sich zwei unterschiedliche erkenntnistheoretische Paradigmen unterscheiden: die verhaltensorientierte und die gestaltungsorientierte Forschung [10, 11].

Verhaltensorientierte Arbeiten setzten sich zum Ziel, mittels Theorien, das Zusammenspiel von Menschen und Organisationen mit Informationssystemen zu erklären.

Dabei wird der gesamte Lebenszyklus dieser Systeme, d. h. ausgehend von deren Entwicklung bis hin zur letztendlichen Verwendung, betrachtet [11]. Gestaltungsorientierte Forschung (im Englischen Design Science Research) zeichnet sich dagegen nicht durch das Aufstellen, Ableiten und schließlich Verifizieren von Theorien zur Beschreibung der komplexen Wechselbeziehungen von Informationssystemen aus, sondern beschäftigt sich mit der Entwicklung neuer und innovativer Artefakte der Informationstechnik. Diese Entwicklung ist stets durch eine betriebliche Herausforderung motiviert, die es durch das neu zu schaffende Artefakt zu adressieren gilt.

Im englischsprachigen Raum, insbesondere in den USA, wird überwiegend ein verhaltensorientierter Ansatz verfolgt. Im Gegensatz zu der dort vorzufindenden Information Systems Research, wartet dessen Schwesterdisziplin, die deutschsprachige Forschung der Wirtschaftsinformatik mit starkem Fokus auf eine Gestaltungsorientierung auf [13]). Die hierbei geschaffenen Artefakte lassen sich in Konstrukten (bspw. Konzepte oder Sprachen), Modelle, Methoden und konkrete Instanzen (Implementierungen von Konstrukten bspw. als Softwareprototypen) klassifizieren [13]; eine detaillierte Analyse unterschiedlicher Typen von Artefakten wird in [12] vorgenommen.

Das vorliegende Dissertationsvorhaben folgt somit der grundsätzlichen Forschungsrichtung der deutschsprachigen Wirtschaftsinformatik. Die adressierte betriebliche Herausforderung manifestiert sich in der Schaffung einer proaktiven Entscheidungsunterstützung, mit deren Hilfe schneller auf (zukünftig) eintretende Ereignissen, die einen Geschäftsprozess maßgeblich beeinflussen können, reagiert werden kann. Hierdurch kann ein betrieblicher Mehrwert, basierend auf dem gewonnenen Informationsvorsprung, geschaffen werden. Als Gestaltungziel soll hierzu ein Referenzmodell eines Systems zur proaktiven Entscheidungsunterstützung konstruiert werden.

Nach [11] hat sich gestaltungsorientierte Forschung bzw. Design Science Research an sieben Richtlinien zu halten, um gleichzeitig eine akademische strenge sowie eine praktische Relevanz der Forschung zu gewährleisten: die Relevanz (*Guideline 2*) der zugrundeliegenden Forschungsarbeit wurde bereits in den Abschnitt 1 und 2 darlegt und manifestierte sich grundlegend auch in zwei vom Doktoranden betreuten, praxisnahen Forschungsprojekten aus denen die Idee sowie Teile der Arbeit entstanden sind (vgl. hierzu die Danksagung am Ende des vorliegenden Beitrags). Wie zuvor beschrieben, stellt das zu entwickelnde Referenzmodell den Kern der Arbeit dar und repräsentiert das zentrale Artefakt der Arbeit (*Guideline 1*). Im Methodenspektrum der Wirtschaftsinformatik stellt die Referenzmodellierung eine valide Forschungsmethode dar, die „induktiv (ausgehend von Beobachtungen) oder deduktiv (bspw. aus Theorien oder Modellen) meist vereinfachte und optimierte Abbildungen (Idealkonzepte) von Systemen [erstellt], um so bestehende Erkenntnisse zu vertiefen und daraus Gestaltungsvorlagen zu generieren.“ [14]. Das Dissertationsvorhaben verfolgt im Speziellen einen deduktiven Ansatz. Die geschaffene Gestaltungsvorlage wird in Form einer prototypischen Implementierung auf ihre grundsätzliche Implementierbarkeit geprüft (*Guideline 4*). Das geschaffene Referenzmodell-Artefakt gilt es gemäß der *dritten Richtlinie* zu evaluieren. Eine Evaluation kann grundsätzlich gegen eine existierende Forschungslücke als auch gegen die Realwelt erfolgen [15]. Hierzu wird in der Arbeit auf den in der Wirtschaftsinformatik vorzufindenden Pluralismus an Forschungsmethoden zurückgegriffen [16]. Zur Evaluation gegen die Forschungslücke soll in Kapitel 5 der Arbeit

zunächst eine merkmalsbasierte Evaluation des Referenzmodells gegenüber den in Kapitel 4 aufgestellten Anforderungen vorgenommen werden [15, 17]. In Kapitel 6 erfolgt ferner die Vorstellung eines Demonstrationsbeispiels sowie eines generellen Prototypen. Um eine Evaluation des Referenzmodells gegen die Realwelt vorzunehmen [15] wird angestrebt, zum einen Experteninterviews durchzuführen – insbesondere mit Experten, die aus der Branche des gewählten Demonstrationsbeispiel stammen (vgl. hierzu auch Abschnitt 4 zu Kapitel 6 der Dissertation) – und zum anderen eine Simulation auf Basis des zu entwickelnden Prototypen mit Echtdaten vorzunehmen.

