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Data driven X — Turning Data into Value

Band II

Paul Drews, Burkhardt Funk, Peter Niemeyer und Lin Xie (Hrsg.)

6. - 9. März 2018, Leuphana Universität Lüneburg

LEUPHANA
UNIVERSITÄT LÜNEBURG

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Digitale Ökosysteme und Plattformen

Teilkonferenzleitung

Rainer Alt
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Modelling Ecosystems in Information Systems – A Typology Approach

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Abstract. Ecosystems as a modern concept of interorganisational networks are often discussed in current information systems research. There is a lot of investigation in the field of behaviouristic information system research. However, when designing ecosystems there is not much guidance and methodical support. In particular, modelling methods as a specific methodical support for ecosystem design are rare. Based on a literature review, this paper introduces specific types and characteristics of ecosystems. As a first step towards a comprehensive modelling framework, we use these types to propose views for the modelling of ecosystems. The framework organizes the modelling of ecosystems in three aspects: goal modelling, ecosystem modelling and platform modelling.

Keywords: ecosystems, platform, design, literature review, modelling

1 Introduction

Researchers in information systems propose networks of independent actors that they name as an "ecosystem" [1–3]. Ecosystems have become a popular research object and an often-used term for distributed networks of independent industrial partners and their technology. Even in practice and funding politics, ecosystems have become a design goal of innovative projects (e. g. [4]).

An uprising challenge is to design and engineer information technology (IT) artefacts that form ecosystems. However, in practice as well as in research the concept of ecosystems is often used without specifying why an implemented system is understood as an ecosystem and how this system achieves specific effects that are associated with the concept of ecosystems. Therefore, in each project, the expectations that are comprised in the idea of ecosystems have to be specified.

In economics, ecosystems are defined as evolutionary self-organizing cross-industrial systems of independent economic actors that are connected by value-added chains and behave similarly to naturalistic systems [5, 6]. General expectations towards ecosystems are postulated in a range of publications. These publications focus on the governance [7, 8], the business models and strategies of ecosystems [9–11], the architecture and properties of ecosystem components [12, 13] and the relationships between the participants of an ecosystem [14–16]. However, different term conjunctions describe

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specific types of ecosystems (e.g. software ecosystem, platform ecosystem, business ecosystems) that are bound to different ideas how these systems are structured and how they behave. Consequently, a construction of ecosystem architectures and a modelling of ecosystem-creating artefacts cannot be conducted without taking into account these different types of ecosystems. Moreover, the differences between them may lead to differences in the design implications of the underlying artefacts. However, prior research of ecosystems in information systems is primarily located in the field of behaviouristic research. Concrete guidance for artefact construction and modelling of ecosystem-building artefacts is rarely available. For example, ADOMAVICIUS ET AL. propose an IT ecosystem model to evaluate IT landscapes, but lesser describe design models for the engineering of ecosystems [17]. Some papers investigate the properties of specific types, like software ecosystems [18, 19] or business ecosystems [20, 21] and create taxonomies. Yet, there is a little investigation on how different ecosystem concepts lead to different ecosystem-building artefacts and how we can represent them in an adequate architectural model. Though, there are some authors proposing modelling and visualization approaches [22–25]. They focus on specific dynamics or specific configurations of ecosystems. So far, the diversity of ideas about ecosystems is rarely considered when modelling ecosystems. A comprehensive framework which systematizes the modelling aspects of ecosystems is missing. We argue that a systematization of types of ecosystems in information systems helps to derive these modelling aspects. Therefore, we question which aspects must be considered when specifying ecosystem models with a design-oriented lens. Based on a literature review, we contribute by providing a comprehensive understanding of different ecosystem types and derive views for a modelling framework from their characteristics.

This paper is structured as follows: In section 2 we introduce our literature review and the research questions. In section 3 we systematize seven types of ecosystems as ideal-typical forms. For these types, we explain common characteristics. In section 4, as an initial step towards a modelling framework, this paper concludes with a proposal for an ecosystem modelling that is based on the different types of ecosystems.

2 Literature Review

The literature study was conducted using a top-journal oriented literature analysis [26] based on the German VHB Jourqual ranking, which contains all journals that are also in the AIS senior scholars basket. We selected all publications with the ranking of A and A+. Even if an initial focus on top-rated journals restricts the view to dominant understanding of ecosystems, it is one possible point of origin to identify the predominant discussed archetypes. Additionally, we included the most important IS conferences (ICIS, ECIS, AMCIS, PACIS, ACIS). This ensures that recent changes in understandings of ecosystems are also considered. Furthermore, the conference "Wirtschaftsinformatik" as well as the journal "Business & Information Systems Engineering" (BISE) is included to consider design-oriented information systems. *"ecosystem*"* was used as search term. We applied ot to the title, the abstract and the keywords. We used Thomson Reuters WebOfScience and AIS Electronic Library, because these

databases index the publications of the named rankings and conferences. Based on the abstracts we selected the publications which directly discuss ecosystems. We rated all papers as relevant except those that focus on ecosystems in the sense of an environmental or biological view. We conducted an analysis of the ecosystems definitions in the remaining papers. In order to conduct the literature study, we have formulated two research questions:

(I) Which types of ecosystems are discussed in information systems research?

(II) Which implications for design-oriented modelling of ecosystems arise from the characteristics of these types?

We excluded papers that did not discuss the characteristics of ecosystems. Finally, we identified 163 papers. Table 1 gives an overview of the number of papers for each year. We have done a full-text analysis for papers that directly discuss the concept of ecosystems. For papers that apply the concept of ecosystems (e. g. ecosystems in payment) or analyse a specific property, we analysed the sections where the concept of ecosystems is explained. Subsequent, we identified dominant types of ecosystems which are mentioned more than one time by different authors. Specific types were assigned to a more abstract type (e.g. mobile platform ecosystems to platform ecosystems). After identifying the types, we inductively identified characteristics during the text analysis. We used two primary characteristics two describe two dimensions in which we assigned the different types of ecosystems. We derived *implications for modelling* ecosystems from these characteristics. These implications for modeling provide guidance to create the modelling framework with different modelling views.

Table 1. Overview of publications discussing ecosystems in IS journals and conferences

Publicat.	*2000*	*02*	*03*	*04*	*06*	*07*	*08*	*09*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*#*
AMCIS	1		1					3	2	1	3	1	3	4	7	6	32
BISE										1	1				1		3
DKE						1											1
ECIS		1			1		1	1		1			5	5	7	8	30
ICIS							1	2	1	1	1	2	4	8	11		31
ISJ												1	1		1	1	4
ISR									2		1			1			4
JAIS												2		2			4
JIT					2			1	1			1	1	4			10
Strateg. IS				1							1				1		3
MISQ							2				1	2		3	2	1	11
PACIS							2		1	4	1	1	2	3	5	5	24
WI								1		1				3		1	6
# p. a.	**1**	**1**	**1**	**1**	**3**	**1**	**6**	**8**	**7**	**9**	**9**	**10**	**16**	**33**	**35**	**22**	**163**

3 Systematization of Ecosystems in Information Systems

In the following, we describe the identified types and assign them to two specific dimensions. Based on the identified types we synthesize a systematization for ecosystems which is outlined in figure 1. We observed different concepts in ecosystems and different characteristics that can be assigned to each type. Two principal characteristics are

discussed in a broad range of papers: the social entities in the ecosystems and the platform as a focal component. From this, we derived two dimensions of ecosystem design: system types and platform focus. We assigned the different types of ecosystems to these dimensions. Furthermore, for each type, we annotated additional characteristics that are emphasized in the literature and discuss them below. These represent different dynamics that are expected in ecosystems.

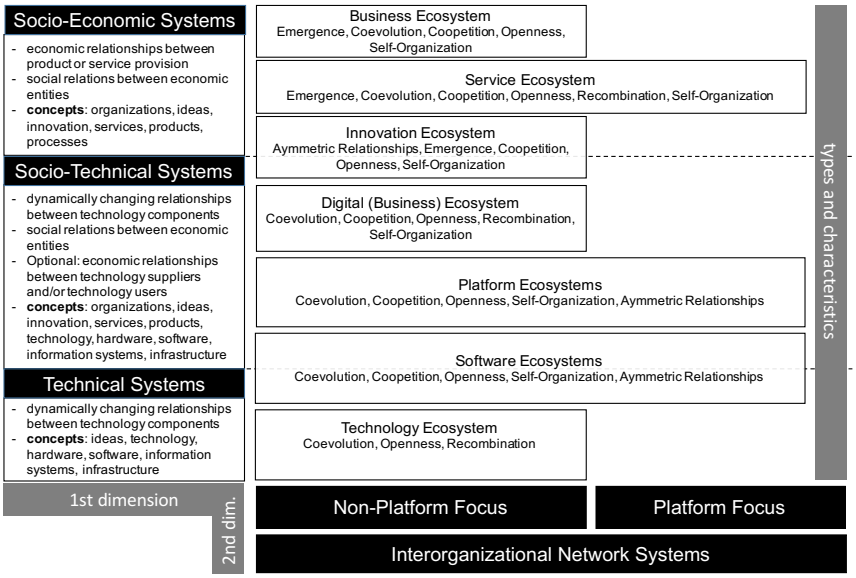


Figure 1. Systematization of ecosystems research in information systems research

3.1 Predominant Types of Ecosystems

Business Ecosystem: Business ecosystems were initially described by MOORE and by ROTHSCHILD [5, 6]. They were established in the context of economic and organization sciences but occur also in the information systems literature. Business ecosystems are defined as networks of organizations that are formed around a central innovation [6], technology or company [27]. The main focus is to establish economic relationships between the different participants around a focal technology. The existing research focuses *on actors, the relationships between them* and the *(economic) effects*.

Digital Ecosystem: A digital ecosystem is a business ecosystem, based on an organizational network in the context of a digital technology [10]. Digital ecosystems are *formed on the basis of digital objects (digital content, products, ideas, software, hardware, infrastructure)* that are interchanged and shared between *independent actors* [28, 29]. In this context, the term digital business ecosystem is also used, where the economic aspect in the sense of the business ecosystems is more emphasized [10, 21].

Innovation Ecosystem: Innovation ecosystems are networks of companies that share knowledge (skills and technology) to create innovation and to provide it to con-

sumers [30]. In such ecosystems, the *shared set of skills and knowledge* forms the foundation for new business and entrepreneurial opportunities [31]. This kind of ecosystems can be considered as communities as well as business networks [32]. Both, the innovators as well as the innovations play an important role.

Platform Ecosystem: Platform ecosystems emerge around a focal platform [14]. The platform provides a combination of *hardware, software and infrastructure* as well as *organizational and social rules* that connect actors around the platform [7, 14]. A platform owner (platform sponsor/provider) controls the platform and consequently influences the ecosystem [33]. Through the establishment of platform ecosystems, additional offers for end users are created which the owner of the platform cannot or does not want to offer [34]. Platform ecosystems may emerge from existing products. This can happen also unintendedly [35]. By the provision of user-adequate *boundary resources*, the platform providers enable platform users to participate [13, 36].

Software Ecosystem: The software ecosystem emerges analogue to the platform ecosystem around a *software technology* (e.g. a browser) or *a combination of software and hardware* (e.g. a smartphone). The distinction between platform ecosystem and software ecosystem is blurred. TIWANA [7] uses the term "platform based software ecosystems" as an equivalent to "platform ecosystems". Actors in software ecosystems can contribute new software components and services [16]. A distinction is possible using the contribution of hardware in the ecosystem as a criterion. Software solutions of actors play the central role in software ecosystems [19]. There are existing literature reviews on software ecosystems from the perspective of software engineering [18, 37].

Technology Ecosystem (IT/ICT Ecosystem): Technology ecosystems describe a *set of information technologies* that share a certain common context of usage and are connected to each other. The technologies mutually interfere with each other and are able to play different roles in the context of the ecosystem (products, applications, components, infrastructure) [17, 38]. Actors do not play a key role and are not a component of the ecosystem. Technology ecosystems focusing on *the relation of technology* [17].

Service Ecosystem: Service ecosystems are shaped by an *exchange of services* within the ecosystem. Due to this exchange of services, the integration of resources as well as a common creation of value by the different connected actors is realized [39].

Implication for Modelling: Allow modelling of technical concepts (software, hardware), conceptual non-materialistic concepts (ideas) and business concepts. Provide modelling facilities for boundary resources.

3.2 First Dimension: System Types

The first dimension describes the differentiation between socio-economic systems, socio-technical systems and technical systems. These differentiation results from the different types of ecosystems that represent specific views to an ecosystem (business view, technology view etc.).

We perceive socio-economic systems as systems which comprise social relationships and economic decision-making entities with specific operating characteristics [40]. Business ecosystems, innovation ecosystems and service ecosystems are considered as socio-economic systems by scholars because their focus is on the relationships

between the actors and their value-creating concepts which may be products, services or knowledge (ideas). As socio-technical systems, we understand systems that comprise decision-making social entities like humans or enterprises as well as technical-components [41, 42]. Socio-technical systems can be understood as a result of the interdependence of technical systems and social systems [43]. Digital ecosystems, platform ecosystems and software ecosystems are socio-technical systems that comprise social actors and technical components that have reciprocal relationships. Innovation ecosystems can be socio-technical systems if they focus on technological innovations as system components and can be socio-economical systems if ideas and concepts are in the focus. Technical systems comprise only technical components as entities with reciprocal relationships. However, these types of systems may be subsystems in a social context, but the technical relationships and units are emphasized [44]. For each of the system types, the emphasized concepts are named in figure 1.

Implication for Modelling: Model the social actor's needs, organizations, socio-technical structures and behaviour as well as technical components and technological relationships on different modelling layers [43].

3.3 Second Dimension: Platform Focus

A second dimension is the distinction between platform focused and non-platform focused types of research. Ecosystems with non-platform focus do not exclude platforms but emphasize the actors and components around the focal platform. Regarding this characteristic, we observed that in several types, platforms are generally defined as focal components of ecosystems that provide a clear ruleset and boundary resources [36] to access the ecosystems. Therefore, a stream of research focuses on the design of platforms [7, 11, 13, 14, 34, 36, 39, 45]. In these papers, explicit characteristics of the focal components are described. In contrast, some researchers are not focusing directly on the characteristics of platforms even if they often name a central platform [10, 21, 22, 29, 46–48]. Thus, it can be argued, that the authors, who name those types of ecosystems, emphasize the socio-economic or socio-technical relationships in the platform environment (e. g. common goals of ecosystem participants). There are also authors who mention platforms despite their view is more abstract [28]. For example, an innovation ecosystem may emerge around an existing network of companies and may have a platform, but the focus is on the characteristics of entrepreneurs [31]. Other authors also combine a platform focus with the analysis of the actors [16, 49]. Thus, every type can be used as a subject of research in studies which does not focus on the platforms but on the environment.

Implication for modelling: Differentiate between platform modelling and ecosystems modelling.

3.4 Characteristics of Ecosystems

In table 2 we describe the different characteristics of ecosystems that were gathered in the literature review. For each characteristic, we identify implications for modelling of ecosystems. These are used to derive views for modelling in section 4.

Table 2. Characteristics and implications for modelling

Characteristic	*Description*	*Implication for Modeling*
Asymmetric relationships	- asymmetry (unilateral dependency) between platform owner and ecosystem participants - focal authority controls the ecosystem - control of the ecosystem with direct and indirect measures [7, 33, 50]	Model governance measures, direct influences measures and power relationships.
Emergence and Generativity	- unpredictable development of the whole ecosystem for all actors - generativity as a property to allow unanticipated changes[7, 24] - unanticipated relationships may develop over time, environment is turbulent, emergence as the characteristic which means the systems structure and behaviour is not predictable [20, 39, 46].	Provide an extension mechanism for new modelling elements to consider unpredicted actors, social-structures and technologies.
Coevolution	- actors cause effects on other actors as well as on the ecosystem as a whole [39, 51] - adaption of individual system components result from changes of other components [6] - constant screening of the environment by each actor due to ongoing evolution = continuous reinterpretation [7, 39]	Model temporal ecosystem development, mutual dependencies, mutual information flows and technology interaction.
Cooperative behavior	- integration of actor-oriented resources to create shared value [39] - contribution of knowledge, content and technological solutions to all actors [7, 52–54] - symbiotic relationships [10], social rules [39] and a common view [7], mutual trust [21, 52]	Model the business models and their combination by different partners.
Competitive behavior	- performance- and value-oriented behaviour between different ecosystem actors [5] - evolutionary-like competition [14] (“predators and prey” [6]), replacement and suppression of actors [46], egocentric behaviour [21] - two-sided markets [16, 49, 53, 55]	Model economic relationships and mutual competition relationships.
Coopetition	- the simultaneous presence of competitive and cooperative behaviour [6, 56].	Integration of cooperation and competition modelling
Openness	- number of system components (actors and technology) is dynamic - new components may enter the ecosystems, other components may leave it [11, 39, 57] - different levels of openness are possible - interoperability is a base of openness [28, 33]	Describe openness measures in the platform architecture, assign levels of openness to technical components.

Recombination	- similar to recombination in nature, ecosystem components (e.g. ideas, services and products) are combined to new components [47, 58] - resource integration leads to innovation, innovations are used in further innovation cycles [39]	Realize a component oriented modelling and allow business interface modelling.
Self-organization	- direct control of ecosystem actors is impossible - actors possess freedom of action within the governance limits and may act independent [7, 39] - self-regulation [51] of relationships between actors, adaption to the environment [22, 58] and unsolicited transition of the ecosystem [54]	Model individual goals and restrictions for each actor.

4 A Proposal for an Ecosystem Modelling Framework

Ecosystems as networks of independent actors cannot be designed directly [7, 59]. Using a design-oriented lens, a focal component, the platform and its boundary resources play the dominant role when engineering ecosystems [13]. The most authors, even those who discuss business ecosystems, mention a focal platform. Therefore, a modelling framework for ecosystems should comprise the aspect of platform modelling. In figure 2 we outline a basic dependency model that describes the relationship of the ecosystem and the concrete platform design measures. We use it to derive modelling aspects. The dynamics that occur in ecosystems are directly influenced by governance measures and a platform architecture [7]. This creates a solution space which should be modelled. The initial spark for the set-up of an ecosystem comes from the business environment and the intention to enable ecosystems dynamics [24, 59]. The intentions to create an ecosystem may differ, therefore a modelling approach should consider the modelling of the basic design objectives (aspect 1). The second aspect focuses on the direct system modelling of the platform (solution space: platform strategy and design). The third aspect focus on modelling of the relationships between the participants of the ecosystems, the relationships and the effects that occur in the ecosystem.

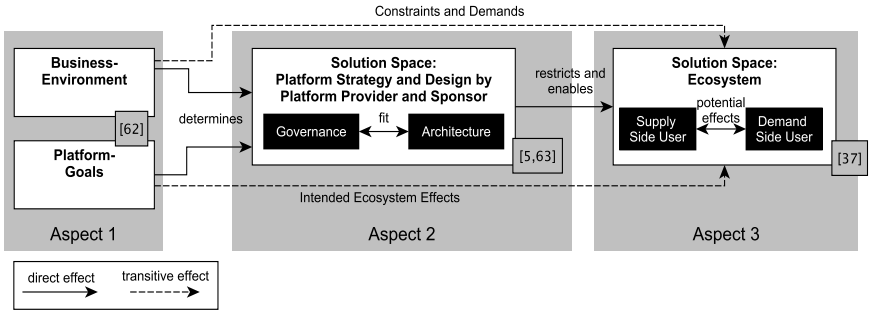


Figure 2. Dependency model for ecosystems, based on [7, 33, 59, 60]

In figure 3, we outline a basic modelling framework for ecosystems with different model types. The model aims to support ecosystem construction by separating different aspects of ecosystem specification. The first aspect, the goal modelling, describes two

types of goal models and a restriction model: The internal goal model describes the motivation of the platform sponsor to set-up an ecosystem while the environmental goal model specifies the objectives for the participants in the ecosystems.

In contrast, the restriction model explicates the constraints and negative effects that may hamper the goal achievement. The modelling of the ecosystem comprises the modelling of ecosystem participants, the relationships between the participants (socio-economic layer), the value-creating concepts (ideas/products/services, socio-technical layer) that are combined in the ecosystem and the basic technological components and their relationships (technical layer). Supplementary to these structural aspects, the modelling approach considers the dynamics that occur in the ecosystem. For example, it should be modelled to which relationships describe coevolutionary effects. The definition of these dynamics could be specified by the concrete business processes that occur between specific types of actors. For example, to get a more detailed view to coevolution between two partners it should be specified how they combine specific ideas, products or services. The technology-layer focuses on how the business processes are integrated. The platform model describes the boundary resources as well as the technological architecture and the governance measures for ecosystem participants. In this aspect, the measures, that enable concrete ecosystem dynamics, should be modelled. They have direct influence on possible business models and the technology.

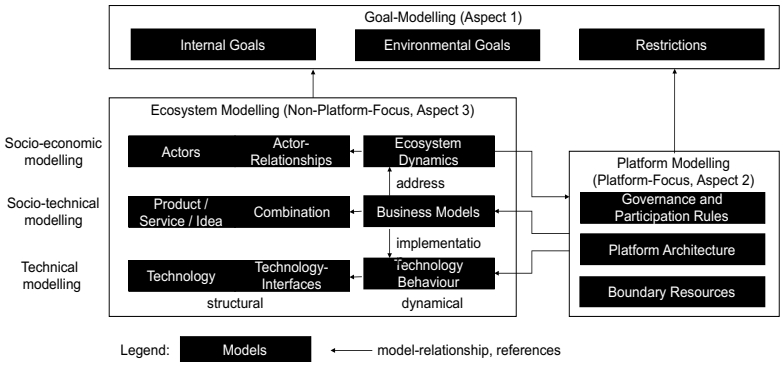


Figure 3. Proposal for conceptual modelling framework for ecosystems

5 Conclusion

This paper analyses how ecosystems are currently understood in information systems research. It systematizes seven dominant types of ecosystems and outlines a modelling framework. However, in our literature review, we found that seven types are often used synonymously. The use of a specific type is associated stronger with an emphasis on specific characteristics than a clear typology of ecosystems. Applying a design-oriented lens, platform ecosystems are dominant in information systems research. Nevertheless, when engineering ecosystems the use of the types may help to specify different design dimensions. Furthermore, the identified characteristics may help to formulate evaluation criteria for designed artefacts. The outlined modelling approach for ecosystems can

be used for research to create a view-based architecture framework for ecosystems and may also provide a basis for architectural modelling. For this purpose, existing enterprise architecture frameworks should be considered. Existing modelling methods should be analysed for their ability to be used in ecosystems modelling. An evaluation of the proposed modelling framework is planned for further research. However, a methodical support for modelling is needed. In particular, there is a need for guidance how specific architectural measures can be obtained from the goals in aspect 1.

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Platform Configurations within Information Systems Research: A Literature Review on the Example of IoT Platforms

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Abstract. This contribution aims to shed light on the usage and application of different platform constructs within the context of IoT platforms. The motivation is that Information Systems (IS) scholars and practitioners use the term platform frequently as an unspecific or vague construct. Different research streams shape and influence the understanding of a platform. They range from economic practices like the Two-Sided Market (TSM), Multi-Sided Platform (MSP) or platform business models, to technical platform aspects including standardization and modularization, to the platform ecosystem and the construct of an IS platform fostering value co-creation. Within those constructs, the upcoming phenomenon of IoT platforms represents a specific case to analyze what constructs are used to which extent. Thus, the study helps future IS scholars to use the term platform more precisely and reveals the interrelatedness of the identified constructs. However, the literature review is only a first step towards demystifying the phenomenon of a platform, due to the limited context of IoT platforms.

Keywords: IoT, Platform, Platform Ecosystem, Two-Sided Market, Multi-Sided Platform

1 Introduction

The success in terms of company valuation of recently emerging platform companies indicates their rising importance. A prominent representative is Uber, a transportation service platform that ranks among the top of the Unicorn[1] list with a valuation of over $68 billion [1]. Fueled by this success, more and more companies try to jump on the bandwagon of platforms. To name but a few, Microsoft established the Azure Suite as a platform in the context of the Internet of Things (IoT), Apple created HealthKit as a healthcare platform, and Daimler founded the mobility platform moovel. Inevitably, this raises the question of what a platform is and how companies utilize this construct.

[1] A Unicorn defines a start-up company with an evaluation of over $1 billion.

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Unfortunately, there is no clear answer to those questions, as the construct of a platform is context dependent. This becomes clear when considering that researchers use the term platform in various disciplines and meanings. They range from describing vehicles or carriers in the field of biology or medicine [2], to economic research streams on the example of Two-Sided Markets (TSMs) [3], to technical and architectural considerations [4], to production platforms [5]. Also, even within disciplines, scholars do not define the term platform accurately. They use the term platform depending on the context, where the level of analysis varies from a platform's technical architecture to economic and market effects [6, 7]. Thus, it is not clear if the construct platform only describes a technical architecture, or on the contrary a whole market. Using the constructs indifferently blurs the actual meaning of the construct platform in a specific context. To illustrate this point, this contribution draws on the emerging phenomenon of IoT platforms to shed light on what constructs are how used. IoT platforms act as intermediaries to connect different parties like companies, sensor manufacturers, and third-party developers within an ecosystem [8]. One reason for the selection of IoT platforms is that they provide a specific context to elaborate on what platform constructs Information Systems (IS) scholars use. Secondly, the IoT platform literature relates to the interdisciplinary IS research community and, thus, covers a broad range of platform constructs. Further, the community combines several constructs of the term platform, which helps to illustrate the need for a differentiation of platform constructs.

The first construct of a platform relates to TSMs or Multi-Sided Platforms (MSPs). The platform economics go back to the research stream influenced by Rochet and Tirole [3], Eisenmann, Parker and Alstyne [9], Armstrong [10], Evans [11], Hagiu [12], Rysman [13], and Bharadwaj [14]. Economic principles reflect constructs like TSMs or MSPs and deal with network externalities, the chicken & egg problem, pricing mechanisms, and platform envelopment. On the contrary, the idea of an IS platform originates from Gawer and Cusumano [15], Baldwin and Woodard [4], and Tiwana et al. [16]. Key aspects are technical considerations by taking advantage of standardization and modularization through Application Programming Interfaces (APIs) and Software Development Kits (SDKs), as well as the influence of the innovation capabilities within the platform. Besides the different constructs, there are also different levels of analysis. The (platform) ecosystem originates from Moore [17] and is subject to the fact that companies do not evolve in a vacuum but rely on their environment and resources. Here, the platform forms the core of the ecosystem by taking advantage of third-party innovations, also called value co-creation through turning competitors into complementors and suppliers into partners [15, 18]. Hence, the ecosystem takes the organizational level of analysis through value co-creation [19], as well as the market level through network externalities and pricing strategies into consideration [3]. Another level is the design of the technical platform architecture to foster standardization and modularization with the help of APIs and SDKs.

The presented constructs indicate that a platform can, dependent on the use of the construct, affect one or a combination of several levels of analysis. Platform constructs range from TSMs or MSPs including network effects or to more technical constructs in the form of an IS platform including standardization and modularization. Also, each of those constructs can be used to analyze different levels of analysis. Thus, this contribution aims to provide a first step in the direction of differentiating and

delineating different platform constructs on the example of IoT platforms. For this purpose, the authors conduct a systematic literature review to reveal how IS scholars use the platform constructs of TSMs and MSPs, as well as IS platforms. The results show how the platform constructs differ, delineate, as well as the level of analysis ranging from technical, over to ecosystems.

2 Design of Literature Review

The literature research follows the proposed approach of Webster and Watson [20]. The structured process ensures reproducibility, transferability, transparency and to work towards a clearly defined goal.

The scope aims to identify how the platform constructs of TSMs [3, 9, 13, 21] or MSPs [11, 14, 22, 23] and IS platforms [4, 15, 16] are applied and differentiated within the IoT literature. The primary audience are IS scholars. The findings show a representative cross-section of the IoT platform literature [24, 25].

The central concept of the literature review is to identify how IS scholars use platform constructs in the context of IoT platforms to reveal differentiations, delineations, and the respective level of analysis. Accordingly, the authors spread the search terms across IoT platforms and the key IS scholars who influenced the constructs of TSMs/MSPs and IS platforms. For the literature search, the terms *"IoT Platform" and "[Alstyne | Armstrong | Baldwin | Bharadwaj | Eisenmann | Evans | Gawer | Hagiu | Rochet | Rysman | Tiwana]"* were used. To reduce the number of false negatives, the authors used the specification of the exact phrase to search the whole text (e.g., *"IoT Platform"* AND *"Gawer"*). By including the main contributors of both constructs in the search term, we focus the literature review on IoT platforms that utilize one or both constructs. This approach can be justified as the goal was not to identify new IoT platform constructs, but to show how TSMs/MSPs and IS platforms were used in the context of IoT platforms and on which levels of analysis. Only peer-reviewed papers were considered to meet the quality standards in research. However, we also included grey literature if the citing source was a peer-reviewed paper (e.g., during the backward search). The time period was not specifically set, as the key IS scholars determine the period for the two platform constructs.The selected database source was Google Scholar to incorporate a broad range of databases for the relatively new topic of IoT platforms. Further, we used Scopus to validate the results.

During the *first iteration,* we scanned the title and abstract and sorted out duplicates, no peer-reviewed, and non-English articles, to determine relevant documents. In the *second iteration,* we dismissed papers that were not subject to the phenomenon of platforms or did not fit the IoT context by reading through the whole text. Thirdly, we conducted a forward and backward search according to the remaining literature to identify additional articles [20]. In the *last step*, the final set of literature was used to conceptualize the findings according to the two constructs of TSMs / MSPs or IS platforms, as well as the units of analysis ranging from an ecosystem or technical perspective in a matrix.

3 Findings for IoT Platforms

In the initial search, we identified 210 articles. In the first iteration, we sorted out three duplicates, five non-English, one patent, ten not peer-reviewed articles, as well as 104 documents due to scanning the title and abstract. In the second iteration, we dismissed 73 articles due to a lack of context. In the third iteration, we completed the resulting 14 papers though adding three in regards to forward and 14 due to backward scanning. In total, the literature review revealed 31 relevant articles (see Table 1). Regarding the meta-data, over two-third (22) papers originate from the IS literature and are marked with parenthesis "[A | B | C | D | 0]". Further, the ranking from "A" (best) to "0" is shown, where "0" means that the conference or journal is not ranked at all[2]. Also, the table marks other research streams like books and book chapters. Additionally, the literature review revealed that other research areas like Marketing and Management work on the subject of IoT platforms.

Table 1 summarizes the results in a concept matrix. Here, the columns show the two major platform constructs of an *IS Platform* and a *TSM / MSP*. We divided them into sub-columns to show on which configuration they were applied (*Tech.* = technical, *Ecos.* = ecosystem).

Table 1. Results of the Literature Review to Identify Platform Constructs in the context of IoT Platforms

Literature	*IS Platform*		*TSM / MSP*	
	Tech.	*Ecos.*	*Tech.*	*Ecos.*
Berkers et al. 2013 [6] [0]				x
Fleisch et al. 2015 [26] [Whitepaper]				x
Giessmann et al. 2014 [27] [C]	x	x		x
Giessmann & Legner 2013 [28] [A]	x	x		x
Hahn et al. 2016 [29] [B]	x	x		x
Hahn et al. 2015 [30] [D]	x	x		
Huntgeburth et al. 2015 [31] [B]		x		
Iivari et al. 2016 [32] [Management]				x
Karapantelakis & Markendahl 2015[33] [0]				x
Keskin & Kennedy 2015 [34] [C]				x
Kortuem & Kawsar 2010 [35] [0]	x	x		
Kübel & Zarnekow 2014 [36] [C]	x	x		x
Kübel et al. 2014 [37] [D]	x	x		x
Leminen et al. 2012 [38] [Book]	x	x		x
Mack & Veil 2017 [39] [Book]	x	x		x
Mazhelis et al. 2012 [40] [Book]	x			
Mazhelis & Tyrvainen 2014 [41] [0]	x			
Menon et al. 2015 [42] [0]	x	x		x
Mineraud et al. 2015 [43] [0]	x			
Mohapatra & Bhuyan 2016 [44] [0]	x			
Ng & Wakenshaw 2017 [45] [Marketing]	x	x		x

[2] The rankings derive from the VHB expert assessment, which can be found at http://vhbonline.org/vhb4you/jourqual/vhb-jourqual-3/hinweise/ (Accessed: 2017-3-14).

Literature	*IS Platform*		*TSM / MSP*	
	Tech.	*Ecos.*	*Tech.*	*Ecos.*
Rong et al. 2015 [46] [Marketing]		x		
Saariko et al. 2016 [47] [C]	x	x		
Tesch 2016 [48] [B]				x
Toivanen et al. 2015 [49] [0]	x	x		
Turber & Smiela 2014 [50] [B]	x	x		
Turber et al. 2014 [51] [C]	x	x		
Westerlund & Leminen 2014 [52] [Management]	x	x		
Yablonsky 2017 [45] [Management]				x
Yu et al. 2016 [53] [0]	x			
Zdravkovic & Trajanovic 2016 [7] [0]	x			

The IoT platform literature reveals three different configurations for the two constructs and their application on different levels (see Figure 1 and Table 2).

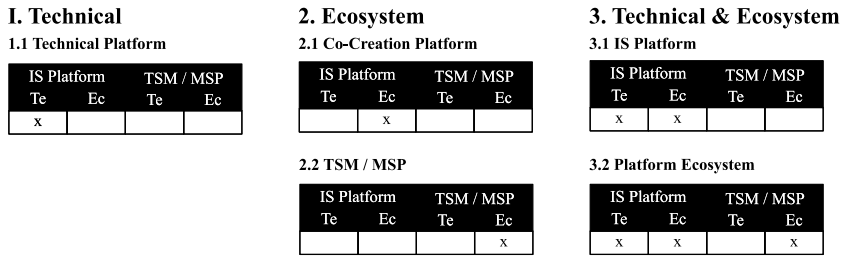


Figure 1. Different IoT Platform Configurations based on the Constructs: IS Platform and TSM or MSP, as well as the Level of Analysis

The *technical* configuration describes the case of a *technical platform* utilizing the construct of an IS platform. Going hand in hand with the definitions of Baldwin and Woodard [4], this configuration illustrates the technical nature of IoT platform regarding standardization and modularization aspects. In the defined context of IoT platforms, the technical usage of the term platform describes an isolated view on the *technical platform* as the core of a *technical* ecosystem, which specifies a corresponding set of modules. The modules serve as sub-systems that connect and add functionality to the core platform [40]. Another interpretation shows the IoT platform as the infrastructure that enables the end-user to interact with smart objects [43]. Lastly, IS scholars utilize the case of technical platforms to introduce technical encapsulated modules offering services like device management, connectivity, and testing on an IoT platform [44]. In total, the technical platform applies concepts like standardization or modularization to provide essential IoT specific services on a technical level.

Both, the case of a co-creation platform and TSM / MSP apply separately in the context of IoT platforms to the second ecosystem configuration. In the first case, the construct of an IS platform solely focus on the ecosystem perspective. A theoretical foundation can be found in the term value co-creation, where independent ecosystem participants

influence the overall value captured of a platform [19]. In the context of IoT platforms, this configuration focuses on the organizational ecosystem and helps, for example, understanding the influence of platform openness on value co-creation or innovation [46]. The second case within this configuration is the utilization of the TSM or MSP construct on the ecosystem level. Regarding theory, this case is grounded in the principles of network effects, overcoming the chicken & egg problem, and platform envelopment [3]. Within IoT platforms, scholars apply this case on the organizational level to describe network externalities between products or services [32] and between devices and consumers [33]. Thus, depending on which case of configuration is applied, a co-creation platform describes the effect of value co-creation within the organization, while TSMs or MSPs help to describe network externalities on the organizational or market level.

Table 2: Summary of the Key Concepts of Platform Constructs in the Context of IoT Platforms.

#	Configuration	Level of Analysis	Key Concepts	IoT Example
1	Technical	Architecture	Standardization / Modularization	Technical architecture describing which standards (e.g. technical protocols) or modules (e.g. device management) are used [41].
2.1	Ecosystem	Organization	Value Co-Creation	Connection and co-evolution of stakeholders with the help of IoT devices [46].
2.2		Market	Network Externalities	The role of network externalities in machine-to-machine partnerships [33].
3.1	Technical & Ecosystem	Combination 1 + 2.1		Show the role of industry standards (e.g. technical protocols) for industry partners on the willingness to participate in an IoT platform [47].
3.2		Combination 3.1 + 2.2		Development of IoT business models based on modularized applications and the technical architecture, value creation through customer data, and the incorporation of network externalities [39].

Thirdly, the technical & ecosystem configuration covers the construct of an IS platform solely or in combination with a TSM / MSP and represents the cases of an IS platform or a platform ecosystem. Case one combines the technical and organizational level and, thus, follows the definition of an IS platform according to Gawer and Cusumano [15]. Within the IoT literature, IS scholars use this configuration to describe the technological platform including standardization and modularization as the technical core of an ecosystem [49, 52]. In this ecosystem, modular services or applications like

APIs, mobility or user management are combined with organizational considerations like fostering value co-creation through governance structures are of interest [30, 54]. In addition, IS scholars describe the roles of platform participants in the process of value co-creation [47, 50]. The second case combines the construct of an IS platform with a TSM or MSP, which leads to the case of a platform ecosystem. Besides value co-creation, the analyzed papers take network externalities, pricing, and competition into consideration. In the literature, IS scholars apply this concept, for example, by declaring technical platform modules or devices as a participant in the organizational ecosystem [28]. Those modules can then be extended (e.g., through complementaries) to foster network effects, which lead to a reinforcing effect [29, 37]. In total, the technical & ecosystem configuration applies on multiple layers and ranges from architectural and organizational aspects within the case of an IS platform, to the addition of market considerations in the case of a platform ecosystem.

4 Discussion

In total, the contribution reveals that IS scholars use the term platform with different meanings and on diverse levels. The literature review shows that the constructs of an IS platform, and a TSM / MSP appear in three different configurations in the context of IoT platforms. Each of the configurations results in one or two particular cases. Thus, the boundaries between the various configurations, as well as different manifestations within a configuration are an obvious choice to illustrate differences and commonalities (see Figure 2).

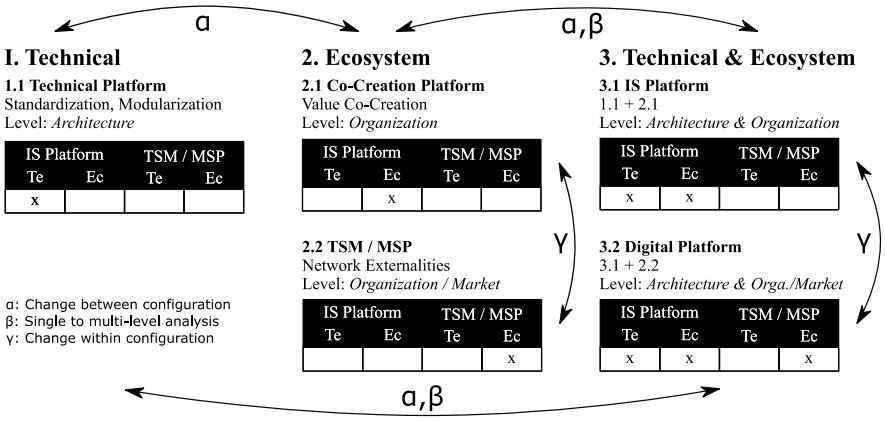


Figure 2. Illustration of changes between and within configurations and the underlying level of analysis.

Differences between configurations, as illustrated in Figure 2 α, lead to a shift in the level of analysis. The first scenario (α) explains a change from the technical to the ecosystem configuration. Here, IS scholars focus on an isolated configuration like the technical architecture or the ecosystem. A typical example is analyzing the influence of

standardization and modularization on the development process of IoT applications [41] or taking organizational aspects like value co-creation through roles and complementaries into consideration [31]. The second scenario (α, β) illustrates a shift from a single to a multi-level analysis, where the level is dictated by the configuration. While the first and second configuration describes the phenomenon of platforms in isolation, the third configuration utilizes multiple constructs. In contrast to the example of the technical configuration, a multi-level analysis describes, for instance, the influence of technical modularized layers, like the integration of various IoT devices, on the capability of value co-creation with devices of partners [50]. Also, each of the different platform configurations incorporates distinct attributes like network externalities or value co-creation that help to describe the phenomenon on the respective level. Thus, it is of importance to apply the best-fitting platform construct to suit the underlying context and research design's needs.

For the second and third configuration, the results indicate differences within each of them (γ). The *ecosystem* perspective comprises two lenses. On the one hand, the case of a *co-creation platform* focuses on the organizational viewpoint, while the *TSM or MSP* help to explain organizational and market-based effects according to network externalities. So even in the ecosystem perspective, one must be aware of the different usage of the cases of a *co-creation platform* and a *TSM / MSP* and the underlying context varying from an organizational or market perspective. The *technical & ecosystem* point of view follows a multi-level analysis by combining technical and organizational or market-based aspects. In this case, the effect of technical aspects can influence either organizational roles on value co-creation activities or the whole market through economies of scale resulting from standardization, which leads to a more favorable pricing structure. Hence, even if the level of analysis is correct, IS scholars still need to determine if the particular case fits the research's needs regarding the constructs specific effects.