Um auf vorhandenem Wissen aufzubauen (*Guideline 6*), greift das zu entwickelnde Modell auf existierende Arbeiten zurück, die in Kapitel 4 der Dissertation eingehend analysiert werden sollen (vgl. hierzu Abschnitt 4). Durch die explizite Darlegung der verfolgten Forschungsmethodik wird der *fünften Richtlinie* ebenfalls Rechnung getragen. Letztlich wird durch die Publikation der Dissertation sowie bereits zuvor veröffentlichte Teile, die Erfüllung der *siebten Richtlinie* angestrebt, die eine Verbreitung der entwickelten Artefakte vorsieht. Darüber hinaus soll das entstandene Wissen der Dissertation in die weitere Durchführung des Forschungsprojekts iPRODICT einfließen, in dem insbesondere eine Überführung der Artefakte in einen industrienahen Piloten erfolgen soll (vgl. hierzu die Danksagung dieses Beitrags).

# 4 Gang der Arbeit

Die Arbeit gliedert sich in sieben Kapitel. **Kapitel 1** manifestiert die Motivation zur Dissertation, skizziert die Problemstellung und geht auf deren Zielsetzung und die dabei adressierten Forschungsfragen ein. Darüber hinaus wird die grundlegende Forschungsmethodik der Arbeit dargelegt und der Aufbau der Arbeit beschrieben.

**Kapitel 2** führt in die grundlegende Themenstellung einer proaktiven Unternehmenssteuerung ein. Hierzu erfolgt zunächst eine systemtheoretische Betrachtung des Untersuchungsobjekts eines betriebswirtschaftlichen Unternehmens. Die Systemtheorie untersucht komplexe (realweltliche-)Phänomene und versucht deren zugrundeliegendes Systemverhalten zu beschreiben und somit vorhersagbar zu gestalten [18]. Aufbauend auf diesen Ausführungen wird Proaktivität – als angestrebte Handlungsoption einer Vorhersage – aus betriebswirtschaftlicher Sicht beleuchtet und die historische Entwicklung der Umsetzung beschrieben. Ergänzend zu primär betriebswirtschaftlichen Betrachtungen erfolgt anschließend eine dedizierte Auseinandersetzung aus informationssystemtechnischer Sicht. Daran anknüpfend zeichnet die Arbeit die Evolution von Datenmengen zu den heute vorzufindenden „Big Data“, die einen entscheidenden Einfluss auf treffsichere Prognose von Unternehmensabläufen ausüben.

An die generelle Betrachtung von Unternehmen anknüpfend wird das Themenfeld der Dissertation schließlich auf das Untersuchungsobjekt Geschäftsprozesse im sich anschließenden **Kapitel 3** fokussiert.