Lastly, the results share common threads to the Service-Dominant (S-D) logic of Lusch and Nambisan [18]. Their conceptualization differentiates between innovation as an actor-to-actor (A2A) network represented by a service ecosystem, a technical platform that incorporates resources for the facilitation of resources, as well as the value co-creation processes fostering resource integration. Our configuration of a technical platform maps to the concept of a service platform. The TSM/MSP platform illustrates an A2A network incorporating network externalities. Third, the value co-creation concept maps to the case of a co-creation platform. The third configuration with the cases of an IS platform and a digital platform is a combination of the service platform and value co-creation or all three constructs [18]. By combining our research with the results of Lusch and Nambisan [18], we contribute towards a better understanding in terms of the single- and multi-level characteristics of S-D logic in the light of different platform constructs.

Finally, all platform configurations share common features. Each of them aims to increase the value captured for the owner through, technology, organizational or market-based mechanisms ranging from modularization, value co-creation, and complementaries, to pricing and network effects.

This contribution provides theoretical and practical implications. On the theoretical side, the literature review increases the awareness and transparency of the two most

common platform constructs in IS research. Here, the results indicate that the respective platform construct and configuration needs to suit the level of analysis. Further, the platform constructs differ also within the configurations by applying different mechanisms like value co-creation and network externalities. Thus, a clear definition of the underlying term platform is of importance and should always go along with the research design. Further, the results indicate that a majority of articles does not stick to one configuration, but utilizes also a second one to explain systemic effects between the technical and market/ecosystem level. Those findings highlight the interrelatedness to the S-D logic, where central S-D concepts can be mapped to concrete platform cases. For the practitioners, this contribution reveals the systemic character of the term platform. The technical introduction of APIs and SDKs, for example, also influences the capability of value co-creation of external partners or complementors through an increased ease of use and economies of scale. Also, the optimized value co-creation process might foster positive network effects that lead to positive reinforcement within an ecosystem. Those insights might help practitioners to take into account that technical changes on the infrastructure level might lead to consequences within the market or ecosystem level.

As a further result, the perspective on the different levels of analysis reveals fruitful avenues of future research. On the one hand, the results show the need of platform governance mechanisms in a new light. The different platform configurations could help to explain how different governance mechanisms [54, 55] mediate or moderate between the layers of analysis. Here, the introduction of boundary resources like APIs may influence the technical architecture, but also indirectly affect the organizational or market perspective. Thus, especially platform governance literature could benefit from future research from the angle of a multi-level characteristic and the systemic implications of the different platform constructs. Lastly, the literature review faces limitations. At first, this contribution can only be a first step towards demystifying the term platform, as the scope is limited to IoT platforms only. By expanding the view through a more established platform context, the study could benefit from an increased generalizability, which leads to a more accurate model of configurations. Also, the study focuses on the two most common platform constructs, ignoring similar constructs like electronic markets, which leads to a limitation regarding the completeness.

5 Conclusion

Overall, this contribution is a first step towards disentangling the buzzword of platforms into logical and understandable configurations. The literature review shows that IS scholars apply different platform constructs on different levels of analysis. On the example of IoT platforms, the results indicate that the technical and ecosystem layer are most frequently used. The usage varies depending on the underlying level of analysis. While the technical constructs focus on standardization and modularization, the ecosystem perspective differentiates between value co-creation and network externalities. Consequently, the exclusive sole bearing of either technical or ecosystem considerations follows a single-level analysis. In addition to that, the literature search revealed that those layers can be combined in a multi-level analysis elaborating on both, the technical and ecosystem perspective. Concluding, this contribution stresses the

importance of defining the term platform according to the research subject and the underlying constructs.

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State-of-the-practice in analyzing enterprises' business ecosystems

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Abstract. Business ecosystems are gaining more relevance both in research and in practice. The analysis of business ecosystems is thereby a data intense process. To better understand the current state-of-the-practice within enterprises addressing the analysis of business ecosystem we conducted an online survey asking participants about their division of labor, collection, documentation and processing of business ecosystem related data. 52 experts from mainly German based companies completed the questionnaire stating, inter alia, that the main data sources in use are internal company information sources and online search engines, and additionally that the time-consuming process of collecting and documenting business ecosystem related information is perceived as a major challenge in the context of business ecosystem analysis.

Keywords: Business Ecosystem, State-of-the-Practice, Competitor Analysis

1 Introduction

Undoubtedly, companies increasingly recognize the relevance of their complex business environment, which is also referred to as business ecosystem and which is already reality for most companies nowadays [1]. One aspect of the growing relevance of business ecosystems is the perceived shift of the competitive environment between no longer single companies and their supply chains but towards ecosystems competing against each other [2].

Thereby, a business ecosystem enlarges the classic supply chain, consisting of suppliers and customer, by also including other entities within the business environment of the enterprise. We define ***business ecosystems*** *as the holistic environment of a company covering current and potential future business partners, customers, suppliers, competitors, regulatory institutions, and innovative start-ups. It exhibits a high dynamic as continuously entities enter and leave the ecosystem.* For a comprehensive definition we refer to [1]. Analogously to the metaphor of a biological ecosystem, which served as a basis for the initial definition of business ecosystems, the economic success of an enterprise can therefore depend on the health and ability to evolve their business ecosystem. The role of the enterprise within its ecosystem can range from a

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keystone to a niche player, contributing with or to products or services developed, produced and distributed within this ecosystem.

Due to the influence on the economic success of the enterprise and the dynamic characteristic, enterprises increasingly realize the need to analyze their business ecosystem continuously, in order to identify and address changes within their ecosystem, adapt own business activities accordingly and to "learn what makes the environment tick" [3].

Through qualitative interviews with industry partners, we extracted a high-level understanding of the business ecosystem analysis process and the challenges perceived by enterprise stakeholders. The analysis is a data-intense process, consisting of the steps of a) *data collection*; b) *data documentation*; and c) *data processing and reporting* using heterogeneous data sources within and beyond the enterprise. To achieve a holistic picture of the business ecosystem, several stakeholders within an enterprise in different roles and responsibilities should contribute with their knowledge, but also by communicating their requirement towards the analysis outcomes. Succeeding in such a holistic ecosystem analysis would enable enterprises to play a more active role within its business ecosystem.

With the here presented survey results, we aim at a contribution to capture the current state-of-the-practice how enterprises analyze their business ecosystem as part of their daily business. Thus, the subsequent research questions are addressed in this work:
RQ1. What is relevant business ecosystem related information and how do German companies organize the work associated with the analysis of their business ecosystem?
RQ2. How do German enterprises collect, document and process this business ecosystem related information?
RQ3. Which challenges do German organizations perceive within the analysis of their business ecosystem?

To answer these questions, we set up an online-based questionnaire inviting German experts to share their working experience analyzing their companies' business ecosystem. Particularly interesting for us were the sources the responsible stakeholders within the enterprise currently use and where they conceive the biggest challenges.

The paper is organized as follows: in Section 2 related works in literature covering business ecosystems are presented. Section 3 describes the survey and presents the survey results; this is followed by a discussion covering the limitations of the survey but also presenting results of additional workshops/feedback talks conducted prior and during the survey in Section 4. The work ends with an outlook in Section 5.

2 Related Work

Since the conceptualization of business ecosystems by James Moore in the mid-1990s, who defined it as a collection of interacting companies [4], the concept has been widely studied (cf., [5], [6]). Thereby, ecosystems "are interconnected through a complex, global network of relationships" [7]. In a business ecosystem, firms take on roles such as „suppliers, distributors, outsourcing firms, makers of related products or services, technology providers, and a host of other organizations" [8], all affecting the

characteristics and boundaries of the ecosystem. As "firms continuously enter and leave the ecosystem" [5], they constantly evolve and exhibit a dynamic structure [1].

Research on business ecosystems has recently highlighted the role of novel challenges for ecosystem formation, including technology contexts, e.g., the Internet of Things (IoT) [9] or policy contexts, e.g., smart city [10]. This has focused researchers' attention on ecosystem modeling [6]. Current approaches focus on frameworks to grasp the scope of ecosystem complexity ([9], [10]), or on visualization to understand emerging structures and patterns ([11], [9]).

Thereby, to be informed about changes within the business environment at an early stage enterprises analyze their ecosystem in order to adjust its entrepreneurial actions to these changes. Already existing decision support systems in research provide interactive visualizations that are presented to users and decision makers with models, methods, and problem-related data with the aim of decision support ([12], [13]) . These systems are applied in various fields using different data.

The visualization currently available in science for the support of decision-makers in relation to business ecosystems use data collected from trade journals, industry publications, registers, or paid data collections. However, the amount of data used is always huge and the data is diverse and often inaccurate [7]. To date, there are few scientific contributions to address this challenge or the inclusion of internal data with a focus on business ecosystem data ([9], [14]).

To understand the business ecosystem both the rather static network of entities (firms, technologies), and the dynamic network characteristics, i.e., the relationships between entities, and activities, all changing over time, must be part of the analysis process. Entities comprise "small firms, large corporations, universities, research centers, public sector organizations, (...) other parties [and human actors], which influence the system" [1] must be taken into account. They are linked through a variety of different relationship types, such as (past) cooperations, negotiations or personnel changes.

Which entities and relationship types need to be analyzed depends on the requirements put forward by the (business) stakeholders. Their needs and demands that define which (visual) views are relevant, and which insights are vital, are fundamental for generating and adapting the model as a possible result of the analysis process.

3 Survey

As the relevance of business ecosystems is often discussed in research (as described in Section 2), with our survey, we aim to contribute to a better understanding on how enterprises analyze their ecosystems as part of their daily business. This includes how the work is distributed within the enterprise, how data is collected, which sources are used, how data is documented and reported upon using various available tools and what main challenges of the business ecosystem analysis are considered. In addition, we try to identify where responsible stakeholders conceive challenges which can be addressed in future work.

3.1 Research design

After designing the questionnaire following [15], we performed a pre-test consisting of its completion by three independent and non-related researchers. The questionnaire was adapted according to the received feedback. The final version of the questionnaire was published as an online survey available between beginnings of July to end of August 2017. In total, we contacted 51 industry partners from various fields of business activity via e-mail and published an open call for participation using social media[1]. All contacts were approached twice via e-mail whereby the survey was also posted once using LinkedIn[2]. Within the e-mails, we briefly explained the concept of business ecosystems and the relevance for enterprises due to technological innovations. The completion time of the questionnaire was estimated with 15 to 20 minutes.

The online questionnaire consisted of seven sections, starting with questions covering the participants' and enterprises' details and if the enterprise is active in analyzing their business ecosystem (section one and two of the questionnaire), followed by the participants' role and the division of labor (section three). The fourth section addressed the business ecosystem related data collection, followed by the process step of data documentation and processing (section five), the perceived challenges within the analysis process (in section six) and finally the reasons why companies are not active in analyzing their business ecosystems (section seven).

After the question if companies are active in analyzing their business ecosystem in the second part of the questionnaire, the questionnaire was split into two paths. One path following for participants and enterprises active in the business ecosystem analysis (covering the section four to six with an overall of 21 questions) and one for the others (only comprising of section seven asking for the reasons of inactivity with an overall of 8 questions). This allowed skipping questions not fitting to a certain group of participants.

The only mandatory question for participants to answer within the questionnaire was if the company is active in analyzing its business ecosystem in section two, whereby the remaining other questions could be omitted by the participants. Whenever a question allowed multiple answers this was explicitly stated, for questions with exclusive options the used tool provided a suitable feature only allowing one answer to be given. Wherever feasible the answer option *other* allowed the participants to enter additional information as free text. For each question addressing business ecosystems, the definition of business ecosystem was displayed in the header of each questionnaire page.

3.2 Results

Upon survey closure, we received input from 52 survey participants of overall 86 survey participants opening and 61 survey participants starting but not finishing the

[1] For this survey, we used the survey software questback (https://www.questback.com). The full survey is accessible on https://tinyurl.com/ybgwgbgy

[2] https://www.linkedin.com/

questionnaire. The answers of the different questionnaire sections are described in detail in the according section below.

Participants' details. The participating companies are active in a broad variety of business areas, ranging from Information Technology (IT) Providers (25%), Automotive Manufacturer (17%) to Public Institution (10%). Most of the participants described their job as Enterprise Architect (34%) or Innovation Manager (21%). Out of these, 25% worked as external consultant. Descriptive statistics of the responses of the participants' details are presented in Table 1.

Table 1. Participants' details

Company information							
Auto-motive OEM	Mobility Service/ Platform Provider	IT Pro-vider	Parts Supplier	Insurance Provider	Energy Pro-vider	Public Insti-tution	Other
9	7	13	2	3	1	5	12
Number of employees							
1 - 100		100 – 1.000		1.001 – 30.000		> 30.000	
8		5		16		23	
Current job position							
Enterprise Architect	Market (Intelligence) Analyst	Market Research Analyst	Business Value Analyst	Compe-titor Analyst	Innovation Manager		Other
18	2	1	3	0	11		17
External consultant							
Yes				No			
13				39			

Active in business ecosystem analysis. We asked if the company is active in analyzing its business ecosystem, which was answered by 88% with yes, i.e., 46 participants.

Division of labor. Aiming to understand the participants' roles within the analysis process, and how the work is divided within the company, we ask three questions. When asked for the responsibilities within the business ecosystem analysis, multiple answers were possible. 27% answered with *data and information collection*; 19% each with *information processing* or u*sing (processed) information for strategic decisions*; *answering to higher management level* were chosen by 17%; *responsibilities not clearly defined* 13%, and 5% answered with *other*. The business ecosystem related tasks are performed *full-time* by 42%, *part-time* 12% work *on a daily basis*, 24% *on a weekly basis* and 10% *on a monthly basis*. The final single-answer question of this section addressed the potential existing teamwork within the enterprise and no participant answered that she is working *alone, no other responsible colleague known*. 56% stated they work *collaboratively in a team and the responsibilities are clearly defined*, 32%

selected *not alone, but work is rather uncoordinated between me and other colleagues*, and 12% chose *other* as answer.

This indicates that enterprises realize the importance of analyzing their business ecosystem as they already invest manpower with more than 40% of the participants working full time in this area and more than half working collaboratively in a team.

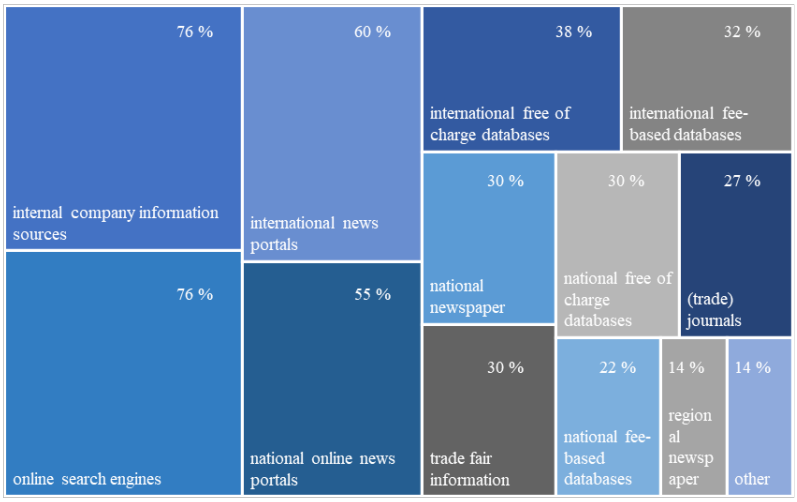


Figure 1. Sources used for Information Gathering within the Business Ecosystem Analysis

Data collection. The fourth section of the questionnaire entailed questions about the data collection process, the information gathered and the sources used. It comprised of seven questions, which could all be answered by the participants choosing multiple answers. 81% of the participants answered that they collect the information *actively, by searching for relevant information*, compared to 38% *collecting only by chance, i.e., passively*. When asked for time related development of the market as part of the analysis, 92% responded with *current development of the market and existing business relations*, 76% with *future development of the market and business relations within the next five years*, and 30% with *future development of the market and business relations exceeding the next 5 years*. As an increasing amount of information is now available in digital format, we asked participants which format of data is used, which was replied by 92% with *digital information, e.g., news feeds*, and 32% with *digital information, such as brochures*. The next two questions aimed at the data sources in use when collecting business ecosystem data, visualized in Figure 1 and Figure 2. The main data sources in use are *internal company information sources* and *online search engine* (both 76%), followed by *internal news portals* (60%) and *national online news portals* (55%).

When asked to name three sources according to their order of usage, *internal sources* were stated most as first source (9 participants) and *online search engine* as second or third source (4 participants or rather 2 participants). Often used are also *multi client market research studies*, e.g., published by Gartner, stated by 3 participants as first source, and by one as second and third source in each case.

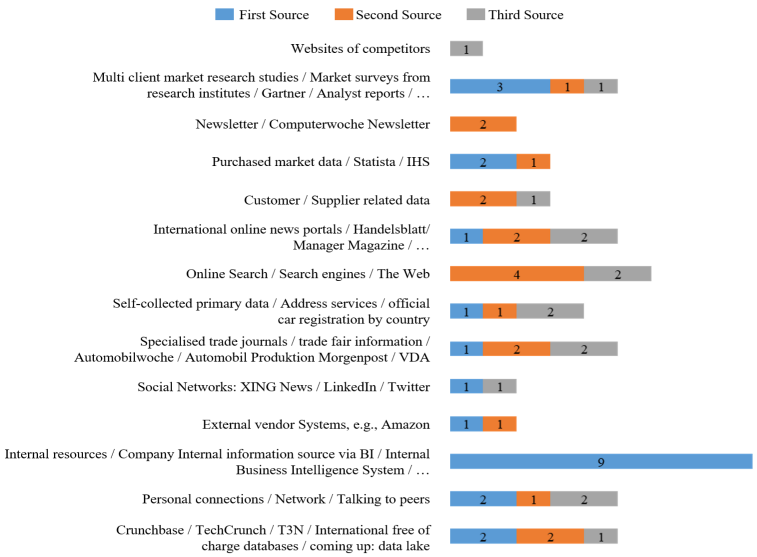


Figure 2. Main Sources for the Business Ecosystem Analysis

Using these data sources, the next questions addressed the information collected. Within the business ecosystem analysis, 81% of the participants are interested in information about *competitors*, 84% in *business partners*, 62% in *start-ups*, 59% in *suppliers*, 43% in *public regulatory institutions*, 22% in *public regulatory institutions*, and 11% stated *other*. Thus, besides the classic competitor analysis, enterprises also analyze their direct and indirect environment. As companies of the business ecosystem can be described using various attributes, we asked for company related information interesting for stakeholders analyzing the business ecosystem. 81% answered with *Business Model*, 76% with *Business Area*, and 70% with *Strategic Decision*. For a comprehensive list of answers, see also Figure 3.

Data documentation and reporting. Section five of the questionnaire comprised five questions about the current state-of-the-practice in documentation and processing of business ecosystem related data. Multiple answers were allowed for all questions. When asked how the participants document the collected information, 16% answered *with pen, paper and non-electronical document storage*, 73% selected *as digital documents in a (shared) file system*, 38% *transfer the information into a standard tool*, 16% *into a dedicated commercial tool* and 14% *into a custom -developed tool providing business ecosystem related features*, 8% chose *other*. Within this questions the participants were able to state the tool in used in a free text field for the different answer options. Thereby, the *standard tools* in use appear to be Microsoft Office software such as Word, Excel, PowerPoint, OneNote, but also Google Drive; as

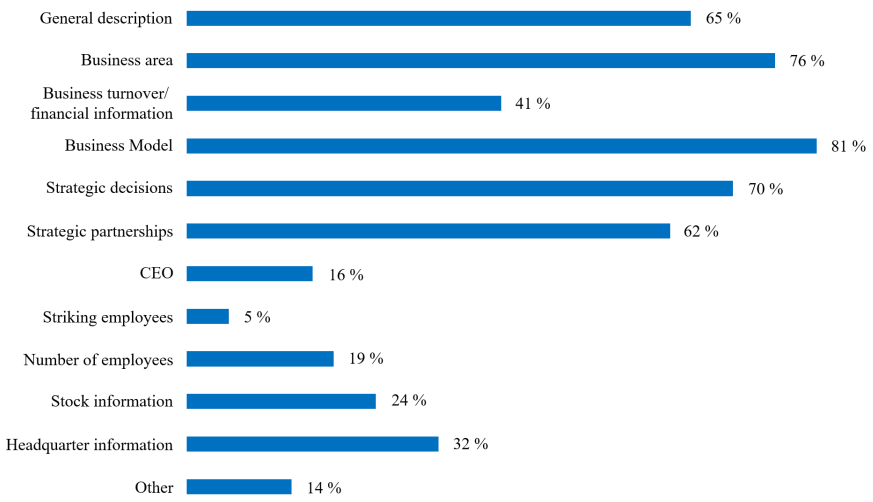


Figure 3. Company-related Information for Business Ecosystem Analysis of interest

commercial tools SugarCRM[3] and SAM CRM[4]; and as *custom-developed tools* Tableau[5], Qlik Sense[6], and PoolParty[7].

The next questions targeted at the reporting of the collected and processed business ecosystem information whereby 51% of the participants *notify colleagues ad hoc whenever information is available*, 41% *notify colleagues according to an agreed reporting schedule*, 51% *provide access to information, but perform no active notification*, 11% *carry out no reporting or sharing of information*, and 8% selected *other*. Based on this, the results of the processed business ecosystem analysis information are an *updated and accessible database* (30%), *a list of current / potential future competitors, business partners and innovative start-ups* (43%), *(economic) figures / performance indicators* (29,7%), *visualizations* (49%), *collected data is not processed* (19%), and *other* (14%). The answers of the questions which visualization types are already provided and in use and which are interesting for future usage is pictured in Figure 4. *Networks* are currently used by 19% and would be interesting for future use by 52%, *treemap visualizations* are used by 24% compared to 49% interested in this kind of visualization. 30% stated that *no visualizations are currently provided or in use*.

[3] https://www.sugarcrm.com
[4] http://www.netzon.se/?portfolio=sam-crm
[5] https://www.tableau.com
[6] http://www.qlik.com
[7] https://www.poolparty.biz/analytics-visualization/

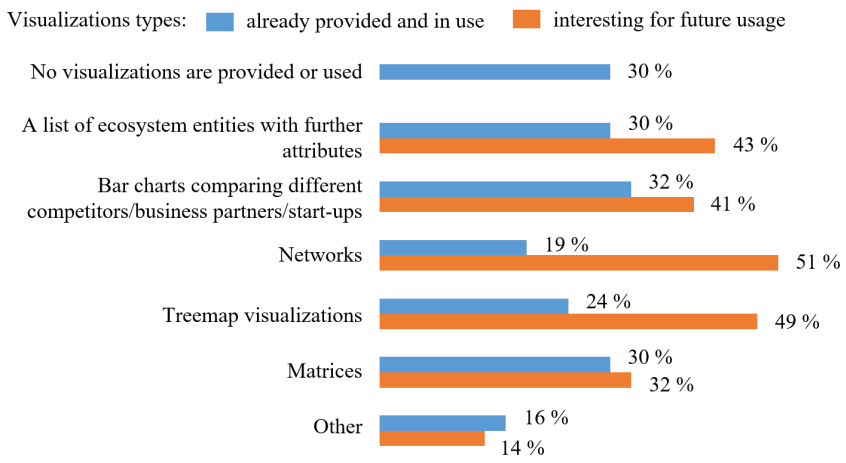


Figure 4. Visualization types already in use (blue) versus visualizations interesting for future usage (orange)

Perceived challenges. The final question of section six of the questionnaire addressed the perceived challenges within the business ecosystem analysis. More than half of the participants (65%) stated the *time-consuming processing of collected and documented data*. 46% selected that *several business units are involved, working rather uncoordinated*. No participant stated that *no challenge is perceived* within the business ecosystem analysis. All results are pictured in Figure 5.

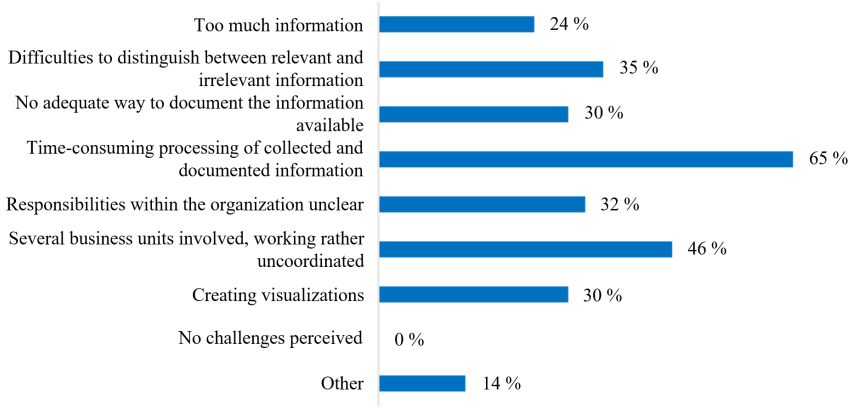


Figure 5. Main Challenges within the Business Ecosystem Analysis perceived by survey participants

Valuable insight also delivered two statements within the free text field attached to the answer option *other*, stating a *lack of understanding in the higher management,* and *identify possible stakeholders for the Data/I'm collecting for completeness of EAM.*
Reasons for inactivity. The four participants completing the questionnaire not active in the analysis of their business ecosystem were asked three questions addressing their

reasons for inactivity and their potential interests. When asked for the reason why the enterprise the participant works for is not active in analyzing its business ecosystem, 25% replied that the *responsibilities within the company are unclear*. 25% selected *information gathering not possible / too difficult*, 25% chose *no free capacities*, and the remaining participant answered in the free text in the answer option *other* that there is no holistic approach. According to the participants' answers information of the following entities would be interesting, *business partners*, *suppliers*, and *public regulatory institutes* (all 75%), *start-ups* (50%), and *competitors*, *public research institutions* (both 25%). The final question addressed in which area support within the business ecosystem analysis would be interesting for the participants. 75% answered *provision of information visualizations*, 50% selected *provision of relevant information*, also 50% chose *tool support for the processing of information, e.g., providing a list of competitors / business partners / start-ups or calculated figures*, and 25% said *tool support for the documentation of information*. That indicates a perceived need to address the enterprises' business ecosystem analysis.

4 Discussion

Obviously, the number of survey participants limits the generalizability of the survey results presented. Also, the survey - as it is presented here - targeted mainly German enterprises. Thus, further work could distribute the survey to a broader, international audience. As an additional limitation, the usage of the survey tool must be stated. As participants completed the survey remotely, full transparency within the response process is not provided. Offering participants with predefined answer options might have led to a biased result as participants face specific choices instead of open questions, which we tried to counteract with the free text answer option "other" whenever feasible. Finally, a shared understanding of analyzing business ecosystems amongst all participants might be missing.

With regard to the five in depth semi-structured interviews we conducted prior, and during the execution of the survey, all interviewed participants stated that they are active in analyzing the company's business ecosystems or at least focus areas of interest within the business ecosystems. The reasons for conducting the business ecosystem analysis were very diverse among the interview participants. Ranging from networking purposes to pure competitor analysis to gain a better understanding of all existing business relations with external partners. Of these five interviews, three representatives also completed the questionnaire. All five representatives stated that the greatest part of knowledge of the business ecosystem is bound to individuals within the company and not further documented. All were dissatisfied with the current tool support in use, ranging from Customer-Relationship-Management tools, to Microsoft Office Products (which were in use mainly), such as Microsoft Excel or Microsoft PowerPoint. These insights confirm the results we gained from our survey.

Considering the results of the survey, we can answer the aforementioned research questions: Participants stated that relevant business ecosystem information is the business model (81%), the business area (75%) and strategic decisions (70%) of the

analyzed ecosystem entity. Even though more than half of the participants work collaboratively in teams when analyzing their business ecosystem, a third of the survey participants stated that they do not work alone but rather uncoordinatedly within the enterprise, which recurs as a major challenge as responsibilities within the enterprise are unclear (32%) [**RQ1.**, **RQ3.**]. The survey participants use mainly internal company information sources or online search engines (both 76%), but more than half of all participants notify colleagues on an ad-hoc basis (51%), which indicated a missing alignment in the process of communicating and discussing changes within the business ecosystems [**RQ2.**]. This is reflected in the identified major challenge of time-consuming processing of collected and documented information [**RQ3.**].

By analyzing their business ecosystem, enterprises can identify and address changes within their environment and adapt own business activities accordingly which could lead to a business benefit for these enterprises. According to the survey results, the growing influence of business ecosystems on the economic success of an enterprise is increasingly perceived by enterprises. Nevertheless, enterprises are facing multiple challenges when analyzing their business ecosystem due to the data intense process it is based upon.

5 Conclusion

With this work, we provide a state-of-the-practice in how enterprises in Germany analyze their business ecosystem and which challenges to be addressed by research to support enterprises in their efforts.

For future work, besides the above-mentioned limitations of the presented survey, tasks and questions in the context of business ecosystem analysis could be identified in close collaboration with enterprises within future research. These could be the basis to identify stakeholders to be integrated in a collaborative process to achieve a holistic model of the enterprise business ecosystems. In a next step, suitable data sources could be selected for the analysis.

To address the identified challenges within the data collection process step, potential future research could address automated data analysis of heterogeneous data sources both enterprise internal but also external, such as in use CRM tools or news feeds.

For the challenges of data documentation and processing, current results in research already proved that visualizations help support business ecosystem stakeholders in their decision ([12], [13]). Future research could analyze suitable visualizations for the identified tasks and questions, the provided features of these visualizations, and how the visualizations could be provided within a collaborative process of analysis and modelling in an enterprise.

Therefore, we are developing a prototype that facilitates data collection and implements findings from existing work on ecosystem visualization to support companies in this complex task. Future work will evaluate and improve this prototype.

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Service Classification Scheme for Platform Businesses

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Abstract. This article addresses the shortcoming that existing service classifications cannot characterize services of platform businesses. To resolve this shortcoming, a literature review has been conducted, identifying existing service classifications and their attributes. Our comparison shows also that there are similarities between existing classification schemes with respect to customer and managing processes. To identify limitations of existing classifications, a use case about a platform business was analyzed. Our results show that traditional attributes are not sufficient to describe platform services. To settle this, we propose additional attributes that can also address services of platform businesses.

Keywords: Services, Service classification schemes, Platforms, Use Case

1. Introduction

Existing research has defined services in many different ways. Judd defines services as market transactions [1]. According to Hill, services represent 'a change in the conditions of a person or a good belonging to some economic unit'[2]. Mills and Turk describe a service as 'a performance or an effort rendered by one party for another' [3]. Other scholars consider services as performance and processes [4, 5]. Furthermore, there is comprehensive definition from Vargo and Lusch. They define services as 'the application of specialized competencies (knowledge and skills) through deeds, processes, and performances for the benefits of another entity of the entity itself' [6]. In addition, Rathmell explains services by distinguishing goods and services [7], and Edvardsson views services as a 'part of the wider concept product' [8]. As can be seen from this brief review, the definitions of services address different aspects in different research fields.

Moreover, service classifications have been considered in marketing [9-13], service industry and business management [14-17], operation studies [18-21], and economics [2, 22, 23]. In general, marketing and operation studies discuss service classifications and characteristics, to develop and improve processes of delivery services. Economics studies rather focus on outputs, to understand and distinguish between goods and services in their classifications.

Although most of existing classifications have been discussed to provide strategic and managerial implications, there are difficulties to use them empirically [24]. It is caused by the fact that existing service classifications are mostly derived from

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conceptual and theoretical approaches. To overcome this problem, a few studies (e.g., Glückler and Hammer [24], Shafti et al. [25]) have reviewed literature, to find a solid classification model that could be adopted across services, and combined the literature review with their empirical data.

Recently, new services emerged through platform-based businesses. A platform is a centre for connections between providers and customers, and its development is based on an information and communication technology infrastructure, comprising software, ubiquitous networks, and computing power [26, 27]. One of the well-known platform businesses is TaskRabbit. The company connects providers, who are willing to provide labor, to customers, who need help for everyday tasks such as cleaning, moving, and assembling furniture[1]. Through platform businesses, customers and providers join to conduct economic transactions freely and without any barrier. The technological availabilities of software, distributed computing, and the Internet make a platform possible [28]. As platform businesses have the potential to change the shapes of industries and even affect whole economic structures, it is highly relevant to check whether existing service classifications allow covering these services properly.

Following this discussion on emerging platform businesses in services and their relevancy, our research objective is to provide a service classification scheme by identifying service types of existing service classifications and by proposing new attributes that allow characterizing services of platforms. Related to this research objective, the research questions are: What are the similarities of existing classification schemes? What are the shortcomings of existing classification schemes with respect to platform services? What could be the definition of a comprehensive classification scheme for platform services?

To answer the research questions, a literature review is carried out, capturing similarities of existing classifications. Cook et al. [21] has been chosen as the basis for searching further journal articles. As the study of Cook et al. does not cover literature from 2000s, we extend the list by conducting forward citation search at Web of Science. Additional papers between 2000 and 2017 that developed classification schemes have been determined. From this literature review process, we obtain an understanding of which attributes exist and how they can be grouped into attribute types. In order to identify shortcomings of these attribute types, we explore a use case of a platform business that offers platform services.

As a result of this analysis, we provide a comprehensive list of attribute types of existing service classifications and a list of additional attribute types for platform services. These attribute types can be helpful to describe different service types and to are expected to explain transitions caused by technology developments.

The remainder of the article is organized as follows: In chapter 2, we provide an overview about services and service classifications of previous studies on services. Chapter 3 describes our research methodology and findings from our literature review. A case study is introduced in chapter 4 and discussed in chapter 5. Finally, chapter 6 concludes our study with a discussion on limitations and future research.

[1] Official website of TaskRabbit (https://www.taskrabbit.com/about)

2. Existing Research Directions on Services

2.1. Service Theories

One notable study of services in marketing defined the service-dominant logic (S-D logic). The S-D logic considers a service as 'a process of doing something for another party' [29] and a customer as 'a coproducer of service' [6]. By moving the goods-centered perspective of marketing into a service-dominant view, Vargo and Lusch determine value of services differently than in a goods-dominant logic (G-D logic). In the traditional G-D logic, value has been determined by value-in-exchange, while S-D logic defines it as value-in-use [6]. Therefore, service is viewed as a value co-creation by all involved actors in the logic [29].

Another study in operation management defined the unified service theory (UST). UST considers a customer as a significant input in the process of production [30]. Furthermore, UST also gives managerial implications for the production and extends customers' role in the service supply chain. Overall, these theories (S-D logic, UST) are important, as they consider customers as co-creators and co-producers of services.

2.2. Service Characteristics

With respect to characteristics, four service characteristics have been commonly known as natures of services: intangibility, heterogeneity, inseparability, and perishability. These characteristics are called IHIP [31, 32]. Typically used in service research, despite the fact that IHIP comes with a few limitations [33, 34]: First, although intangibility relates to the fact that services are not physically visible as goods [33], it gets criticized as some services (e.g., teaching) come entangled with tangible goods (e.g., teachers, books, and classrooms) [9, 34]. Second, as heterogeneity concerns services that vary in terms of service operations and customer experiences, it does not reflect the difficulties with respect to standardization through technology and equipment [32-34]. Third, inseparability is about simultaneous production and consumption. However, there are separable services that allow customers' absences at production such as laundry service and maintenance service of equipment and facilities [32]. Lastly, perishability means that services cannot be stored, as following service definitions that consider them to be processes and performances [7]. However, there is frequently mentioned example of ATMs, which store a standardized process of cash withdrawal [33-35].

2.3. Service Classifications

Customer contact has been considered as important in classifying services. Chase proposes the customer contact model that concerns customer's physical presence in service creation and classifies services into four groups: pure service, mixed service, quasi-manufacturing service, and manufacturing service [36]. In other traditional service studies, the model has been adopted to explore service organization designs [37] and has been extended by Mersha, who considers that communication

technology affects to contact time [19]. Wemmerlöv presents a framework with customer contact levels and service process characteristics being rigid or fluid [20].

With respect to processes, Chase defines customer contact as customer's presence [36, 38], while Schmenner discusses that customers may have little interaction with service providers in processes, even if they are present physically. Schmenner proposes a service process matrix with a degree of customer interaction and customization and a degree of labor intensity [14, 39]. In addition, Silvestro et al. point out that service contact could consist of two elements as frequency and duration [15]. Regardless of the perspective on physical presence of customers during services, it can be said that one significant classification type on services is performed based on customer contact.

Other studies take on a customer-centered perspective and consider service activities (actions) for classifying services. For example, Lovelock [9] and Kelley et al. [18] mainly focus on the level of customization and the nature of service actions. Cunningham et al. capture how customers recognize and classify services [12, 40-42]. Besides, there is a mathematical model that is called 3P + C (provider, process, place, and customer) [16, 43]. Zysman et al. distinguish ranges of service activities [44], and Altmann et al. propose a new definition of service networks by identifying relations between actors in service context [45]. Furthermore, Maglio et al. focus on values that are created from relationships between providers and customers [46], and Hennerberg et al. have identified service networks from relations of services and products [17].

Even though previous studies take various approaches to classify services, their service classifications are mostly suggested conceptually and would not be sufficient to embrace other than their own domains.

3. Towards a Consolidated Classification Scheme Unifying Existing Service Classifications

3.1. Methodology

As services have been defined and classified differently depending on their foci, we believe that a literature review is a useful method, to find unrecognized aspects and to address current trends in a more inclusive service classification scheme. Webster and Watson provide a guideline for writing a literature review, stating that a thorough literature review can be a way of facilitating theory development, welding various research topics, and revealing unidentified research objects [47]. They recommend three steps to determined review materials: first, finding major contributions from leading journals; second, finding articles by checking references of articles identified in step 1 (going backward); and lastly, finding articles by checking citations to the articles identified in step 1 using Web of Science (going forward) [47].

Following Webster and Watson, we explore well-known service studies with respect to service classification schemes (Figure 1). Among them, Cook et al. [21] provide the most comprehensive perspective on the topic. Although the paper provides a fine start that can lead to major literature on service classifications, it includes studies only until 1990s. To find more recent studies, we identified journal

papers using forward citations of major studies listed in Cook et al. on Web of Science (WoS)[2]. We use WoS for searching articles as Webster and Watson's recommendation.

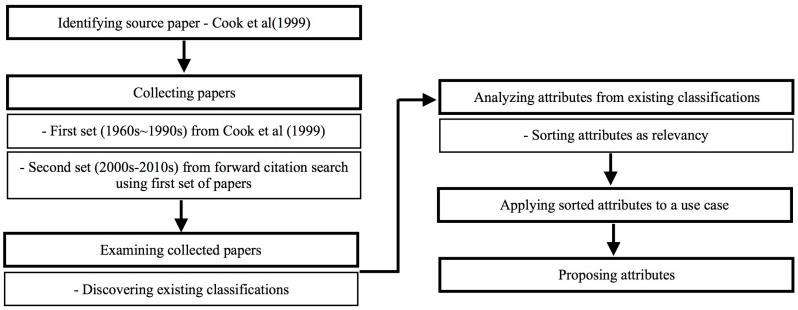


Figure 1. Research Framework

As we wanted to observe direct connections between frequently used studies and more recent studies, we conducted forward citation searches. A total of 1,126 journal articles were found since the year 2000. The abstracts, keywords, and research fields of those journals were examined. 84 articles were considered for a detailed analysis with respect to service classifications. The analysis result of all 84 articles revealed that 19 studies developed and proposed their own classifications schemes. Overall, 35 articles were collected to be examined in this study. Of those 35 articles, 16 articles were proposed in the 1990s and 19 since 2010s.

3.2. Analysis of Attributes Used in Classification Schemes

Based on the 35 articles about service classifications, we analyzed attributes that were used to classify and segment services. Attributes have been reviewed with respect to relevancy and similarity, and have been categorized into attribute types. For example, attributes, such as contact, customer contact, client contact, degree of contact, and contact intensity, were covered with the general type 'degree of customer contact'.

Table 1 shows that 13 classifications have used an attribute to reflect customer contact. They mostly followed an identical notion of Chase's that describes customer's physical presence in a service creation. We grouped these attributes under the attribute type 'degree of customer contact'.

In 11 classifications, attributes appeared that have addressed the concept of alteration of processes for meeting customers' needs in services and that describe the level of modification of services. The attribute type 'degree of customization' aggregates these attributes.