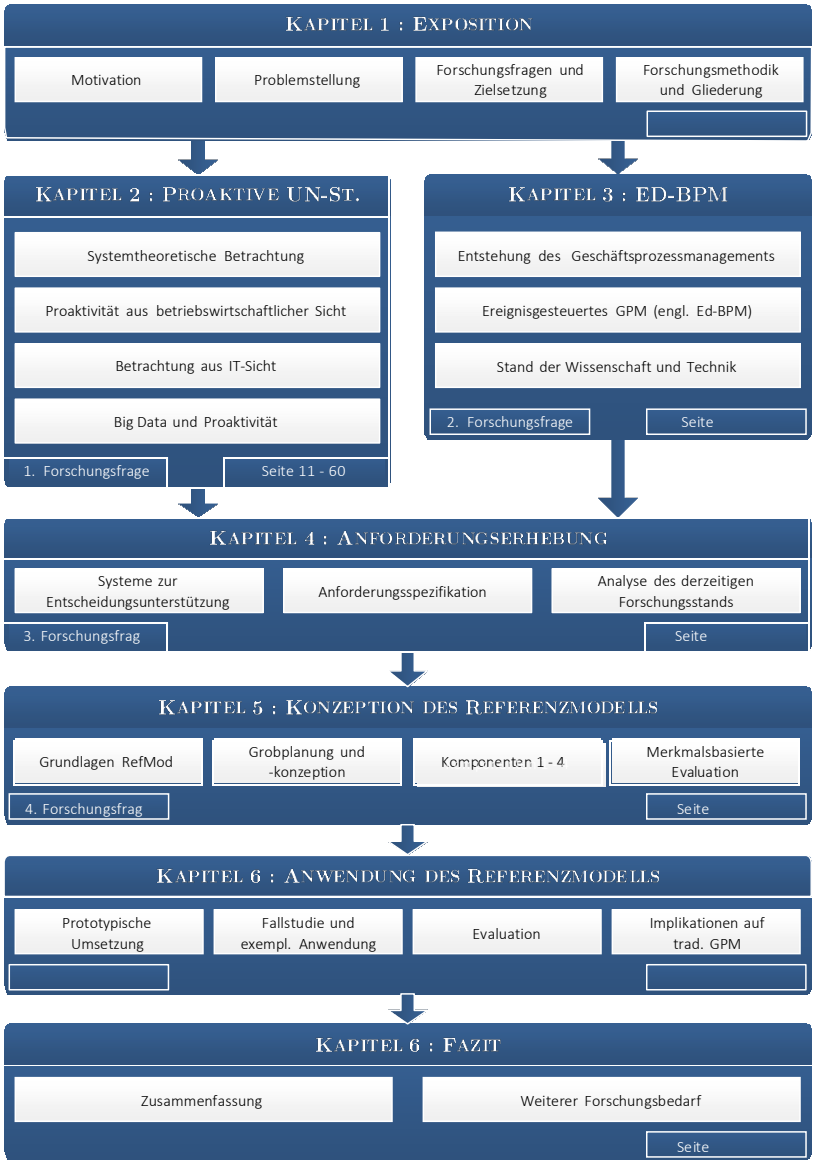


**Abb. 2.** Darstellung des Aufbaus des Dissertationsvorhabens

Hierzu wird dieser Begriff terminologisch eingeführt und die historische Entwicklung ausgehend von der funktionalen zur prozessorientierten Unternehmensorganisation erörtert [19] als auch die traditionelle Disziplin des GPM beleuchtet. Durch die rasant stattfindende Digitalisierung der realen Welt, mittels vielfältiger Sensorik, ist eine Abbildung dieser zunehmend detaillierter und kostengünstiger möglich. Solche Hard- und Softwaresensoren bedingen einen enormen Anstieg an Einzelereignissen, die im Ge-

schäftsprozessablauf detektiert und die derzeitige Prozess- und Geschäftssituation feingranular abbilden können. Dabei können insbesondere das Auftreten und die Aggregation mehrerer atomarer Ereignisse, die miteinander bspw. temporal oder sequenziell in Beziehung stehen, eine signifikante Auswirkung auf eine Prozessausführung besitzen. Wenngleich der Ereignisgedanke keinesfalls neu im GPM ist, so hat sich in den letzten Jahren eine dedizierte Forschungsrichtung etabliert, die CEP mit GPM verschmilzt [6]. Kapitel 3 führt daher in ED-BPM als Subdomäne des GPM ein und leitet deren aktuellen Forschungsbedarf ab. Hier zeichnet sich vor allem eine mangelnde Unterstützung bzw. Abbildbarkeit von komplexen Ereignissen in bestehenden fachlichen (Prozess-)Modellierungssprachen [20] sowie eine unzureichende Verzahnung von ED-BPM mit PA ab ([6], Research Challenges 4 u. 9).

Es zeigt sich nunmehr, dass für die Beherrschung der Vielzahl an Ereignissen, die eine jeweilige Kontext- oder Prozesssituation darstellen, in denen ein Prozess stattfindet und gesteuert werden muss, eine Entscheidungsunterstützung für den jeweiligen Prozessverantwortlichen bedarf. Aus diesem Grund führt **Kapitel 4** eingangs in das Themenfeld von System zur Entscheidungsunterstützung ein. Dabei wird auf die Datenanalysetypen der deskriptiven, prädiktiven und präskriptiven Analyse eingegangen. Basierend darauf wird eine Anforderungserhebung und -spezifikation für ein solches System vorgenommen und der derzeitige Stand der Wissenschaft und Technik damit verglichen.

Daran anknüpfend wird in **Kapitel 5** ein Referenzmodell eines proaktiven Systems zur Entscheidungsunterstützung auf der Grundlage ereignisbasierter Prognosen entwickelt. Hierzu erfolgt zunächst eine Einführung in das Themenfeld der Referenzmodellierung. Darauf aufbauend erfolgt eine Grobplanung des Referenzmodells, das in vier Hauptkomponenten zerlegt und konzipiert wird.

**Kapitel 6** widmet sich der Instanziierung des Referenzmodells in einen Softwareprototyp als Proof-of-Concept. Daran anknüpfend wird in der Anwendungsdomäne der Planung und Steuerung von Prozessen in der Stahlindustrie illustriert, wie ein solches System gemäß dem konzipierten Referenzmodell eingesetzt werden kann [8]. Auf dieser Basis erfolgt eine Evaluation der Ergebnisse durch Experteninterviews. Schließlich erfolgt eine Betrachtung der Implikationen auf das traditionelle GPM.

Die Arbeit schließt in **Kapitel 7** mit einem Resümee und einem Ausblick auf zukünftig zu adressierende Forschungsfragen.

# 5 Erwarteter Beitrag des Dissertationsvorhabens

Der vorliegende Abschnitt skizziert den erwarteten Kernbeitrag des Dissertationsvorhabens in Form eines Referenzmodells eines Systems zur Entscheidungsunterstützung, das, auf Basis ereignisbasierter Prognosen, eine proaktive Steuerung von Geschäftsprozessen ermöglicht. Zudem wird eine Referenzarchitektur als Basis für eine prototypische Realisierung illustriert.

## 5.1 Referenzmodell

Das Referenzmodell soll aus vier Hauptkomponenten bestehen, auf fachkonzeptioneller Ebene angesiedelt sein und primär eine Steuerungs- und Datensicht abdecken [19]. *Komponente 1* dient sowohl dem fachlichen Abbild von komplexen Ereignismustern als auch von Prognosezielstellungen in Prozessmodellen. *Komponente 2* detektiert mittels CEP-Methoden die spezifizierten Ereignismuster in laufenden Prozessinstanzen. Im Falle des Auftretens eines solchen Musters wird über *Komponente 3* eine Prognoseberechnung für die laufende Instanz unter Berücksichtigung der vorliegenden Prozesssituation angetriggert. Die Ergebnisse dieser Prognoseberechnung werden in *Komponente 4* zur Simulation und Optimierung von festgelegten KPI-Werte gemäß einer definierten Optimierungsfunktion genutzt. Die hierdurch berechneten Ergebnisse können sodann zur Entscheidungsunterstützung dem Prozessverantwortlichen offeriert werden. Prinzipiell könnten diese Ergebnisse auch in eine automatisierte Entscheidungsfindung fließen, das Referenzmodell strebt jedoch eine primär unterstützende Rolle für Prozessverantwortliche an.