[2] Final accessed date - 19/July/2017 (https://apps.webofknowledge.com)

Table 1. List of Attribute Types

Attributes	#	*Literature*
Degree of customer contact	13	Chase (1978), Maister&Lovelock (1982), Lovelock (1983), Haywood-Farmer (1988), Bowen (1990), Mersha (1990), Wemmerlöv (1990), Silvestro et al. (1992), Cunningham et al. (2005), Shafti et al. (2007), Theotokis et al. (2008), van der Valk & Axelsson (2015), Jaakkola et al. (2017)
Degree of customization	11	Maister&Lovelock (1982), Lovelock (1983), Schmenner (1986), Haywood-Farmer (1988), Bowen (1990), Silvestro et al. (1992), Cunningham et al. (2005), Shafti et al. (2007), Cunningham et al. (2008), Liu&Wang (2008), van der Valk&Axelsson (2015)
Service process	10	Lovelock (1983), Zvegintzov (1983), Wemmerlöv (1990), Silvestro et al. (1992), Kellogg&Nie (1995), Buzacott (2000), Cunningham et al. (2005), Johansson&Olhager (2006), Carlborg&Kindström (2014), van der Valk&Axelsson (2015)
Object of service	9	Murphy&Enis (1986), Silvestro et al. (1992), Kellogg&Nie (1995), McDermott et al. (2001), Cunningham et al. (2005), Liu&Wang (2008), David (2014), van der Valk&Axelsson (2015), Cusumano et al. (2015)
Service characteristics (IHIP)	9	Lovelock (1983), Murphy&Enis (1986), McDermott et al. (2001), Cunningham et al. (2005), Shafti et al. (2007), Cunningham et al. (2008), van der Valk&Axelsson (2015), He et al. (2016), Jaakkola et al. (2017)
Degree of application / implementation	9	Thomas (1978), Silvestro et al. (1992), McDermott et al. (2001), Wynstra et al. (2006), Theotokis et al. (2008), Liu&Wang (2008), Glückler&Hammer (2011), van der Valk&Axelsson (2015), Jaakkola et al. (2017)
Labor intensity	9	Thomas (1978), Mills&Margulies (1980), Schmenner (1986), Haywood-Farmer (1988), Silvestro et al. (1992), Shafti et al. (2007), Lee&Park (2009), Wünderlich et al. (2013), Roels (2014)
Degree of interaction	7	Mills&Margulies (1980), Schmenner (1986), Haywood-Farmer (1988), Cunningham et al. (2005), Shafti et al. (2007), Roels (2014), van der Valk&Axelsson (2015)
Degree of standardization	7	Bowen (1990), Buzacott (2000), Cunningham et al. (2008), Liu&Wang (2008), Roels (2014), van der Valk&Axelsson (2015), He et al. (2016)
Customer participation	6	Larsson&Bowen (1989), Shafti et al. (2007), Wünderlich et al. (2013), Carlborg&Kindström (2014), Roels (2014), van der Valk&Axelsson (2015)
Diversity	4	Shostack (1987), Larsson&Bowen (1989), Glückler&Hammer (2011), van der Valk&Axelsson (2015)
Place	3	Silvestro et al. (1992), Shafti et al. (2007), Liu&Wang (2008)
Complexity	3	Shostack (1987), van der Valk&Axelsson (2015), Jaakkola et al. (2017)
Volume	2	Johansson&Olhager (2006), Lee&Park (2009)
Judgement	2	Cunningham et al. (2005), Shafti et al. (2007)
Convenience	1	Cunningham et al. (2005)
Contingency	1	Liu&Wang (2008)
Riskiness	1	Cunningham et al. (2005)
Switching	1	Cunningham et al. (2005)

Variations of the attribute type ‘service process’ have been found in 10 classifications, covering distinct qualities of delivery and processes. Most of the classifications have discussed service processes under the assumption of physical contact between customers and providers.

Nine studies brought the aspect of results of services into their classifications. They covered outcomes that customers get from services. We categorized them with the attribute type ‘object of service’.

‘Service characteristics (IHIP)’ comprises attributes on the nature of services. These attributes, which were mentioned 9 times in classifications, are subsets of IHIP.

Attributes, which concern the utilization of technology, knowledge, and equipment in services, were put into a group of attributes named ‘degree of application and implementation’. Nine classifications used this type of attribute.

The attribute type ‘labor intensity’ concentrates on service providers’ activities and how services depend on individual workers. It has been used in 9 studies.

Four of the studies, which also used labor intensity, consider also the depth of interactions between customers and providers. In total, seven studies applied this notion, which we named ‘degree of interaction’.

An attribute regarding the level of routinization and standardization can be found more frequently in literature after 1990. In total, seven classifications considered this attribute type, which we named ‘degree of standardization’.

With the increasing attention on customer’s role in services since the year 2000, six classifications considered the attribute type 'customer participation'. It describes customers’ activities and roles for joining services.

Four classifications focused on attributes about the variety of customer’s demands. We named this attribute type ‘diversity’.

Though expressed differently, three classifications followed a very similar concept of ‘place’. They expressed focus of a service to be at the front office, back office, or a virtual space.

The attribute type ‘complexity’, which has been addressed three times in classifications, describes the complexity of the provisioning of a service.

The remaining six attribute types (i.e., volume, judgement, convenience, contingency, riskiness, switching), which appeared less than three times, considered a unique quality in each study.

4. Application of Attribute Types to the Use Case TaskRabbit

TaskRabbit is a company, which has been founded in 2008. It connects platform users: those (Taskers), who are willing to provide labor, and customers, who need help with tasks (e.g., cleaning, moving, and assembling furniture). TaskRabbit, which advertises itself as a “same-day service platform”, can be considered a platform service provider. TaskRabbit is useful as a case study, as its service does not require any tangible products and does not involve complex transactions between its users.

With the help of attribute types listed in Table 1, we can describe the service of TaskRabbit in detail. For establishing connections between customers and taskers, TaskRabbit's platform users do not need to be present physically, when the transactions on the platform happen. Therefore, it is hard to measure customer contact between TaskRabbit and users. TaskRabbit provides information and connections using standardized processes to both types of its platform users. At the same time, the

platform can also be seen as providing customized services, since platform users can decide on the service and its provisioning according to their particular needs. In addition, as TaskRabbit is a platform that connects both types of users, a relationship between a customer and a tasker can hardly be defined as unidirectional. Moreover, it is not only hard to measure the degree of contact but also the degree of interaction. Furthermore, as customers are provided labor for their needs by taskers, who are hired temporarily by TaskRabbit, TaskRabbit can be rated as high 'labor intensity'.

Based on the TaskRabbit's service description that followed our consolidated classification scheme (Table 1), we got a solid classification of the service of TaskRabbit. However, there are three properties of the TaskRabbit service, which could not be described accurately by the attribute types shown in Table 1.

First, existing classification schemes assumed that service processes require physical contact between customers and providers [10, 14, 45, 48, 49]. However the TaskRabbit case showed that the service contract conclusion can be performed without any physical contact between customer and provider. Moreover, there are platform services, which do not even require any physical contact for the entire service process, including contract conclusion, provisioning, and delivery. Examples of these platform services are online services such as music streaming, video on demand online, and cloud services. The lack to express this is a shortcoming.

Second, in existing classification schemes, the degree of customization and the degree of standardization could not be rated as high at the same time. If one service has been rated as highly customized, the service could not be rated as standardized [14, 31, 32, 50]. However, businesses, which are based on platforms such TaskRabbit, were able to provide not only standardized services through the availability of public domain software, ubiquitous Internet, and computing power [26, 27] but also highly customized services (e.g., openness of services and flexibility of services) through digitalization and automation [28]. This is a shortcoming of existing classifications.

Third, although interactions between customers and providers have often been discussed [51-53], the environment (virtual world or real world), in which the interactions have happened, did not get sufficient attention. Existing classifications have the shortcoming of only considering service transactions that can either occur in the real world or in the virtual world. Combinations of occurrences in the real and virtual world (as for the case of the platform TaskRabbit service) cannot be expressed.

5. New Attribute Types for Platform Services

From the analysis of the TaskRabbit use case in chapter 4, it became clear that the attribute types of existing classifications are not sufficient to describe platform services. To resolve the three shortcomings identified in chapter 4, additional attribute types are needed for comprehensively describing platform services. In detail, we propose to add three new attribute types to the classification shown in Table 1:

The first new attribute type, which is related to the first shortcoming listed in chapter 4, describes the 'degree of involvement' of actors in the service process,

covering the quality of interaction and the kind of information exchanged. The 'degree of involvement' is used to express the quality of interaction with the actors.

With respect to the second shortcoming listed in chapter 4, if some people are familiar with digital devices, they may join a platform with a higher likelihood (as also in the case of TaskRabbit). Knowing how to use a technical device is a kind of competency (skills and knowledge) as described by Vargo and Lusch. This new attribute type is called 'degree of competency'. A high 'degree of competency' allows the platform user to use a service more effectively and to obtain a more customized service through the interaction. Consequently, the higher the 'degree of competency" is, the higher the 'degree of involvement' can be.

We believe that it is important to consider 'service scene' as another new attribute type for classifying platform services, addressing the third shortcoming identified. 'Service scene' is defined as a sequence of continuous actions in the service process that can take place in the virtual world or the real world. This definition allows for a combination of occurrences in the virtual world and the real world. This attribute type helps describing where services are agreed upon, provisioned, and delivered.

6. Conclusion

This research addressed shortcomings of existing service classifications. For this, we conducted a literature review, studying existing service classifications and their attributes. There were similarities between existing classification schemes about considering customers and managing processes. To identify limitations, existing attributes were applied to the platform service TaskRabbit. We found that traditional attributes are not sufficient to explain the TaskRabbit use case. Therefore, we proposed three additional attributes, which can cover emerging platform services, and a consolidated service scheme.

There are a few limitations to this research. First, there may be articles that are not included in the analysis, although we followed a comprehensive methodology to find all relevant studies. The cause might be the focus on only one database, namely Web of Science. Second, as we analyzed the classification schemes and attributes based on our interpretations, a quantitative method using text and clustering analyses might be considered less subjective.

In conclusion, although there are many service classifications, these classifications fail to explain current transitions from traditional services to pure online services (e.g., video rental shop to online streaming) caused by technology developments. To understand platform services, we need an appropriate service classification scheme.

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Preismodelle für Software-as-a-Service - Ein empirischer Vergleich des B2B- und B2C-Marktes

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Abstract. Software-as-a-Service hat sich als Modell in der Software-Industrie etabliert. Ziel dieses Artikels ist es zu klären, welche Preismodelle, insbesondere hinsichtlich nutzungsabhängiger oder -unabhängiger Bemessungsgrundlage bei aktuellen Anbietern herangezogen werden, sowie insbesondere ob es Unterschiede zwischen Business-to-Business (B2B)- und Business-to-Consumer (B2C)-Anbietern gibt. Insgesamt zeigt sich klar, dass vor allem nutzungsunabhängige Komponenten herangezogen werden, und eine gewisse Standardisierung vorliegt. Unterschiede zeigen sich beispielsweise bei der Verwendung von Freemium-Strategien, die im B2C-Bereich weit stärker verbreitet ist, und einer dort generell etwas höheren Anzahl von Preiskomponenten und stärkeren Betonung des Funktionsumfangs als Preistreiber.

Keywords: SaaS, Softwaremarkt, Preismodelle.

1 Einleitung

Software-as-a-Service (SaaS), also Bereitstellung und Nutzung von Software bzw. Anwendungen über das Internet und beispielsweise Web Browser, ist ein wichtiger Trend in der IT-Branche, welchem Branchenanalysten steigende Umsätze und ein anhaltendes Wachstum prognostizieren. Internet-Technologien wie AJAX, neue etablierte Standards und serviceorientierte Architekturen ermöglichen neue Ansätze sowohl für Anbieter als auch für Anwender. Für den Anwender reichen in den meisten Fällen ein moderner Browser und ein Internet-Zugang um die angebotenen SaaS-Lösungen nutzen zu können [1]. Während der SaaS-Umsatz im Jahr 2006 noch 1,5 Milliarden US-Dollar betrug [2], lag dieser im Jahr 2015 bereits bei 31,4 Milliarden US-Dollar [3].

Um ein derart starkes Wachstum zu erzielen, waren seitens der Anbieter auch Preismodelle notwendig, die vom Kunden gut angenommen werden. Da sich Preismodelle aus verschiedenen Elementen zusammensetzen, gibt es kein allgemeingültiges Preismodell für Softwareprodukte. Gerade im SaaS-Markt erwarten die Kunden flexible Preismodelle, die sich den individuellen Bedürfnissen anpassen [4]. In der heutigen Geschäftsrealität wurden für SaaS daher auch unterschiedliche

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Preismodelle entwickelt, und das, obwohl die preisliche Transparenz die durch SaaS sowohl für den Anwender als auch für den Anbieter entsteht ein wesentlicher Treiber für den Erfolg von SaaS ist. Die bestehenden Preismodelle sind nicht nur sehr unterschiedlich, sondern auch komplex [5].

Ziel dieser Arbeit ist es, einen Überblick darüber zu geben, wie sich Preismodelle im B2B- und B2C-Markt für SaaS zusammensetzen und welche Modelle im jeweiligen Markt vorherrschen. Zudem sollen eventuelle Besonderheiten hinsichtlich der Ausgestaltung des Preismodells für den österreichischen gegenüber dem internationalen Markt festgestellt werden, bzw. ob von den jeweiligen SaaS-Anbietern das Preismodell an regionale Märkte angepasst wird.

2 Software-as-a-Service und Preismodelle

2.1 Software-as-a-Service

Die Bereitstellung und Nutzung von Software bzw. Anwendungen (SaaS), die auf elektronischem Weg über das Internet zur Verfügung gestellt werden, aber auch von IT-Infrastruktur (IaaS) oder Plattformen (PaaS) beruht auf dem Modell des Cloud-Computing [6, 7]. Dieses wird von Mell und Grance [6] definiert als „a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.“ Die Komplexität der hinter den Modellen liegenden IT ist dabei für den Anwender nicht sichtbar, und gleichzeitig wird die einfache Nutzung der Schichten, also deren Funktionalität und Ressourcen, erlaubt [8].

SaaS ist einer der großen Trends in der Software-Industrie. Laut einer Vorhersage von Gartner aus dem Januar 2016 wächst der SaaS-Markt im Jahr 2015 um 15,5% und 2016 um 20,3%. Außerdem wird vorhergesagt, dass dieses rapide Wachstum auch im Jahr 2017 ungebremst voranschreiten wird [3]. Wie auch Cloud-Computing definieren Mell und Grance [6] SaaS als Servicemodell: “The capability provided to the consumer is to use the provider’s applications running on a cloud infrastructure. The applications are accessible from various client devices through either a thin client interface, such as a web browser (e.g., web-based email), or a program interface. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, storage, or even individual application capabilities, with the possible exception of limited user-specific application configuration settings.“ SaaS ist damit ein Modell wie Software ausgeliefert wird, aber auch ein Geschäftsmodell bei dem der Softwareanbieter eine standardisierte Software über das Internet als Service anbietet. Der Anwender kauft dabei keine Lizenz um die Software lokal bei sich zu betreiben, sondern abonniert einen Service, und die Software wird ohne Implementierung beim Anwender auf der Infrastruktur des Anbieters betrieben [9].

Aus Anwendersicht sind als Vorteile herauszuheben, dass die Kosten für die Einführung von SaaS durch den Wegfall von Lizenzkosten und geringeren Implementierungskosten üblicherweise geringer sind als eine vergleichbare Vor-Ort-Lösung anzuschaffen [9]. Des Weiteren sind Updates und Upgrades schneller verfügbar

[9]. Für SaaS-Anbieter besteht der Vorteil, dass diese einen größeren Anteil der Wertschöpfungskette für sich beanspruchen können, und die Distribution der Software-Piraterie entgegenwirkt [10]. Für Anbieter ergibt sich die Notwendigkeit Preismodelle zu entwickeln, die die Kundenbedürfnisse treffen und zudem das Problem reduzierter Kosten eines Anbieterwechsels. Das kann dazu führen, dass Anwender häufiger einen Anbieterwechsel durchführen. Diesem Risiko gilt es mit wertsteigernden Zusatzleistungen entgegenzuwirken [9], sowie auch durch Angebot von APIs und Entwicklungstools, die es dem Kunden erlauben, eine maßgeschneiderte Lösung zu entwickeln. Der zusätzliche Aufwand der dabei für den Kunden entsteht, kann nicht ohne weiteres auf ein anderes Produkt übertragen werden, wodurch dieser unter Umständen von einem Wechsel abgehalten wird [11].

2.2 Preismodelle und Bemessungsgrundlagen

Für Anbieter von SaaS verändern sich im Vergleich zu Vor-Ort-Software die Einnahmequellen [12], da Kunden in der Regel keine Wartungs- und Lizenzgebühren im eigentlichen Sinne bezahlen, die für Anbieter sonst oft etwa zwei Drittel der Einnahmen ausmachen [11]. Gerade Einnahmen für üblicherweise in Wartungsverträge inkludierte Leistungen entfallen durch die Softwareauslieferung [13]. Das Finden von Preismodellen, die für diesen Distributionsweg von Software passend und profitabel sind, stellt eine schwierige Aufgabe dar [14].

Grundsätzlich sind die Parameter der Preisgestaltung für SaaS und Vor-Ort-Software analog. Lehmann und Buxmann [15] geben einen Überblick über diese, und Softwarehersteller verwenden bei der Gestaltung ihres Preismodells eine Kombination mehrerer Parameter, oftmals sind auch mehrere Varianten abgedeckt. Neben der Bemessungsgrundlage sind dies Preisbildung, bestehend aus kostenbasierter, nachfrage-, wert- oder wettbewerbsorientierter Preisermittlung und Interaktionsgrad, Struktur des Zahlungsstroms in Einmal- oder periodische Zahlungen, Preisdifferenzierung, Preisbündelung, und dynamischen Preisstrategien wie Penetrations-, Abschöpfungs- und Freemium-Strategie. Letzeres bedeutet, dass die Software grundsätzlich kostenlos angeboten wird, für einen erweiterten Funktionsumfang allerdings Kosten anfallen.

Die Bemessungsgrundlage besteht aus einer flexiblen Anzahl an Preiskomponenten. Jeder dieser Preiskomponenten unterliegt einer Bemessungsgrundlage, die entweder als nutzungsabhängig (in weiterer Folge NA) oder -unabhängig (NU) eingeordnet werden kann. Damit ist auch eine hybride Variante (HY) mit beiden Arten von Preiskomponenten möglich, wenn beispielsweise ein fixer monatlicher Grundbetrag eingehoben wird, und zusätzlich noch ein Betrag, dem eine bestimmte, gemessene Nutzung zugrunde liegt [15].

Für eine nutzungsabhängige Bemessungsgrundlage geben Lehmann und Buxmann [15] einige Beispiele wie Transaktion, Speicherbedarf und Zeit. Auch Ojala [13] geht auf die Unterscheidung nach der Bemessungsgrundlage für eine Preiskomponente ein. Er bezeichnet die nutzungsabhängige Bemessungsgrundlage als pay per use, bei der es eine Einheit mit einem fixierten Preis gibt und dem Kunden periodisch der Verbrauch an Einheiten in Rechnung gestellt wird. Als Beispiele führt Ojala die Zeit die die

Software in einer Periode läuft, die Anzahl von Routinen-Aufrufen, die Anzahl von verarbeiteten Transaktionen oder auch eine Kombination davon an. Für Anbieter ergibt sich der Vorteil, dass auch Kunden erreicht werden können, die sich eine traditionelle Software-Lizenz nicht leisten können, gerade wenn diese die Software nur eingeschränkt benötigen. Damit geht auch ein gewisser Werbeeffekt einher [16]. Es ergeben sich allerdings auch Nachteile, da es ohne langfristigen Vertrag einfach ist den Anbieter zu wechseln. Außerdem muss der Anbieter die tatsächliche Verwendung durch den Kunden jederzeit nachweisen können, wodurch der administrative Aufwand steigt. Durch den ungewissen Zahlungsstrom ist es zudem schwieriger vorherzusehen, wann die für die Entwicklung erbrachten Aufwände durch Einnahmen gedeckt werden. Ein wesentlicher Vorteil für den Kunden ist, dass er für keine monatliche, fixe Gebühr aufkommen muss, auch wenn die Software nur gelegentlich benötigt wird. Zudem ist auch ein Anbieterwechsel einfacher. So kann auch getestet werden, ob die Software den erwarteten Nutzen erfüllt. Als Nachteil kann angeführt werden, dass es für den Kunden oft schwierig ist vorherzusehen, wie intensiv die Software tatsächlich verwendet werden wird. Das macht die zu kalkulierenden Kosten schwer abschätzbar. Der Preis pro Einheit ist außerdem meist als fix anzusehen und nicht verhandelbar [13].

Für eine nutzungsunabhängige Bemessungsgrundlage spricht aus Sicht des Anbieters die Tatsache, dass Nutzer in der Regel bereit sind für eine unbegrenzte Nutzung mehr zu bezahlen als für eine limitierte [15]. Als Beispiel wird unter der Preiskomponente „Named User“ verstanden, dass die Nutzungsrechte der Software an eine spezifische Person gebunden sind und sich der Preis auf diese Person bezieht. Ob diese die Software verwendet, und in welchem Ausmaß, ist für die Abrechnung unerheblich [15]. Ojala [13] bezeichnet diese Variante als software rental, bei dem der Kunde eine verhandelte Abo-Gebühr bezahlt, die es ihm erlaubt, die Software für einen definierten Zeitraum zu verwenden. Auch hierbei ist aus Anbietersicht eine gewisse Flexibilität gegeben, indem die Abo-Gebühr beispielsweise an Unternehmensgröße, Benutzeranzahl oder Abo-Länge angepasst werden kann, um Preisdifferenzierung zu betreiben. Hier entfällt außerdem administrativer Aufwand, weil die tatsächliche Nutzung nicht zu messen und belegen ist. Die Nachteile für den Anbieter sind ähnlich gelagert wie beim Modell mit nutzungsabhängiger Bemessungsgrundlage, mit Ausnahme des Wegfalls des Nachweises der Nutzung. Vorteile des software rental Modells aus Kundensicht sind die größere Flexibilität hinsichtlich Preisverhandlungen und die besser kalkulierbaren Kosten. Als Nachteil ist zu nennen, dass Kosten anfallen, egal wie intensiv die Software verwendet wird [13].

Bisherige empirische Untersuchungen zeigen eher eine Dominanz nutzungsunabhängiger Preismodelle. Lehmann et al. [4] haben bei einer Untersuchung unter 114 SaaS-Produkten von 80 Anbietern gezeigt, dass zu diesem Zeitpunkt „ausschließlich nutzungsunabhängige“ Preismodelle dominierten, gefolgt von hybriden, und erst dann nutzungsabhängigen Preismodellen. Damit widersprechen die Ergebnisse der häufig in der Literatur vertretenen Meinung, dass SaaS vor allem für nutzungsabhängige Preismodelle prädestiniert ist [4]. Auch Laatikainen et al. [17] kommen bei Ihrer Untersuchung von 54 Cloud-Service-Anbietern, unter denen sich 33 SaaS-Anbieter befanden, zu dem Ergebnis, dass sich vor allem nutzungsunabhängige Preismodelle am Markt etabliert haben. 85% der 33 SaaS-Anbieter Ihrer Untersuchung

setzen auf ein nutzungsunabhängiges Preismodell und nur 15% auf ein nutzungsabhängiges Preismodell [17].

3 Methodik

Zur Beantwortung der Frage, welche Preismodelle und -komponenten bei SaaS-Anbietern verwendet werden, wurden die aktuellen Angebote einer Stichprobe von B2B- und B2C-Anbietern herangezogen. Die folgenden Daten der einzelnen Anbieter wurden manuell aus öffentlich zugänglichen Webseiten extrahiert und gespeichert: Anbieter, Produkt, Preiskomponenten (Kategorisierung, Bemessungsgrundlage, Einstufung), eventuelle Differenzierung nach Region, Free-Trial-/Freemium-Strategie, Datum der Erhebung, sonstige Auffälligkeiten, URL Österreich sowie International. Der Zeitpunkt der Erhebung ist wesentlich, da festgestellt wurde, dass die Preismodelle der Anbieter durchaus häufigen Änderungen unterliegen. Konkrete Gründe für diese Änderungen sind nicht bekannt, es ist aber denkbar, dass SaaS-Anbieter schnell auf geänderte Marktgegebenheiten reagieren.

Damit die Preiskomponenten vergleichbar sind, wurde eine Kategorisierung vorgenommen. Dabei wurden ähnliche und sich wiederholende Ausprägungen iterativ zusammengefasst und entsprechend benannt. Die identifizierten Preiskomponenten wurden anschließend als nutzungsabhängig (NA), -unabhängig (NU) oder hybrid (HY) eingestuft. Wie bereits erwähnt kann eine Preiskomponente selbst hybrid sein, wenn eine nutzungsabhängige und eine -unabhängige Bemessungsgrundlage vorliegen. Im Endeffekt wurden die folgenden Kategorien mit entsprechenden Beispielen für Einstufung der Bemessungsgrundlage verwendet:

- Funktionsumfang: Preis abhängig vom Funktionsumfang der enthalten ist (z.B. einzelne Module). NA: Im Abrechnungszeitraum wird berücksichtigt, welche Funktionen tatsächlich verwendet wurden. NU: Dem Kunden steht ein gewisser Umfang an Funktionen zur Verfügung, Verwendungsausmaß spielt preislich keine Rolle.
- Support: Preis abhängig von Umfang oder Reaktionszeit des Kundensupports. NA: Abrechnung nach Support-Tickets o.ä. die bearbeitet werden. NU: Festpreis für die Verfügbarkeit des Supports der nicht vom Ausmaß der Nutzung abhängt.
- Anpassbarkeit: Preis abhängig von der Anpassbarkeit des Produkts (optisch, aber eventuell auch gewisse Funktionalitäten). NA: Pro Modul das ein Kunde mit seinem Logo individualisiert fällt ein bestimmter Betrag an. NU: Eine Pauschale für die Möglichkeit der Anpassung wird verrechnet.
- Speicherplatz: Preis abhängig vom (meist) Cloud-Speicherplatz der zur Verfügung gestellt wird. NA: Die Abrechnung erfolgt nach verwendeten Gigabyte. NU: Dem Kunden wird pauschal eine Anzahl Gigabyte zur Verfügung gestellt, unabhängig davon wie viel davon verwendet wird.
- Lizenz: Manche Anbieter verlangen zur erstmaligen Einrichtung eine Lizenz- bzw. Einrichtungsgebühr. Normalerweise immer rein nutzungsunabhängig (NU).

- Benutzer: Preis abhängig von Anzahl der Benutzer welche die Software verwenden (können). NA: Abrechnung erfolgt pro Benutzer die im Abrechnungszeitraum aktiv gearbeitet haben. NU: Der Kunde kann Pakete mit einer Anzahl von Benutzern buchen denen die Software zur Verfügung steht.
- Produkte: Preis abhängig von der Bündelung unterschiedlicher eigenständiger Softwareprodukte als Paket verkauft werden. NA: Dem Kunden werden alle Produkte zur Verfügung gestellt, die Abrechnung erfolgt auf der Basis der im Abrechnungszeitraum verwendeten Produkte. NU: Es werden unterschiedliche Softwareprodukte zu einem Paket gebündelt, für die Abrechnung ist die Verwendung irrelevant.

Eine hybride Bemessungsgrundlage ergibt sich aus Kombination unterschiedlicher Bemessungsgrundlagen. Bei Support würde dies bedeuten, dass der Kunde einen pauschalen Betrag pro Zeitraum für die Verfügbarkeit des Supports bezahlt. Konsultiert er diesen dann an Feiertagen oder außerhalb der Geschäftszeiten, fällt zusätzlich ein Betrag für dieses Support-Ticket an.

Mit Free-Trial-/Freemium wird vermerkt, ob eine entsprechende Strategie Verwendung findet. Unter Free-Trial wird verstanden, dass die Software für einen Zeitraum, meist in vollem Funktionsumfang, kostenlos getestet werden kann.

Für die Untersuchung der Preiskomponenten des Preismodells und deren Bemessungsgrundlage wurden sowohl B2B- wie auch B2C-Anbieter ausgewählt.

Für den Bereich B2B wurden 15 der umsatzstärksten SaaS-Anbieter, welche Preisinformationen auf deren Website zur Verfügung stellen, herangezogen. Die SaaS-Anbieter wurden anhand von „PwC Global 100 Software Leaders“ ausgewählt [18]. Dabei wurden die 15 umsatzstärksten SaaS-Anbieter aus der Liste verwendet, die zumindest zu einem der angebotenen Produkte Preisinformationen auf der firmeneigenen Website anbieten. Die Stichprobe umfasst damit Microsoft SharePoint, IBM Watson Analytics, SAP Anywhere, Symantec Endpoint Protection Cloud, VMWare Workspace ONE, HP Agile Manager Salesforce.com Sales Cloud, Intuit ProConnect Tax, Adobe Creative Cloud, CA Technologies Flowdock, Cisco Systems WebEx, Siemens Polarion ALM, Autodesk AutoCAD 360, Citrix Lifecycle Management, und Google Gsuite.

Die Auswahl von SaaS-Anbietern mit einer B2C-Orientierung erfolgte anhand einer Online-Recherche. Im Zuge der Online-Recherche wurden unterschiedliche Anbieter-Verzeichnisse (u.a. http://www.getwebapp.net/de/tag/saas, http://www.clouds360.com/saas.php, https://montclare.com/saas-250/ und weitere) durchgearbeitet. Dabei zeigte sich, dass SaaS im B2C-Bereich weitaus weniger verbreitet ist. Unter den 50 umsatzstärksten SaaS-Anbietern, die die Basis für die Auswahl der B2B-Anbieter darstellten, findet sich nur ein Anbieter, der auch auf die direkte Vermarktung an den Endkonsumenten abzielt (Microsoft mit Office365 und Skype). In Summe konnten 11 Anbieter gefunden werden, die SaaS-Anbieter im eigentlichen Sinn sind. Viele weitere Anbieter, die oftmals mit SaaS assoziiert werden, verkaufen keine Software, sondern dahinterliegende Inhalte, Dienstleistungen oder Produkte [16], beispielsweise Spotify oder Netflix. Folgende 11 Anbieter wurden ausgewählt: Evernote, Microsoft Office 365, Strava Premium, Dropbox, Microsoft

Skype, Vimeo Plus, Floorplanner, Learnvest, Dashlane, Rentberry, und Animoto for Family.

4 Ergebnisse

4.1 Überblick

Tabelle 1 zeigt einen Überblick über die Ergebnisse beider Gruppen, die in weiterer Folge noch detailliert dargestellt und im Anschluss verglichen werden.

Tabelle 1. Übersicht über die Ergebnisse für B2B- und B2C-Markt

	B2B *(Häufigkeit, n = 15)*	*B2C* *(Häufigkeit, n=11)*
Preiskomponenten		
- 1	5	4
- 2	5	5
- 3	5	1
- 4		1
Preiskomponenten		
- Benutzer	10	
- Funktionsumfang	5	8
- Speicherplatz	3	3
- Lizenz	3	2
- Produktumfang	2	
- Support		3
- Anpassbarkeit	1	1
Preismodell		
- NU	13	7
- NA	1	1
- HY	1	3
Preisstrategie		
- Freemium	1	8
- Free Trial	14	2

4.2 B2B-Anbieter

Die Auswertung der 15 B2B-Anbieter zeigt starke Gemeinsamkeiten, und es ist ein gewisser Grad der Standardisierung erkennbar. Die Anzahl der im Preismodell enthaltenen Preiskomponenten bewegt sich zwischen einer und drei, wobei diese völlig gleichverteilt sind. Es wurden insgesamt 11 verschiedene Preiskomponenten identifiziert wobei Benutzer besonders häufig vorkommt, gefolgt von Funktionsumfang sowie Speicherplatz. Auffällig ist weiters, dass auch die klassische Lizenz unter den

häufigsten Preiskomponenten ist. Diese Kategorie wurde für Named (Single) User Lizenzen, wie bei Vor-Ort-Software üblich, verwendet. Hinsichtlich der Kategorisierung der Preismodelle zeigt sich, dass nutzungsunabhängige ganz klar vorherrschen (13 Anbieter versus je einem). Preismodelle dieser Kategorie weisen ausschließlich Preiskomponenten mit entsprechender Bemessungsgrundlage auf, analog für nutzungsabhängige Preismodelle. In die Kategorie hybrid fallen Preismodelle, die einen Mix aus nutzungsabhängigen und -unabhängigen Preiskomponenten beinhalten oder bei denen einzelne Preiskomponenten selbst als hybrid kategorisiert wurden.

Auffällig ist, dass im B2B-Bereich nur ein Anbieter auf die Freemium-Strategie setzt, jedoch 14 Anbieter die Möglichkeit einer kostenlosen Testversion bieten. Bei 14 der Anbieter ist diese für einen Zeitraum zwischen 14 und 30 Tagen verfügbar. Um festzustellen, ob hinsichtlich der Preismodelle Unterschiede zwischen dem lokalen und internationalen Markt bestehen, wurde eine eventuelle regionenbezogene Preisdifferenzierung untersucht. Dabei hat sich gezeigt, dass keiner der untersuchten Anbieter hinsichtlich Preiskomponenten und deren Bemessungsgrundlage differenziert. Bei den neun Anbietern die ein länderspezifisches Angebot haben, bezieht sich dieses lediglich auf entsprechendes Umrechnen der Preise in die jeweilige Währung.

Anbieter versuchen einem Anbieterwechsel entgegenzuwirken, indem sie Vergünstigungen bei langfristiger Bindung anbieten oder Abrechnungszeiträume entsprechend lang gestalten. Es ist durchaus üblich, dass die Anbieter teils erhebliche Rabatte auf eine monatliche Gebühr bei jährlicher Zahlung gewähren, oder dass eine Mindestlaufzeit von 2 bis 3 Jahren angegeben wird. Anbieter die ihre Pläne auf die Einsatzzwecke unterschiedlicher Unternehmensgrößen anpassen, verlängern die Mindestbindung oft gerade bei den Plänen für Großunternehmen. Interessant ist auch, dass ein Anbieter seine Kunden zwischen einem nutzungsabhängigen und einem -unabhängigen Preismodell wählen lässt und diese durch einen Online-Rechner beim Finden der günstigsten Variante unterstützt.

4.3 B2C-Anbieter

Die Auswertung der 11 untersuchten B2C-Anbieter zeigt, dass auch im B2C-Markt eine gewisse Standardisierung Einzug gehalten hat und sich die Preismodelle in vielen Aspekten ähnlich sind. Bei keinem der Anbieter kommen zum Zeitpunkt der Erhebung mehr als vier Preiskomponenten zum Einsatz, wobei auch diejenigen mit drei beziehungsweise vier eine Ausnahme darstellen. Sehr häufig kommen zwei unterschiedliche, und beinahe gleich oft nur eine Preiskomponente zum Einsatz. Die mit Abstand häufigste Preiskomponente ist der zur Verfügung gestellte Funktionsumfang der Software. Bei acht Anbietern ist Funktionsumfang eine der Preiskomponenten, bei manchen sogar die einzige.

Da beinahe alle B2C-Anbieter auf eine Freemium-Strategie setzen, wird ein erweiterter Funktionsumfang als Anreiz für den Umstieg auf einen zahlungspflichtigen Plan genutzt. Einige Anbieter setzen (zusätzlich) auf eine Erweiterung von Speicherplatz oder auf erweiterten oder priorisierten Support. Auch ein klassisches

Lizenz-Modell kommt bei zwei Anbietern zum Einsatz. Im B2C-Bereich haben sich bei den verglichenen Anbietern ebenfalls nutzungsunabhängige Preismodelle durchgesetzt. Sieben der Anbieter setzen auf ein solches, ein Anbieter auf ein rein nutzungsabhängiges und drei Anbieter haben hybride Preismodelle im Einsatz. Bei den vier Anbietern, die nutzungsabhängige beziehungsweise hybride Preismodelle im Einsatz haben, ist es zudem durchaus legitim ist zu sagen, dass sich die Preiskomponente weniger auf die Software selbst als auf eine angebotene ergänzende Dienstleistung bezieht. Im Falle von Microsoft Skype kann Gesprächsvolumen gebucht beziehungsweise gekauft werden, Learnvest bietet die Möglichkeit, den Rat von Finanzexperten hinzuzuziehen, und Rentberry hebt eine Gebühr ein, wenn ein Mietvertrag zustande kommt. Lediglich bei Floorplanner bezieht sich die Bemessungsgrundlage auf die tatsächliche Software, indem das Hinzufügen von weiteren Hausmodellen in Rechnung gestellt wird.

Zwei der Anbieter setzen auf die Free-Trial-Strategie, sie bieten also die Möglichkeit, die Software für einen kurzen, bestimmten Zeitraum kostenlos zu testen. Auffällig ist, dass beide Anbieter die Software auch an Unternehmen vertreiben. Ein Anbieter stellt keine Möglichkeit die Software zu testen zur Verfügung. Eine regionenbezogene Preisdifferenzierung kommt bei den B2C-Anbietern nicht zum Einsatz, der größte Teil der untersuchten Anbieter hat ein länderspezifisches Angebot, das im Umrechnen der fälligen Beträge auf die dementsprechende Landeswährung besteht. Nur zwei der Anbieter haben kein länderspezifisches Angebot, insbesondere wohl da die Software konkret auf einen geografischen Markt zugeschnitten ist (Learnvest und Rentberry).

4.4 Vergleich

Bei einem Vergleich der beide Märkte gibt es einige Auffälligkeiten. Allen voran die Erkenntnis, dass B2C-Anbieter vorwiegend auf eine Freemium-Strategie setzen, wohingegen diese im B2B-Bereich kaum vorkommt. Die im B2B-Bereich vorherrschende Free-Trial-Strategie findet wiederum im B2C-Bereich deutlich weniger Anwendung. Damit geht die Tatsache einher, dass im B2C-Bereich die häufigste Preiskomponente der Funktionsumfang ist. Die Einschränkung des Funktionsumfangs in der kostenlosen Version soll zusammen mit einem Lock-In Effekt [16] den Anwender animieren, auf eine kostenpflichtige Version zu wechseln, die einen erweiterten Funktionsumfang bietet.

Alle Anbieter setzen vorwiegend auf nutzungsunabhängige Bemessungsgrundlagen. Auch eine Untersuchung von Chun und Choi [19] ergab, dass im SaaS-Markt vorwiegend auf Mietmodelle gesetzt wird, wohingegen bei IaaS und PaaS durchaus benutzungsabhängige Bemessungsmodelle vorherrschen. Die im B2B am häufigsten vorkommende Preiskomponente Benutzer kommt hingegen im B2C-Bereich nicht vor, da es sich in der Regel um Software für einzelne Benutzer handelt. In beiden Gruppen sind hybride oder völlig nutzungsabhängige Preismodelle eine Seltenheit und eine Preisdifferenzierung nach Regionen wird nicht durchgeführt. Auch Laatikainen et al. [17] kamen bei Ihrer Untersuchung zu dem Ergebnis, dass seitens der Anbieter keine entsprechende Preisdifferenzierung durchgeführt wird. Die Ergebnisse hinsichtlich der

Bemessungsgrundlagen überschneiden sich weitgehend wie auch die Tatsache, dass meistens mehr als eine Preiskomponente vorkommen [17].

Die Anzahl der Preiskomponenten ist in den B2B- und B2C-Stichproben ähnlich, jedoch wurden diese durch unterschiedliche Strategien gewonnen. Auffällig ist auch, dass im B2B-Kontext gezielt versucht wird, längerfristige Verträge zu forcieren, wohingegen bei B2C großteils maximal Jahresabonnements abgeschlossen werden können.

5 Diskussion und Abschluss

Ziel dieser Arbeit war, die Preismodelle von B2B- und B2C-Anbietern zu analysieren und zu vergleichen, vorwiegend hinsichtlich Preiskomponenten und Bemessungsgrundlagen, da gerade dort Unterschiede zu Vor-Ort-Software vermutet wurden.

Es zeigt sich, dass die Bildung von Preismodellen durchaus komplex ist, dennoch hat bei SaaS scheinbar ein gewisser Grad der Standardisierung Einzug gehalten. Das zeigt sich darin, dass sich die Anzahl der Preiskomponenten in einem eher kleinen Rahmen bewegt und darin, dass gewisse Preiskomponenten bei sehr vielen Anbietern eine Rolle spielen. Bei der Bündelung der einzelnen Preiskomponenten sind die Anbieter jedoch durchaus kreativ. Auch hinsichtlich der Strategie zur Kundengewinnung zwischen Free-Trial und Freemium ergibt sich ein deutliches Bild. Während B2B-Anbieter vorwiegend auf eine Free-Trial-Strategie setzen, herrscht im B2C-Bereich ganz klar die Freemium-Strategie vor.

Interessant ist auch, dass die viel propagierte leistungsbezogene Abrechnung in der SaaS-Praxis kaum Anwendung findet, weder im B2B- noch im B2C-Bereich konnten sich in dieser Arbeit und in vergleichbaren anderen Untersuchungen wie Lehmann et al. [4] oder Laatikainen et al. [17] nutzungsabhängige Preismodelle durchsetzen. Eine Preisdifferenzierung anhand von Regionen nehmen Anbieter nicht vor, eventuell würde eine zu solche Differenzierung auch im Widerspruch zum SaaS-Gedanken stehen.

Da für diese Arbeit eine kleine Stichprobe verwendet wurde, ist es denkbar dass bei einer Wiederholung mit einer größeren Stichprobe die Ergebnisse abweichen. Zudem musste bei den Stichproben von B2B- beziehungsweise B2C-Anbietern eine unterschiedliche Gewinnungsstrategie verwendet werden, und die Daten wurden den entsprechenden Webseiten entnommen. Dadurch könnte es zu Verzerrungen kommen, sollten Anbieter mit bestimmten Preismodellen diese seltener entsprechend publik machen, oder wenn tatsächlich abgeschlossene Verträge von den Angeboten abweichen, was eher im B2B-Bereich zu vermuten wäre.

Ein weiteres Problem besteht darin, dass die Kategorisierung der Preiskomponenten manuell basierend auf den vorliegenden Daten und Literatur vorgenommen wurde. Da in dieser Arbeit lediglich untersucht wurde, ob die Preismodelle der Anbieter auf einen Markt zugeschnitten werden, wäre auch eine Untersuchung interessant, ob sich die Preismodelle der Anbieter unterschiedlicher geografischer Herkunft unterscheiden.

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The Role of E-Intermediaries in Local Retail Hyperlink Networks: A Hyperlink Network Analysis

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Abstract. Local Owner Operated Retail Outlets (LOOROs) are threatened by the digitalization pressure from offline and online competitors on the one hand and by changing shopping habits of customers on the other. The involvement of e-intermediaries like e-marketplaces could help LOOROs to regain competitive power – not only in terms of additional online sales channels, but also with regard to professional online behavior and e.g. online visibility in terms of SEO. However, little is known about LOOROs online networking patterns, link-building strategies and the specific role of e-intermediaries in this matter. To investigate the raised questions, this study analyzes hyperlink networks of local retailers in three German cities. We explored 14.780 websites and identified 12 categories of important stakeholders for local retail hyperlink networks. Our results reveal that LOOROs neglect the opportunities of local online cooperation. E-Intermediaries act as link hubs for local retailers, but local retailers follow passive link-building strategies and hesitate to link to e-intermediaries.

Keywords: LOOROs, Retail, Hyperlink Network Analysis, Stakeholder Analysis

1 Introduction

Despite the omnipresence of large retail chains and pure online players, local owner operated retail outlets (LOOROs) constitute the vast majority of retailers in German cities [1]. LOOROs are characterized by small-sized store areas, a limited number of staff and high owner-involvement in the day-to-day business operations [2]. Although LOOROs operate in a growing market environment, they are exceedingly challenged by the transformation of the retail industry and pressured to adapt their traditional business model to the intense competitive situation in the retail sector. The market share of the LOORO business type has already declined from 26% in 2003 to 17.9% in 2015 [1]. Further, several independent studies predict a decline in revenue for

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LOOROs of 30% in the next four years [3] and about 50% in the next ten years [4]. The fundamental cause of this negative development is the growing online trade that challenges LOOROs with strong price and service competition, while, at the same time big-box retail outlets and chain stores have started to digitalize their business models and offer multichannel sales and services to their local customers [1]. At the same time, customers are verifiably changing their shopping habits: as they are already used to online shopping and digital services, accordingly their shopping frequency in city centers is diminishing [5]. To increase the ability of LOOROs to meet customer expectations and to compete with pure online players and large retail chains, the use of e-intermediaries like e-marketplaces is an intensively discussed approach / research topic [6] and part of government subsidy programs in Germany [7]. E-intermediaries provide brokerage functionality by connecting the supply and demand of goods, information, and/or services [8]. For LOOROs, e-intermediaries as e-marketplaces are extra-organizational support for the evolving challenges of e-commerce [9]. E-intermediary roles range from simple externalization of online front-end management (e.g., e-commerce site, e-marketplace) to the outsourced management of complex marketing and sales processes related to e-commerce, including pricing, invoicing, and logistics [10]. However, little is known about the online networking activities of LOOROs and the specific role of e-intermediaries in this matter. As the local retail sector is composed of businesses that are diverse and independent in nature, explorative research on relationships on the company-level is challenging. In this paper, we therefore analyze hyperlink structures to learn about online networking patterns within the local retail sector.

Hyperlinks are the structural elements of the Web. They are designed and modified by the owners and administrators of the retail websites and reflect their communicative agenda (e.g. exchange of information or maintaining collaborative relationships) [11]. Hyperlinks thereby are a type of representational communication because no information flow is involved [12]. The totality of hyperlinks on a company's website constitutes an inter-organizational network [13] and demonstrates the structural embeddedness of online organizational behavior [14]. Therefore, organizational hyperlinking is a purposive and strategic communication choice [15]. Hyperlinks have been described as vehicles for the expression of collective identity, public affiliation, credibility, visibility, reputation, authority, and endorsement [16]. Furthermore, the resulting link structures play an important role for the visibility of websites in search engines. Active link-building strategies are a core measure of search engine optimization (SEO) [17].

Therefore, in this paper, we aim to analyze the online networking patterns of LOOROs and all other relevant local retail stakeholders. A thorough understanding of online connections between the stakeholders can provide valuable insights into LOOROs online networking strategies and the specific role of e-intermediaries in this matter. Furthermore, it can shed light on how to promote local retailers online visibility and on how to improve their network relationships with e-intermediaries. Accordingly, we aim to answer the following research questions:

RQ1: What hyperlink structures exist among the stakeholders of local retail?

RQ2: Is there a visible link-building strategy of LOOROs?

RQ3: What role do e-intermediaries play in local retail hyperlink networks?
This study is structured as follows: In section 2, we discuss the methodological background. In section 3, we describe the research framework and the conducted analysis. In section 4, we discuss our findings and point out the implications and limitations of our research.

2 Theoretical Background

Hyperlink Network Analysis (HNA) is a subset of Social Network Analysis (SNA). SNA is the process of investigating social structures by applying networks and graph theory [13]. A social network is a representation of social structures, containing components (people, organizations or other social entities) and relationships such as friendships, affiliations and information exchange [18]. SNA examines the structures of social networks, based on the analysis of relationships (also referred to as links) among the system components (also referred to as nodes) [18, 16]. The difference between hyperlink and social network analysis is that HNA does not analyze social relationships. HNA relies on the use of hyperlink data that can be obtained only from websites. A hyperlink network emerges if at least two nodes (two websites) are connected through hyperlinks. HNA therefore requires an exploratory analysis of the hypertext markup (HTML) of websites to determine if there is a unilateral or bilateral hyperlink relationship between the examined websites [18]. This procedure is named link mining and is usually carried out by web crawlers [16]. In contrast to SNA, in HNA it is difficult to assign weights to links between nodes (websites) as link mining does not collect any additional information or attributes about links, like e.g. the interaction intensity (traffic) between the linked nodes. HNA assesses the importance of nodes by interpreting the identified link structure, considering also secondary data, e.g., external attributes of the nodes based on grouping, clustering or classification [18]. For the examination and assessment of hyperlink networks, 1) link based and 2) network related measures are applicable.
1) Link-based object ranking: The PageRank [19] and HITS [20] algorithms are the most notable approaches for link-based object ranking. PageRank looks at the number and quality of links to a page to determine a rough estimation of the importance of a website [19, 21]. The underlying assumption is that more important websites are likely to receive more links from other websites (link impact) [21]. The HITS algorithm takes this assumption one step further and differentiates between two types/qualities of web pages, called hub and authority. Hubs are web pages that link to many authoritative pages. Authorities are web pages that are linked to by many hubs. Each page in the web is assigned hub and authority scores. The algorithm computes the scores as part of an iterative process and regularly updates the scores of a page based on the scores of the pages in its immediate neighborhood [20].
2) Network theory: The measures of network and graph theory are derived from the relationships between the nodes of a network. Degree, for example, is the number of relations (links) of a node (websites) in a network. In directed networks, an in-degree (e.g. number of incoming links) and out-degree (e.g. number of outgoing links) can be

measured [22]. Based on the relationships between nodes it is also possible to compute the network density of the network and the positioning of single nodes within the network. Network density represents the portion of all possible connections within a network that are actually present [23]. It thus indicates the overall level of integration of the assessed hyperlink network. Ranging from 0% (every node is isolated) to 100% (all nodes are connected with each other), network density is computed as the number of actual connections between nodes divided by the number of possible connections [22]. Network centrality, in contrast, refers to the extent to which a node (website) holds a central position in a hyperlink network [22]. In a connected graph, closeness centrality is an indicator of the extent to which a given node has short paths to all other nodes in the graph. It is calculated as the sum of the length of the shortest paths between the node and all other nodes in the graph. Thus, the closer a node is to all other nodes, the more central it is. Closeness centrality is a reasonable measure to identify nodes in the "center" of a given network [24]. Further, for every pair of vertices in a connected graph, there is one shortest path between them. Either the number of edges that the path passes through (for unweighted graphs), or the sum of the weights of the edges (for weighted graphs) that the path passes through, is minimized on this shortest path. Betweenness centrality measures the number of such shortest paths going through each vertex [25]. The measure thus indicates, which individual nodes play a "brokering" or "bridging" role within a network.

3 Methodology

We carried out the HNA in 5 steps: 1) Definition of scope and sample: First, we defined a clear research scope and chose a representative sample of retailers accordingly. 2) Seed list development: The seed list is the starting list for the examination. It is based on the chosen sample of retailers, from which we have identified and collected the seed URLs for the link mining process. 3) Link Mining: Using a web crawler, we collected the hyperlink data from the seed URLs as well as from the linked network pages. 4) Network Analysis: From the collected link data, we derived the hyperlink networks, which we then analyzed. 5) Interpretation: Finally, we analyzed and interpreted the revealed network data regarding the presented theoretical background [26].



Figure 1. Research procedure

4 Analysis

In our study, all types of resident stationary retailers are considered part of the examination group for local retail hyperlink networks. According to the German Retail Federation, local retailers can be categorized into three types [1]: 1) Local Owner Operated Retail Outlets and 2) Local Chain Stores, both dealing with fast moving consumer goods (FMCG), and 3) Local Specialized Stores, doing business with capital or durable goods (e.g. car dealer).

To gain a better understanding of local retail hyperlink networks and network patterns in Germany, we selected a set of three heterogeneous examination areas (German cities), including one small (10.000-30.000 inh.), one medium (30.000-100.000 inh.), and one large city (>100.000 inh.) [34], with at least one subsidized e-intermediary in each: 1) Attendorn (24.786 inhabitants), as a sample small size city located in North Rhine-Westphalia with a total 103 local retailers; 2) Wolfenbüttel (53.779 inhabitants), as a sample medium size city, located in Lower Saxony with a total 114 local retailers; 3) Heilbronn (122.579 inhabitants), as a sample large city, located in Baden-Wuerttemberg with a total 259 local retailers.

To get an overview of the current state of local retail in each city, we conducted an explorative web research among online vendor archives and city information websites. Subsequently, we established a local retail database for each city including all resident stationery retailers. From this database, we then selected all local retailers with a web presence, resulting in the three seed lists for the HNA:

1) The seed list for Attendorn contains 75 URLs for 103 local retailers (73%), covering 48 LOOROs, 12 Chain Stores, and 15 Specialized Stores. 2) The seed list for Wolfenbüttel contains 50 URLs for 114 local retailers (44%), covering 31 LOOROs, 17 Chain Stores, and 2 Specialized Stores. And finally, 3) the seed list for Heilbronn contains 199 URLs for 259 local retailers, covering 97 LOOROs, 88 Chain Stores, and 14 Specialized Stores.

4.1 Data Collection / Link Mining

We collected the link data in July 2017, harnessing the VOSON web crawler (www.uberlink.com) to visit each of the given seed URLs. The VOSON crawler was configured to focus on outbound links and to ignore internal links. For each seed page, the following stop criteria for the crawling process were defined: > 1000 OutLinks (max. OutLinks); > 25 pages crawled without finding a new outbound link (max. unproductive pages); > 50 pages crawled (max. depth of crawl / pages), and > 2 levels crawled (depth of crawl / levels) [26].

The crawling results helped us derive three types of hyperlink networks, which we used to develop the final stakeholder network for our analysis:

1) The Seed Network, purely based on the hyperlinks of the local retailers of each city.

2) The Full Network, containing all identified and explored stakeholders of the local retail hyperlink network.

3) The Seed + Important Stakeholder Network as a compressed network, including all local retailers and important stakeholders. We considered a stakeholder important when it contained links to at least two seed sites of the local retail hyperlink network [16]. For the analysis of the discovered networks, we used Gephi (www.gephi.org) as an open source software. Fig. 2 shows the identified Seed+Important Networks for the three cities, which we discuss in the following section.

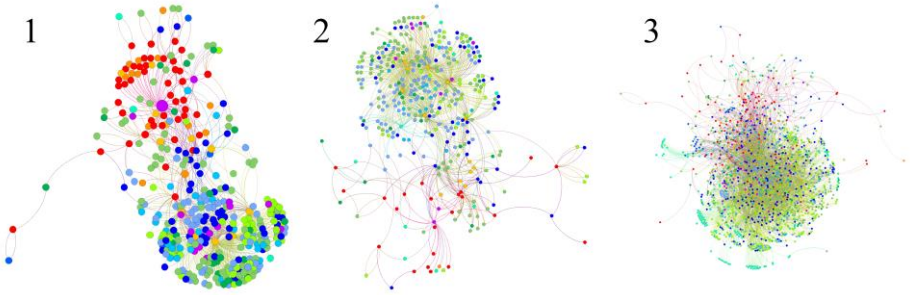


Figure 2. Seed+Important Networks 1) Attendorn, 2) Wolfenbüttel, 3) Heilbronn

4.2 Node Classification and Stakeholder Network

Since the explored Seed+Important and Full Networks are highly complex, we classified all important stakeholders of the local retail hyperlink networks. The categorization is based on the stakeholder classification of Chua et al. (2005), who differentiate between five groups of e-commerce retail stakeholders: customers, retail organizations, suppliers, regulators and indirect stakeholders. We extended this categorization by 12 subtypes in order to allow for a more detailed analysis of local retail hyperlink networks:

Table 1. Stakeholder Categories & Color Code

1.	LOOROs		Websites of local owner operated retail outlets
2.	Chain Stores		Websites of local resident retail chains
3.	Specialized Stores		Websites of local resident specialized stores
4.	Intermediaries		E-Marketplaces (e.g. local shopping platforms, ebay, amazon)
5.	Non-Local Retailer		Websites of non-local resident retailers
6.	Manufacturer		Websites of manufacturers
7.	Service Provider		Websites of service providers
8.	I&C Provider		Websites of information and communication providers
9.	Web Archives		Web-Archives (e.g. address archives of local shops)
10.	Public Sector		Websites of city administration and local clubs
11.	Spam		Content and link pharms and malicious websites
12.	Miscellaneous		Other websites, e.g. foreign language websites

With the help of these stakeholder categories, we derived a final less complex hyperlink network: **4) The Stakeholder Network**. This network shows all explored actors grouped along the 12 stakeholder subcategories (see fig. 4 below).

Table 2. Overview Network Size (Nodes)

	Seed Network	S+I Network	Full Network	Stakeholder Network
Attendorn	75	371	2328	
Wolfenbüttel	50	395	2617	12
Heilbronn	199	1671	9835	

5 Discussion and Conclusion

With the help of the VOSON web crawler and a link mining approach, we investigated local retail hyperlink networks of three German cities. We explored 14780 websites of possible stakeholders and labeled 2437 websites that were considered important according to a developed stakeholder categorization (see table 1).

Regarding the first research question "*What are the link characteristics of local retail stakeholders in local retail hyperlink networks?"* our results show (see fig. 3 below) that there are no direct hyperlink networks between local retailers. If at all, only a very few retailers link to each other.

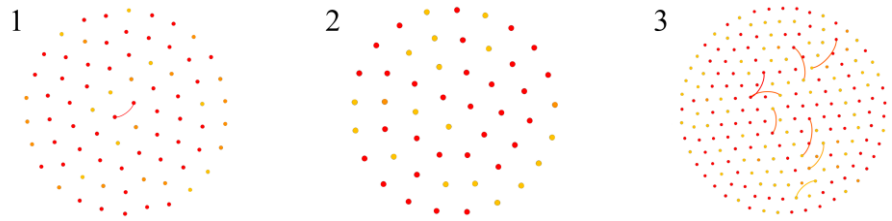


Figure 3. Seed Networks 1) Attendorn, 2) Wolfenbüttel, 3) Heilbronn

However, local hyperlink networks between local retailers and other retail stakeholders are present. Our explorative analysis discovered that all 12 considered stakeholder groups have hyperlink connections to at least two other groups (table 4 / figure 4).

Concerning the relationships between the stakeholders in the identified networks, our results show that the local chain stores have the highest degree and due to the high number of InLinks they act as link authorities (table 4). LOOROs have a high degree of InLinks as well, but significantly fewer relationships compared to Chain Stores (e.g. average degree in Heilbronn, LOOROs 19 and Chain Stores 21). Specialized Stores also tend to be authorities.

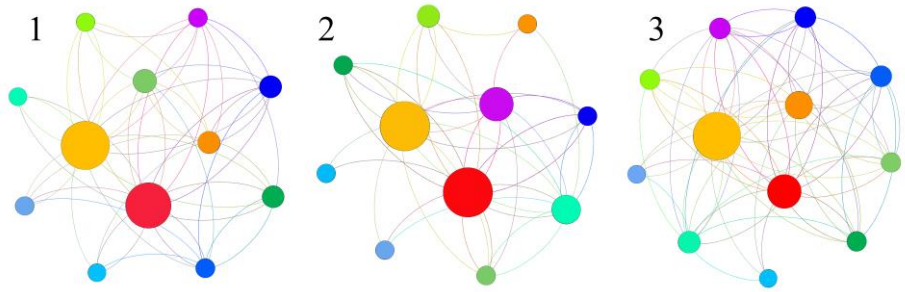


Figure 4. Stakeholder Networks 1) Attendorn, 2) Wolfenbüttel, 3) Heilbronn (Node size according to betweenness centrality)

With regard to the examined link structures, all groups of retailers hesitate to implement OutLinks and rely mainly on InLinks (e.g. indegree/outdegree of retail chains for S+I: Attendorn 513/61, Wolfenbüttel 752/92, Heilbronn 3756/629). Further, local retailers and in particular LOOROs seem to be reluctant to link to e-intermediaries, which could extend their service capabilities (e.g. product visibility, product information, online shopping functionality, etc.) for their customers [17]. On the contrary, e-intermediaries act as link hubs within the hyperlink networks, mainly targeting all three groups of local retailers.

The sparse link building between the local retailers leads to a low overall network density below 1% for all three cities' Seed+Important networks. These low network densities indicate a low bond between the stakeholders of the local retail hyperlink networks. Due to the aggregation of "important" nodes into stakeholder categories, the density of the stakeholder networks is significantly higher (see table 3) - but still only on a medium level.

Table 3. Network density for S+I and Stakeholder Networks

	Nodes S+I	Links S+I	Density S+I	Nodes Stakeholder	Links Stakeholder	Density Stakeholder
Attendorn	371	845	0.62%	12	56	42.42%
Wolfenbüttel	395	1000	0.64%	11	43	39.09%
Heilbronn	1671	5285	0.19%	12	72	54.55%

E-intermediaries act as central nodes within the local retail networks (Attendorn 0.733, Wolfenbüttel 1.000, Heilbronn 0.769), as they are connected to most of the other explored stakeholders. However, the Local Chains and LOOROs also act as brokers in the local hyperlink networks (e.g. Attendorn: LOOROs 29.7, Chain Stores 32.8). Most of the nodes are connected through them. All results for centrality are provided in table 4.

With regards to our second research question "*Is there a visible link-building strategy of LOOROs?"* our analysis shows that LOOROs do not link to other local retailers. This finding is in line with hyperlink research on tourism providers located in one city

[28]. It seems that local businesses do not yet understand the relevance and the opportunities of local networking and local link building, e.g. in terms of search engine visibility [17] and clickstream optimization [29]. Accordingly, there is no local hyperlink network among local retailers. However, there are connections between LOOROs and the other stakeholders, which rely mainly on link-building from the other stakeholders. In conclusion, if at all, LOOROs follow a passive link strategy and only collect InLinks. We found no proof for an active link-building strategy.

Table 4. Network data

Stakeholder Category	Indegree	Outdegree	Degree	Indegree (S+I)	Outdegree (S+I)	Degree (S+I)	Closness centrality	Betweeness centrality	Hits Auth	Hits Hub
Stakeholder Network Attendorn										
LOOROs	3	4	7	104	75	179	0.733	29.7	0.449	0.321
Local Chains	1	11	12	513	61	574	0.688	32.8	0.479	0.264
Specialized Stores	1	0	1	41	14	55	0.478	5.15	0.347	0.163
Intermediaries	0	2	2	9	109	118	0.733	1.59	0.11	0.453
Non-Local Retailer	2	1	2	2	6	8	0.524	0.81	0.11	0.174
Manufacturer	1	1	2	12	6	18	0.611	1.92	0.292	0.294
Service Provider	0	3	3	75	133	208	0.688	6.38	0.226	0.413
I&C Provider	0	2	2	70	88	158	0.579	4.90	0.359	0.24
Web Archives	0	2	2	1	150	151	0.611	1.48	0.05	0.294
Public Sector	0	2	2	12	40	52	0.550	4.59	0.281	0.229
Spam	0	2	2	1	74	75	0.611	0.64	0.06	0.294
Miscellaneous	0	2	2	5	89	94	0.458	1.03	0.273	0.155
Stakeholder Network Wolfenbüttel										
LOOROs	8	6	14	40	77	117	0.800	19.00	0.456	0.345
Local Chains	8	6	14	752	92	844	0.800	19.00	0.456	0.345
Specialized Stores	1	2	3	1	2	3	0.500	0.00	0.103	0.151
Intermediaries	2	8	10	7	43	50	1.000	9.33	0.137	0.520
Non Local Retailer	8	4	12	26	18	44	0.615	6.33	0.492	0.300
Manufacturer	-	-	-	-	-	-	-	-	-	-
Service Provider	4	3	7	84	227	311	0.571	0.33	0.300	0.279
I&C Provider	4	3	7	66	63	129	0.571	0.33	0	0.279
Web Archives	0	3	3	0	308	308	0.563	0.00	0.300	0.279
Public Sector	4	4	8	17	60	77	0.571	0.33	0.240	0.279
Spam	0	2	2	0	43	43	0.529	0.00	0	0.181
Miscellaneous	4	2	6	7	67	74	0.533	2.33	0.270	0.181
Stakeholder Network Heilbronn										
LOOROs	10	9	19	385	236	621	0.833	11.65	0.377	0.343
Local Chains	11	10	21	3756	629	4385	0.909	21.78	0.429	0.352
Specialized Stores	10	5	15	162	39	201	0.588	7.07	0.431	0.206
Intermediaries	6	8	14	22	172	194	0.769	2.23	0.241	0.362
Non Local Retailer	6	9	15	133	179	312	0.833	3.17	0.229	0.394
Manufacturer	6	6	12	41	76	117	0.714	2.42	0.247	0.327
Service Provider	6	4	10	339	1103	1442	0.625	1.35	0.303	0.226
I&C Provider	6	5	11	319	670	989	0.667	2.27	0.303	0.263
Web Archives	1	4	5	1	816	817	0.625	0.13	0.054	0.224
Public Sector	6	4	10	67	252	319	0.625	1.35	0.303	0.226
Spam	0	4	4	0	325	325	0.611	0.00	0	0.224
Miscellaneous	4	4	8	60	788	848	0.625	1.60	0.198	0.225

With regards to our last research question "*What is the role of e-intermediaries in local retail hyperlink networks?"* our results show that e-intermediaries play a central role in the analyzed local retail hyperlink networks. They have relationships with most of the other stakeholders and have a high closeness centrality. Furthermore, e-intermediaries act as link hubs and mainly target local retailers. However, the brokerage power of the e-intermediaries within the networks and between the stakeholders is limited. The low average betweenness centrality of the e-intermediaries is attributable to two facts: 1) LOOROs hesitate to link to e-intermediaries and therefore thwart their brokerage role. 2) Consumers, as the second important target group of e-intermediaries, were not considered in the hyperlink networks. Accordingly, the full brokerage power of e-intermediaries could not be ascertained in the above analysis [30]. The low levels of integration of e-intermediaries in the local retail hyperlink networks in general, and the reluctance of the local retailers regarding OutLinks in specific, are indicators of the inefficient utilization of e-intermediaries in local retail communities.

Practical Implications: Our findings provide valuable insights for the owners of LOOROs and e-intermediaries. LOOROs should revise their link policy and start linking to the e-intermediaries that they collaborate with. They would benefit in at least two ways: 1) Search Engine visibility: Link building is an essential SEO measure and will increase the ranking of LOORO websites as well as the websites of the e-intermediaries [17]. 2) Service infrastructure: With the help of links to e-intermediaries, LOOROs can offer additional online sales and service channels to their customers and website visitors [29]. When LOOROs sell through e-marketplaces and do not link to them from their own web presence, they solely depend on the native visitors of the e-marketplace, and waste the opportunity to offer digital sales and service channels to their own customers. This is becoming more and more problematic, as customers are changing their shopping habits [5] and are adopting practices like showrooming (research offline and purchase online) [31].
E-intermediaries need to recognize this linking failure of local retailers and should provide information and training on the benefits of links to their business partners. LOOROs, in particular, appear unable to integrate e-intermediaries efficiently, in order to facilitate seamless access to digital sales and service channels to their customers and to use click-stream optimization [32, 29].

Limitations and Future Research: Due to the high pace of digital change, the manually derived seed lists for the HNA can only be considered as snapshots. Furthermore, the necessary stop rules for the VOSON crawler limited the link collection. Huge sites (with more than 50 pages) and sites with many links (more than 1000) were not completely analyzed, as this would have overwhelmed our resources. Finally, the conducted crawling process could not reveal any profiling information about the examined websites at this point. Thus, for example, missing information on the SEO-level of a website, the used content management systems, the used shop system(s), etc., limited the explanatory power of the study.

Reflecting on our approach and our findings, future research on the following aspects would be valuable: 1) HNA Process Improvement: How can web and data mining approaches help overcome manual seed list development and manual classification of discovered nodes (automatic node recognition)? 2) Node-Profiles: How can crawler-based node profiling improve the explanatory power of the analysis? 3) Link Building for LOOROs: How can LOOROs be motivated to link to and cooperate with other local retail stakeholders online?

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Much more than "same solution using a different technology": Antecedents and consequences of technology pivots in software startups

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Abstract. In search of a viable and scalable business model, software startups implement and deploy innovative software-based products and services. In the well-established Lean Startup Approach, pivoting – making major rather than minor adjustments – is a standard method applied in this process. Failing to pivot at the right time and for the right reasons can substantially jeopardize startup success. Given the alleged importance of pivots, surprisingly little is known about the events leading up to and resulting from pivots. Our study starts to fill this gap in theoretical knowledge by empirically investigating the circumstances under which it is beneficial to perform pivots and what to expect from them for product development, business model development and innovation. Focusing on one specific type of pivot – technology pivots – we use an embedded inductive multi-case research design to propose a model that identifies three prerequisites, five antecedent and nine consequence categories of technology pivots.

Keywords: Lean Startup, Technology Pivot, Antecedents, Consequences, Prerequisites, Business Model

1 Introduction

Software startups focus on the implementation and deployment of innovative software-based products and services in search of a viable and scalable business model (BM). In the well-established Lean Startup Approach, performing a pivot – an adjustment "[…] designed to test a new fundamental hypothesis about the product, strategy, and engine of growth" [1] – is the standard method applied in this search process. In this research, we focus on one specific type of pivot: *technology pivots* in software startups. In his seminal work, Ries [1] conceptualizes technology pivots as a means to "[…] achiev[ing] the same solution by using a completely different technology". According to Ries, the decision to exercise a technology pivot is driven by the question of "[…] whether the new technology can provide superior price and/or performance compared to existing technology" [1]. Furthermore, according to Ries [1], technology pivots are

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supposedly sustaining innovation, that is, an incremental improvement that does not affect customer segments, value-capture model or channel partners.

The environments software startups operate in are dynamic, unpredictable, and even chaotic at times [2]. Throughout their search for a viable and scalable BM, they face the challenge of having to define their technological foundation whilst being uncertain about their future BM, and not knowing in which direction individual technologies will develop and what new technologies they will have to compete against [3, 4]. Given this highly changeable environment, we argue that the antecedents and consequences of technology pivots may go beyond what Ries [1] has conceptualized so far. The existence of further antecedents and consequences was already indicated in a study by Bajwa et al. [5] based on secondary data, in which the authors call for primary data studies to extend the existing knowledge base. Although technology is crucial for software startups, and their innovative products and services have a substantial impact on the global economy [6], surprisingly little effort has been made to theorize the role of technology in shaping entrepreneurial opportunities, actions, and outcomes [7]. To the best of our knowledge, no empirical study has yet elaborated on the antecedents and consequences of technology pivots. Hence, we posed the following research question: *What are the antecedents and consequences of technology pivots in software startups?*

In the absence of a sound theoretical basis that can be used to answer this question, we conduct an exploratory multiple-case study. The findings are presented in the form of a preliminary theoretical model consisting of antecedent and consequence categories. By so doing, this study provides empirical evidence for the interdependencies between technology, BM development and innovation in software startups [8].

2 Background

2.1 Software Startups & Business Models

In order to understand the concept of pivots and their importance to the success of many startups, we need to first understand what characterizes startups. Startups frequently operate in highly volatile markets and try to "[…] solve a problem where the solution isn't well known" [9]. They often are new organizations with no operational history searching for a "[…] scalable, repeatable, [and] profitable business model" [10]. A software startup, in the context of this study, mainly focuses on the implementation and deployment of innovative software-based products and services [6].

A BM describes "[…] how a firm organizes itself to create and distribute value in a profitable manner" [11], by "[…] outlin[ing] the architecture of revenues, costs, and profits associated with the business enterprise delivering that value" [12]. In the case of software startups this means that a BM captures the value created through software-based products and services, to obtain a match between technological innovation (value creation) and BM (value capturing), identified throughout BM development. Without a well-defined BM, startups fail to capture the value of technological innovation. In dynamic market environments, in which technologies constantly change, BMs are not stable [13]. Software startups with a viable and scalable BM often need to iterate their

existing BM because of evolving technologies, network positions or emerging competition [8, 12]. This process is called business model innovation (BMI). Using BMI, software startups react to "[…] major and unpredictable changes in the business environment" [14], which includes the "[…] discovery of a fundamentally different BM in an existing business" [15].

2.2 Lean Startup and Pivot

The Lean Startup approach encourages startups in environments of high uncertainty to develop their products and services iteratively [1, 10]. Its goal is to maximize the learning while keeping the resource investment efficient. To significantly change the development path based on learning, startups often exercise pivots [1, 5, 10]. Pivots are "[…] structured course corrections designed to test a new fundamental hypothesis about the product, business model, and engine of growth" [1]. Through fast iterations and "[…] by reducing the time between pivots, it is possible to increase the odds of success" [16]. However, Ries [1] also stated that the "[…] decision to pivot is so difficult that many companies fail to make it". Ries [1] initially presented ten different types of pivot that can appear in startups (e.g., product zoom-in, product zoom-out, technology). This list was confirmed and extended by Bajwa [17], who found three new pivot types. According to Ries' conceptualization [1], technology pivots help to "[…] achieve the same solution by using a completely different technology" in order to improve performance or reduce costs. This conceptualization, however, requires systematic and scientific validation. Yet, despite the acknowledged difficulty concerning the decision to pivot and the assumed importance of pivots in startup success, little theoretical and empirical knowledge exists about which antecedents lead up to technology pivots and what consequences result from them. This is especially surprising as Giardino et al. [18] found that "[…] thriving under technological uncertainty" is the number one challenge in software startups. Consequently, we argue that an empirically grounded understanding of the antecedents and consequences can lead to theory development explaining the circumstances under which it is beneficial to perform technology pivots and what to expect from them for product development, BM development and BMI, so that an increase in successful startups can be achieved.

3 Method

The phenomenon of pivots is a relatively new field of research [17]. To understand the antecedents and consequences of technology pivots in software startups, an explorative research approach is chosen. This study applies a qualitative research design performed in the form of an embedded inductive multi-case study, according to Yin [19].

3.1 Selection of the Case Studies

As we seek to explore the broad variety of antecedents underpinning the technology pivots performed in software startups, we selected software startups with B2C- and

B2B-BM from different focus industries. Our research sample contains 14 software startups (cf. Table 1) who completed one to three technology pivots. The authors could not identify any cases of discontinued technology pivots. We assigned pivot instances to life-cycle stages according to Kazanjian [20]. The cases were selected to achieve theoretical replication [19], with the aim of increasing the variance of antecedences and consequences of technology pivots across life-cycle stages [21].

Table 1. Overview of Case Study Participants

Name	*Type*	*Employees*	*Interviewee*	*Description of Technology Pivot(s)*	*Life-Cycle Stage*
ST0	B2C	450	CEO	(1) Replaced the core frontend framework of their SaaS product.	Commerc.
				(2) Shifted their focus to a mobile, instead of a desktop-based product.	Growth
ST1	B2C	270	VP Tech.	(1) Replaced their desktop-based product with a mobile-based product.	Growth
				(2) Replaced native mobile development with a cross-platform engine.	Stability
ST2	B2C	100	CEO	(1) Introduction of CRM system that includes core business logic.	Growth
				(2) Replacement of CRM system with self-made solution.	Growth
ST3	B2C	250	CTO	(1) Enhanced their core business logic with machine learning solution.	Stability
ST4	B2C	20	CEO	(1) Shifted their focus to a mobile, instead of a desktop-based product.	Growth
ST5	B2C	40	CTO	(1) Relocated extensive frontend logic into backend services.	Growth
				(2) Replaced the database and data storage logic of their SaaS product.	Growth
				(3) Replaced their mobile development framework.	Growth
ST6	B2B	15	CEO	(1) Replaced automation framework with a semi-manual approach.	Growth
ST7	B2B	50	CTO	(1) Replaced their client-server-architecture with a SaaS solution.	Concept. & Dev.
ST8	B2B	20	Dev. Lead	(1) Replaced their monolithic system architecture with micro-services.	Growth
ST9	B2B	10	CEO	(1) Replaced their architecture for data storage and data provisioning.	Commerc.
ST10	B2B	12	CTO	(1) Introduced a container-based architecture.	Commerc.
				(2) Replaced the core frontend framework of their SaaS product.	Commerc.
ST11	B2B	5	CTO	(1) Abandoned their mobile-based solution and created a BaaS solution.	Commerc.
ST12	B2B	15	CEO	(1) Replaced the core frontend framework of their SaaS product.	Concept. & Dev.
ST13	B2B	5	CEO	(1) Replaced their web-app solution with a mobile-based solution.	Commerc.

3.2 Data Collection

We relied on documents, recorded presentations and interviews as data sources. First, publicly available documents were collected. Then, to fully understand the nature of technology pivots, semi-structured interviews were conducted with senior managers who made the decision to perform a technology pivot. They were also able to observe at first hand the consequences that resulted from the technology pivot. In total, we conducted 14 interviews. The interviews covered four question blocks: (1) company growth path, (2) key (technological) pivot points, (3) antecedents for technology pivots, and (4) consequences observed after technology pivots. The interviews had an average length of 39 min (median 40 min) and were transcribed. To triangulate and enrich the interviews, case-specific documents consisting of internal presentations and public announcements (n = 9) as well as recorded public presentations (n = 4) were analyzed.

4 Data Analysis

The data analysis was performed according to Yin [19], based on the transcripts of the semi-structured interviews. An iterative approach to the data analysis and theory building using open, axial, and selective coding was chosen [22]. The coding was done in Atlas.ti 8. We systematically compared antecedents and consequences within and across cases using replication logic. In a cross-validation process with two academic colleagues, the core-concepts were iteratively refined in two separate one hour workshops and became more robust and reliable [19]. During selective coding, the main categories were identified and linked to core-concepts. We used pattern matching as the analysis technique [19]. This final step of theory building resulted in a model.

5 Findings

Based on the identified antecedents and consequences of technology pivots, a preliminary theoretical model was created (cf. Figure 1). The model also shows the

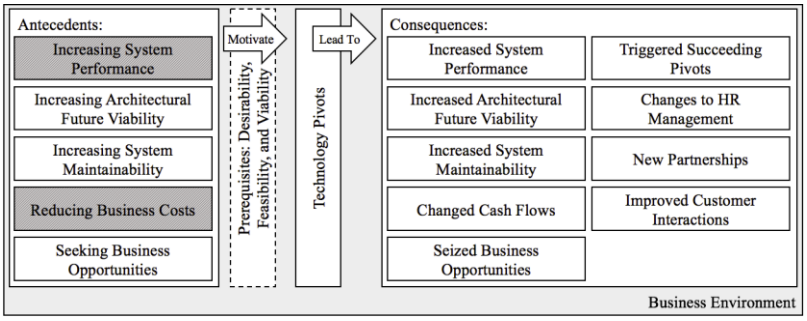


Figure 1. Preliminary Model of Antecedents and Consequences of Technology Pivots[1]

[1] A detailed version can be found online: https://goo.gl/G6VDYm

three identified prerequisites preceding the performance of technology pivots.

5.1 Antecedents of Technology Pivots

The identified antecedents of technology pivots were grouped into five distinctive categories. The first three categories (1-3) are related to the technology level, while the two remaining are focused on financial (4) or strategic aspects (5). The two antecedent categories shaded in grey were previously conceptualized by Ries [1]. It was found that technology pivots can be motivated by individual or multiple antecedents.

Increasing System Performance (1). For software products, system performance [23] is an essential quality attribute [24]. Depending on the chosen technology stack and implementation approach, performance can fluctuate quite substantially. Several study participants experienced this issue, which motivated them to exercise technology pivots ("[…] a powerful impetus was reaching performance limits" (ST12) [2]). The resulting fluctuation in system performance led to negative customer feedback, which further motivated the study participants to increase their system performance ("We received feedback that our system was not stable and responded slowly" (ST9)). Performance considerations included stability and resolving issues customers experienced from bugs. In other cases (ST5 and ST10), limited system performance constrained the implementation of new functionality, as stated by ST10, "[…] we knew that a certain set of features is only feasible with a significantly higher performance".

Increasing Architectural Future Viability (2). Some study participants were concerned about the future viability of their architectural design [23]. First, this was expressed through the pursuit of increasing internal software quality (ST12), as well as by applying technological standards as soon as they emerged (ST7). ST10 added that when they saw that a technology "[…] represents what people will use in the future" it made sense for them to pivot in this direction. Second, future viability was pursued by avoiding technological obsolescence of internal systems, through pivoting to more viable options (ST0 and ST1). Third, choice errors made earlier in the implementation and system architecture were adjusted through technology pivots, which further increased future viability (ST 5). Fourth, when internally developed solutions "[…] could not compete with external solutions for the required business value which was needed very close in time" (ST10), motivation to exercise a technology pivot increased.

Increasing System Maintainability (3). Due to the nature of software startups, where decisions are made frequently and are fast-paced, implementation can be sub-optimal. As a result, system maintainability [23] can become a pressing issue. Some study participants reached a point where their systems became unmaintainable internally ("[…] considerable bottlenecks emerged. There were a few people that knew the implementation inside out, but when they were not available, development stopped" (ST8)). Furthermore, new staff needed considerable time to be inducted, and functionality was not verifiable, which led to unexpected system behaviors. In order to

[2] All quotes were translated by the authors for interviews not conducted in English.

increase the manageability of their architectural design, complexity reductions were frequently desired, and "[…] it became clear to us that the fewer technologies we are using, the better" (ST0). At the same time, they attempted to reduce knowledge silos and to increase their team's overall understanding of the systems (ST8 and ST9).

Reducing Business Costs (4). For software startups with little to no profits, business costs are challenging ("You always have to consider carefully how you can realize things in order to reduce costs" (ST5)). Business costs include both fixed and variable development and operational costs. For ST9, due to their implementation approach, the operational costs rose to a level equal to their revenues, making a technology pivot inevitable. For ST10, the high level of development costs hindered any further business growth. In order to account for a high level of business costs, the study participants exercised technology pivots by either implementing 3rd party solutions, which reduced internal development efforts or by developing enhanced home-made solutions, reviewing their product's technology needs.

Seeking Business Opportunities (5). As a result of the flexibility of their products and internal agility, pursuing new business opportunities is not uncommon for software startups [17]. Business opportunity recognition describes the "[…] alertness to changed conditions or to overlooked possibilities" [25]. ST5 stated "[…] we see ourselves as a growth-company, and we expected this technology to become a massive topic, that's why we wanted to be part of this opportunity right from the beginning" (ST5). It was observed that strategy changes, caused by the available business opportunities, can go hand-in-hand with subsequently necessary technology pivots being performed (ST1, ST4, and ST10). These cases represent instances of pivots appearing in groups, as first identified by Terho et al. [26]. In other cases, as a result of their learning through the Lean Startup approach, the study participants changed their targeted customer segments (i.e., exercise of a *customer-segment pivot*). This made it necessary to exercise a subsequent technology pivot to reach the new customer segments (ST11 and ST13).

5.2 Prerequisites for Technology Pivots

Before the study participants exercised technology pivots, the following prerequisites needed to be fulfilled: (1) desirability, (2) feasibility, and (3) viability [27, 28]. As a first threshold, there need to be sufficient antecedents which confirm the desirability of a technology pivot. Subsequently, feasibility and viability are validated. Feasibility describes the skill and knowledge-based ability to implement technological changes. For this, the study participants utilized proof-of-concepts. Viability describes the possibility to successfully exercise a pivot based on the prevailing resources (e.g., HR, time, and money) and circumstances (e.g., roadmap). The participants estimated the required resources and made roadmap changes before performing technology pivots.

5.3 Consequences of Technology Pivots

The identified consequences of technology pivots were grouped into nine distinctive categories. The first three cover the technology level (1-3) and could be directly related to the following antecedent categories: increasing system performance, future viability,

and maintainability. The subsequent two categories (4-5) appertained to reducing business costs and seeking business opportunities, respectively. However, the observed effects are ambiguous. The latter four consequence categories (6-9) affect different aspects of the BM [29] and were not assignable directly to any antecedent categories.

Increased System Performance (1). The study participants who aimed for an increase in system performance stated that performance goals were reached. ST9 stated "[…] customers were receiving their request results within milliseconds, which was a massive performance increase" and ST5 said that "[…] the improved performance was immediately visible to the customer". In retrospect, ST1 stated that "the change, especially when looking back over the last years, certainly had positive impact on the performance". Improved performance aspects mentioned included stability, response time, computing power, and availability, resulting in a considerably better user experience and reduced negative customer feedback.

Increased Architectural Future Viability (2). The study participants perceived an increase in future viability for two reasons. First, the new architectural design supported the long-term product vision (ST1 and ST9). ST9 stated that "we always considered our long-term vision and what technology stack would be needed for it; more importantly, how we can get from our MVP to that long-term vision". Second, the new system architecture appeared to provide long-term future manageability (ST0 and ST3).