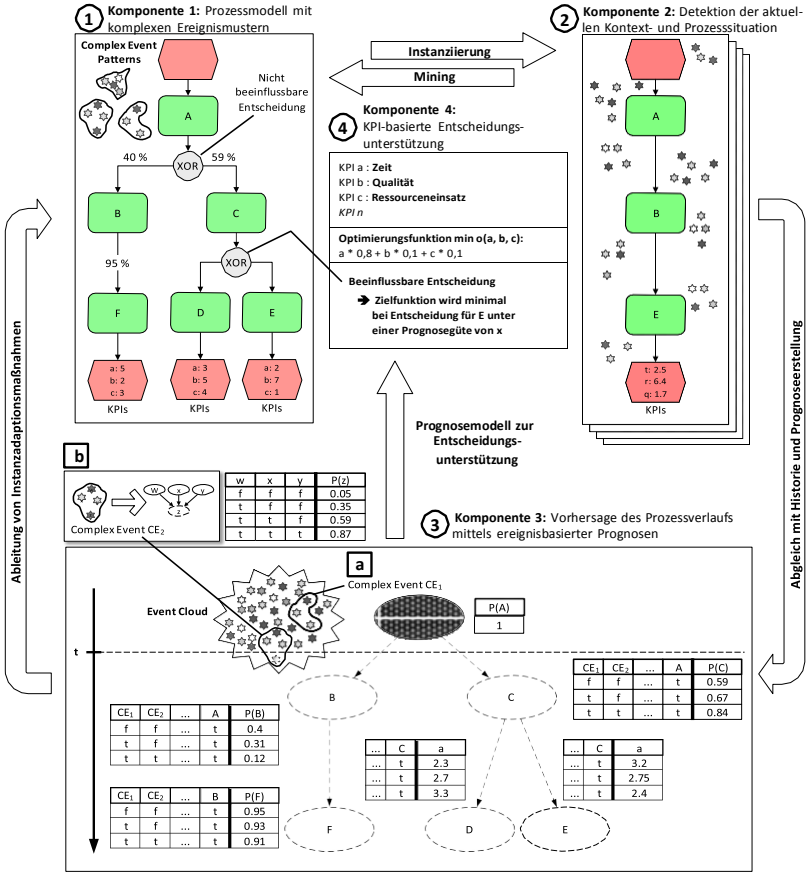


**Abb. 3.** Komponenten des geplanten Referenzmodells und deren Zusammenspiel

**Komponente 1.** Die Basis des Referenzmodells bilden Prozessmodelle, die in Process-Engines instanziiert werden (vgl. Abb. 3, 1). Prozessmodelle können grundsätzlich aus abgeschlossenen Prozessinstanzen – gemäß Prinzipien des Prozess-Mining [21] – erhobenen werden. Dies steht jedoch nicht im Fokus des Dissertationsvorhabens. Vielmehr soll erforscht werden, wie Kontextsituationen, die als komplexe Ereignismuster verstanden werden, auf fachlicher Ebene in Prozessmodelle abgebildet werden können. Dies schafft eine Grundlage, ereignisbasierte Prozessprognosen prinzipiell zu realisieren, denn das Auftreten bestimmter Ereignismuster kann sich signifikant auf Prozessinstanzen auswirken. So können komplexe Ereignisse zum einen Bestandteil von Entscheidungsregeln sein, d. h. primär struktureller bzw. steuerungsrelevanter Natur sein, zum anderen aber auch verantwortlich für Schwankungen einzelner Performanzwerte von Prozessen sein. Die Abbildung solcher Informationen ist aktuell nur bedingt in Prozessmodellen möglich [6, 20]. Eine kürzlich veröffentlichte Dissertation widmet sich daher einem Ansatz, um komplexe Ereignisse in Prozessmodelle, im speziellen mit Bezug zur Business Process Modeling Notation (BPMN), einzubetten [20]. Das vorliegende Dissertationsvorhaben wird eine Abbildungsmöglichkeit in die Ereignisgesteuerte Prozesskette (EPK) [22] untersuchen. Ferner gilt es, Prognosezielstellungen im Prozessmodell aus fachlicher Sicht zu verankern, d. h. Prozesskennwerte, wie bestimmte Durchlaufzeiten, das Eintreten gewisser Ereignisse oder auch die Ausführungswahrscheinlichkeit alternativer Prozessstränge. Basierend auf diesen Prognosewerten kann proaktiv eine Entscheidung gefällt werden, ohne reaktiv auf Basis des sich ergebenden Wertes zu entscheiden. Zweifelsohne kann eine Divergenz zwischen Prognosezielstellungen und dem tatsächlichen Prognosepotenzial, das auf Basis vorhandener Datenbestände vorliegt, existieren. Während ersteres primär von Prozessexperten und -verantwortlichen spezifiziert werden soll, analysieren sogenannte Data Scientists vorhandene Datenbestände zur Umsetzung eben dieser Zielsetzungen. Welche Implikationen ein Zusammenspiel beider Expertengruppen auf das traditionelle Verständnis des GPM aufweist, ist eine, der zu beantworteten Forschungsfragen im vorliegenden Dissertationsvorhaben (vgl. Abschnitt 2, 5. Forschungsfrage).

Wie eingangs skizziert, ermöglicht der technologische Fortschritt im Bereich von Sensortechnologien als auch die zunehmende Digitalisierung physischer Objekte die Möglichkeit Kontextinformationen äußerst feingranular zu erfassen. Damit einhergehend steigt jedoch auch die Masse an zu analysierenden Daten, was den Bedarf höherer Rechenleistungen oder Parallelisierungen von Rechenoperationen im Kontext von Big-Data nach sich zieht (vgl. Abschnitt 4 zum Abschnitt 2.4 des Dissertationsvorhabens).

**Komponente 2.** Um Ereignisse, die einen signifikanten Einfluss auf Prozessergebnisse haben, automatisiert zu identifizieren, finden sich in der Literatur erste Data-Mining-Ansätze sowie weitere statistische Methoden, wie mehrfaktorielle Varianzanalysen [9, 23]. Durch die Anwendung von Clustering-Algorithmen können solche Ereignisse zu Clustern kombiniert werden (vgl. Abb. 3, 2). Diese Cluster reflektieren komplexe Ereignisse, die eine hohe Signifikanz auf resultierende Prozessergebnisse besitzen. Das bedeutet, dass bspw. nur das gleichzeitige Eintreten oder Ausbleiben bestimmter Einzelereignisse eine entsprechende Situation kennzeichnen.

Die identifizierten Ereignismuster treten jedoch nicht in jeder Prozessausführung auf. Daher beinhaltet diese Komponente Methoden zu deren Erkennung basierend auf CEP-Verfahren (vgl. Abb. 3, 2). Eine solche Detektion von komplexen Ereignissen kann mittels Ereignismustern und -regeln erfolgen, die mit speziellen Event Pattern Languages (EPL) spezifiziert werden. Ein Ziel dieser Komponente wird es daher sein, eine Möglichkeit zu schaffen, wie ausgehend von den im Fachmodell spezifizierten komplexen Ereignissen, maschinenverständliche Konstrukte generiert werden können. In diesem Bereich lassen sich datenstromorientierte, regelbasierte sowie imperative Sprachen unterscheiden [6]. Wird ein entsprechendes Muster im Ereignisstrom erkannt, so erfolgt automatisch ein Prognosetrigger.

**Komponente 3.** Mittels der über Komponente 2 erfolgten Detektion der vorliegenden Prozess- und Kontextsituation(en) kann nun ein Abgleich dieser mit dem Prozessmodell und den darin gespeicherten historischen Prozessinstanzen erfolgen. Dies ermöglicht es, mittels Machine-Learning-Ansätzen sowie Methoden der künstlichen Intelligenz, Prognosemodelle über den weiteren Prozessverlauf als auch über Prognosezielstellungen, häufig in Form von Key Performance Indicators (KPI), zu berechnen [8]. Durch den Situationsbezug hat diese Art der Prognosegenerierung potenzielle Vorteile gegenüber klassischen statistischen Verfahren, die meist reine Durchschnittsbetrachtungen über historischen Prozessinstanzen hinweg vornehmen.