Increased System Maintainability (3). The study participants perceived that technology pivots had direct impact on the software development efficiency within their business ("[…] the whole implementation process is a lot faster now" (ST11). Moreover, it increased system as well as code maintainability ("[…] we gained more control about what happens to the end-user" (ST8)). Also, additional functionality became implementable through the opportunities of the new technology ("[…] we can implement functionality, which we could not implement before, which makes our customers happy" (ST8)).

Changed Cash Flows (4). In contrast to the obvious motivation to reduce costs (cf. Section 5.1), the actual consequences on cash flows are ambiguous. Both the cost structure and revenue streams were affected by technology pivots. While in some cases (e.g. ST5, ST9, and ST11) operational and development costs were reduced, in other cases, costs increased (e.g. ST0 and ST1). ST5 managed to "[…] reduce deployment times from hours to seconds, which implied drastically lower costs of change". However, for ST1 business costs increased because of additionally required HR ("[…] we needed special experts with new engineering skills" (ST1)) and licenses ("[…] a financial investment to get the right package" (ST1)). While technology pivots generally led to increased revenues, ST0 and ST1 then had to pay certain shares of their revenues to key partners ("[…] we implemented a revenue-share-deal" (ST0)). Furthermore, revenues were no longer received from clients directly but from platform providers.

Seized Business Opportunities (5). Through technology pivots, study participants were enabled to validate further BM hypotheses ("New configurations of our business model became easier to validate" (ST4)). Furthermore, new business opportunities were enabled and utilized through technological pivots; as stated by ST1 "[…] there was a

massive spirit of optimism in this new market. During our launch, the growth potential became visible very quickly".

Triggered Succeeding Pivots (6). The changes introduced through technology pivots triggered the necessity or desirability of additional pivots of different types [26]. For example, new customer segments resulted in a subsequent *customer-segment pivot* (ST0, ST1, and ST11), at times surprising study participants ("It was a bit of a surprise that we reached them, because initially we aimed for another group of customers" ST7).

Changes to HR Management (7). Study participants reported a change in HR management in three aspects. First, they adapted their HR requirements in terms of number of employees, skills, and expert knowledge ("[…] we had a much bigger team before [the pivot]" (ST11)). Through the newly required skills, knowledge transitions for existing employees became necessary ("[…] a critical problem was that engineers did not know the new technology yet. Thus, they needed to invest time to learn it" (ST11)). Second, with regards to hiring opportunities, it was stated that "[…] it is a lot easier to find engineers now […] and especially engineers with the same mindset" (ST8). As a result of a better technological foundation, new employees were able to "get started a lot faster" (ST8). Third, study participants noted greater employee satisfaction a result of less complexity and better manageability; as stated by ST10 "[…] we received the feedback from our employees that work is a lot more fun now", because "[…] you are less scared to break things, which increases satisfaction".

New Partnerships (8). As part of performing technology pivots, our study participants established new partnerships and collaborations. These could be active, newly established partnership contracts, or passive, through engagement with the open source community. As stated by ST0 "[…] suddenly, we had new partnerships that needed to be managed". These partnerships then required time ("[…] you need to make time for your partners and they need to make time for you" (ST1)). This required an unexpected effort for the study participants. Through new partnerships, "[…] new dependencies were created" (ST6) that could not easily be resolved. ST1 stated that "[…] it would be possible to do a technological switch to resolve the partnership but it would be difficult to do this from one day to the next". Furthermore, collaborations with the open source community were established by "[…] publishing a large part of our product as open source" (ST10).

Improved Customer Interactions (9). We found that technology pivots resulted in improved customer interactions changes in two ways. First, new distribution channels became available and were added to the BM ("[…] the Appstore was super exciting for us because it was a new channel that allowed to grow easily" (ST1). Second, the way the study participants interacted with their customers changed. In regards to their new SaaS BM ST7 stated that "[…] the amount of self-service is much higher" and ST1 that their customer communication was moved to a new CRM tool that became necessary.

5.4 Business Environment Complications

Within the internal business environments in which technology pivots are exercised, we observed three complications. First, we found that exercising technology pivots can lead to an increased friction between stakeholders (e.g., between management and

employees). This results from disagreements about the necessity of technology pivots and frustration while performing them. “The consequence we saw internally was a high level of frustration” (ST6) as “[…] there were a lot of discussions in which direction we are going” (ST11). This then resulted in “[…] losing momentum as a team […] that you need to rebuild” (ST11). This increase in friction was not anticipated by the study participants who exercised their first pivot. Second, exercising technology pivots creates considerable management overheads on the project at people management level as well as on a technical level. Third, the completion of technology pivots often took more time than expected (“We underestimated the complexity and how long we will end up working on it until it works” (ST4)).

6 Conclusion

6.1 Implications for Theory

Our study results in a preliminary theoretical model that considerably extends the knowledge on the role of technology pivots in software startups. It identifies a list of antecedents of technology pivots that empirically confirms the conceptualizations made by Ries [1] and extends them by adding new antecedent categories. Additionally, it identifies a list of consequences resulting from technology pivots. Empirical evidence also shown that three prerequisites need to be fulfilled before software startups perform technology pivots: (1) desirability, (2) feasibility, and (3) viability.

We have illustrated that technology pivots go beyond incremental changes and describe rapid adaptations of core technology parts with a high level of BM impact. They are an important means of course correction for software startups during their search for a viable and scalable BM [9]. Furthermore, our results show that pursuing new business opportunities and thus, changing business strategies, is linked to exercising technology pivots and adapting BM components (cf. Section 5.1). As we have shown, software startups introduce technological innovation to markets through technology pivots. Our findings contribute to the understanding of BMI in strategic entrepreneurship, which focusses on BMI as a means to exploring and exploiting opportunities within an external environment [30, 31]. Our findings enhance the understanding of the relation between business strategy, BM, and technology [29, 32]. Moreover, we have shown that technology pivots have considerable impact on the internal business environment (cf. Section 5.4). Our findings support the development of comprehensive theories in the domain of BM development and BMI about the role of technology pivots for future startups.

6.2 Practical Implications

Our findings carry important implications for practice. First, software startups need to identify at what life-cycle stage technology pivots become essential for them to reach strategic, financial or technical goals, e.g., to reach alignment between their technological foundation, business strategy and BM. Failing to identify the need to

pivot can substantially decrease the odds of startup success. Second, technology pivots can support software startups in exercising BMI within markets in which technology is constantly changing [13]. Third, software startups need to check if they fulfill the prerequisites when considering technology pivots. Fourth, software startups need to be aware of the consequences that can result from performing technology pivots. Finally, these considerations also need to include reflections about complications being created within the internal business environment in which technology pivots are performed.

6.3 Limitations & Avenues for Future Research

Our research has certain limitations. First, the cases included in this study all completed their exercised technology pivots. Thus, the antecedents and consequences might not represent a comprehensive list of all antecedents and consequences of technology validity is limited and needs to be confirmed in a quantitative study. Third, data triangulation via internal documents was not possible to the desired extent as decisions were often made based on the results of internal discussions.

Future research can extend our findings in at least two promising directions. First, future research should quantify the business performance impact of technology pivots on software startups [8]. Second, future research could further increase the understanding of pivots as facilitating BM development and BMI.

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Digital Business Engineering: Findings from the Install4Schenker case

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Abstract. The development of digital business models is a key field of research in the age of digitization. As companies embark on the journey to develop digital business models, the need for a methodology which supports their journey is imminent. This paper contributes to sharpening the methodological foundation of Digital Business Engineering by conducting a single case study exemplified by Install4Schenker. Install4Schenker is a digital service coordinating, controlling and validating external craftsmen with the goal of avoiding two-men-handling while delivering products requiring installation such as heaters. Based on this case study, this paper aims to identify the potential for further research, optimizations, and clarifications for the Digital Business Engineering methodology.

Keywords: Digital Business Engineering, Digitization, Logistics, Business Engineering, Case Study.

1 Introduction

Concepts of business model research have gained increasing attention in information systems research [1], e.g., in prestigious journals [2]. The most of the business model conceptualizations address vital aspects such as value proposition, value creation, and revenue model [3]. Prominent examples are the Business Model Ontology (better known as Business Model Canvas) [4, 5] and the Business Model Navigator [6]. Emerging and existing technological innovations stemming from digitization pose disruptive change for business models [7]. The disruptive character of such innovation affects critical infrastructure, social structure, markets and more, which puts increasing pressure on traditional business models [8]. Even though there exists research on digital business models (e.g., see [9–12]), there is a lack of methodological assistance in their design [13].

Otto et al. propose Digital Business Engineering as a method for designing digital business models [13]. Digital business models take explicitly into account the conditions set by digitization in representing the inherent business logic [14]. As of now, Digital Business Engineering consists of method fragments, which have rarely

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been applied as a holistic method [13]. Through the application of the method in the environment of the use case Install4Schenker, the authors analyze its suitability and its purposefulness regarding the development of digital services. For this reason, the authors convey the development process of Install4Schenker utilizing the Digital Business Engineering method.

The paper is organized as follows. Chapter 2 introduces the engineering approach to the development of business models, namely Business Engineering. Lastly, this chapter introduces Digital Business Engineering, exploring its methodological fragments and its objective. Chapter 3 specifies the research design of this paper. Further, the authors introduce the problem at hand, two-men-handling, and the Install4Schenker use case. Following, Chapter 4 documents the application of Digital Business Engineering onto the problem leading up to the authors reasoning their propositions for enhancements and extensions for the method. Chapter 5 summarizes the research that was conducted and gives an outlook as to further potentials for research into Digital Business Engineering.

2 Background

2.1 Business Engineering

The primary goal of Business Engineering is to assist companies in conducting professional and fruitful transformation processes while developing new business models and products. This includes restructuring of organizational structures, processes, and habits regarding technical as well as human resources [15]. Business Engineering represents the construction gauge of business models [16]. The goal of Business Engineering is to generate business models as professional and logical fragmented as highly sophisticated products such as planes [17]. This is achieved, at its core, by using methods, which makes the work-process repeatable and plannable [18]. The connotation of the construction of business models in an engineering manner is not uniformly defined in the literature [19]. In literature, the general context of using methods and models is prominently associated with engineering. At its core, engineering practice is a design-oriented approach, which utilizes methods of Design Science Research [20], such as case studies or laboratory experiments, for developing knowledge [19].

A multitude of approaches to Business Engineering has developed over the last years [21–24]. Examples of this are Multiperspective Enterprise Modeling (MEMO) [25], Semantic Object Model (SOM) [26] or the Architecture for Integrated Information Systems (ARIS) [27]. While these approaches assist the user in modeling and structuring organizational processes, none of them takes explicitly into account conditions set by digitization.

2.2 Digital Business Engineering

Digital Business Engineering is a method being developed at the Fraunhofer Institute for Software and Systems Engineering [28] and the Center of Excellence for Logistics

and IT (Leistungszentrum Logistik und IT), from which this paper originates [29]. The method aims towards assisting enterprises in the development of digital business solutions and follows the design principles of Method Engineering. Method Engineering conceptualizes components of methods into activities (What is to be done?), deliverables (What is the result of the activity?), techniques (How is the result produced?), roles (Which roles are involved?), and meta-models [30]. Figure 1 depicts the Digital Business Engineering methodology.

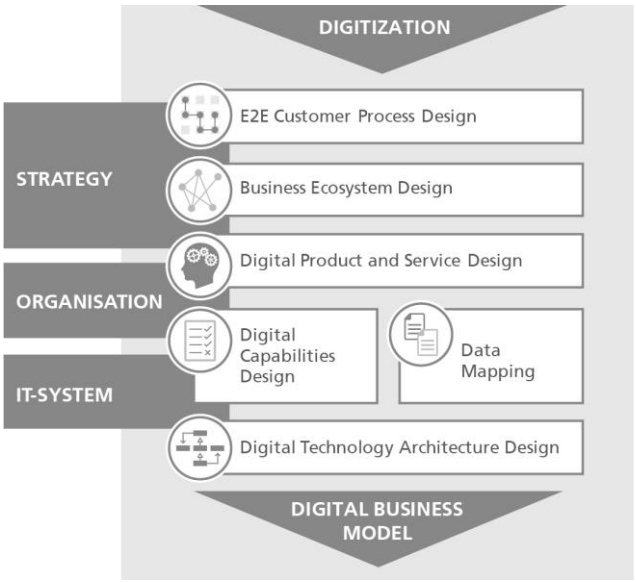


Figure 1. Digital Business Engineering Methodology [13, 31]

As of the current state of development, Digital Business Engineering consists of six activities, integrated into three design layers. The three design layers stem from Business Engineering and provide a Top-Down approach to subdividing the makings of an enterprise. The three design layers are Strategy, Organisation, and IT-System.

The ultimate starting point of Digital Business Engineering is End-to-End Customer Process Design. The activity aims to acquire knowledge about the future customer process, starting with the client being aware of a product and building a desire up until the fulfillment of the desire [32].

As a result of the gathered understanding of the End-to-End Customer Process, the activity Business Ecosystem Design provides tools such as network analysis for identifying possible competition, partners or actors in the value creation network. Depending on the case-specific requirements, techniques such as SWOT-Analysis can be applied to investigates one's market position [33].

The activity Digital Product and Service Design aims at developing digital services and products. Techniques such as Design Thinking or Business Model Canvas guide and assist the creativity and development process leading to innovative digital goods and services.

Digital Capabilities Design identifies and maps capabilities required for the development of digital products or services. The approach to identifying capabilities is of a holistic nature, in which it is not limited to taking into account digital capabilities, but capabilities of all organizational areas. Concenputalizations of capabilities are, e.g., dynamic capabilities and data management capabilities [14].

Further, the activity Data Mapping outlines the required data and data sources. Among other sources, this activity sub-divides and structures data in, e.g., internal and external data, while also providing room for appending additional data taxonomies. Finally, the last activity is Digital Technology Architecture Design, which conceptualizes data streams and individual components of the technology architecture.

3 Research Design

3.1 Case Study Research

The development process of Digital Business Engineering is based on the Design Science Research (DSR) methodology as proposed by Peffers et al. The design science research process consists of six activities, namely, *identify problem & motivation*, *define objectives of a solution*, *design & development*, *demonstration*, *evaluation*, and *communication* [34]. This publication builds upon the DSR results stemming from Otto et al. providing us with the current state of the Digital Business Engineering methodology [13]. The authors continue the DSR process with activity 4 Demonstration and activity 5 Evaluation for the method at hand. Demonstration entails finding a suitable environment to apply the artifact. For this, the authors chose to demonstrate the development of Install4Schenker as a single case study. Utilizing a single case provides an opportunity for intensive analysis of the given case [35]. With Install4Schenker, the authors can demonstrate the complete application of the method. Further, the activity Evaluation strives to analyze how well a solution is suited to solve a specific problem. Lastly, by the publication of this paper, the authors also conduct activity 6 Communication. The authors chose to utilize Install4Schenker because this project entails various requirements and conditions, as they are typical for the design of a digital business model. The solution requires the definition of a digital ecosystem, the development of a digital platform, is a data-driven approach and provides a digital service [36]. Thus, this project offers high value regarding the usability for further use-cases.

In literature, there is much discussion on the validity and generalizability of outcomes of single case studies [37]. Still, various rationales for conducting single case studies exist, e.g., if the conducted case studies is the starting point for more case studies to come [38]. Further, the basis for generalization of the results from single case studies is not based on statistical results, but on analysis and reasoning [39]. Even though, the previous rationales apply to the present case study, analyzing a single case in-depth to further scientific development and generate comprehensive understanding is valid on its merit [40].

3.2 Install4Schenker

Products, such as electric stoves or heaters require professional installation. Two employees, one driver, and one professional craftsman deliver and install the product. This process is called two-men-handling.

Developing a service covering this process was one of the goals of the DB Schenker Enterprise Lab for Logistics and Digitization at the Fraunhofer Institute for Material Flow and Logistics, under cooperation with the Fraunhofer Institute for Software and Systems Engineering. Under the premise that large cities have a heterogeneous profile of customers, i.e., customers purchasing a vast variety of different products, it became known that the two-men-handling process is inefficient. Every delivery of, e.g., a bathtub or electric stove would require differently specialized craftsmen. Additionally, while the specialist would install the product, the driver would be waiting in the vehicle.

The Install4Schenker digital service provides a solution for this problem. Instead of utilizing in-house craftsmen, the platform coordinates delivery and installation between in-house drivers and external craftsmen. A mobile application handles the communication between the platform and the craftsmen.

The following chapters showcase the development process of the Install4Schenker digital service by utilizing Digital Business Engineering. The authors investigate, whether Digital Business Engineering provides a suitable method for assisting users in engineering a solution like Install4Schenker.

4 Developing Install4Schenker with Digital Business Engineering

4.1 End-to-End Customer Process Design

From the perspective of DB Schenker, retailers make up the body of the customer segment. The authors aim to investigate the complete end-to-end customer process and thus consider the whole process of buying a product up to its delivery and installation. Henceforth, we differentiate between the customer (retailer) and the end-customer (consumer).

The end-to-end customer's journey starts with an end-customer realizing his desire or need to buy a product, which requires installation. The end-customer uses different channels such as the internet or print to gain information about the product. He further purchases the delivery and installation service with a retailer and thus awaits the delivery of the product. The end-customer's desire lies solely in acquiring a product and the installation service as well as to receive the service comfortably, i.e., at his desired point of time.

Initially, the end-customer informs himself about a product, which satisfies his desire, e.g., to buy new furniture via the different channels. Once the end-customer reaches a decision, he purchases the product online or at a store. The retailer receives the order and triggers the installation and delivery process with DB Schenker. From the customer's point of view, the next interaction takes place once the product is delivered

and installed. The end-customer does not have any insight regarding how DB Schenker provides the service. Figure 2 visualizes the customer process as a service blueprint.

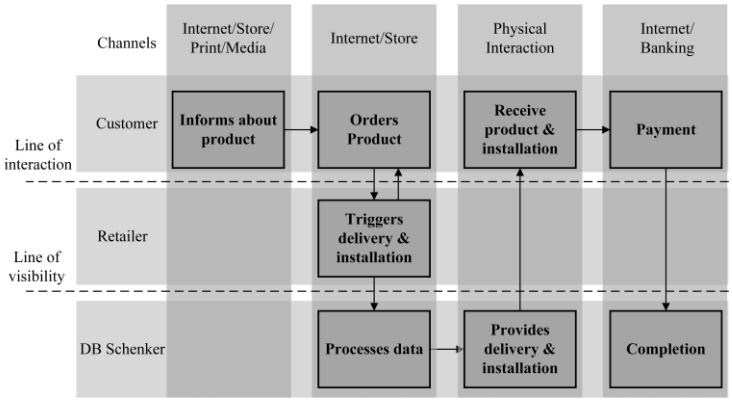


Figure 2. Excerpt of the customer journey depicted as a service blueprint.

4.2 Business Ecosystem Design

The realization of Install4Schenker requires different actors in the value creation ecosystem. The authors determine the following players in the ecosystem: Customer, Retailer, Service Provider (DB Schenker), Craftsmen, and Driver. Between those actors, different activities and information flow takes place.

Further, the authors apply techniques of network analysis to identify possible patterns, as well as critical nodes in the graph. Measures, such as Betweenness Centrality, are indicators of the importance of a node in regards to the overall network [41]. Figure 3 shows the resulting business ecosystem. The scaling of the nodes indicates the betweenness, i.e., the significance. Based on the network analysis, both the Consumer and DB Schenker are the most critical parties in the network.

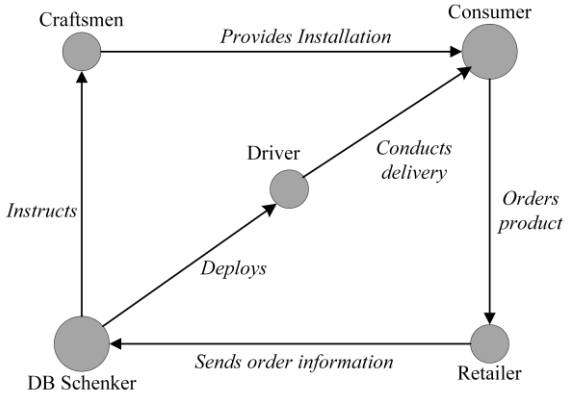


Figure 3. Graph representation of the business ecosystem. Each node represents an actor.

4.3 Digital Product and Service Design

Based on the initial problem of DB Schenker to provide delivery and installation services while utilizing only one driver, the authors developed the following solution. Instead of using in-house craftsmen, the authors implement a digital platform coordinating drivers with external craftsmen. The digital platform offers various potentials such as utilizing network effects, scalability and laying a basis for future additional revenue models. For example, at a later point, the platform could be extended to service additional industry sectors.

Figure 4 shows the operation of Install4Schenker in context of the provision of the delivery and installation service. The retailer triggers the installation and delivery service with the logistics service provider DB Schenker. The platform integrates order information as provided by the retailer. The platform triggers delivery by instructing a driver and feeds job information into the mobile application acting as an interface for the craftsmen. Both driver and craftsmen arrive simultaneously at the targeted destination. From this point, the driver delivers the product to the end-customer's doorstep and his responsibilities end. The platform provides a multitude of functions, e.g., the coordination and distribution of jobs, processing customer evaluation of the job, validating the craftsmen's certifications, and provide geographical information for each task.

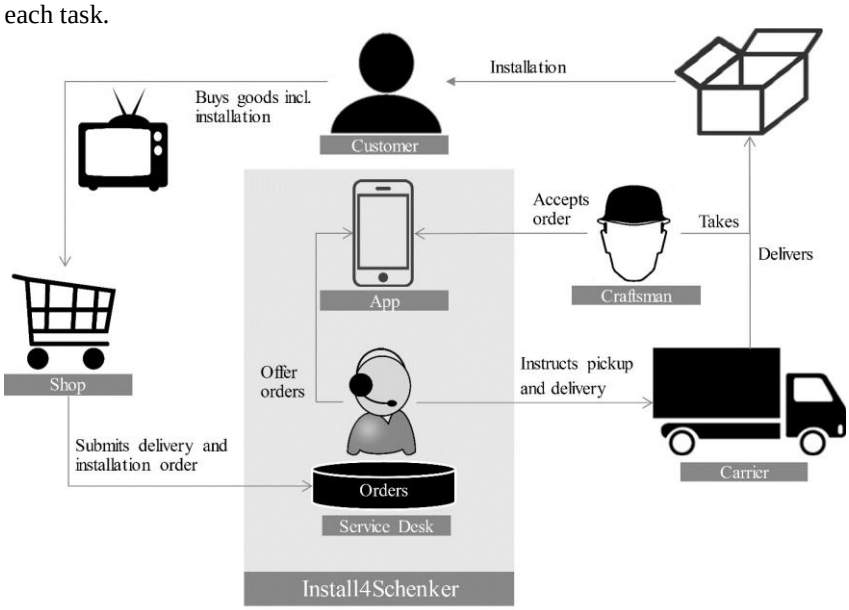


Figure 4. The future customer process for Install4Schenker

The authors further utilized the Business Model Canvas to fulfill requirements of a business model such as value proposition, revenue streams or cost structure. This step takes into account, e.g., resulting costs like development, maintenance, and operating expenses.

4.4 Digital Capabilities Design

Based on the previous steps the authors derive digital capabilities required for the realization of Install4Schenker. The authors chose to follow the capability reference model for dynamic and data management capabilities as proposed by Bärenfänger et al. and apply the framework to the use case [14]. Based on the reference model the authors outlined capabilities required for designing a digital service and needed for the realization of Install4Schenker. Figure 5 shows data management capabilities. Both the capabilities and the relevant data were worked out in a workshop setting by three researchers from the Fraunhofer ISST and the Technical University of Dortmund.

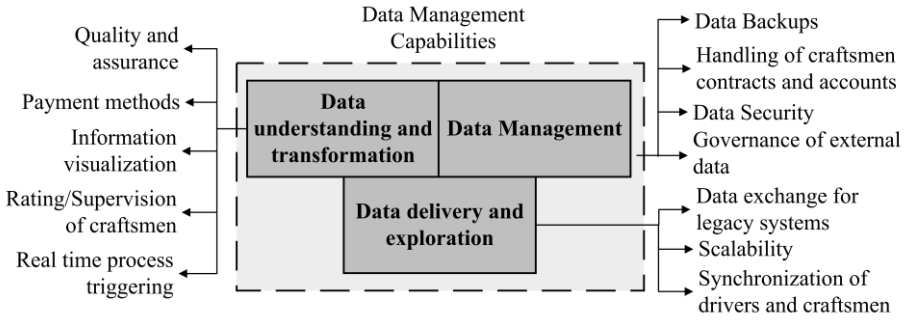


Figure 5. Capabilities as proposed by Bärenfänger et al. [14] for Install4Schenker

4.5 Data Mapping

Further, the authors analyzed the required data and data sources. The data structure divides twofold, into internal data on the one hand and external data on the other. Internal data contains information about the drivers, their location and job status. Further, data about the statistics, i.e., quality measurement of completed jobs, or feedback and TMS (Tour Management System) information accumulate internally. Information about orders provided by the retailer or the customer is integrated from external sources. Also, craftsmen need to provide certificates as well as payment information and personal data. Figure 6 indicates an excerpt of occurring data.

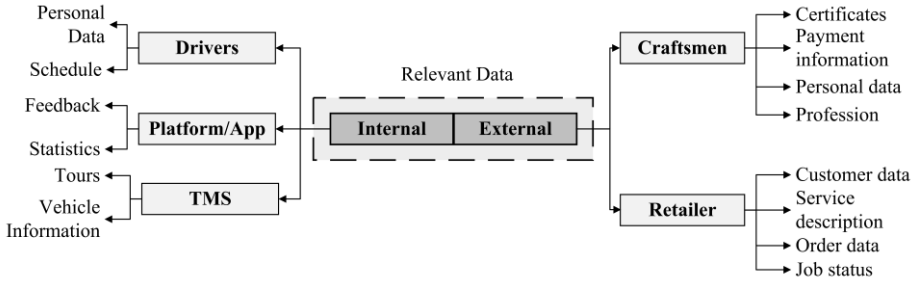


Figure 6. Excerpt of required data and data sources for Install4Schenker

4.6 Digital Technology Architecture Design

Figure 7 shows a conceptual representation of the technology architecture underlying the Install4Schenker digital platform. The data management system PostgreSQL provides order information and feeds it to the server using an Application Programming Interface (API). Via the internet, the platform exchanges data between the server, the service desk, and mobile devices. A browser application and a mobile application provide user interfaces, for drivers and craftsmen respectively. Figure 7 depicts the conceptual technology architecture. The level of detail of the digital technology architecture depends on the requirements set by each case.

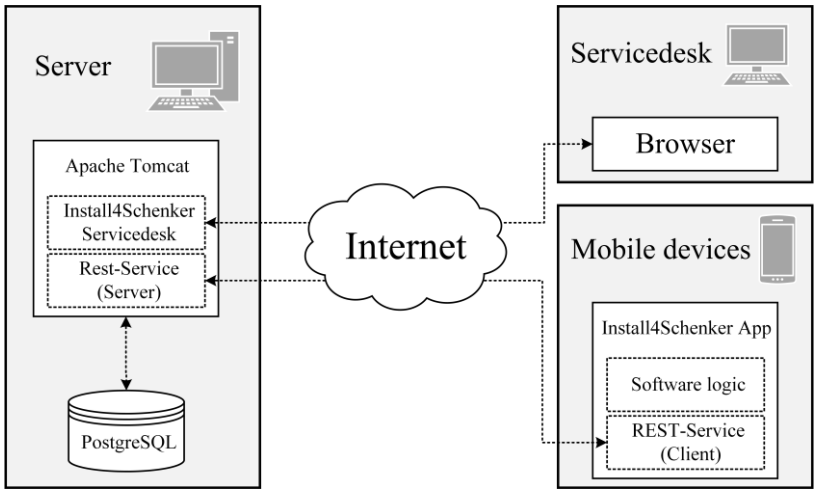


Figure 7. Conceptualization of the digital technology architecture of Install4Schenker

5 Discussion and outlook

In this paper, the authors aimed towards showcasing the development process of the Install4Schenker digital service and identifying possibilities for further research regarding the Digital Business Engineering method. At this point, the authors can conclude that Digital Business Engineering provides a practical blueprint for the development of a conceptual digital business solution.

The activities End-to-End Customer Process Design and Business Ecosystem Design provide a clear picture of the future customer process and the corresponding business ecosystem. As identified, there is no need for further research. Digital Product & Service Design operates with generalized techniques for product and service development. At this point, the development or implementation of solution-specific (e.g., for platforms) techniques is advised. In the activity Digital Capability Design, the authors implemented the capability reference model as proposed by Bärenfänger et al. [14]. Still, there is additional potential for considering dynamic capabilities. The activities Data Mapping and Digital Technology Architecture Design result in a

conceptual representation of data and the technology architecture. At this point, the authors propose contextualization of both activities to get a clear picture of their correlation. Further, based on the scenario of application, Data Mapping, as well as Digital Technology Architecture Design, need situational techniques assisting the development of more detailed deliverables. Table 1 summarizes the conducted case study and points for future research.

Table 1. Summary of the techniques used to develop Install4Schenker

Activity	Deliverable	Technique	Future Work
E2E-Customer Process Design	Future Customer Process	Service Blueprint	-
Business Ecosystem Design	Actors in the value creation network	Network Analysis	-
Digital Product & Service Design	Concept of digital products or services	Business Model Canvas	Implementation of case-specific techniques (e.g., Platform Business Model Canvas)
Digital Capabilities Design	Overview of required capabilities	Capability Reference Model	Further implementation of the capability reference model
Data Mapping	Overview of data and data sources	Data Mapping	Contextualization of data with capabilities and technology architecture
Digital Technology Architecture Design	The concept of the digital technology architecture	Digital Architecture Design	Contextualization of data and technology architecture

Additionally, general points of interest for further research were identified. Firstly, the generated deliverables for each activity require methodological contextualization. Method Engineering provides the concept of a meta-model acting as a blueprint for the method, which serves this purpose [30]. Secondly, further application of Digital Business Engineering in case studies and workshops in both academia and practice is imporant for further development of the method. Thirdly, a toolset providing tools for different scenarios and guidance towards their usage is needed.

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When Local Praise Becomes Cheap Talk – Analyzing the Relationship between Reviewer Location and Usefulness of Online Reviews

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Abstract. With a growing number of online reviews, it becomes increasingly important for customers and online review platforms to find groups of reviewers who write useful reviews. Customers who review local offline businesses such as restaurants can identify themselves as locals or travelers and thus implicitly assign themselves to a specific reviewer group. This study investigates the relationship between identifying as a local and the perceived usefulness of their online reviews. Using data from Yelp.com, we empirically test hypotheses derived from attribution theory. Our results suggest that neutral and negative reviews by locals tend to be perceived as more useful than reviews by travelers. Positive reviews by locals, however, are not perceived as more useful. These findings provide significant practical implications for online review platforms and local offline businesses.

Keywords: Online Reviews, Geographic Location, Causal Attribution

1 Introduction

Online review systems represent a core component of today's e-commerce landscape. Consumers increasingly support their decision-making process using reviews published by previous consumers [1]. While aggregated measures such as the average rating or total number of all reviews facilitate consumers' search for businesses [1], single reviews, and the textual content in particular, can also contain valuable information. Faced with the growing amount of online reviews which can complicate the searching process and actually increase search costs, online review systems aim to reduce the information asymmetry and search costs for consumers. For this reason online review systems frequently offer the option to vote for a review as being useful/helpful to indicate whether the textual information in a review is particularly valuable. Other users can then observe the number of votes and focus on useful reviews which reduces the effort they need to invest in the search process. This, in turn, means that online review platforms and customers need to identify characteristics of useful reviews or reviewers.

Research suggests that reviewer characteristics significantly influence perceptions of usefulness [2, 3]. For instance, if a reviewer has provided her real geographical location, her reviews are perceived as more useful [3]. For local offline businesses, e.g.,

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restaurants, the information on the geographic (home) location of a reviewer can distinguish locals from travelers. Intuitively, this information can be a signal for being knowledgeable about a location. Nevertheless, no research has so far investigated whether reviews by locals are more valuable to readers than reviews by travelers. To this end, we aim to answer the following research question:
Are there systematic differences between the perceived usefulness of reviews written by locals and the perceived usefulness of reviews written by travelers?

We develop empirically testable hypotheses based on attribution theory (e.g., [4]) and the discounting principle [5]. To test our hypotheses, we use a comprehensive data set containing restaurant reviews from Yelp.com. Our results suggest that being a local is indeed associated with an increase in perceived usefulness of a review. Interestingly, we find this increase only for neutral and negative reviews written by locals but not for positive ones and attribute this finding to the discounting principle. Thus, we contribute to existing research by examining the impact of geographical location as a reviewer characteristic and by explaining a part of the negativity bias (e.g., [6]), which is often discussed in this stream of literature. In the conclusion, we discuss practical implications for online review platforms and businesses.

2 Related Literature

Research on the perceived usefulness of online reviews has mainly focused on two features, namely review characteristics and reviewer characteristics [7]. Review characteristics consist of the review's text and its associated rating. For instance, reviews with a negative rating are perceived as more useful than those with a positive rating because readers attribute positive ratings to the reviewer's personal reasons, which is referred to as negativity bias (e.g., [6]). Review texts, which contain cues that indicate a short time period between consumption and publication of the review for example, lead to a higher perceived usefulness for reviews with a positive rating and to a lower perceived usefulness for reviews with a negative rating [6].

The characteristics of the reviewer also affect perceptions of usefulness. Characteristics that are directly observable to the reader can enhance or weaken the reviewer's credibility. The disclosure of personal information (e.g., real name, hobbies, location) or badges awarded by the platform (e.g., Amazon's top reviewer badge) make the reviewer more credible and thus increase perceived usefulness [2, 3]. It has been shown in an experimental setup that sharing the same geographical location as the reader creates a common ground and increases perceived usefulness as well [8]. There also exists experimental evidence that, regardless of being a local or a traveler, exhibiting local knowledge in one's review text is associated with an increase in perceived usefulness [9].

However, to the best of our knowledge, there is no research yet that has analyzed home locations of reviewers and explored the relationship between being a local, review valence and perceived usefulness. We contribute to the literature on reviewer

characteristics by investigating how the visible home location of a reviewer affects the perceived usefulness of her reviews for local offline businesses.

3 Theoretical Background and Hypotheses

The influence of being a local on the perceived usefulness of a customer's reviews is twofold. First, having experienced different businesses in the vicinity, one can convey local knowledge through the review's text. Such individuals can be referred to as market mavens [10]. Market mavens possess valuable information on the market, are willing to provide others with this information and can be identified reliably by other customers [10]. Second, by revealing her geographical location (i.e., place of residence), a reviewer can easily indicate whether she is a local or a traveler. Depending on the online review system, readers of the review can then either directly observe the reviewer's location, as in the case of Yelp, or find it on the reviewer's profile, as in the case of Airbnb. Observing the reviewer's location may change the reader's general perceptions of the reviewer even when no local knowledge is present in the review's text. Thus, even if a reviewer does not convey any local knowledge through the review's text, readers could still believe the reviewer to be knowledgeable about the area, consequently assess her as a credible source, and find her reviews more useful. Therefore, we argue that readers perceive reviews of locals as more useful.
Hypothesis 1: Online reviews given by locals are perceived as more useful than online reviews given by travelers.

Causal attribution theory suggests that readers attribute negativity in reviews to low product or service quality while they attribute positivity to the reviewer's personal reasons (e.g., [4]). Therefore, one needs to consider the valence of a review when developing hypotheses concerning reviewer characteristics. According to the discounting principle of causal attribution theory, consumers are less likely to attribute causes to the actual quality if there are valid external reasons for positivity or negativity [5]. In other words, if readers of reviews find a reason to believe that the reviewer's personal traits are the cause of positivity or negativity, they will discount their assessment of usefulness accordingly. We argue that a reviewer's geographical location is one such personal trait. Reviews by locals might be positive due to the shared connection with the location and therefore readers will attribute the reviewer's positivity to being local instead of high quality. Thus, readers of a positive review written by a local might perceive this review as less useful.
Hypothesis 2: The positive relationship between the reviewer being a local and the perceived usefulness of her review is moderated by the positivity of the review, so that positive reviews by locals are perceived as less useful than positive ones by travelers.

4 Research Setup and Data

We obtained data published by Yelp during the ninth round of the Yelp Dataset Challenge. On Yelp.com, consumers can review service-oriented businesses, from

restaurants to car mechanics. Yelp is suitable for our research context because it does not promote a clear focus on traveling like Trip Advisor so that both locals and travelers are likely to use Yelp. From this data, we extract the complete review histories up to the beginning of 2017 for five US cities: Champaign (IL), Las Vegas (NV), Madison (WI), Phoenix (AZ), and Pittsburgh (PA). In line with existing literature [7], we restrict our sample to each city's top 10 restaurants in terms of total review count to ensure high levels of reader and reviewer involvement. The data also contains various reviewer- and review-related variables along with the review's text. As the data set provides no information on the reviewers' locations, we collected the current location for each reviewer manually in July 2017 to create a unique data set. We conducted this collection by matching each business's reviews with reviews from our dataset.

Table 1. Descriptive Statistics on Review Level (N=72,759)

Variable	Mean	Std. Dev.	Min	Max
USEFUL	0.941	3.001	0	247
POSITIVE	0.717	0.450	0	1
NEGATIVE	0.134	0.341	0	1
LOCAL	0.180	0.384	0	1
RATING	3.933	1.166	1	5
EXTREMITY	0.870	0.699	0	5
WORDS	122.623	111.709	1	981
$WORDS^2$	27514.986	62436.790	1	962361
FUNNY	0.481	2.250	0	166
COOL	0.601	2.632	0	234
TEMP_CONTIGUITY	0.020	0.141	0	1

Table 1 presents summary statistics for review-related data. To empirically test our hypotheses, we generate variables regarding location and review valence as well as various control variables. For each review, we compare the business's location with the user's location on a city level to identify whether the review was written by a local. The dummy variable *LOCAL* represents the result of this procedure. *USEFUL* is the number of users that have voted this review to be useful. Following previous work, we generate several review characteristics from the review's rating and text. As ratings are given on a scale from 1 to 5, we define a positive review (*POSITIVE*) if a review has a rating of 4 or 5 and similarly define a negative review (*NEGATIVE*) if a review has a rating of 1 or 2 [6]. We create a measure for the review's length in form of the count of words and add a squared term as well (*WORDS* and $WORDS^2$) because lengthy reviews might be more useful but too long reviews might be less useful [2]. We also introduce review extremity (*EXTREMITY*) as the absolute difference of the review's rating from the average rating of a business [2]. *TEMP_CONTIGUITY* is a dummy variable that indicates whether the review text contains any cues that indicate a short period of time between consumption of the service and publication of the review [6]. We also dispose of the review's rating (*RATING*) and how many users voted the review to be 'cool' or 'funny' (*COOL*, *FUNNY*). Examining reviewer-related variables, one can observe how many compliments (e.g., for having nice pictures) a reviewer has received from other

users, how many friends a reviewer has registered, how many other users are following a reviewer, how many reviews a reviewer has written, how many votes a reviewer has sent, and how many years a reviewer has been an 'Elite Yelper'. Elite Yelper status indicates very active and reputable reviewers. On a restaurant level, we compute average ratings and review counts.

5 Empirical Analysis

Because our dependent variable (*USEFUL*) is a count variable that exhibits overdispersion and zero inflation, we use negative binomial regression and estimate Equation (1):

$$\begin{aligned} USEFUL_{ij} = \exp\big[&\beta_0 + \beta_1 POSITIVE_{ij} + \beta_2 NEGATIVE_{ij} + \beta_3 LOCAL_i \\ &+ \beta_4 \big(LOCAL_i * POSITIVE_{ij}\big) \\ &+ \beta_5 \big(LOCAL_i * NEGATIVE_{ij}\big) + \gamma X_{ij} + \zeta Y_i + \xi Z_j + \delta_j \\ &+ \epsilon_{ij}\big] \end{aligned} \tag{1}$$

In this model, $USEFUL_{ij}$ represents the number of usefulness votes user i has received for her review on business j. X, Y, Z are vectors of review-, user- and restaurant-related control variables as described in Section 4, respectively. Additionally, we include restaurant fixed effects in form of vector δ. Reviews with a 3-star-rating (i.e., neutral ones) are the base case in this model. Therefore, the coefficients have to be interpreted with respect to neutral reviews. For instance, a significantly positive β_3 describes an increase in perceived usefulness for neutral reviews written by locals. A significantly negative β_4 then indicates that positive reviews written by a local are less useful and that the impact of β_3 is reduced by β_4 (i.e., moderated). We also incorporate an interaction of *LOCAL* with *NEGATIVE* (β_5), which again needs to be interpreted as a sum with β_3 to examine the influence of negative reviews by locals.

Table 2 presents our preliminary results in form of estimated coefficients. First, the coefficient for *LOCAL* is statistically significant and positive while the coefficient for the interaction term *LOCAL*NEGATIVE* is small and insignificant. This supports our first hypothesis since, according to these results, readers perceive neutral and negative reviews by locals as more useful than similar reviews by travelers. Second, the statistically significant, negative coefficient for the interaction term *LOCAL*POSITIVE* indicates that positive reviews by locals, however, are not associated with a higher perceived usefulness. The sum of the coefficients for being a local and writing a positive review is 0.029 (0.124-0.0950). Thus, positivity moderates the increase in perceived usefulness due to being a local. This supports our second hypothesis.

We conduct a series of robustness checks to ensure validity of our results. First, the emotional tone a reviewer conveyed through her review text may affect perceived usefulness. One might argue that emotions associated with a restaurant visit differ for locals and travelers. Therefore, in line with previous studies (e.g., [11]), we use the text analysis tool Linguistic Inquiry and Word Count (LIWC) [12] to obtain a measure for the emotional tone in a review text. This measure seems to be robust to linguistic

aspects such as irony, since it is positively correlated with the review's star rating. Our results remain qualitatively unchanged after we add this measure as a control variable. Second, our choice of top restaurants may influence our results. Therefore, we re-estimate our model for the top 20, 30 or 40 restaurants and get qualitatively unchanged results. Third, we validate our results by re-estimating our model for businesses of different categories such as "Nightlife", "Bars" and "Beauty & Spas", again with qualitatively unchanged results.

Table 2. Results from a Negative Binomial Regression (N=72,759)

Variable	*USEFUL*
POSITIVE	—0.0114
	(0.0171)
NEGATIVE	0.250***
	(0.0262)
LOCAL	0.124***
	(0.0328)
*LOCAL*POSITIVE*	—0.0950**
	(0.0361)
*LOCAL*NEGATIVE*	0.0442
	(0.0465)
Review-level Controls	✓
User-level Controls	✓
Restaurant-level Controls	✓
Restaurant Fixed Effects	✓

Note: Robust standard errors are in parentheses. *p < 0.05; ** p < 0.01; *** p < 0.001.

6 Conclusion

Online shops and online review platforms strive to provide their customers with valuable information in form of reviews which customers perceive as useful. Literature suggests that reviewer characteristics (e.g., awarded badges or information disclosure) influence perceptions of usefulness [2, 3]. For local offline businesses such as restaurants, the geographical location of a reviewer conveys additional information to the reader as it indicates whether the reviewer is a local or traveler. We investigate the relationship between a reviewer's geographical location and perceptions of usefulness. As hypothesized by attribution theory (e.g., [4]) and the discounting principle [5], our empirical results suggest that online reviews written by locals are perceived as more useful than those written by travelers. However, this holds only for non-positive reviews (below four stars). We argue that readers attribute positivity in locals' reviews to their personal reasons (e.g., connection with the location, being a regular customer, positivity bias) and thus do not see being a local as a sign of credibility but more as a reason for doubt. These findings imply that online review platforms focusing on local offline businesses should highlight negative and neutral reviews by locals to guide their

users whereas businesses should address such reviews with carefully drafted management responses since these reviews receive additional reader attention.

We plan to extend this research in three major ways. First, we plan to further investigate this relationship in a controlled experiment to measure reviewer attribution (e.g., [6]) and investigate the role of the reader's origin. Second, we want to analyze how geographical distance (e.g., not being a local but coming from a location close to the business's location) relates to our results. Third, we want to separate the impact of local knowledge from the impact of credibility for being a local, for instance, by analyzing review texts for cues that demonstrate local knowledge.

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With or Without You? The Influence of Search Partners on Consumer Behavior in Paid Search

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Abstract. Paid search is widely considered an effective marketing tool and as such has attracted much scholarly attention. Yet, current research does not account for one major decision every marketer faces when crafting a campaign: whether to solely rely on the search engine (e.g., Google) or include websites of so-called search partners (e.g., T-Online.de). This paper investigates whether search partners can be beneficial for bricks-and-mortar retailers. Our results indicate that consumers are less likely to click on a paid ad when searching on partner websites, compared to paid ads on a search engine's website. However, after clicking on a paid ad, subsequent behavior remains unaffected regardless of whether the ad was shown on a partner's or on a search engine website. Due to the pay-per-click billing this combination allows marketers to increase campaign reach at no additional costs. We conclude that bricks-and-mortar retailers would benefit from advertising on search partner websites.

Keywords: paid search, search partners, field experiment, bricks-and-mortar, competition for attention

1 Introduction

It has become common practice for consumers to use search engines when looking for information on retailers, brands, and products. Over 80% of all consumers use search engines to find information across channels whether to find directions to a local bricks-and-mortar-store, to check store hours or product availability in a local store [1]. Hence retail experts and business consultants strongly recommend that both online retailers and bricks-and-mortar retailers invest in search engine marketing. A common way to invest in search engine marketing is to rely on paid search – the mechanism of placing online ads in response to consumer search queries on search engine result pages – to reach potential customers during their search phase [2].

Current research draws attention to three main factors said to influence consumer behavior and hence increase advertisers' immediate paid search success: First, the phrasing of *ad copies* [3]; second, the choice of appropriate search terms (i.e., *keywords*) for which advertisers want to be listed on a search engine result page (SERP) [4], and third, a paid ad's position on a SERP. Indeed, a SERP displays numerous paid ads by a variety of advertisers in a hierarchical order. Advertisers have to bid for

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favorable *ad positions* as differently positioned ads are not equally well-suited for every advertiser [5].

However, when crafting a paid search campaign advertisers face a fourth decision that might directly impact paid search success. Many portals (e.g., t-online.de, web.de) offer search functionalities to their customers and integrate services of external search engines (typically Google or Bing) to provide their results. For example, when a consumer uses the search functionality of t-online.de all the results, including paid ads, will be provided by Google. Advertisers can either include or exclude these so-called *search partners* when crafting a paid search campaign. News articles written by practitioners suggest that the use of search partners might influence paid search success (e.g. [6], [7]) as consumers might use search features of regular websites quite differently. Yet, to our knowledge, current research has only investigated the influence of ad copies, keywords and ad positioning on immediate paid search success, rather than examined whether the use of search partners might also prove to be a key determinant for paid search success. However, from the perspective of an advertiser who has to choose whether to incorporate or exclude search partners when crafting a paid search campaign, it is important to know whether consumers show distinct behavior patterns and whether and how this impacts paid search success. We therefore seek to augment current research by addressing the following research question: *Does the incorporation of search partners into a paid search campaign affect consumer behavior?*

To answer this research question, we teamed up with a bricks-and-mortar business-to-consumer (b2c) furniture retailer operating in Germany. We conducted a field experiment aimed at quantifying the impact of search partners on subsequent consumer behavior. By developing an experimental research setting based on random assignment to conditions combined with a pre-treatment/post-treatment design, we are able to address common endogeneity concerns of paid search campaigns [8]. The experiment commenced in May 2017 and was executed over 20 days in which more than 325,000 consumers were exposed to our paid ads and more than 2,500 reached the website via those ads. Our results reveal that including search partners might be highly beneficial as it allows advertisers to greatly increase the reach of their marketing campaign at no additional costs. At least in our case, consumers who were exposed to a paid ad on a SERP of a search partner website were eight times less likely to click on it. Therefore, due to the pay-per-clicking billing in paid search, advertisers can eightfold the reach of their marketing campaigns. However, our analysis also reveals that consumer behavior does not seem to be any different once they have reached the advertised website: whether they reached it via the partner website or via Google has no impact on their behavior. In other words, consumer behavior seems only to be influenced on SERPs. Therefore, by including search partners in their campaigns, marketers make better use of their advertising budgets since they are able to reach more customers at the same cost without affecting the consumer behavior on their own website.

2 Related Literature

Paid search is considered a highly dynamic market [9] which is well suited to aiding consumers' search process [10] and has generated numerous studies, especially in the fields of Information Systems and Marketing [11]. The current state of the literature suggests that advertisers can increase their immediate advertising success especially via three specific paid search elements: keywords, ad positioning, and ad copies. Immediate advertising success is commonly evaluated on the basis of consumer behavior on the SERP as well as on the advertised website.

Whenever a consumer enters a search term into a search engine, the term will be linked to contextually matching keywords and display ads of advertisers who bought those keywords. Current research suggests that keyword characteristics widely influence consumer behavior on the SERP (e.g., [12], [13]) as well as on the advertised website (e.g., [14], [15]). In scholarly research keywords are commonly grouped based upon their specificity. For example, Rutz and Bucklin [12] analyze spillover-effects from generic search terms (e.g., "furniture") to more specific branded terms (e.g., "furniture of retailer X"). All available studies agree that consumers show distinctive behavior patterns based upon the keyword they have entered. For example, if a user incorporates the company's brand name in their search it is obvious that they are already familiar with the brand and may have formed specific associations towards the brand and/or its products. However, even when keyword characteristics are a pivotal determinant of consumer behavior, various studies established that keywords interrelate to other paid search-specific factors such as the position [4] as well as the phrasing of the ad [16].

Whenever a consumer enters a keyword into a search engine a multitude of ads might be presented on a SERP. The number of ads shown depends on how many advertisers have bought keywords matching the search query. Google Search, for example, presents up to four ads in the most prominent slots directly below the search query. Current research suggests that consumer behavior on the SERP (e.g., [17], [18]) as well as on the advertised website (e.g., [19], [20]) is highly influenced by the visual placement of the ad on a SERP. Yet, position effects seem to be weaker for well-known firms [17] or when customers use more specific keywords [20], or conduct the search using a mobile device [18]. Furthermore, studies by Animesh et al. [21] and Chan and Park [22] have established that different types of consumers are likely to click on the ad depending on its position, and therefore, the ad position parameter lends itself to segmenting customers into groups.

With regard to ad copy design, researchers have either focused on individual phrasing elements within an ad copy (e.g., [23], [3]) or on the ad copy as a whole (e.g. [24], [25]). All studies conducted to date agree that the ad copy design influences consumer behavior at least on the SERP. Beyond these findings, in a field experiment in cooperation with a b2c retailer in the Netherlands, Haans et al. [25] investigate the influence of different description texts in an ad copy and present first empirical evidence that ad copy design might also influence consumers on the advertised website.

Conceptually speaking, according to the current body of knowledge, keyword characteristics, ad position as well as the ad copy might be pivotal determinants of

consumer behavior. Furthermore, these determinants interrelate and therefore need to be considered jointly in paid search analysis. We performed a systematic literature research in accordance with the suggested procedure proposed by Webster and Watson [26] including keyword, backward and forward searches to identify studies which analyze immediate paid search success factors in the light of search partners. Yet, our literature research reveals that current research solely focuses on major search engines and does not at all analyze the potential impact of search partners.[1] Therefore, we would like to augment current research by analyzing the impact of search partners on paid search success measures.

3 Hypothesis Development

Search partners receive all paid search entries from the search engine (e.g., Google). As can be seen in Figure 1 the search procedure is identical for search partners as well as for the original search engine. Whenever a consumer enters a keyword into the search box a multitude of different ad copies on different ad positions will be shown to him. However, search partners do have an incentive to enrich their SERPs to increase their own revenue. For example, they might provide their own offers to increase revenue or present informational content which guides the consumer to their own website. In other words, when comparing a SERP of a search engine (Figure 1/2 – Left Part) to a SERP of a search partner (Figure 1/2 – Right Part) consumers are likely to be exposed to an increased number of information and offers.

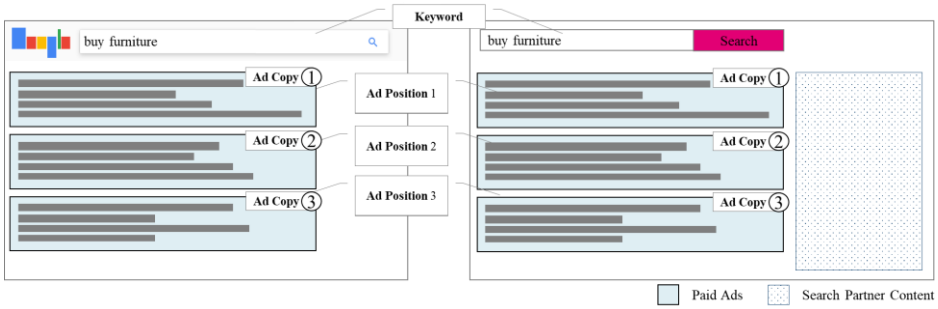


Figure 1. Conceptual View – SERPs

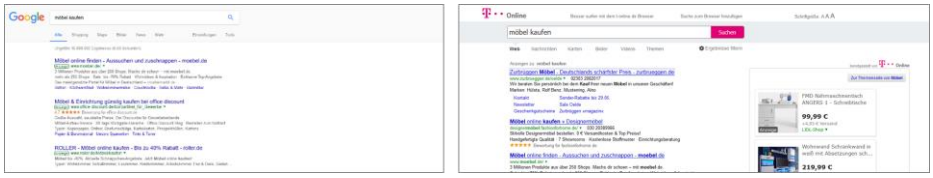


Figure 2. Screenshot –SERPs

[1] The procedure as well as the results of our systematic literature review can be found in our online appendix: http://go.upb.de/PartnerNetworks

According to the competition for attention theory [27], every item on a SERP competes for the consumer's attention [28]. Therefore, providing additional content should lead to an increased competition for attention. Accordingly, consumers should in turn be more easily distracted and might chose different options. Hence, we formulate our first hypothesis:

H1: Consumers who are exposed to paid ads via search partners are less likely to click on a paid ad compared to consumers who are exposed to paid ads via a search engine.

However, even when the percentage of consumers who click on an ad might decrease we would expect to find that similar consumers are likely to be attracted by the paid ad since the ad serves as the sole content provider, which a consumer evaluates and on the basis of which she decides to click on an ad (e.g. [29], [30]). Therefore, we would expect consumers who reach the website via a search partner to behave similarly to those who reach the website via a search engine. Hence, we formulate our second hypothesis:

H2: Consumers who reach the website through paid ads via search partners behave similarly compared to consumers who reach the website via a search engine.

4 Research Setup

We teamed up with a well-known b2c bricks-and-mortar furniture retailer in Germany in order to estimate the impact of paid ads placed on search partner websites on consumer behavior. As suggested by Bandiera et al. [31] we take advantage of experimental methods and design a field experiment to address general endogeneity biases. Our field experiment consists of a pre-treatment/post-treatment design and is based on random assignment to conditions to enhance reliability [32].

In May 2017, the field experiment was conducted over a time span of 20 days. In a 10-day *pre-treatment phase* the crafted ad copy was shown only on Google SERPs. In accordance with the current state of the literature (e.g., [12]) generic as well as specific keywords were used. To prevent the common endogeneity problem of shifting marketing budgets due to endogenous events, the paid search advertising budget was fixed on a daily basis and held constant throughout the experiment. After the pre-treatment phase we randomly assigned all keywords either to a control or a treatment group. In the 10-day post-*treatment phase* the fixed daily advertising budget was equally split between control group keywords and treatment group keywords. All keywords belonging to the control group were shown only on Google SERPs. Keywords assigned to the treatment group were shown on Google SERPs as well as on search partners' SERPs. Figure 3 depicts the overall research setup. To estimate the impact that the inclusion of search partners has on consumer behavior we analyzed their behavior on the SERP (see Figure 3, (1), (2)) as well as on the advertised website (see Figure 3, (3)).

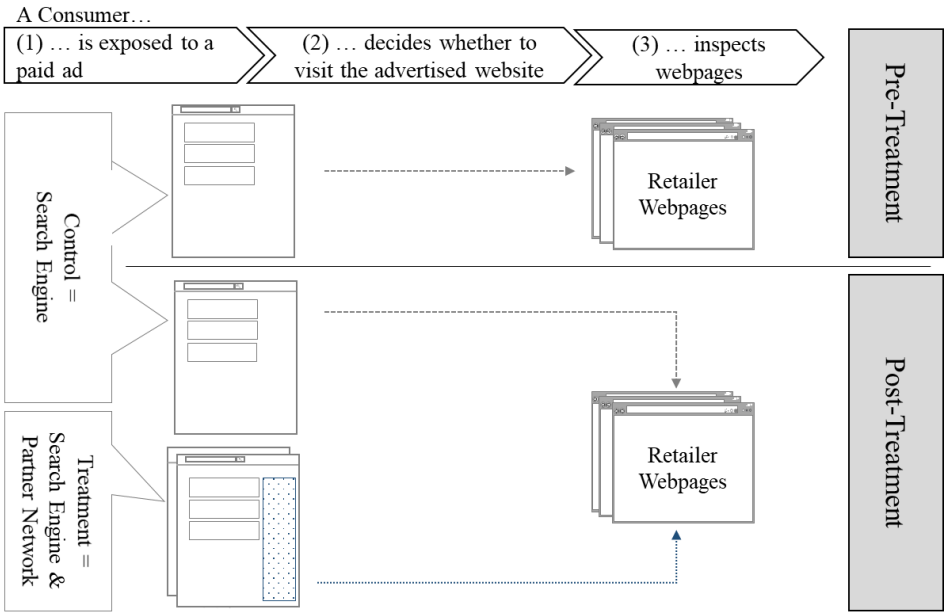


Figure 3. Research Setup

5 Empirical Model

Previous studies stressed the need to incorporate keyword characteristics, ad position and the ad copy when analyzing immediate paid search success measures. Accordingly, regression analysis is used to investigate the search partner's effect while simultaneously controlling for potential confounding factors. Table 1 lists all variables considered in our regression analysis.

Table 1. Main Variables

Variable	Description	Type
$TREAT_i$	Every keyword *i* is assigned to the control or treatment group.	Independent
KW_i	Every keyword *i* either belongs to keyword group (KW) generic or specific.	Control
POS_i	For every keyword *i* the ad position (POS) measures the ad position on which a paid ad appears on a SERP.	Control
CTR_i	For every keyword *i* the Click-Through-Rate (CTR) measures the percentage of consumers who click on a paid ad out of the total number of consumers who were exposed to it.	Dependent
DUR_i	For every keyword *i* the Duration (DUR) measures the average time in seconds consumers spend on the website.	Dependent
WV_i	For every keyword *i* Webpages Viewed (WV) measures the average number of webpages a consumer inspects.	Dependent

Note: Variables were obtained via Google Analytics & Google Adwords.

Within our experiment we only use one fixed ad copy and include all other paid search specific elements as controls. Accordingly, we can distinguish between effects that are caused by search partners ($TREAT_i$) and those that are driven by keyword heterogeneity (KW_i) and the visual placement of the ad (POS_i). Hence, we formulate the following OLS regression model to assess consumer behavior on the SERP (CTR_i), and on the advertised website (DUR_i, WV_i):

$$Y_i=\beta_0+\beta_1 TREAT_i+\beta_2 KW_i+\beta_3 POS_i + \varepsilon_i \quad (1)$$

6 Empirical Analysis

Throughout the 20 day-long experimental period, a total of 327,710 consumers were exposed to the firm's paid ad, and 2,550 clicked on the ad and visited the firm's website. Table 2 presents the summary statistics of the average values of our focal variables in the pre- and post-treatment phase in respect to the assigned control or treatment group.

Table 2. Summary Statistics

	Impressions	Clicks	CTR	DUR	WV
Pre-Treatment	**54,119**	**1,170**	**2.2%**	**31.8**	**1.7**
Control	18,625	397	2.1%	29.3	1.7
Treatment	35,494	773	2.2%	34.2	1.7
Post-Treatment	**273,591**	**1,380**	**0.5%**	**41.8**	**2.0**
Control	25,789	672	2.6%	39.2	1.8
Treatment	247,802	708	0.3%	43.5	2.1
	327,710	2,550	0.8%	37.6	1.8

Tables 3 and 4 depict the estimates of the regression model (see Equation 1) for the pre- and post-treatment phase, respectively. As can be seen in Table 3 no systematic differences in respect to the variables of interest can be detected. For all dependent variables (Table 3, Model 1-3) the treatment group estimator (TREAT) remains insignificant and close to zero. Therefore, we conclude that our randomization seems to be well suited to draw conclusions on the impact of using search partners within the post-treatment phase.

Consumer behavior on the SERP is evaluated based on the likelihood to click on a paid ad. As can be seen in Table 4, Model (1) which using CTR_i as the dependent variable, the estimator measuring the impact of search partners (TREAT) indicates a highly significant negative relationship. In the post-treatment phase the paid ad which is only displayed on Google SERPs is clicked by 2.6% of all consumers who were exposed to it. Yet, when the paid ad is displayed both on Google SERPs and on search

partner websites (treatment group) the percentage of consumers who click on the paid ad decreases to a CTR of 0.3%. In other words, when introducing search partners, consumers become eight times less likely to click on a paid ad. Accordingly, we do not reject hypothesis H1 as consumers become less likely to click on a paid ad when the it is delivered via a search partner.

Consumer behavior on the advertised website is evaluated based on the time she spends as well as on how many webpages she inspects. Those metrics were chosen in accordance with past research findings which suggest that especially the time spent acts as a suited proxy to determine consumers' behavior (e.g., [33]) and interest in the offers of an advertiser (e.g., [34]). As can be seen in Table 4, Model (2) and (3) consumer behavior do not seem to be influenced by the advertised website as estimator results remain insignificant. At least in our case, the introduction of search partners does not significantly impact consumer behavior in terms how long they stay on a website and how many webpages they inspect within this time frame. Apparently, consumers seem to be equally interested independently of the introduction of search partners. Therefore, we accept hypothesis H2.

We performed several robustness checks to enhance the credibility of our findings.[2] To ensure that the common-trend assumption holds within our context we re-estimated all models excluding search partners. When doing so, all effects become insignificant. As a second robustness check we split up the post-treatment phase based on the search network (Google vs. search partners) were the ad was displayed (as opposed to the control-/ treatment-group split). In this case, the observed CTR effects further increase. All other dependent variables remain insignificant. Hence, we conclude that observed group differences can be considered robust and it is highly likely that the observed effects are caused by the introduction of search partners. We also log-transformed all dependent variables to account for a potentially skewed dataset. However, when using log-transformed dependent variables, all results remain qualitatively unchanged. Beyond these analyses, we also used the likelihood of being classified as a new visitor (a person who has not visited the advertiser's website for at least one year) as a proxy to determine whether consumers show distinct attributes. However, when comparing search partner visitors to regular search engine visitors, no systematic differences could be detected.

[2] Results for robustness checks are provided as part of our online appendix: http://go.upb.de/PartnerNetworks

Table 3. Regression Results – Pre-Treatment

	Dependent variable:		
	CTR	DUR	WV
	(1)	(2)	(3)
TREAT	**-0.00**	**9.54**	**0.06**
	(0.01)	**(8.61)**	**(0.19)**
POS	-0.01	18.10***	0.08
	(0.00)	(6.24)	(0.14)
KW	0.01	-13.55	-0.19
	(0.06)	(42.51)	(0.94)
Constant	0.04	-7.24	1.63
	(0.06)	(48.76)	(1.08)
Observations	713	179	179
Adjusted R^2	-0.00	0.04	-0.01
Note:			*p<0.1; **p<0.05; ***p<0.01

Table 4. Regression Results – Post-Treatment

	Dependent variable:		
	CTR	DUR	WV
	(1)	(2)	(3)
TREAT	**-0.02*** **	**-3.37**	**0.29**
	(0.01)	**(9.35)**	**(0.20)**
POS	-0.00	1.59	-0.14
	(0.00)	(4.22)	(0.09)
KW	0.02	0.77	-0.51
	(0.02)	(26.79)	(0.59)
Constant	0.03	37.44	2.77***
	(0.02)	(30.11)	(0.66)
Observations	1,457	343	343
Adjusted R^2	0.01	-0.01	0.00
Note:			*p<0.1; **p<0.05; ***p<0.01

7 Conclusion

The purpose of this field experiment was to investigate the question whether advertisers should include search partners. Our study provides evidence that advertiser might benefit in several major ways when relying on these search partners. First, including search partners allows advertisers to increase their marketing reach significantly. In our case, 0.3% of all consumers click on a paid ad when exposed to it via search partners compared to 2.6% when the same ad is shown via Google. Due to the fact that only every click is billed, by introducing search partners, advertisers can increase by eightfold the reach of their campaigns. In our field experiment, introducing search partners increases the number of consumers who are exposed to paid ads to 247,802 compared to 25,789 when only Google is used. Second, our analysis indicates that consumer behavior on the advertised website does not seem to differ. At least in our case, consumers tend to inspect a comparable number of webpages and spend a comparable amount of time inspecting the offers. Hence, advertisers can increase the reach of their marketing campaigns when introducing the partner network at no additional costs as consumer behavior does not differ on the subsequent website.

With our study, we provide first empirical evidence that search partner websites might only affect consumer behavior on the SERP and does not seem to impact behavior on the advertised website. Results indicate that differences in consumer behavior on a SERP might be rooted in an increased competition for attention on search partner websites. However, on the website of the advertiser the paid search specific elements, namely keywords, ad copy design and the ad position, determine consumer behavior. Yet, as an anonymous field experiment is used our contribution should be viewed as mainly empirical [35] as further research is needed to determine consumers' true intentions.

Our results carry several practical implications. First, our study illustrates the need for advertisers to actively decide whether they should include search partners as this directly impacts the advertising reach of the campaign. Second, as we observe no behavioral differences on the advertised website, bricks-and-mortar retailers at least should consider including search partners to increase advertising efficiency. Due to the pay per-click bidding mechanism in combination with a lower percentage of users who click on a paid ad on search partner websites the total number of consumers who will be exposed to the firms' ads increases at no costs when introducing search partners. Third, in line with Sudhir [36], our results further emphasize the importance of using experiments to measure the effectiveness of marketing campaigns and to derive guidance for managerial decisions based on causal claims. Accordingly, marketers should systematically test the impact of variations – such as whether they should include search partners – on consumer behavior to allocate marketing budgets more efficiently.

Yet, our study has several limitations. Obtained results might be limited to our specific research context (furniture retail) and could only apply to bricks-and-mortar retailers who rely on their website to foster local store sales. A potential avenue for future research would be to extend our study to other firm types as it is already known that paid search impact highly depends on the focal firm and branch [37].

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Functional service description on service marketplaces

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Abstract. Software customers increasingly externalize the operation of software applications and use software as a service (SaaS) via cloud service platforms. During the service search and selection process on a service marketplace, customers depend on comprehensive and detailed descriptions of service offers as a basis for service comparisons and for well-grounded service selections. Functional-oriented service descriptions are of particular importance here. In practice, service descriptions on marketplaces tend to be not as precise as required, and therefore they cause increased effort for service customers to understand the real scope of software services. Most approaches addressing business-oriented service description in scientific literature only consider functional aspects marginally and provide no further, application-domain specific functional description patterns. For this reason, this research paper analyzes the state of the art concerning functional-oriented service description on four selected cloud service marketplaces in the special domain of analytical services in order to obtain insights for the subsequent creation of a design proposal of a set of functional description attributes for analytical services on service marketplaces.

Keywords: cloud service platform, service marketplace, functional service description, analytical service

1 Introduction

Cloud software service marketplaces (like *Amazon Web Services Marketplace*) assume the role of an intermediary / service repository between multiple software service vendors and the customers. As in other service repositories, software service vendors have to fill sets of attributes predetermined by the marketplace with service-related information to explain and describe the specific design and scope of their service offers. Some service description attributes allow a great latitude in the information presentation, e.g. attributes like “service description”, used to explain the essential aspect of software service functionality and associated use cases. Such descriptions, by means of free text or heterogeneous and vendor-specific function lists, impede the intersubjective understanding and the discriminability of service functionalities [1]. Therefore, search queries in service repositories and service marketplaces often return a large amount of services, and extensive human intervention by the service customers is needed to develop a functional understanding and to compare services [1,2].

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In contrast to this, a service search, which is supported by advanced models considering functional facets, would generate reduced result sets and would provide a consistent vocabulary [3]. Although there are some previous research approaches addressing business-oriented service description models (find an survey in [4]), there is no approach providing a precise functional substructure (compare chapter 2). To sum up, there is a need to create domain-specific service description models [5] representing the precise functional range of software services from a customer´s point of view. One domains is the sector of analytical / big data services, which is an emerging topic in e-commerce research and still contains open research questions, e.g. regarding IT infrastructure and service selection [6]. Analytical services are addressed in the current research because the functional content of various analytical services can be traced back to basic functional characteristics (e.g. provided analysis algorithms, data diagrams, metrics and data import formats), which facilitate a service comparison.

Due to the lack of functional-oriented service description models in literature, an analysis of description models of analytical service offers on market-leading service marketplaces (compare chapter 3) was conducted to obtain information regarding the handling and attributes of functional service description. Afterwards, these findings were combined with a literature review regarding general analytical functions to create a first set of description attributes of analytical services for cloud service marketplaces. Based on these insights, this paper answers the following research questions: 1.) Which functional service description structures are used to provide information about analytical service offers to customers on the most prevalent service marketplaces?; 2.) What does the structure of a functional-oriented set of description attributes for analytical services on marketplaces look like?

Chapter 2 shows the status quo regarding functional service description approaches in research. Chapter 3 contains the examination of analytical service offers focusing the functional service description on four service marketplaces. Chapter 4 presents a service description model aiming at functional-related aspects in the domain of analytical services. The paper ends with a conclusion in chapter 5.

2 State of the art concerning functional service description models

Widely used standard service description models in practice (e.g. WSDL, USDL, UDDI) are aware of the aspect of providing service information to service customers (e.g. attribute “description“ in the area “BusinessService” of the UDDI specification [7]), but they leave the modeling of further service description concepts and detailed semantic models and ontologies to the model users [5,8]. In addition, there are few approaches in research addressing business-oriented service description models, which were collocated and compared by [4]. These approaches consider varied dimensions, but in most cases they focus on generic service description aspects irrespective of user functionality and application domain (e.g. hardware platform, pricing). As an exception in the model set compared by [4], [9] suggest the attributes *individualization of the web interface* and *usability of services*, but provide no further details. [10] distinguish

taxonomy levels, e.g. *intended user group* and *customer/application domain*. These attributes are useful to classify services and to reduce the overall amount of offered services via filters, but they are not sufficient for giving deep functional insights to support final service selection.

Furthermore, [11] conducted a systematic literature review to find approaches regarding the evaluation and selection of software services, and [12] provide an overview of research approaches in the area of cloud service selection. In both compilations, approaches related to service functionality were rarely represented, and an analysis of the mentioned articles revealed no further contribution to the specific research topic of this paper. Due to the absence of a detailed functional service description model in research literature, it is necessary to analyze service marketplaces in practice to collect suggestions for functional description patterns.

3 Analysis of functional service descriptions on marketplaces

3.1 Selection of service marketplaces and analytical services

With reference to [13], the service platforms of *Amazon*, *Microsoft*, *IBM* and *Google* had the largest market shares in 2016. For this reason, four analytical services on each of the following multi-vendor service marketplaces were examined in January 2017: *Amazon Web Services Marketplace*, *Microsoft Azure Marketplace*, *IBM Cloud* and *Google Cloud Launcher*. Four Services offered by a set of seven top vendors of analytical information systems (derived from [14]) were only available on *Amazon* and *Microsoft* marketplace, whereas the four analytical services on *Google* and *IBM* marketplace were picked by random selection. The analysis revealed, that each marketplace uses a uniform set of descriptive attributes for all analytical services.

3.2 Functional service description and classification

All marketplaces use one- or two-tier hierarchical classification models to cluster and filter their service offers (e.g., the model of *Amazon* is built on terms of software applications (e.g. 1st tier: business software, 2nd tier: business intelligence)). However, these models are insufficient for two reasons: First of all, the classifications are not detailed enough to reduce the amount of service offers to a small service set (e.g. on *Amazon* the sub-category *business intelligence* contains ca. 380 services). Secondly, they do not contain sub-categories or additional remarks for the structuring of analytical application systems / functional areas.

On all marketplaces, service offers include a textual service description regarding the purpose and key functions on a high abstraction level using running text (Table 1), which provides only a vague and fragmentary impression of the real service functionality. The same applies to the headwords of service product highlights. Nevertheless, the listings of included sub-modules / products (*Amazon*, *Google*), and especially the so far heterogeneous and service vendor-specific listings of service functions (*IBM*) are first steps towards a detailed and systematic presentation of service functions. But until now, there are no further guidelines / standard models with regard

to service functionality provided by the marketplaces. A closer analysis of the function lists of the selected service offers on *IBM Cloud* led to a first short list of mentioned analytical functions (e.g. data profiling, multidimensional data operations, static reporting, dynamic dashboards). This list of analytical functions was used as a basis of comparison during the literature-based development of the set of functional service description attributes presented in chapter 4 because all functions from the list had to be related to at least one attribute.

Table 1. Functional service description attributes used on cloud service marketplaces

Amazon Web Services (AWS) Marketplace	*Microsoft Azure Marketplace*	*IBM Cloud*	*Google Cloud Launcher*
- Textual service description - Service product video - Individual headwords of service product highlights - List of sub modules / products integrated in the service	- Textual service description - Screenshots	- Textual service description - Link to service documentation - Screenshots - Service product video - Individual headwords of service product highlights - Individually structured lists of service functions with textual function descriptions	- Textual service description - Link to service documentation - List of sub modules / products integrated in the service

4 A set of functional analytical service description attributes for service marketplaces

A detailed functional-oriented set of service description attributes has to cover the most important functional items and usage aspects of the particular software application domain. Information on the inner structure of a software artifact is stored in system architecture models or function models. To refer to the special section of analytical services, there are a couple of approaches regarding the architecture and functional layers of analytical software systems. The approach of [15] subdivides the *presentation layer, information allocation layer, data storage layer,* and *data collection layer.* This structure was selected because it includes a strict functional-oriented separation of layers. These layers are suitable for forming the first level of the set of analytical service description attributes. In this connection, the *presentation layer* refers to the aspects web interface and usability suggested by [9] (compare chapter 2). A literature search in monographs (e.g. [16,17]) and research papers regarding the functional range of analytical software systems on the different analytical architectural layers revealed single functions representing an own description attribute (e.g. display of a graphical diagram) with different attribute values (e.g. bar diagram). On the other hand, there are single functions (e.g. sending analysis results via email; providing analysis results in an XLS file) with a functional contiguousness which belong to a superordinate attribute (e.g. information distribution - instruments) (Table 2). As mentioned in chapter 3.2, the successful comparison of the functions derived from *IBM Cloud*-services with the analytical description attributes in Table 2 served as a first access point towards a more

extensive and still outstanding evaluation. The example of an energy consumption analysis service shows, how the functional aspects of this analytical service offer would be displayed for a customer on a marketplace.

Table 2. Description attributes of analytical services for cloud service marketplaces

Description attributes	*Comment*	*Possible attribute values*	*Example: energy consumption analysis service*
Presentation Layer			
Reports	Static presentation of analytical information without user interaction	- Yes/no	- Yes
Information distribution - instruments	(Technical) interfaces / instruments, whereby the analytical service pushes predefined structured analytical information towards a user	- File (doc, pdf, csv, xls, xml, …) - External database entry - Fax, email, SMS	- Email - File (csv, xls)
Information distribution - intervals	Specified interval for the supply with analytical information	- Fix time interval (every year/month/day/hour/…) - Specific date/time - Event-based (after data updates, ...)	- Fix time interval (user-defined) - Specific date and time
Dashboards	Dynamic presentation of analytical information in an interactive graphical user interface	- Yes/no	- Yes
Diagrams	Techniques of information visualization	- 2D, 3D - Diagram type (table, bar diagram, net graph, ...)	- 2D - Bar diagram
Alarm - instruments	Information distribution in the course of threshold violation	- Communication medium (display, email, fax, SMS) - Audio alarm	- Email
Alarm - escalation management	Functions to adjust alarm instruments or intervals in the course of continuing threshold violation	- Yes/no	- No
Information allocation layer			
Statistical methods	Mathematic methods to analyze basic data including data mining	- Methods of descriptive, inductive or explorative statistic	- Sum calculation - Average calculation
Multidimen-sional data operations	Methods to adjust views on multidimensional data	- Pivoting - Drill down, roll up - Slice, dice - Split, merge	- No
Analysis information	Labeling of concrete information objects provided by the service	- Performance indicators	- Active energy consumption (MWh)
Free data query	Function to create individual database queries	- Yes/no	- No

Description attributes	*Comment*	*Possible attribute values*	*Example: energy consumption analysis service*
Data storage layer			
Database architecture	Type of database model used by the service	- Hierarchic, relational, network, object-oriented, document-oriented	- Document-oriented
Integrated database	Name of a database product integrated in the service	- DB2, MySQL, …	- MongoDB
Data histo-riography	Handling of outdated data in the case of data updates	- Data update, data snapshot, delta historiography	- Data update
Data collection layer			
Data import	Predefined interfaces/data formats for the import of data into the database	- Standard interfaces/data formats	- CSV
Data export	Predefined interfaces/data formats for the export of data from the database	- Standard interfaces/data formats	- CSV
Data trans-formation	Functions to check data structure/quality and proceed data adjustments	- Data profiling - Data harmonization - Data enrichment	- No

5 Conclusion

The analysis of four cloud service marketplaces revealed an insufficient level of detail and a limited comparability regarding the functional description in the special domain of analytical service offers. On all marketplaces, classification models used for filtering don´t contain additional sub-categories underneath the level of analytical application systems, and textual service descriptions are not standardized and just provide heterogeneous structured content that is more or less related to analytical functionality. Only *IBM Cloud* considers the provision of a function list as a single description attribute, but a pre-configured functional structure is missing here as well. Due to this insufficient starting position, it was necessary to create a first draft of a functional-oriented set of service description attributes largely based on a literature review regarding the functional range of analytical application systems and supported by a set of analytical functions derived from the service-specific function lists of *IBM Cloud.* Additional research is necessary to evaluate the description attributes and to adjust the whole attribute set's level of detail to make it suitable for marketplace customers by means of expert interviews and a comparative study regarding the perceived comprehensibility and comparability of standard and enlarged service offers from a service customer´s perspective. The final attribute set could be used as a basis for analytical domain-specific enlargements of service description attributes on service marketplaces in practice and as a basis for further developments of functional analytical information system ontologies (e.g. in the context of OWL-S).

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A stakeholders' perspective on the effects of the Sharing Economy in tourism and potential remedies

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Abstract. Due to the continuous growth of the Sharing Economy, its positive and negative consequences become highly visible in our daily life and are controversially discussed. The majority of existing studies on the impact of the Sharing Economy and corresponding actions stays on a descriptive level and is mostly limited to governmental intervention without incorporating other involved parties. This study provides empirical data on the impact of P2P accommodation sharing and derives precise and applicable recommendations for regulations, platform providers, and users of Sharing Economy services. We found that the consequences of this phenomenon depend on the kind of sharing and differs regionally. Our findings indicate that the Sharing Economy could be managed without necessarily imposing bans or adapting existing regulations.

Keywords: Sharing Economy, P2P accommodation, impact, recommendations.

1 Introduction

Nowadays, the Sharing Economy is well known by a lot of people. Besides success stories on this phenomenon, a variety of negative headlines circulated through the media - in particular, associated with the prime examples Airbnb and Uber [1]. Sharing Economy supporters bring forward the arguments that it will lead to reduced unemployment, increased sustainability, and increased social interaction [2–4]. Critics dissent and argue that Sharing Economy firms circumvent consumer and employment rights [5] and, accordingly, unfairly disrupt existing industries [6].

These negative effects raise questions concerning the necessity for stricter regulations of the Sharing Economy, a question that is discussed controversially: some reject the idea of establishing new regulations as market failures will be countered by self-regulation [7], while others demand strict governmental intervention to protect the rights of consumers and employees [8].

Existing studies discussing the impact of the Sharing Economy tend to bring important ideas forward, but often lack empirical evidence supporting their feasibility. Studies in search of solutions for potential issues cover the phenomenon on a very broad level and mostly are limited to the intervention and regulations of the government without incorporating other parties that also shape the influence of Sharing Economy services such as platform providers or service users.

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In order to gain in-depth insights on the impact of the Sharing Economy, we focus our research on peer-to-peer (P2P) accommodation sharing – one of the fastest-growing types of sharing economy services [9]. In contrast to an all-encompassing perspective, this focus allows us to directly link effects to precise and applicable recommendations for regulations, platform providers, and users that go beyond regulation and also consider facilitation of the Sharing Economy. Based on interviews with representatives of the tourism industry, we aim to answer the following research question: *How does P2P accommodation potentially impact our society, the tourism market, and the users and how can these effects be supported and mitigated?*

In the following, we provide a conceptual understanding of the Sharing Economy and review extant literature on its impact. We then describe the qualitative research methodology before presenting the potential impact and recommendations to address them. Finally, we conclude with a discussion of our findings.

2 Theoretical foundation

2.1 The Sharing Economy

In line with common definitions, we see the Sharing Economy as an umbrella concept encompassing different forms of consumption [10–13] that focus on capturing and redistribution of idling capacity [14] and eventually lead to a reduced need for ownership [15]. We investigate one of the fastest-growing type of Sharing Economy services [9] and focus on P2P accommodation services like Airbnb, wimdu, or 9flats.

2.2 Studies on the impact of the Sharing Economy

The impact of the Sharing Economy can be classified as economic, ecological, or social impact [16]. We review prior studies on those aspects and reveal a collection of effects that are partially contradicting and span across a broad variety of contexts.

Economic impact. A variety of studies claim that the Sharing Economy has both positive and negative economic effects. It is seen as a way to save money for resource providers and consumers through cost sharing [3, 17]. Carsharing, for instance, reduces ownership duties and lowers the number of vehicles held by individuals [18]. By providing new forms of work (e.g. renting out own property), the Sharing Economy may decrease unemployment [2]. In the tourism industry, the reduction of costs leads to an increase of travel frequency, length of stay and expenditures at the destination [19]. The higher expenditures benefits the entire tourism industry and may generate new jobs [19]. However, Zervas et al. [6] show that P2P accommodation negatively affects lower-priced hotels not catering business travelers. Therefore, the marginal effect of P2P accommodation decreases as its size increases [20]. This is aggravated by the fact that most jobs which are created by these services are part-time employment [8] and are often described as “precarious and grey workforce” [5].