Abb. 3, 1 zeigt exemplarische Wahrscheinlichkeiten eines laufenden Prozesses auf Basis solcher Durchschnittsbetrachtungen. Demnach wird nach dem ersten (nicht-beeinflussbaren) Entscheidungspunkt mit 59 %-iger Wahrscheinlichkeit Prozessschritt „C“ ausgeführt und es ergeben sich die spezifizierten KPI-Werte resp. Prognosezielstellungen. Wenngleich diese Wahrscheinlichkeit im Mittel korrekt ist, so könnte die aktuell vorliegende Prozesssituation eine davon abweichende Ausnahme darstellen. Ereignisbasierte Prognosen entschärfen diese Fehleinschätzung durch eine dedizierte Berücksichtigung der aktuellen Prozess- und Kontextsituation [8]. Somit würde sich bspw. im Falle der Erkennung des komplexen Ereignisses $CE_1$ die Wahrscheinlichkeit P(C) zu 0.67 verschieben.

Ereignisbasierte Prognosemodelle lassen sich darüber hinaus selbst zur Vorhersage zukünftig eintretender komplexer Ereignisse nutzen [9]. Werden somit z. B. die atomaren Ereignisse w, x und y detektiert, so wird das Auftreten des Ereignisses z – verbunden mit dem gleichzeitigen Auslösen des komplexen Ereignisses $CE_2$ – mit P(z) = 0.87 berechnet. Dieser Umstand könnte wiederum einen signifikanten Einfluss auf die Prognose und letztendliche Steuerung des weiteren Prozessverlaufes nehmen. Die als Bayes'sches Netz dargestellten bedingten Wahrscheinlichkeiten in Abb. 3, 2 geben als Wahrscheinlichkeit für P(C | $CE_1$ und $CE_2$) den gestiegenen Wert von 0.84. Gleichzeitig weißen sie auf einen signifikant geänderten KPI-Wert für a (Zeitverbrauch) für die Prozessschritte „D“ und „E“ hin. Unter Annahme $CE_2$ tritt ein, sollte somit im Anschluss an „C“ – entgegen der Durchschnittsbetrachtung – nicht Schritt „D“, sondern „E“ ausgeführt werden (im Falle einer gewünschten Minimierung von a; vgl. a = 3.3 vs. a = 2.4). Es gilt an dieser Stelle anzumerken, dass typische Prognoseansätze jedoch keine Punktwahrscheinlichkeiten berechnen, sondern eher mit Wahrscheinlichkeitsdichten für KPI-Werte aufwarten.

**Komponente 4.** Basierend auf der berechneten ereignisbasierten Prozessvorhersage kann die Prozessausführung nun proaktiv gesteuert werden. Hierzu muss eine Optimierungsfunktion o(a, b, c, …) definiert werden, bei der die einzelnen KPI-Werte gewichtet werden (vgl. Abb. 3, 4). Auf dieser Grundlage kann nun der weitere, optimale Prozessablauf berechnet und für eine sogenannte präskriptive Entscheidungsunterstützung genutzt werden. Im zugrundeliegenden Szenario wird o(a, b, c) minimiert, falls Prozessschritt „E" ausgeführt wird; der Entscheidungspunkt zwischen den Schritten „D" und „E" ist somit exemplarisch entscheidbar. In diesem Fall könnten Maschinen, die in Schritt „E" benötigt werden, bereits proaktiv gestartet werden, um instantan nach Fertigstellung von Schritt „C" mit der Arbeit beginnen zu können.

## 5.2 Referenzarchitektur

Um das zuvor beschriebene Referenzmodell technologisch zu instanziieren – unter Berücksichtigung der zunehmenden großen Menge an detektierbaren Ereignissen – ist eine leistungsfähige Technologie zur Ereignisverarbeitung (engl. Event Processing) notwendig [1, 4]. In diesem Bereich hat sich CEP als grundsätzlicher Wegbereiter zur (Nah-)Echtzeit Prozesssteuerung etabliert (vgl. Abb. 4, 1). CEP wird als Technologie für eine dynamische und zeitgleiche Bearbeitung einer Vielzahl von Ereignissen verstanden. Dabei ermöglicht sie kausale, temporale, räumliche sowie weitere Beziehungen zwischen Ereignissen auszudrücken. Diese Beziehungen spezifizieren Muster, die zum Echtzeit-Ereignis-Monitoring einer genutzt werden kann [1]. Wissen über mögliche Ereignistypen und deren Abhängigkeiten zueinander wird mittels Event Processing Agents (EPA) in Ereignismodellen zur Verfügung gestellt (vgl. Abb. 4, 1).

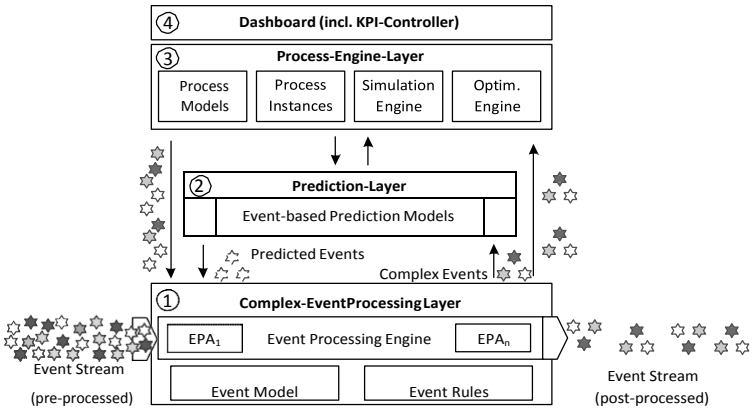


**Abb. 4.** Schematische Referenzarchitektur

Deklarative Ereignisregeln definieren ferner spezifische Ereignismuster und Aktionen, die nach deren Detektion ausgeführt werden sollen. Während deduktive Regeln neue aggregierte bzw. komplexe Ereignisse ableiten, initiieren reaktive Regeln bestimmte Prozeduren innerhalb verbundener Event Handler, wie z. B. das Anstoßen von Prognosen im Prediction Layer oder von Aktionen in der Process Engine (vgl. Abb. 4, 2 und

3). Sobald komplexe Ereignisse detektiert wurden, wird dies dem Prediction Layer mitgeteilt, somit folgt die Architektur grundsätzlich den Prinzipien der Event-Driven Architecture (EDA) und führt ein flexibles Verarbeitungsmodel innerhalb einer entkoppelten Systemstruktur ein. Deren Komponenten kommunizieren asynchron gemäß Publish-und-Subscribe unter Nutzung des Push-Prinzips. Diese Vorgehensweise ist grundlegend verschieden vom anfragesteuerten bzw. Pull-basiertem Paradigma, welches in traditionellen Architekturansätzen implementiert wird. Gleichzeitig können mittels PA ebenfalls Wahrscheinlichkeiten des Auftretens komplexer Ereignisse bestimmt werden, bei denen erst vereinzelte Musterteile eintraten bzw. detektiert wurden. Dies führt zu prognostizierten komplexen Ereignissen. Mittels Prozesssimulationen und Optimierungsalgorithmen wird das Prognosewissen genutzt, um eine optimierte Prozessausführung basierend auf den gewählten KPI zu berechnen und Prozessmanagern in einem Dashboard zur Entscheidungsunterstützung zu visualisieren (vgl. Abb. 4, 4).

Das Dissertationsvorhaben wird bei der Vorstellung des Softwareprototyps insbesondere auf dieses Dashboard näher eingehen (vgl. Abschnitt 3 zu Kapitel 6 des Dissertationsvorhabens).

### 5.3 Limitationen des zu entwickelnden Referenzmodells

Proaktivität birgt stets die Gefahr, Sachverhalte fälschlich vorherzusagen und Entscheidungen basierend auf inkorrekten Annahmen zu treffen. Aus diesem Grund wird das Referenzmodell derart konzipiert, dass es primär als Entscheidungsunterstützung für menschliche Akteure dient und dabei gleichzeitig einen möglichst hohen Grad an Transparenz bietet. Somit können Experten, die in ihrer Entscheidung unterstützt werden sollen, stets die inhärente, jedoch im Grade variierende, Unsicherheit vor Augen geführt werden. Auf dieser Basis gilt es dann, den potenziellen betrieblichen Mehrwert, aufgrund einer proaktiven Handlung, gegenüber einer sich dadurch möglicherweise resultierenden Fehlentscheidung, abzuwägen.

Darüber hinaus erheben weder das Referenzmodell noch die darin entwickelten Ansätze zur Prozessprognose einen Anspruch darauf, existierende Ansätze im Punkt eines möglichst geringen Prognosefehlers zu unterbieten. Entscheidend hierfür ist stets die Wahl des „richtigen“ Prognosemodells, die abhängig der jeweiligen Prognosezielsetzung, aber auch der vorhandenen Datenbasis getroffen werden muss. Hier kann das Referenzmodell keine allgemeingültige Gestaltungsvorlage bieten. Dennoch soll das Modell derart konstruiert sein, dass es nicht auf die Anwendung eines einzelnen, spezifischen Prognosemodells limitiert ist, sondern gemäß des Anspruchs eines Referenzmodells in vielfacher Hinsicht – jeweils zugeschnitten auf den vorliegenden Sachverhalt – instanziiert werden kann.

## 6 Betrachtung verwandter Arbeiten

Seit einigen Jahren wird in der Wissenschaft der Forschungsbereich des Ereignisgesteuerten Geschäftsprozessmanagements (ED-BPM) propagiert, das die beiden Disziplinen GPM und CEP kombiniert [24]. Einen Überblick über den aktuellen Stand zur ED-BPM-Forschung ist in [6] zu finden.