Ecological impact. Sharing Economy services in general are said to reduce waste and carbon emission, as compared to traditional businesses [3, 21]. Furthermore, it should

result in a more efficient use of resources [22]. However, lower prices of providers and increased supply may lead to higher consumption which would compensate the claimed positive effects on emissions and waste [8]. From a tourist perspective, the increased travel frequency caused by P2P accommodation may lead to an increased resource exploitation and overcrowding in certain destinations [19].

Social impact. Besides economic and ecological impacts, the literature states that Sharing Economy users aim for new social connections [23]. A variety of studies found that the Sharing Economy conveys the perception of belonging to a community [11, 24]. P2P accommodation services satisfy in many cases this need by facilitating direct interactions with the host and hereby ease the access to local communities [25]. Renting a shared room may yield a more intense social interaction with the hosts, compared to renting an entire house or apartment [19].

3 Research design

3.1 Research methodology

We draw on a multiple-case study approach to uncover the impact of the Sharing Economy and to derive recommendations. This method is particularly suitable in this context for three reasons. First, it is in line with our goal to derive an in-depth understanding of the impact of the Sharing Economy [26]. Second, the case study approach is particularly suitable to investigate how and why certain impacts of the Sharing Economy occur and to derive recommendations for regulations, platform providers, and users of these services [26]. Third, we are able to triangulate our insights by combining multiple sources of evidence [27] such as interview data and other available documents (e.g. reports) of different tourism and hotels associations.

We follow a multiple-case study design [26] with an interpretive stance to understand the phenomena by exploring the subjective and intersubjective meanings of participants when they interact with their environment [28]. We are conscious that the investigations are shaped by predefined beliefs, interests, and values of the researchers [29]. With our multiple-case study approach and the interpretative stance we are able to deeply understand the potential impact of the Sharing Economy in the context of accommodation sharing without manipulation or explicit control of variables [29]. The collection of data from multiple organizations supports us in studying the phenomenon in different settings and enables cross-case analysis [26].

We choose the positive and negative impact of the Sharing Economy on the economy, on the environment, and on the society as unit of analysis to derive recommended actions for regulations, Sharing Economy platform providers, and users of these offers.

3.2 Data collection and analysis

For our study, we confine on one of the fastest-growing types of sharing economy services, namely P2P accommodation [9]. By focusing on one sector, the interviewed associations are comparable in their environmental setting. We collected data from 13 tourism associations as well as three hotel and restaurant associations representing the German hospitality sector. As they stand in for the flourishing of a region they have a deeply grounded view on P2P accommodation and observe it practically. In their role as overarching industry proxies, they collect and integrate the perspectives of all involved parties in their area and, therefore, are excellent objects for uncovering the impact of P2P accommodation. Each is responsible for the tourism marketing in their region. However, the associations differ regionally and, therefore, represent different types of tourism (e.g. city vs. nature tourism), allowing us to uncover the impact of P2P accommodation in different settings by cross-case analysis. At the same time, agreement between different associations points towards possible paths on how to reduce negative and foster positive impact for the region, hosts, and individuals. We combined different sources of evidence and triangulated interviews with presentations and reports of the associations and data extracted from news and websites.

We developed a semi-structured interview guideline [27, 30] with 64 questions based on the literature on the potential impact of the Sharing Economy [6, 19, 20, 25, 31], surrounding conditions [22, 32, 33], drivers and motives of the Sharing Economy [11, 24, 34]. This guideline was used to conduct 16 semi-structured interviews with top level representatives of the respective associations. The interviews, with an average length of 42 minutes, were recorded, transcribed, and coded.

We first coded the interviews regarding potential impacts of the Sharing Economy, based on the different areas of impact (economic, ecological and social). Then we explored who is affected by this impact and derived three different actors: the society, the tourism market, and users of Sharing Economy offers. Based on the consensus among different approaches named by the interviewed stakeholders as potential solutions for these effects, we finally derived six applicable recommendations to positively shape the effects of P2P accommodation and show how regulations, platform providers, and users could contribute to these actions.

4 Findings

This section describes the findings of our analysis. We structured our results according to the three affected parties (society, market, and users).

4.1 Impact of the Sharing Economy

Impact on society. Our analysis indicates that P2P accommodation has both positive and negative effects for the society. P2P accommodation services seem to attract new guests in a specific region. This is triggered, on the one hand, by providing further accommodation options to tourists who cannot, or are unwilling to stay in hotels. On

the other hand, P2P accommodation services increase publicity to less well-known regions, in particular, for rural areas and tourism with natural heritage:

"It is certainly positive that one [thus] reaches target audiences, which one wouldn't reach otherwise. […] The success of Airbnb, or also of Wimdu, shows the potential [of these new types of hospitality]." (I2)

In line with the findings from Tussyadiah and Pesonen [19], our analysis denotes positive economic side effects: an increased amount of visitors leads to an increase in touristic consumer spending (e.g. for dining out, museum visits, etc.):

"But at least the other parties that participate in tourism, namely, the guests will eat out, go out for drinks. […], this will have [positive] economic impact." (I2)

Third, in rural areas, private rental is an important part of the economy [35]. Yet, in many of these regions, private rental is declining. P2P accommodation services help to compensate this trend, to preserve the rural structures, and the village life by leveraging the above mentioned economic side effects:

"Airbnb helps to compensate the declining offers of private accommodation. It is important that private accommodation exists. Especially, rural areas with traditional structures need holiday guests to keep up these rural structures." (I10)

Besides positive effects, the Sharing Economy also bears negative economic effects for the society. Critics claim that Sharing Economy suppliers (e.g. hosts) actively bypass existing regulations [7, 8]. Some, for instance, do not adhere to applicable safety rules (e.g. fire protection) [22, 36], or avoid taxes and further royalties (e.g. visitor's tax) [37]. The missing transparency and the lack of cooperation of P2P accommodation services impedes the work of tax authorities and control organizations which leads to tax losses and even conscious delusion of tax authorities:

"These [nights' stays] are missing in taxes. This means, the profit is taken from the destinations. […] We know of apartment blocks, which have fantasy doorbell nameplates, to confound the tax authorities." (I3)

Impact on the tourism market. Offers in P2P accommodation also have implications for the tourism market. By leveraging technology, the Sharing Economy facilitates new ways of how goods and services are offered [38] and leads to an increased competition for existing market participants [4], which will be beneficial for the market since the hotel industry now has to compete with innovative services:

"Prices and accommodation became more transparent. This might lead to bandwagon effects [that hosts need to modernize their holiday apartments]. […] Landlords of holiday apartments in our area are fully loaded at the moment, they have not yet come to the conclusion that they need to change." (I11)

Again, these positive effects are confronted with negative effects. We discussed how the breach of regulations negatively affects the society. Yet, it also distorts the competition. By ignoring regulations, P2P accommodation offers gain competitive advantage over competitors [22] and, consequently, can offer lower prices than the traditional businesses [8]. This applies in particular in times of high demand:

"Throughout the year we don't have problems. But with certain events (e.g. the Oktoberfest), […] a lot of people offer their own sleeping rooms, […] this forces us to reduce our [otherwise increased] prices." (I12)

Impact on users. Apart from the impact on the society and the market, our analysis denotes impact for consumers and providers of Sharing Economy services. If private individuals become a potential peer provider for goods or services, the supply capacity increases drastically [5]. This increased supply encompasses not only offers similar to existing ones, but also an extension to the existing portfolio:

"Take the [name of exhibition]. […]At that time, [the city] is fully occupied. […] Naturally companies come up with the idea to have a look at Airbnb." (I3)

The Sharing Economy claims to increase the social interaction among the involved actors [25]. Our analysis indicates that, if hosts act as tourist guides or do share their apartments with the guests, P2P accommodation can indeed increase the social interaction. However, this effect decreases with an increasing frequency of renting:

"I am certain that some people enjoy hosting guests three or four times a year, and to show them around in the city. […] But they won't do this twice a month."(I9)

Likewise, if the host is neither sharing the apartment with the guests, nor acting as a local guide, the positive social interaction may reverse in even more anonymity, than in hotels, where one at least regularly interacts with staff.

Finally, the issue of the digital divide in the context of the Sharing Economy needs to be discussed [39]. Some private lenders and renters are without the necessary access (e.g., due to lack of knowledge or infrastructure) to those technologies which are necessary to participate in the Sharing Economy. This could lead to crowding out of traditional private renters and lenders of holiday flats:

"We observe a predatory competition. […] Grandmother Jane Doe is, naturally, not connected to digital platforms." (I11)

Finally, Sharing Economy platforms claim to be solely intermediaries and not the provider of resources. Thus, they do not assume any liabilities, which leaves any risks with the individual providers and consumers (consciously or unknowingly) [8, 22]:

"Hosts often don't even know which risks and which insurance risks they take." (I3)

4.2 Recommended actions

This section describes a solution-oriented approach to overcome the previously discussed negative effects of P2P accommodation and to promote the positive effects.

Improvements of infrastructure. One way of facilitating the positive effects of P2P accommodation is to improve the public transport infrastructure. This includes an extension of the public transport, for instance, by carsharing with participation of municipalities to avoid the necessity of arriving with own vehicles in a tourist region:

"Nowadays it is desired that guests also use trains. […] With the help of the visitor's tax, it is possible to rent a car […] for free [in certain regions]." (I11)

Some regions in Germany still have limited access to broadband internet [40], which increases the negative effect of the digital divide. There is an ongoing debate in German Federal ministries how to accelerate the roll-out of broadband internet access [41], since the improvement of infrastructure lies in the responsibility of regulations and telecommunication providers and can facilitate the distribution and scope of the Sharing Economy, while mitigating the effect of the digital divide.

Better controls instead of more regulations. There is a variety of sources claiming that further regulation of P2P accommodation is not necessary, since market failures will regulate themselves [5, 7, 8, 42]. On the one hand, many sharing platforms check their users before entering their network and sort out automatically any black sheep of the actors after incidents through rating and feedback systems [8, 38]. On the other hand, the transparency enabled through information technology decreases the chance for undesired behavior [38]. The majority of our interviewees agrees that existing laws are sufficient for fair competition, as long as these are generally enforced:

"As a hotel, you have to provide two emergency exits. […] In a private holiday flat, you are left without any emergency exits. […] We don't need to curtail the Sharing Economy, but it should adhere to the same regulations as others." (I3)

For real private offers (e.g. if the host shares, from time to time, his or her apartment with guests), no tax problems arise, since these hosts don't have to pay taxes:

"Municipalities say that as long as the host remains in the apartment, we will tolerate these sharing models. […] in [all] other cases they step in."(I3)

A more problematic situation arises for offers that are actually commercial, but operate under the smoke screen of private rentals. Therefore, clear boundaries for private rentals have to be defined, and effective control mechanisms established:

"Overregulation is completely unnecessary. We need clear boundaries for private and commercial activities. Thresholds could help […], but the best regulations will achieve little, if the market is not audited."(I9)

In the long run, if these regulations are enforced, the market will regulate itself:

"For many hosts, renting out flats is only profitable in a gray area. […] If certain regulations have to be met, then these offers would certainly be culled." (I8)

It's the government's duty to assure that regulations are met by intensifying controls. These controls create political pressure for platform providers and could convince them to cooperate with the government. In the long run, this leads to an increased transparency on the market mentioned in the next paragraph.

Increasing transparency. An increased transparency concerning P2P accommodation offers and the numbers of users could contribute to both, society and platform providers, as it could mitigate the circumvention of taxes, by ensuring that tourists are registered and, consequently, pay their visitor's taxes and further royalties:

"Obliging platform providers to certain transparency towards authorities, […], so that taxes are paid on commercial activities. […] Airbnb already moves a little […], yet it is still not ready to provide municipalities with their user data." (I6)

For the provider of the sharing platform, an increased transparency helps to transform the business into a sustainable business, in particular in terms of scalability:

"[More transparency] would facilitate a fair trade. […] Especially if one wants to grow and expand […] it is sensible to cooperate, to reach, with refreshed and rejuvenated established concepts, further positive effects for the market." (I6)

Third, visitor's tax and other royalties are a necessity for municipalities to preserve the touristic infrastructure. Thus, if sharing platforms facilitate the comprehensive evasion of taxes and royalties, this would, in the long run, contribute to a deterioration of the local touristic conditions and, therefore, reduce the attractiveness of a region:

"The landlord needs to complete a federal registration form for each guest. I don't know whether the tax, which is essential for the survival for the touristic infrastructure, is deducted in all cases [of P2P accommodation offers]." (I11)

Besides the mentioned political pressure, cooperation of the platforms in form of providing data on offers could contribute to increased transparency and could transform the business from a legal grey area into a sustainable business.

Comply with existing policies. A trivial approach to overcome the majority of the negative impact of the Sharing Economy is to comply with existing policies. This includes that both platforms and users observe applicable laws and regulations to eliminate the distortion of competition and to create fair conditions for all:

"Airbnb became a professional business, thus, one needs to take care that all participants have to adhere to the same regulations." (I4)

One way to achieve compliance with policies, is to offer an incentive for users:

"Some [regions] introduced clever guest card systems, which created a large covetousness by the guests. This card permits free entrance to mountain railways, swimming pools […] and led to a strong increase in paid visitor's taxes." (I10)

Increased controls could contribute to the compliance of users. For the platform, the transformation into a sustainable business and the increasing professionality of offers entails compliance with existing regulations. From a consumer's perspective, certain incentives can improve compliance with existing policies (e.g. discounts).

Assure quality of offers. Besides complying with the policies previously mentioned, the quality of the offered accommodation should be assured:

"We, as a destination, have certain quality requirements. […] It is not about offering just anything. We want to convey a positive image." (I5)

The assurance of the offered quality should not only avoid negative effects on prices and prevent a race to the bottom, but also ensure that the image a tourist destination wants to create and transfer to its guests corresponds to Sharing Economy offers, in particular private rentals. The following quote highlights this issue:

"We pay attention to this [quality], […] if you suffer from a reputational damage, as a tourist region, then it takes a long time before you can catch up." (I11)

Besides actions triggered by regulations, the increasing professionality of P2P accommodation services forces platforms to ensure the offers' quality, since the majority of users demand a certain standard of quality.

Increase responsibility. Another approach to overcome certain negative effects of P2P accommodation is to express the responsibilities for platforms and users more clearly. On the platform side, an increased responsibility to clarify rights and duties of guests and hosts would contribute to a more enduring business. First, as mentioned above, if the business grows the transfer of royalties for P2P accommodation offers needs to be assured. Second, platform providers should understand their responsibility to inform users and to assure legal royalties. For the platform, it's advantageous to control for duties and constraints of users, before municipalities intervene:

"It is now on the [holiday home] suppliers to make the next move, and naturally on the platform providers, […] who should assign duties to their [holiday home] suppliers, before the municipalities pass corresponding laws." (I3)

The duty of the platform to inform users counters to the unconsciously taken risks, mentioned above, and at the same time, serves as safeguard for the users:

"Hosts often don't even know which risks they take. […] If something happens, then they are left out in the rain. […] Here we need improvements. […] It is the same with carsharing, [but] there we have indemnity insurances." (I3)

By informing the users on their duties, the platform calls attention to the host's responsibilities for the guests and the society, in particular with an increasing professionality of offers. If the platform wants to operate a sustainable business, it has to be aware of its responsibility. The same applies to the user's side. By being aware of risks and duties, the host should realize that the guests' wellbeing is very important. For consumers, an increased awareness of the risks will make them demand certain safety and quality standards from their host.

5 Discussion and conclusion

We provide insights for the effects of the Sharing Economy on the tourism industry. Our analysis shows that P2P accommodation has both positive effects (e.g. increasing the attractiveness of a destination) and negative effects (e.g. distortion of competition by undercutting regulations) on the tourism industry. We recommend six actions to positively shape the effects of P2P accommodation. Some of these can be triggered by regulations, whereas others are dependent on platform providers and users.

Our cross-case analysis indicates that these impacts differ depending on the type of accommodation sharing and the geographic region of the destination. In contrast to other studies social effects of P2P accommodation [25], we found that a positive social impact solely arises if the host truly shares the apartment. However, if the host is neither sharing the apartment with the guests, nor acting as a local guide, this effect may reverse in even more anonymity, since users have less interaction with staff than in hotels. Contradicting to studies on negative economic effects [6], we found that effects differ regionally. Rural tourism destinations welcome the advent of P2P

accommodation, since these regions were highly dependent on the rental of private accommodation in the past. Therefore, the Sharing Economy contributes to the existence of these areas by leveraging economic side effects. However, for urban areas and destinations with hotel tourism, a more negative picture of the Sharing Economy is drawn, as it is doubted that all taxes and duties are paid.

This study aims to contribute to research in two ways: First, we enrich the understanding of potential impacts of the Sharing Economy by providing qualitative empirical data from the tourism industry. The more fine-grained examination on the impact of the Sharing Economy shows that, although focusing the investigation on P2P accommodation, the overall effects of the Sharing Economy not only depend on the type of sharing (e.g. carsharing or accommodation sharing), but also highly differ regionally. Second, we provide avenues to overcome the negative effects and highlight how each party (regulations, platform providers, and users) can contribute to these issues. We show that not only the government and platform providers, but also users could serve as a trigger for better and fair conditions in the Sharing Economy.

Still, we need to acknowledge some limitations to our study. First, we focused on P2P accommodation in Germany. As mentioned above, the results might be different for other types of sharing (e.g. carsharing) or other countries. However, we choose a sample within the same industry and regulatory system to ensure the comparability of the findings. Second, we follow a qualitative approach with an interpretive stance. We recognize that reality is socially constructed, and that the collected data is subject to human interpretation. Accordingly, instead of aiming at generalization, we contribute to the understanding of the Sharing Economy in this specific context [30].

P2P accommodation sharing has without doubt positive impacts on an economic and social level. The analysis with focus on one type of the Sharing Economy and the incorporation of regional differences allowed us to gain a deep contextual understanding of impact and possible actions. In contrast to common belief, our findings suggest that the executive could facilitate those positive impacts and mitigate the negative ones without necessarily imposing bans or adapting existing regulations.

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Towards a taxonomy of algorithmic attribution models – Which is the right model to measure, manage and optimize multiple campaigns?

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Abstract. Algorithmic attribution describes the attribution of marketing value to various channels in an algorithmic or statistical way. This discipline is growing in importance rapidly. This growth is due to an increasing number of potential advertising channels, with an increasing ability to track users along the whole customer journey. In this research in progress paper we develop a morphological box of the various algorithmic attribution models. This box is meant as a first step in the iterative development of a full taxonomy, which we intent to use to identify which models various attribution vendors use. This taxonomy will also be useful for the future development of marketing attribution solutions.

Keywords: Marketing Attribution, Taxonomy, Multichannel Marketing, Web Analytics, Multi-touch attribution

1 Introduction

It is expected that online advertisement will surpass TV commercials in terms of advertisement spending in 2017 for the first time [1]. With Google Adwords as one of the major providers being already for nearly 17 years on the market, online advertisement is not a new phenomenon [2]. However, the rapid growth of the market creates a highly versatile environment. Online marketers have a multitude of tools at their disposal, from which they can not only chose, but use many simultaneously. Additionally, in the digital environment, users can be tracked along the whole customer journey. Marketers know through which online channels customers came to the desired website. This data rich situation leads to new tasks for marketers. When a customer came to the website first through a search campaign, then a display campaign and lastly through e-mail advertisement to finally purchase, the marketer must decide to which of these channels the success should be attributed. Industry standard are heuristic attribution models like “last click wins” or “first click wins”. These attribute the success according to intuitive rules that don’t reflect the reality.

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Particularly, these models have no direct connection to the individual customer journey as they are based on assumptions rather than statistical analysis of each separate touch point [3]. In response to this lack of proper attribution, both academia and professionals started to develop algorithmic attribution models. This rather young trend caused, however, a lot of confusion. While there are already plenty of vendors who offer data driven attribution, most vendors stay purposely unprecise when describing their algorithmic attribution models, calling them data driven, algorithmic or artificial intelligence, expecting the customers to treat these algorithms as black boxes. For example they describe their approaches as follows:

- "Leverage advanced statistics and machine learning to objectively determine the impact of each marketing touch…" [4] or
- "AI-powered attribution attempts to fix this very problem using scientific and proprietary algorithms to allocate credit based on statistics and not human opinion. " [5]

Understandably, vendors try to obscure to some degree how exactly they attribute credit across the marketing channels as a good approach is a competitive advantage within this industry. However, it is a reasonable desire for researchers and for potential customers to get a better idea of what happens within those black boxes. This research attempts to build a taxonomy of algorithmic attribution models, based on academic literature and information attribution vendors share on their websites, technical documentation or other publically available marketing material. The developed taxonomy shall then help to identify the used approach of every vendor within our sample. As means to this end, we want to answer the following two research questions (RQ):

> RQ1: What are dimensions and respective characteristics that differentiate different algorithmic attribution models?

After the first question is answered we will use the created knowledge to answer

> RQ2: Which algorithmic attribution models do attribution vendors actually use to measure, manage and optimize multiple campaigns?

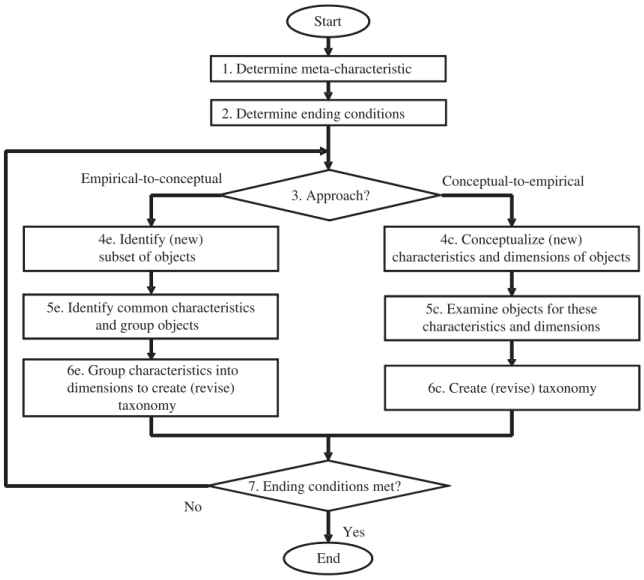
2 Building the taxonomy

2.1 Taxonomy Development

The taxonomy is developed, applying a structured approach developed by Nickerson et al.[6]. This is to our knowledge the first structured approach to taxonomy development within the IS community. Especially its iterative nature with clear ending conditions appeals to us as it has already been successfully applied by several

researchers [7, 8]. Figure 1 shows a schematic description of the taxonomy development process.

Figure 1: Taxonomy development process [6]



Meta Characteristics. The first step is to define meta-characteristics. These should be defined based on the later use of the taxonomy. As mentioned earlier, this taxonomy is meant to help identifying which approach vendors use for their attribution modeling. To this end, we will try to identify what kind of data the vendors need to collect and what kind of data / information they provide as a result of their modeling. Respectively the meta characteristics will be the input and the output of the attribution approach.

Ending Conditions. The second step in the development process is the definition of ending conditions. We opt for two objective ending conditions

1. No new dimensions or characteristics were added in the last iteration
2. No dimensions or characteristics were merged or split in the last iteration

Approach. The third step is to decide whether to use the empirical-to-conceptual or the conceptual-to-empirical approach. In this research in progress we begin the development by applying the conceptual-to-empirical approach, building on the authors' knowledge and experience.

2.2 Academia as Data

To identify all models currently discussed in the academic literature, we performed a literature search, based on suggestions by Webster and Watson [9]. Therefore, we began with searching major databases (i.e. Google Scholar, Ebsco Host, Web of Science, ieeeXplore) for the search term "multi touch attribution" which lead to a total number of 78 results. After screening the abstracts for relevance for the taxonomy, we identified 27 papers. Papers that describe algorithmic attribution models in a detailed manner were included, while papers that rather discuss algorithmic attribution in general or the respective implications were excluded from the sample. In the second step, we performed a backward search by scanning the bibliographies of the identified articles and scanning forward with the help of Google Scholar. This way, we identified additional 10 papers, resulting in a total sample of 37 articles. All identified articles fall into the years 2010-2017. This was not set as a frame but happened due to the novelty of the topic. This novelty motivated us, not to limit the literature in terms of publication type, but rather make the inclusion - exclusion decision based on the papers content. Therefore three papers included are not peer reviewed, but published in the SSRN Electronic Journal [10–12]. Table 1 lists the proposed approaches with the respective references.

Table 1. Algorithmic attribution models derived from scientific literature

Approach	*Sources*
Time Series (Mutually exciting Point Process)	[13]
Time Series (Survival Theory)	[3, 14–17]
Time Series (Structured Autoregressive Model)	[18]
Counterfactual Framework	[19, 20]
Logistic regression	[21]
Bayesian statistics	[22]
Markov Model	[23–25]
Shapley Value	[12, 26, 27]
Sequence mining	[28]

2.3 Vendors

The vendors were identified using the business software review site G2 Crowd [29]. Within the category "Marketing Attribution Software" there was a total number of 32 vendors listed. To be listed on G2 Crowd vendors must "Use multiple attribution models like single touch attribution (when all attribution is assigned to only one event), fractional attribution (to include multiple events in the attribution, with equal or different weights), or algorithmic attribution (which uses data science for advanced attribution criteria and models)" [29]. However, for this research only vendors that offer algorithmic attribution are included in our sample. After screening their websites, we identified a total number of fourteen vendors that offer some form of algorithmic attribution. From those fourteen vendors five either explicitly or implicitly hint their approach, while the other nine keep their description rather vague.

Table 2 lists the fourteen vendors and when possible the most likely approach they apply.

Table 2. Attribution vendors with algorithmic attribution offers

Vendor	*Website*	*Approach*
Abakus	abakus.com	Shapley Value
Datalicious	datalicious.com	Hidden Markov Model
Optimine	optimine.com	Time Series Analysis
Neustar	neustar.biz	Logarithmic Regression
c3metrics	c3metrics.com	Bayesian Model
LeadsRX	leadsrx.com	-
OWOX	owox.com	-
VisualIQ	visualiq.com	-
Adinton	adinton.com	-
Converto	converto.com	-
Google Attribution	google.com/analytics/	-
Kvantum	kvantuminc.com	-
ConversionLogic	conversionlogic.com	-
ZetaGlobal	zetaglobal.com	-

2.4 First iteration and morphological box

For the first iteration we chose a conceptual-to-empirical approach, utilizing our knowledge of the topic. As a result of this first iteration, we identified five dimensions with two to three characteristics each. To validate the idea of this paper at an early stage, we built a morphological box to place three algorithmic attribution models therein. We opted for the development of a morphological box at this stage, as a method to foster creativity, given the less strict requirements towards a morphological box compared to a taxonomy.

Table 3: Morphological box (green: Shapley, red: Sequence mining, blue: Survival theory)

Dimension	*Characteristic*		
Time dependency	No time dependency	Time dependent	
Granularity input	Touchpoints	Ordered touchpoints	Every single Journey
Granularity output	Channels	Sequences	Every single Journey
Prediction qualities	No prediction	Probability of conversion	Probability of every possible next step
Inclusion of additional Data	No inclusion	Inclusion	

The lowest granularity means that all journeys with the same touchpoints are summed up, irrespective the order they occurred. Models that take ordered touchpoints as input, sum up all journeys that have the same touchpoints in the same order. Models that require the highest input granularity, need every single Journey and analyze them potentially with additional information.

3 Implications and Future Work

In this research in progress, we start to develop a taxonomy of algorithmic attribution models. As a firsts result in this iterative development process we present a morphological box and place three approaches that we identified within the academic literature. This box can already be used to differentiate between the various models and help deciding which model to focus on. From here, several more iterations have to follow to build a strict and clear taxonomy. With the results from the first iteration, we are confident that we will be able to build a comprehensive and useful taxonomy.

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Critical Success Factors for the Implementation of the No-Line-Concept in the Context of the Austrian Consumer Electronics Sector

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Abstract. This paper explores critical success factors for the implementation of the No-Line-concept set in the context of the Austrian consumer electronics retail sector. The factors Multi-Channel Integration Service Quality (MCISQ) and Mobile Service Quality (M-S-QUAL), which both had already been tested earlier, were incorporated into a combined research model aiming to integrate different perspectives of No-Line. Based on a questionnaire completed by 105 Multi-Channel-experienced customers of an Austrian consumer electronics retail store, factors were investigated upon their influence on customer loyalty. Through a PLS path model, we found that MCISQ and M-S-QUAL together account for 44.8% of the variance in customer loyalty, and that 22.7% and 52.9%, respectively, have a significant influence on this dependent variable. Concluding it seems that today's customers are mostly ready for No-Line-Commerce and that the concept is generally feasible.

Keywords: No-Line-Commerce, Multi-Channel-Integration, Customer Loyalty, Multi-Channel Integration Service Quality, Mobile Service Quality

1 Introduction

Based on a market survey conducted by SME Research Austria, the Austrian stationary retail marked realized some EUR 66.3 billion in 2015, which represents a nominal sales development of + 1,1% compared to the preceding year [1]. Within the same period, the revenues of Austrian internet retailers nominally rose by + 7% (i.e. up to EUR 3.3 billion), accounting for approximately 5% of Austria's total retail volume in 2015. Within the last decade, Austria's share of online buyers skyrocketed, moving from 1.8 million in 2006 to 3.7 million in 2013. Today, approx. 57% of all Austrian citizens aged between 16 and 74 years have already been purchasing goods online [2].

With an average stake of 22%, the consumer electronics sector is prominently present in all three forms of distribution markets; i.e. bricks & clicks, clicks & sheets, and internet-pure-players. Consequently, it qualifies as a valid stratum to investigate a potential change in the industry [3]; one where the so-called No-Line concept may play

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a major role. According to today's predictions [4], the 8% average growth rate in sales seen with European online retailers will lead to an overall online share of 30% by 2020. In addition, approximately 20% of all in-store purchases will be either "online-induced" or "online-accompanied". This development entails the growing importance of Multi-Channel Marketing and Multi-Channel-Management so as to ensure that a customer's "cross-channel free riding behavior" does not lead to a loss in customer loyalty [5]. In order to provide flexibility as well as independence from business hours or store locations, retailers increasingly seek to gradually integrate their distribution channels. No-Line, the Multi-Channel concept which requires the highest level of channel integration [6], aims at providing a consistent customer experience across channels. That is, it should feel as if buying from one and the same entity, no matter how individuals combine different channels throughout the buying process. An adequate, customer-oriented implementation and operation process, which integrates Multi-Channel Integration Service Quality (MCISQ) as well as Mobile Service Quality (M-S-QUAL), may thus be seen as a critical success factor for this concept.

2 Relevant Theories and Research on the Evolution of Multi-Channel and the Success Factors of No-Line

2.1 Multi-Channel-Evolution

The Multi-Channel concept has been developed as part of the retail marketing landscape [7]. Formerly known as Multiple-Channel, it is mainly characterized by two or more uncoordinated but coexisting distribution channels [8, 9]. Cross-Channel as well as Omni-Channel represent more advanced levels of the Multi-Channel concept and are primarily targeting the customer's desire to use different channels in combination (i.e. they support "channel-hopping") and his/her increased information requirements [10] (although this development is varying among different product categories [11]). While in general Omni-Channeling is defined by a more integrated linkage of all customer contact points [3] and the aim to optimize the customer experience and revenue across all channels [12], it is ultimately characterized by the transition from a sequential customer journey to a parallelization of activities [13, 14]. Omni-Channeling therefore serves as a fundamental requirement to move to the so-called No-Line concept, which aims at maximizing the channel integration [15]. Such is driven by an increased mobile device usage (e.g. Smartphones and/or other portable smart devices [6]) and thus by a greater mix in buying process stages (both chronological and location-wise) [16].

2.2 Changes in the Customer Process

No-Line-Commerce highlights apparent changes happening to the buying process due to the Internet and its extensions. In particular, the disengagement of the Point of Decision and the Point of Sales [17], the consequent adaptation of stores and distribution channels into showrooms [6, 18], and the imperative demand for a sound

balance between “channel cannibalization” and “cross-channel free riding behavior” is what increasingly defines customer loyalty. As integration and mergence are primarily caused by harmonization (which is inevitably necessary so as to define a retailer´s No-Line readiness [6, 19]), van Baal found that a rise in such leads to a higher cross-channel customer retention, which also outpaces the simultaneously increasing cannibalization effects [20]. We might thus conclude that a better coordination of a retailer’s different channels also increases customer loyalty and cross-selling opportunities, and may consequently lead to a growth in sales. Although, the strength of this effect is extenuated with firms that have a strong focus on one specific channel [21].

Building on these rather generic implications, Emrich et al. focused their attention on the relation of channel structures and compared them to assortment structures. In doing this, they found that a complete integration of a retailer’s channels is only beneficial if their assortment relation is substitutive or complementary. Yet, it is rather inferior for independent assortments, typical for department stores [22]. This behavior is based on the lack of competence customers attribute to this retailer type [23] and furthermore demonstrates that a customer’s product evaluation efforts are limited by physical as well as by cognitive search costs [24], making channel and assortment coordination a crucial part of No-Line commerce.

Building on these findings, the goal of our research was to harmonize and integrate perspectives. As a basis we used Heinemann’s 7M Success Factors in No-Line Commerce [6] whose core is constructed around the four dimensions of Multi-Channel Integration Service Quality (MCISQ) [25], and the four dimensions of Mobile Service Quality for Physical Products (M-S-QUAL) [26]. As for a test region, we focused on the Austrian consumer electronics sector, where we distributed a model-driven questionnaire survey to explore relevant No-Line success factors from a customer’s point of view.

3 Methodology

3.1 Measurement of Variables

Multi-Channel Integration Service Quality (MCISQ): MCISQ was measured via the four dimensions of Multi-Channel integration quality proposed by Sousa & Voss [25]. Their study concluded that Multi-Channel quality consists of two main dimensions, namely the channel-service configuration and the integration of interactions. Channel integration, in particular, was found to affect a customer’s service quality perception and not just influence the intersection of his/her perceived in-store and online service quality. Such also implicates that this type of integration acts as a key quality component, which should be implemented using a customer-centric service design so as to overcome potential organizational barriers of grown Multi-Channel retailers. For more information on the resulting 14 questionnaire items which are further categorized within four dimensions, i.e. breadth of channel choice, transparency of channel service configuration, content consistency, and process consistency, please refer to the revised Multi-Channel integration service scale of Wu & Chang [27].

Mobile Service Quality (M-S-QUAL): M-S-QUAL is a measurement tool that specifically addresses smartphones and other ubiquitously available mobile devices as the key cross-technology platform for the development of No-Line-Commerce [28]. It considers mobile service quality an essential part of a customer's overall perceived service quality [26]. Analogous to Service Quality (SERVQUAL) [29, 30] and Electronic Service Quality (E-S-QUAL) [31], Huang et al. developed this model for measuring the service quality of physical and virtual product purchases, of which we incorporated the four physical product purchase dimensions, i.e. efficiency, fulfillment, contact, and responsiveness, adding up to a total of 15 items. The conclusions from Huang et al. explicitly add value to our work as they explain that businesses should rely on standardized mobile purchase processes (particularly with physical products) so as to not keep customers from buying mobile due to differences in given transaction processes (like it is the case for virtual products purchases). These findings are in line with those of Gao et al., who note that mobile customers expect the purchase process to be fast and to require little effort while displaying only up-to date and relevant information [32]. Additionally, they note that the traditional concept of service quality needs to be redefined in a commerce environment increasingly characterized by mobility, and that M-S-QUAL is the first framework which explicitly recognizes the differences between mobile purchases of physical and virtual mobile product [26].

Customer Loyalty: Generally defined by the framework of Dick & Basu [33], and then further specified towards the requirements of Multi-Channel commerce by Wallace et al. [8], customer loyalty was measured with the same three questions used in the work of Qi [34] that, for their part, are based on the results of studies on Multi-Channel loyalty intention by Lee & Kim [35] and Oliver [36].

3.2 Delimitation and Stimuli

In order to guarantee the credibility and comparability of results the product-group specific focus was set on the consumer electronics sector. This choice was further motivated by previous research showing that the share of people described as Multi-Channel enthusiasts is high in this field [37] and that the sector is known for its high Multi-Channel efforts [16]. Therefore, the questionnaire survey was distributed to customers of an Austrian consumer electronics store who had just completed a ROPO-purchase process. They received a printed information letter alongside their invoice when picking up their online ordered product in store. This procedure ensured that all participants were to some extend Multi-Channel-experienced, which we may derive from their awareness for certain advantages of that type of buying process, e.g. the benefit that the offline channel adds to an online transaction and vice versa [24]. These customers were also more likely to be interested in expressing their opinions, as our questions might have covered some of their pre-purchase considerations.

The survey consisting of 35 question items (14 MCISQ items + 15 M-S-QUAL items + 3 LOYAL items + 3 demographic items) was accessible either through a QR-code or through a link, both depicted directly on the printed information letter. All questioner

items were adopted from previously published research (cf. Section 3.1), yet translated to German so as to fit the target group (note: translation-back-translation procedure was applied [38]). Seven-point Likert scales were employed in order to ensure comparability to former studies (cf. [27, 34]).

3.3 Research Hypotheses and Model

Pre-stage demographic Hypotheses: Our general assumption was that improvements in service quality have a positive influence on customer loyalty [39, 40], which is why we determined MCISQ and M-S-QUAL as independent variables and customer loyalty (LOYAL) as dependent variable. In addition, we assumed an impact of the three demographic segmentation variables age, education and welfare as proposed by Konus et al. [24], who analyzed various studies regarding the effect of demographics on Multi-Channel commerce.

Research Model: In order to evaluate the above described assumptions we used a Partial Least Squares Structural Equation Model assembled with SmartPLS V3. This allowed for the analysis of a potential relationship between MCISQ and M-S-QUAL, looked at from a customer's point of view and expressed by their respective influence on LOYAL. The main hypotheses to evaluate were:

H1: MCISQ has a positive impact on customer loyalty
H2: M-S-QUAL has a positive impact on customer loyalty
H3: MCISQ correlates with M-S-QUAL

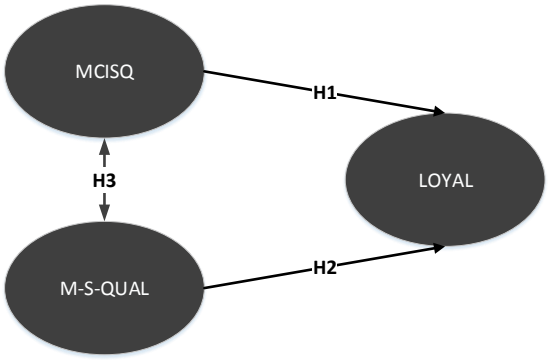


Figure 1. Research Model of Hypotheses H1-H3

4 Results

4.1 Demographic Impact

Based on the design of the study we had to rely on the experience of previous research in the field of Multi-Channel and electronic goods regarding the composition of the participants. The sample was collected over one month (March 2017), generating 105 valid record sets (123 total responses). To test for significance we used an ANOVA. Normal distribution and reliability were tested following the suggested approach by Brown [41]. Both Variables proved eligible (MCISQ $\overline{x}$ = 4.85; s = 0.86; Asymp.Sig. (2side) = 0.19; C.A. = 0.85 and M-S-QUAL $\overline{x}$ = 5.31; s = 0.69; Asymp.Sig. (2side) = 0.2; C.A. = 0.86), with only the disposable income showing a significant impact on M-S-QUAL: F(4/100) = 3.117; p = 0.018. **Table 1** illustrates the allocation of all those demographic variables, which were identified as having a significant impact on the evaluation of MCISQ in previous studies, and their corresponding values in our study.

Table 1. Impact of demographic variables

Variable	Allocation[1] (%)					Impact on	Impact on
	1	2	3	4	5	MCISQ	M-S-QUAL
Age	8.6	58.1	13.3	10.5	9.5	NS	NS
Education	5.7	26.7	61.9	5.7		NS	NS
Disposable Income	6.7	13.3	21.9	23.8	34.3	NS	+/-

4.2 Partial Least Squares – Structural Equation Model

Reliability and validity of the data for the PLS-SEM analysis was ensured by testing skewness and kurtosis for non-normal distribution, and EFA and CFA for multiple item constructs [42, 43]. The MOBFULL_2 loading (0.537) proved to be below 0.6 but was kept in the sample to enable further comparison and recognize possible translation issues (although the removal slightly increased the composite reliability).

As shown in **Table 2**, the traditional desired Cronbach´s Alpha of 0.7 [44] was not reached by all variables, however Hair et al. [45] suggest a Composite Reliability of at least 0.6 and a desired value of 0.7 to 0.9 [46] for PLS modeling. The MOBFULL AVE was below the recommended value of 0.5 [47] but was accepted in order to treat it similar to the way MOBFULL_2 was treated.

[1] Variable Characteristics:
Age (15-20; 21-30; 31-40; 41-50; 50+)
Education (Pflichtschulabschluss; Lehrabschluss/BMS; Matura/Berufsreife; Universitätsabschluss/Meisterprüfung)
Disponable Income € (-50; 50-150; 150-350; 350-700; 700+)

Table 2. Construct Reliability and Validity

Latent Variable	Cronbach's Alpha	Composite Reliability	Average Variance Extracted (AVE)
BREADTH	0.762	0.864	0.679
CONCONS	0.734	0.833	0.555
CONTACT	0.696	0.831	0.622
LOYAL	0.699	0.829	0.621
MOBEFF	0.808	0.868	0.571
MOBFULL	0.638	0.785	0.483
PROCONS	0.722	0.827	0.546
REACTION	0.798	0.882	0.714
TRANS	0.765	0.864	0.680

The discriminant validation did not pass all requirements defined for the pairing correlation of 0.7 [48] and was also lower than the AVE of the corresponding factor [47]. This only occurred in combination with the 2nd order variables MCISQ and M-S-QUAL and can thus be justified by the difficulty of assessing 2nd order variable models [49].