Unter CEP wird eine Technologie für Informationssystemen verstanden, die basierend auf einer Echtzeiterkennung von bestimmten Ereignisse – und der damit einhergehenden veränderten Geschäftssituation – Aktionen auf automatische Weise anstößt [25] Zur Realisierung von ED-BPM existiert technisch gesehen CEP als eigenständige Technologie, die als Middleware einer GPM-Plattform zugrunde liegt [26, 27]. Hierbei wird dem EDA-Architekturstil gefolgt [1].

Um Kontext und Fortschritt laufender Prozessinstanzen in Form von Ereignissen detektieren zu können, müssen Daten entlang der Wertschöpfungskette von Prozessen erhoben werden. Dies geschieht mittels physischer und virtueller Sensoren. Zusätzlich werden Daten traditionell aus IT-Systemen bezogen, indem etwa Log-Dateien oder ausgetauschte Nachrichten auf unterster Systemebene ausgewertet werden. Die hierbei gesammelte Daten- bzw. Ereignismenge gilt es zu analysieren. Ein verbreitetes Vorgehen ist es, atomare Ereignisse, die von Sensoren gemeldet werden, zu komplexen Ereignissen mittels CEP zu kumulieren.

Als PA bezeichnet man, die in die Zukunft gerichtete Vorhersage von Ereignissen. Die hierzu notwendige mathematische Modellierung kann mit Hilfe historischer Daten geschehen. Dabei kann Process Mining zur Anwendung kommen, bei dem aus aufgezeichneten Log-Dateien Prozessinformationen extrahiert werden [21]. Grundsätzlich muss zwischen der in die Vergangenheit gerichtete Analyse und einer Prognose unterschieden werden. Ein klassisches Beispiel für eine simple Prognose ist der gleitende Durchschnitt, der nur auf einer zur Verfügung stehenden Beobachtung berechnet wird. Solche einfachen Modelle können nur dann funktionieren, wenn eine Information unabhängig von allen anderen Ereignissen ist, was nur selten der Realität entspricht. Gerade in Geschäftsprozessen existieren Abhängigkeiten und Einflussfaktoren. Moderne statistische Methoden werden daher notwendig, um Zusammenhänge und Muster in großen Datenmengen erkennen zu können. Zur Anwendung kommen etwa Entscheidungsbäume, univariate und multivariate Statistik oder neuronale Netze [28]. Hiermit lassen sich statistische Modelle erstellen, mit denen sich treffsichere Prognosen ableiten lassen.

Ansätze, die PA mit GPM verbinden, werden teilweise unter dem Begriff BPI subsumiert (vgl. [29] für eine aktuelle Definitionsübersicht). Derzeitige BPI-Ansätze berücksichtigen jedoch meist keine Daten, die nahe der Echtzeit liegen. Zudem werden kaum Technologien wie CEP eingesetzt. Eine Nutzung von Echtzeitdaten findet dagegen beim BAM statt. Hier werden prozessbezogene Daten zu KPI aggregiert. Anhand dieser Größen erhält man schließlich Anhaltspunkte zur aktuellen Performanz von Geschäftsprozessen, die den Prozessverantwortlichen in Dashboards visualisiert und schließlich zur Entscheidungsunterstützung genutzt werden können. Ansätze des derzeitigen State-of-the-Arts im Bereich BAM setzen CEP bereits als Kernkomponente ein [3].

Durch das gestiegene Kontextbewusstsein, das ED-BPM verspricht, liegt es natürlich nahe, eine solche Echtzeitinformationsbasis auch für die ereignisbasierte Vorhersage von Geschäftsprozessabläufen zu nutzen und somit die Anpassung von Geschäftsprozessen nicht nur in Echtzeit durch CEP, sondern auch unter Berücksichtigung von Prognosen durchzuführen. Ein erster prognosebasierter CEP-Ansatz lässt sich bei [9]

erkennen, die einen konzeptionellen Rahmen für die Verbindung von CEP mit PA vorstellen. Eine hinreichende Verzahnung ihres Ansatzes mit ED-BPM bzw. GPM im Allgemeinen lässt sich jedoch nicht ableiten. Ein weiterer Ansatz in diese Richtung ist bei [5] zu finden. Diese konstatieren jedoch ebenfalls, dass „[e]vent-based or event-driven business intelligence“ Ansätze erst rudimentär erforscht und eingeschränkten Einsatz in Softwarewerkzeugen finden. Der kürzlich publizierte Beitrag von [3] verknüpft zwar bereits BAM mit BPI, bleibt aber insbesondere der Frage schuldig, wie Erkenntnisse aus dieser Verbindung für die Adaption von Geschäftsprozessen herangezogen werden können. Somit zeigt sich, dass trotz des Interesses an diesem Forschungsgebiet ein großer Forschungsbedarf besteht [6].

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