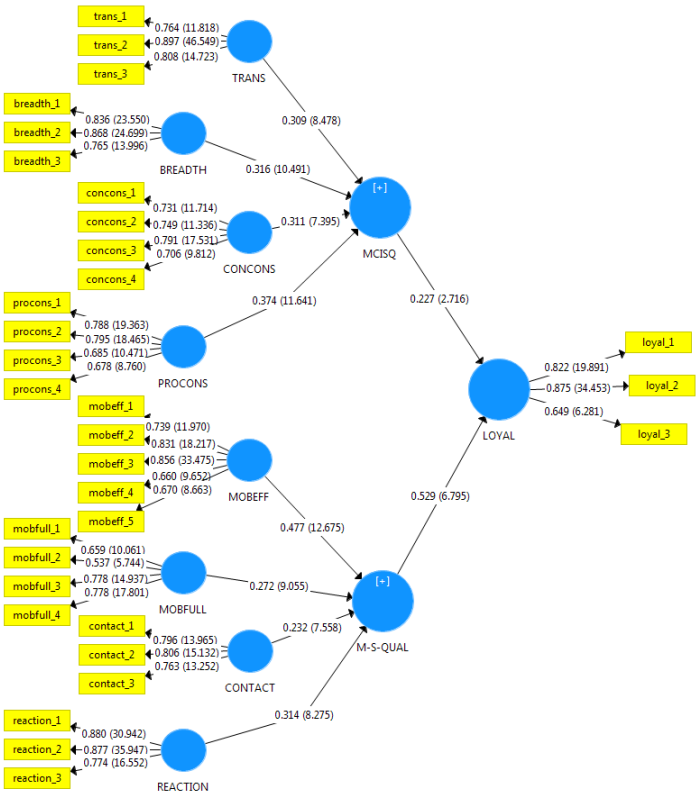


Figure 2. PLS-SEM Model

To measure the predictive quality of the model we used the Q^2 (LOYAL = 0,246, M-S-QUAL = 0,316, MCISQ = 0,321), as recent research has proven that the Goodness-of-fit Index (GoF) is inapt to distinguish valid from invalid PLS-SEM models [50].

Figure 2 shows the calculated PLS - SEM using Smart PLS V3 [51]. We used two tailed Bias-Corrected and Accelerated Bootstrapping (complete) with 5000 subsamples, no Sign Changes and a significance level of 0.05. The outer model displays the weights/loadings with t-values in brackets, the inner model the path coefficients and t-values. Showing a t-value > 1.96 for all path coefficients, we may assume significance on the specified level, with most of the weights exceeding the 0.001 threshold. Multi-Channel Integration Service Quality (MCISQ – 0,227) and Mobile Service Quality (M-S-QUAL – 0,529) both have a significant impact on Customer Loyalty and explain 44,8% of its variance.

The relationship between MCISQ and M-S-QUAL shows a significant medium correlation on the aggregate level ($r = 0,499$, $p < 0,01$) and we also see a significant strong correlation on the dimensional level, namely between CONCON and MOBFULL ($r = 0,525$, $p < 0,01$) and MOBFULL and MOBEFF ($r = 0,554$, $p < 0,01$).

5 Discussion

The continuous shift towards online and especially mobile shopping on the one hand and the increasing competition between former pure brick & mortar and today's online players on the other hand, forces market competitors to adopt customer preferences. This market evolution is best observable in a technology-driven environment, with many innovators and early adopters, like the consumer electronics market.

Previous studies centered on Multi- or Omni-Channel were focused on the company perspective and showed that the benefits of homogenous channel management surmounts its losses, effectively becoming one, if not the recommended driver for online success. From a customer perspective, especially for innovators and early adopters, multi-channel shopping transforms from a delighter to a basic need [52, 53] , which could be one of the reasons for the lower than expected importance of the MCISQ, particularly considering that all participants had recently completed a Multi-Channel buying process. As we have no data on how often the participants use a mobile device in general, and especially whether they use it to perform a buying process or parts of it (either at the reseller we studied or at a competitor), we cannot compare the impact of the participant's experience.

However, our results let us conclude that after reaching an acceptable level of Multi-Channel service integration users tend to focus on the actual channels (although such may require an additional investigation of companies having similar results for M-S-QUAL but offering less homogeneous channels). The correlation between mobile order processing and mobile efficiency seems reasonable, as the ordering process is part of the consumer buying process, which in our case was entirely supported by a mobile solution. The correlation between Consistency across Channels (CONCON) and Mobile Fulfillment (MOBFULL) indicates that people who trust the consistency across

channels are more likely to buy mobile because they avoid another evaluation phase due to channel inequalities like price segmentation or warranty and support issues.

Excluding MOBFULL_2 from the model (loading 0.537), as considered earlier, leads to a slightly higher reliability (Cronbach's Alpha 0.662; Composite Reliability 0.814; AVE 0.595). As a result, the path coefficients shift away from the corresponding factor (CONTACT +0.011; MOBEFF +0.024; MOBFULL -0.027; REACTION -0.002) with a non-significant impact on the predictive quality (M-S-QUAL R^2 0.995; LOYAL R^2 0.449).

To investigate the significant impact the disposable income may have on the mobile service quality and the entire construct, we analyzed the groups regarding M-S-QUAL and reduced the groups from five to three. Such was necessary to fulfill the PLS-SEM eligible group sizes [42], which was not given by the groups with very low (-50€, N = 7) and low (50–150€, N = 14) disposable monthly income. Except for the first group the values show a positive correlation and in combination with the group composition we merged the first three groups, resulting in low, medium and high disposable income (0-350€, N = 44; 350-700€, N = 25; 700+ N = 36). **Table 3** shows that with increased disposable income, the impact of mobile service quality declines and the channel integration becomes more important, yet the model predicts less of the variance.

Table 3. PLS-SEM Results grouped by disposable income

Measured Construct	0-350 €	350-700 €	700+ €	Aggregate
M-S-QUAL -> LOYAL	0.595	0.524	0.415	0.529
MCISQ -> LOYAL	0.225	0.244	0.299	0.227
LOYAL R^2	0.518	0.459	0.388	0.448

6 Conclusion and Further Research

The strong influence of mobile service quality requires additional investigations with respect to the No-Line concept. Mobile technology in combination with (location based) targeted advertising has the power to obliterate the borders of channels, especially reducing the length of the buying process and therefore increasing the conversion rate. The social transformation towards being always available and only having time "in-between" further nourishes mobile interaction. In this context the influence of the product category (convenience vs. shopping goods [22]) should be considered in detail, as mobile devices are very well able to complete a buying process but still lack the comfort more traditional buying processes offer in terms of search and evaluation. Consequently, we expect an even stronger influence on loyalty from mobile service quality in combination with convenience goods.

Further research could also focus on the integration of emerging technologies (channels) and their integration into the No-Line concept, like Virtual & Augmented reality. While initial studies in this field were conducted years ago [54], the topic becomes increasingly more popular today, as more VR and AR devices hit the consumer market.

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E-Government - Digitalisierung im öffentlichen Sektor

Teilkonferenzleitung

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Blockchains zwischen Anarchie und Governance: Steuerungsansätze für die öffentliche Verwaltung

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Abstract. Blockchain-Technologie gilt als disruptiv, da sie potenziell völlig neue Abläufe bzw. Organisation von Leistungen ohne bisher etablierte Intermediäre ermöglicht. Dies stellt staatliche oder anderweitig politisch legitimierte Institutionen vor neue, bisher kaum diskutierte Herausforderungen an die Steuerung. Bezugnehmend auf den Stand der Bewertung von Blockchains werden Notwendigkeiten zur Steuerungsfähigkeit identifiziert und in Abhängigkeit zur technisch-organisatorischen Ausprägung der Blockchain-Anwendung und dem rechtlich legitimierten Aktionsradius der Akteure gebracht: Je stärker der Grad der Dezentralisierung von Registeranwendungen, umso mehr müssen föderierte und dezentralisierte Mechanismen der Blockchain-Governance etabliert werden und sich als effektiv erweisen. Abwägung von Vor- und Nachteilen der Technologieanwendung sowie angemessene Formen der netzwerkbasierten Steuerung gilt es zukünftig zu erforschen, im Zusammenhang mit Visionen für die Dezentralisierung der öffentlichen Verwaltung insgesamt.

Keywords: Blockchain, öffentliche Verwaltung, Anarchie, Governance, Steuerung, Dezentralisierung

1 Einleitung

Die Diskussion um Blockchains hat inzwischen auch die öffentliche Verwaltung und die sie begleitende Verwaltungsinformatik erreicht. Anwendungen dieser Technologie stehen dort noch am Anfang, und so versucht die fachspezifische und wissenschaftliche Diskussion vor allem, die Potenziale und Risiken zu analysieren und zu bewerten, um so eine fundierte Handlungsorientierung zu ermöglichen. Analysten sind sich einig, dass die Blockchain-Technologie als disruptiv einzuschätzen ist, da sie völlig neue Abläufe bzw. Organisation von Leistungen ermöglicht – und dies eben auch in der öffentlichen Verwaltung mit womöglich weitreichenden Folgen für Funktion und Selbstverständnis staatlicher Institutionen.

Über wichtige technische und anwendungsspezifische Aspekte hinaus ist die Steuerung („Governance“) der Technologieanwendung von besonderer Bedeutung, denn dies berührt die öffentliche Verwaltung in ihrem Kern: Können bzw. sollten staatliche oder anderweitig politisch legitimierte Institutionen eine Technologie fördern und einsetzen, die den legitimierten Kontrollanspruch dieser Institutionen als Intermediär tendenziell überflüssig macht? Und wenn ja, welche Technologie-

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varianten und welche Formen der Governance sind geeignet, die öffentliche Verwaltung in der Wahrnehmung ihrer Verantwortung zu unterstützen?

Die Weiterentwicklung der Blockchain-Governance wird eingefordert (u.a. [4, 16, 17]), bisher liegen dazu aber kaum systematisch erarbeitete Ergebnisse vor. Im Folgenden wird daher zunächst der Stand der Bewertung von Blockchains in der öffentlichen Verwaltung anhand von mehreren Dimensionen zusammengefasst. Darauf aufbauend werden dann die verschiedenen Notwendigkeiten zur Steuerungsfähigkeit von Blockchain-Anwendungen identifiziert und in Abhängigkeit von beteiligten Akteuren und Technologievarianten gebracht, um so öffentliche Verwaltungen bei deren Entscheidungen zur Einführung und Anwendung von Blockchain-Technologie zu unterstützen. Der abschließende Ausblick verweist auf zukünftige Forschungsbedarfe.

2 Blockchains in der öffentlichen Verwaltung: Stand der Bewertung

Die Blockchain-Technologie ist weltweit bekannt geworden durch ihre Anwendung bei Management und Validierung von Transaktionen in der Kryptowährung Bitcoin (zu Funktion und beteiligten Akteuren siehe z.B. [2]). Doch der Anwendungsbereich der Technologie geht weit darüber hinaus: „Eine Blockchain ist also ein verteiltes, dezentrales Register, das Transaktionen in chronologischer Reihenfolge unveränderbar und nachvollziehbar speichert und miteinander verkettet. Durch eine Kombination aus kryptografischen Funktionen, verteilten Netzwerken und komplexen technischen Mechanismen erlaubt die Blockchain eine Transaktionsabsicherung, ohne dabei auf eine vertrauenswürdige dritte Instanz zurückgreifen zu müssen." ([19], S. 17)

Anwendungen von Blockchains in der öffentlichen Verwaltung sind bisher noch nicht weit verbreitet und eher im Experimentierstadium [12, 17], wobei international erhebliche Unterschiede bestehen. Beispielsweise wurden bei staatlichen Organisationen in Holland im April 2017 bereits 25 abgeschlossene Pilotprojekte gezählt,[1] während in Deutschland bis dato nur Absichtserklärungen kursieren. Mangels belastbarer empirischer Untersuchungen der Anwendungspraxis fokussiert sich die wissenschaftliche und fachspezifische Diskussion in erster Linie auf die Potenzialanalyse und Risikobewertung. Im Zentrum stehen dabei vor allem die Dimensionen Anwendungen in der Verwaltung, technische Infrastruktur, Risiken und Vertrauenswürdigkeit sowie Steuerung (Governance) und Beteiligung.

2.1 Anwendungspotenzial

Der potenzielle Anwendungsbereich von Blockchains in der öffentlichen Verwaltung wird in der Literatur relativ klar umrissen: „Jegliche Formen von Registern, die über eine öffentlich überprüfbare Transaktionshistorie verfügen und manipulationssicher sein müssen, sind grundsätzlich für eine Blockchain-Umsetzung geeignet. Dies können Grundbucheinträge, Personalausweise, Waffen- oder Kfz-Register, Patientenakten, Geburtsurkunden u.v.a.m. sein." ([4], S. 5) Etwas allgemeiner formuliert eine

[1] https://www.blockchainpilots.nl/results (Zugriff am 23.11.2017)

FOKUS-Studie ([19], S. 18): „Die Blockchain-Technologie setzt da an, wo derzeit zentrale Institutionen die Umsetzung von Regeln sicherstellen“, und verweist auf bereits in der Diskussion befindliche Anwendungsszenarien zu Register und Eigentumsverhältnissen, Verifikation und Bestätigung, Herkunftsnachweisen, Digitale Identitäten, Transparenz und Offenheit sowie Wahlen.

In vergleichbarer Weise wird das Anwendungspotenzial in einer verteilten und transparenten Buchführung gesehen [17], in der Aktenverwaltung generell [8] oder als dezentraler, konsensgesteuerter öffentlicher Verwahrungsort [1]. Der britischen Regierung werden z.B. Anwendungsszenarien empfohlen wie Schutz von kritischer Infrastruktur gegen Cyberattacken, Reduzierung von operationalen Kosten und Prüfung von Sozialhilfeberechtigungen, Transparenz und Nachvollziehbarkeit von öffentlichen Finanzhilfen, Stärkung von KMUs und Vermeidung von Steuerbetrug [17]. Und China hat angekündigt, dass es „die Blockchain-Technologie für die Sozialbesteuerung und für das elektronische Rechnungsausgangswesen nutzen wird“.[2] Auch große IT-Hersteller bauen Blockchain-Kompetenzzentren auf und implementieren Pilotprojekte (IBM z.B. für Handelsregister und Außenhandelsfinanzierung [6]).

Die Bewertung der Potenziale ist vor allem dort kontrovers, wo neue technische Möglichkeiten mit den Kernaufgaben öffentlicher Verwaltung konkurrieren: „Manipulationssichere Registerführung und Beglaubigung stellen gleichermaßen zentrale Aufgaben der Verwaltung sowie das Kernversprechen der Blockchain dar. Sie hat deshalb das Potential, die durch zentrale Organisationsparadigmen geprägte Verwaltung nachhaltig zu verändern.“ ([4], S. 6]. Disruptiv ist die Technologie insofern, als sie die Rolle von vertrauensvollen Vermittlern in Frage stellt, insbesondere in Notariaten, Banken und Verwaltungsabteilungen [16, 17]. Teilweise wird dies als Chance bewertet, um Verwaltungsleistungen zukünftig persönlicher, unmittelbarer und (wirtschaftlich) effizienter erbringen zu können [17] oder um den Abbau von Transaktionskosten und die Beschneidung von Zentralstaatlichkeit zu ermöglichen [10]. Letztlich sind immer Vor- und Nachteile abzuwägen, und die Chance geraten vor allem dann in den Blick, wenn zentrale Institutionen als dysfunktional erscheinen (z.B. wg. Korruption) oder in horizontalen Netzwerken schwer zu etablieren sind (z.B. bei Lebensmittellieferketten, offene Registraturen, internationaler Zahlungsabwicklung; vgl. [15]). Von daher bleiben die meisten Analysten angesichts der Risiken (siehe 2.3) eher vorsichtig und fragend, und manche warnen sogar explizit vor dem technisch induzierten Verlust von staatlicher und ggf. auch demokratischer Kontrolle (z.B. [1], siehe 2.4).

2.2 Technisch-organisatorische Infrastruktur

Laut [19] gehören zu den wesentlichen Merkmalen einer Blockchain: verteilte redundante Datenhaltung, Änderungsresistenz (Zensurresistenz), Anreizsystem, pseudonymer Zugang, Kryptografie-basierte Sicherheit, transparente Buchhaltung, sowie ggf. Kryptowährung-basierte Abrechnung. Bei jedem Merkmal existieren mehr oder

[2] http://www.z-punkt.de/de/news/item/china-blockchain-zur-steuereintreibung-und-zum-rechnungsversand/558 (Zugriff am 21.9.17)

weniger große Gestaltungsspielräume, etwa beim Grad der Dezentralisierung von verschiedenen Registertechnologien („permissioned"/„permissionless", geschlossen/öffentlich) oder beim verwendeten Konsensmechanismus (s.u.). Entsprechend werden in der Diskussion durchaus verschiedene Aspekte hervorgehoben und unterschiedlich bewertet. So bleibt eine auf den ersten Blick plausible Beschreibung der Blockchain als „eine Datenbank mit vier besonderen Eigenschaften: ohne zentrale Instanz, öffentlich einsehbar, manipulations- und ausfallsicher" ([4], S. 1) in keinem dieser Aspekte unhinterfragt:

- Die für das Mining in öffentlichen Blockchains erforderliche enorme Rechenkapazität wird nur in wenigen großen Rechenzentren vorgehalten (v.a. in China [1]), wobei stets das Risiko der Kartellbildung besteht. Eine vergleichbare Zentralisierung gilt für die Entwicklergruppe des Softwarekerns.
- Bei öffentlichen Blockchains ist die technische Einsicht gegeben – aber wie lange? Bisher gibt es keine Bestandsgarantien und keine Verabredungen über Langzeitarchivierung [8], und technische Veränderungen können überdies in Zukunft den Zugang behindern.
- Schutz vor Manipulation besteht nicht an sich, sondern nur durch die sehr hohe Wahrscheinlichkeit, dass Manipulationen sofort aufgedeckt würden („tamper evident"). Zudem werden auch ‚unerwünschte' Transaktionen abgewickelt, solange sie formal den zugrundeliegenden Konsensregeln folgen [12].
- Ausfallsicherheit lässt sich in der Praxis nicht garantieren und die Literatur (z.B. [1, 8, 19]) listet eine Reihe von Anfälligkeiten (siehe 2.3).

Doch auch wenn man auf die genannten Vorteile vertraut, immer wieder werden auch eine Reihe von unstrittigen Nachteilen erwähnt, auf deren Vermeidung sich Ansätze zur technologischen Weiterentwicklung konzentrieren: insbesondere die Komplexität der technischen Verfahren, deren Unveränderbarkeit bzw. Inflexibilität, die sich verschlechternde Performance bei zunehmender Länge der Blockchain, der immense Energieverbrauch aufgrund der erforderlichen hohen Rechenleistung (z.B. [4]). Um insbesondere Skalierung und Energieeffizienz zu verbessern, werden alternative Konsensmechanismen zum sehr aufwändigen „Proof-of-Work" diskutiert und erprobt (z.B. „Proof of Stake" [9]), „Bicoin Next Generation", „Hybrid/Byzcoin", „Solidus", „Spectre" [5]). Weitere Entwicklungen zielen darauf, die Blockchain-Technologie als generelle Plattform und mögliche Serviceinfrastruktur bereitzustellen, z.B. organisiert in aufeinander aufbauenden Schichten (Anwendungen / Bitcoin oder andere Währungen / Konsensregeln, Peer-to-peer, Security / Verteilte Blockchain Datenbank [11]), vergleichbar mit dem Internet-Stack.

2.3 Risiken und Vertrauenswürdigkeit

Die Anwendung der Blockchain-Technologie scheint vielen vertrauenswürdig, gerade weil das Transaktionsprotokoll dezentralisiert und durch algorithmische Berechnung („trust-by-computation", vgl. [1]) abgesichert wird. Übereinstimmend wird konstatiert, dass die Blockchain durch ihre Transparenz eine hohe Fälschungssicherheit bietet und gerade das Fehlen eines zentralen Betreibers gegen eine Vielzahl

klassischer Angriffsmethoden schützt (z.B. [19]). Jedoch ist auch die Blockchain-Technologie in vielfacher Hinsicht angreifbar, wobei die meisten Risiken steigen, je mehr die Blockchain dezentralisiert, unbeschränkt und öffentlich einsehbar ist:

- **Individuelles Sicherheitsmanagement:** Jeder Nutzer muss seine privaten Schlüssel selbst verwalten und schützen. Angreifer, die in Besitz von privaten Schlüssel gelangen können dann Transaktionen signieren und im Fall einer Kryptowährung auch Geld stehlen [8, 19].
- **Kontrolle der Mining-Rechenleistung:** „In aktuellen Blockchain-Netzwerken geht man von der Annahme aus, dass die Mehrheit der Rechenleistung vertrauenswürdig ist. Schafft es ein Angreifer, mehr als die Hälfte der Rechenleistung unter seine Kontrolle zu bringen, kann er statistisch betrachtet langfristig eigene Transaktionen in der Blockchain bestätigen." ([19], S. 26) Angreifer (z.B. Betreiber von Botnetzen) müssen über eine große Rechenleistung verfügen. Und da der Aufwand mit der Größe des Netzwerks steigt, sind vor allem kleinere Blockchain-Netzwerke anfällig für diese Angriffe.
- **Sicherheitslücken im Code:** Ein Beispiel hierfür ist der 2016 erfolgte Angriff auf eine Ethereum-Blockchain, der in Ausnutzung eines Bugs der Blockchain-Software 3,6 Millionen Einheiten der Kryptowährung Ethereum aus dem Crowdfunding-Projekt DAO abzweigte.[3]
- **Sybil-Attacken:** Wenn es einem Angreifer gelingt, genügend Knoten in einem Blockchain-Netzwerk zu kontrollierten, kann er die Weitergabe von Blöcken und Transaktionen verweigern, den Eintrag von Registrierung vom Netzwerk abtrennen und ggf. eigen Blöcke einfügen. Die Wahrscheinlichkeit dieser Art von Angriff nimmt mit wachsenden Konzentration von Minern zu [8].
- **Zeitstempelfehler:** die Funktion und Verlässlichkeit der Blockchain hängt wesentlich von der exakten Zeiterfassung ab. Ein Angreifer könnte die Zeitschalter einzelner Knoten manipulieren oder die Aufzeichnung der Transaktionsreihenfolge durch falsche Zeitangaben mittels selbst kontrollierter Knoten stören [8].
- **Denial-of-Service-Attacken:** Angreifer können das Blockchain-Netzwerk mit massenhaften Kleinsttransaktionen oder Synchronisierungsanfragen überfluteten, so dass es für andere Teilnehmer bzw. für legitime Transaktionen nicht mehr nutzbar ist [8, 19].
- **Unzuverlässigkeit:** Registereinträge werden nur formal geprüft, aber nicht sachlich, d.h. aus Verwaltungssicht gibt es erstmal keinen Schutz vor fehlerhaften und unautorisierten Einträgen. Werden Einträge von sogenannten vertrauensvollen Vermittlern vorgenommen, stellt sich auch dort die Frage nach deren Zuverlässigkeit [8].
- **Inflexibilität:** Die Dezentralisierung erhöht die Resilienz des Informationssystems insgesamt, allerdings um den Preis, dass die einmal unter verbindlichen Regeln gestarteten Prozesse im weiteren Verlauf nicht oder nur mit unvertretbar hohem Aufwand geändert werden können [1]. Damit werden das Schließen von Sicher-

[3] https://www.heise.de/newsticker/meldung/Nach-dem-DAO-Hack-Verbliebenes-Kryptogeld-mit-freundlichem-Hack-gesichert-3246539.html

heitslücken und auch die Anpassung von verwaltungstechnischen Abläufen erheblich erschwert.

- **Fragliche Dauerhaftigkeit:** Bislang gibt es keine verbindlichen Standards, wie lange Blockchains und die von Nutzern vorgenommenen Einträge vorzuhalten bzw. zu archivieren sind [8]. Wird die Anwendung von Blockchain-Technologie mittels Plattformen im Rahmen einer mehrschichtigen Infrastruktur vorgenommen [11], steigen auch die Risiken der technischen Diskontinuität.
- **Systemische „Selbstzerstörung“**: das technisch-organisatorische System kann schnell an seine immanenten Grenzen stoßen, wenn die Profitabilität der Miner erodiert, die enormen Investitionen in die Hashing-Infrastruktur sich nicht mehr lohnen, die Netzwerkneutralität nicht mehr (hinreichend) gegeben ist, ein Mangel an Controlling-Daten besteht und (dadurch ggf. irrationale) Erwartungen der Investoren nicht befriedigt werden [1].

In diesem Abschnitt wurde vornehmlich auf technische und systemische Aspekte der Blockchain-Anwendung eingegangen. Für eine umfassende Risikobewertung greift dies jedoch zu kurz, denn die Verwaltung hat „in zentralen Vorgängen die Rolle des vertrauenswürdigen, neutralen Intermediärs inne“, der bei der Abwicklung komplexer Vorgänge auf ein gewachsenes Arsenal an Instrumenten wie Urkunden, Siegel, notariell beglaubigte Abschriften, Zeugnisse, Zertifikate, Durchschläge usw. zurückgreifen kann ([4], S. 6) Auf weitere Aspekte bezüglich staatlicher Verantwortung, Recht, Verfahrenssicherheit, Personal, Staat-Bürger-Verhältnis kann an dieser Stelle nicht näher eingegangen werden (siehe dazu Abschnitt 4.).

2.4 Governance und Beteiligung

Die Literatur zur Steuerungsfähigkeit von IT-Anwendungen ist vor allem englischsprachig geprägt, weshalb im Folgenden der Begriff Governance verwendet wird. Im Kern geht es dabei um folgende Fragen: Welche Entscheidungen sind zu treffen? Wer sollte diese Entscheidungen treffen? Wie sind diese Entscheidungen zu erreichen? Mit welchem Ablauf werden die Ergebnisse überprüft? Dies gilt auch für den IT-Bereich: “IT governance is specifying the decisions, rights, and accountability framework to encourage desirable behavior in the use of IT.” ([18], siehe auch [13], S. 5)

Die öffentliche Hand hat stets versucht, bei der IT-Governance mit neuen Technologien und Anwendungen Schritt zu halten. Die technische und organisatorische Dezentralisierung der Blockchain-Anwendung bringt jedoch in mehrfacher Hinsicht neue Herausforderungen mit sich:

- **Kontrolle von Blockchains:** „Klassische Regulierungsmechanismen stoßen an ihre Grenzen, wenn Ansprechpartner und Verantwortlichkeiten fehlen. In der Diskussion um die Blockchain wird daher oft von Regulierungsresistenz gesprochen.“ ([4], S. 24) Doch auch in Blockchain-Netzwerken gibt es Schlüsselrollen wie Miner, Händler und Softwareentwickler. Jedoch agieren diese i.d.R. global, was eine nationalstaatliche Regulierung erheblich erschwert [1].
- **Rechtsvorschriften versus Rechenvorschriften:** Rechtsvorschriften sind ‘extrinsisch’, d.h. die Regeln können gebrochen werden, aber die daraus folgenden

Konsequenzen gewährleisten wiederum die Einhaltung der Regeln. Technische Rechenvorschriften dagegen sind 'intrinsisch', d.h. bei Verletzung der Regeln erfolgt eine Fehlermeldung und keine weitere Aktion wird ausgeführt. Die Ordnungsmäßigkeit wird also nur durch die Ausführung der Rechenvorschriften selbst gewährleistet [17]. Die Implementierung geht davon aus, dass die Ausführung der Rechenvorschriften stets aktiv ist und alle Regelungsbedarfe abdeckt – aber sobald dies mal nicht der Fall ist, fehlen oft etablierte bzw. akzeptierte Mechanismen zur Ausnahmebehandlung.[4]

- **Kodierung der Blockchain-Regeln:** Bei IT-Anwendungen übernimmt der Gesetzgeber i.d.R. die Regulierung und überlässt deren Einhaltung der privatwirtschaftlichen Governance. Genauso wie Rechtsvorschriften müssen auch Rechenvorschriften geschaffen, implementiert und weiterentwickelt werden – von Menschen, die letztlich die von Rechenvorschriften verkörperten Regeln definieren [17]. Bislang liegt die Governance der Code-Entwicklung ad hoc in den Händen weniger Kernentwickler, und belastbare Mechanismen zur kollektiven Entscheidungsfindung und zur Handhabung von Konflikten sind nicht in Sicht.

Dezentralisierung bedeutet aber nicht Demokratisierung im Sinne von Beteiligung. Aus den Händen von vertrauensvollen Vermittlern werden Verwaltungsvorgänge im Rahmen der Blockchain-Anwendung an die verteilte „Vertrauensmaschine"[5] übertragen. Manche (z.B. [10]) sehen darin die Chance, das Konzept der Zentralstaatlichkeit zu überdenken und den Leviathan zu dezentralisieren. Doch das revolutionäre Potenzial der Netzwerk-Governance kann dabei nicht ausgeschöpft werden, und z.B. Atzori [1] argumentiert, dass die egalitäre Blockchain-basierte Gesellschaft ein Mythos ist, insbesondere bei Anwendung von offenen und nicht zulassungsbeschränkten („unpermissioned") Blockchains:

- die beteiligten Individuen agieren als Nutzer, aber nicht als Bürger auf der Grundlage eine Gesellschaftsvertrages,
- ein technisch vermittelter Konsens löst keine Konflikte (z.B. Interessenkonflikte, Übertretung von Normen, unethisches Verhalten),
- der Ersatz von Rechts- durch Rechenvorschriften droht so die notwendige Gewaltenteilung und die Balance von Bürgerrechten und Staatsmacht zu verschleiern,
- letztlich dominiert die Marktlogik über grundlegende öffentlichen Leistungen und Bürgerrechte, die eigentlich vor jeder Art Spekulation geschützt sein sollten,
- die Abhängigkeit von Netzwerken privater Oligarchien (z.B. Miner-Kartellen) ist wahrscheinlich und in Ansätzen bereits erkennbar,
- eine dominante Technoelite entsteht, mit wachsenden Überwachungsvollmachten über strategische Leistungen auf globaler Ebene, ohne formale Legitimation.

Wie andere neue Technologien vorher birgt die Blockchain ein großes Potenzial zur Disintermediation. Allerdings, die erforderliche technisch-organisatorische Umge-

[4] Siehe z.B. https://blockchainhub.net/blockchain-governance/

[5] https://www.economist.com/news/leaders/21677198-technology-behind-bitcoin-could-transform-how-economy-works-trust-machine

bung („ecosystem“) ist charakterisiert durch eine Vielzahl von Akteuren und gewinnorientierten Unternehmen mit großen Asymmetrien zwischen Entwicklern und Nutzern hinsichtlich Information und Einfluss. Unter diesen Randbedingungen wird sich mitnichten Anarchie einstellen, und die egalitären Hoffnungen einiger Blockchain-Befürworter erscheinen vor diesem Hintergrund unrealistisch (vgl. [1, 16]). Wird nicht weiter eingegriffen, erscheint am Horizont vielmehr die Dystopie der Entmachtung des Bürgers in einer unpolitischen staatenlosen Globalgesellschaft, beherrscht von Technokratie und im Hintergrund agierenden Blockchain-Governance-Oligarchien.

3 Entwicklung der Steuerungsfähigkeit

Die Fähigkeit oder das Vermögen („capability“) zur Governance einer neuen Technologieanwendung kann nicht einfach voraus gesetzt werden, sondern bedarf insbesondere dann der gezielten Entwicklung, wenn Technologie als disruptiv eingeschätzt wird und somit grundsätzlichen neuen Herausforderungen in der Anwendung zu begegnen ist. Seit einer Reihe von Jahren werden auch in der Verwaltungsinformatik die Potenziale der dezentralisierten Leistungserbringung diskutiert sowie die notwendigen Fähigkeiten zu Orchestrierung und Netzwerkmanagement, um alle Beteiligten zusammenzubringen und gemeinsam Probleme zu lösen (z.B. [7, 13]).

In [14] werden die Fähigkeiten zur IT-Governance definiert als Verbindung von Qualifikationen und den notwendigen Kapazitäten einer Organisation, um so den maximalen Nutzen ihrer IT im gegebenen Kontext zu erreichen. Die oftmals propagierten strukturellen, prozeduralen, und relationalen Mechanismen [18, 20] werden in [14] jeweils kombiniert zu sog. Patterns zusammengefasst und im Hinblick auf die öffentliche Verwaltung als mögliche zentralisierte, föderierte und dezentralisierte Strukturen unterschieden. Ausgehend von einer Vision des öffentlichen Nutzens, den Quellen der Legitimität und Unterstützung sowie dem erforderlichen Leistungsvermögen (intern oder in Koproduktion) kann eine öffentliche Organisation dann jeweils Kontext, Ziele, Akteure, Prozesse und erforderliche Ressourcen spezifizieren.

Um den o.g. Herausforderungen (2.4) angemessen zu begegnen, können hier nur erste Ansätze der Entwicklung von Fähigkeiten zur Blockchain-Governance durch die öffentliche Verwaltung skizziert werden. Dafür werden die jeweiligen Herausforderungen zunächst kontrastiert mit bisher erkennbaren möglichen Zielen bzw. angestrebten öffentlichen Nutzen sowie beispielhaft dafür geeigneten Prozessen (siehe Tabelle 1). Ohne Anspruch auf Vollständigkeit und Validierung soll hier vor allem verdeutlicht werden, wie notwendig die genaue Analyse der Herausforderungen ist und wie unterschiedlich dann die Steuerungsbedarfe und -prozesse sind bzw. sein müssen, um sich jeweils angemessen auf die neuen Entwicklungen einzustellen.

Dabei sind jeweils alle Akteure zu beteiligen, die bei der Blockchain-Anwendung eine wichtige Rolle spielen bzw. diese schon im Vorfeld beeinflussen: Regulierungsbehörden, Fachbehörden, Nutzer (bzw. deren Vertreter), Blockchain-Initiatoren bzw. Projektmanager, Miner, Softwareentwickler, ggf. Händler oder andere Vermittler bei der Front/End-Nutzung der Blockchain. Die Governance-Strukturen und dazugehörigen

Tabelle 1. Ansätze zur Blockchain-Governance

Herausforderung	Ziele der öffentlichen Hand	Governance-Prozesse
Kontrolle von Blockchains	Etablierung von Regulierungsmechanismen, die die Umsetzung von vereinbarten Rechtsvorschriften im jeweiligen Anwendungsbereich gewährleisten	KPI-basierte Messung von Blockchain-Verlauf und -leistung, Service-level-Vereinbarungen, Schiedsgerichtsbarkeit
Rechtsvorschriften versus Rechenvorschriften	Absicherung der Blockchain-Anwendungen jenseits der Rechenvorschriften im Hinblick auf Ausnahmebehandlung, Ausfallsicherheit, Managementversagen, Nachhaltigkeit u.a.	Periodische Risikoanalysen, Vereinbarungen zur Schadensabwendung und -minderung, Mediation
Kodierung der Blockchain-Regeln	Etablierung von kollektiven und legitimierten Mechanismen zur fortlaufenden Qualitätssicherung von beim Blockchain-Betrieb eingesetzter Software	Standardisierung von Requirements und Infrastrukturkomponenten, Zulassung bzw. Zertifizierung, Code-Inspektion

Kommunikationsprozesse können bzw. müssen dabei jeweils verschiedenen Typen (gemäß [14]) folgen, abhängig von der technisch-organisatorischen Ausprägung der Blockchain-Anwendung und dem rechtlich legitimierten Aktionsradius der Akteure:

- *Zentralisiert:* Blockchain ist geschlossen und zulassungsbeschränkt, alle Akteure sind Teil der öffentlichen Verwaltung → formale Prozesse für Kommunikation und Koordination basieren auf existierenden Organisationshierarchien und ggf. neu zu schaffenden Gremien (Lenkungsausschuss, Verwaltungseinheit)
- *Föderiert:* Blockchain ist offen einsehbar, aber zulassungsbeschränkt, alle Akteure sind Teil derselben Rechtseinheit (z.B. Nationalstaat, EU) → erforderlich sind zusätzlich Prozesse für Konfliktmanagement zwischen allen Beteiligten sowie semi-formale Prozesse für horizontale Kommunikation und Koordination
- *Dezentralisiert:* Blockchain ist offen und nicht zulassungsbeschränkt, Akteure agieren global → erforderlich sind zusätzlich Prozesse für Peer-Voting, wechselseitiges Vertrauensmanagement, und Peer-Review

Die Identifikation von Governance-Strukturen und -Prozessen in Abhängigkeit von Technologievarianten und dem rechtlich legitimierten Aktionsradius der Akteure lässt sich auch umkehren, um daraus Handlungsanweisungen für die öffentliche Verwaltung zu generieren:

- In Anlehnung an existierende Rahmenwerke (z.B. [13]) ließe sich z.B. ein „Blockchain Governance Improvement Framework“ erstellen, das die Ausweitung der notwendigen Governance-Fähigkeiten in mehreren Stufen von (meist schon

vorhandenen) zentralisierten Praktiken über föderale bis hin zu dezentralisierten Praktiken organisiert und somit den beteiligten Organisationen sowohl eine Selbsteinschätzung als auch einen Ausblick auf Best Practice ermöglicht.
- Die Selbsteinschätzung der eigenen Governance-Fähigkeiten erlaubt den in der Verantwortung stehenden Institutionen, jeweils über das für sie vertretbare zulässige Ausmaß der Dezentralisierung (Offenheit, Unbeschränktheit) von Blockchain-Anwendungen zu entscheiden – gemäß der Maxime: was nicht steuerbar ist, darf auch nicht für Erbringung öffentlicher bzw. rechtlich verbindlicher Leistungen eingesetzt werden.

Dies sind nur erste Ansätze, wie die öffentliche Verwaltung Fähigkeiten zur Blockchain-Governance herausbilden und auf der Basis der Selbsteinschätzung dieser Entwicklung entsprechend über Einsatz und Förderung der Technologieanwendung entscheiden kann. Der Handlungsbedarf zum Thema Blockchain-Governance ist von allen Akteuren unbestritten, und die bis dato noch geringe Zahl wissenschaftlicher Veröffentlichungen zeigt, dass auch der Forschungsbedarf noch groß ist.

4 Ausblick und Forschungsbedarf

Um zu gewährleisten, dass die Blockchain-Technologie im Einsatz robust und skalierbar ist, müssen wir die ethischen und sozialen Auswirkungen und die (finanziellen) Kosten und Nutzen verstehen (vgl. [17]). Notwendig ist aus Sicht der öffentlichen Verwaltung zu klären, wie der auf Disintermediation abzielende Einsatz in seinen Vor- und Nachteilen abgewogen und wie er gesteuert werden kann und sollte. Daher wurde eingangs gefragt: Können bzw. sollten staatliche oder anderweitig politisch legitimierte Institutionen eine Technologie fördern und einsetzen, die den legitimierten Kontrollanspruch dieser Institutionen als Intermediär tendenziell überflüssig macht? Und wenn ja, welche Technologievarianten und welche Formen der Governance sind geeignet, die öffentliche Verwaltung in der Wahrnehmung ihrer Verantwortung zu unterstützen?

Nachdem der Stand der Bewertung analysiert und Entwicklung der Steuerungsfähigkeit im Ansatz ausgelotet wurde, lassen sich erste Antworten darauf wie folgt zusammenfassen: Im Sinne der Dezentralisierung von Leistungen der öffentlichen Hand kann der Einsatz von Blockchains sich in ausgewählten Bereichen durchaus als sinnvoll erweisen, sofern angemessene Governance-Mechanismen Prozesse und Ergebnisse der Leistungserbringung nachhaltig absichern und die Verantwortung des Staates und Beteiligung seiner Bürger weiterhin ausgeübt werden können. Welche Technologievarianten und welche Formen der Governance dabei tatsächlich zum Einsatz kommen, sollte abhängig von den Governance-Fähigkeiten der legitimierten Kontrollinstitutionen entschieden werden: je stärker Grad der Dezentralisierung der verschiedenen Registeranwendungen, umso mehr müssen föderierte und dezentralisierte Mechanismen der Blockchain-Governance etabliert werden und sich als effektiv erweisen.

Dass mit der Dezentralisierung der Technologie auch die Dezentralisierung der IT-Governance einhergeht, dem muss auch die öffentliche Verwaltung ins Auge sehen

und sich entsprechend darauf vorbereiten. Ein vom World Economic Forum veröffentlichter Report [16] zur Verwaltung von Blockchains und Kryptowährungen erteilt den Bemühungen um (einzel-)staatliche Regulierung eine klare Absage und propagiert stattdessen ausschließlich dezentrale und netzwerkbasierte Herangehensweisen („stewardship“). Zu diesem Zweck werden zusätzlich zu den oben genannten auch noch weitere Akteure identifiziert (Innovatoren, Risikoanleger, Banken und Finanzdienstleister, Akademiker, Nichtregierungsorganisationen), die sich in insgesamt acht verschiedenen Netzwerken engagieren sollen, um aus verschiedenen Perspektiven und Interessen heraus das technisch-organisatorische Umfeld auszugestalten (u.a. Vereinbarung von Steuerungsmechanismen, Standardisierung, Anwaltschaft, Strategie und Monitoring, Gewährleistung, Wissensmanagement). Welche Akteure sich dazu in welchen Netzwerken mit welchen Zielen engagieren sollten und wie die Umsetzung der Ziele erreicht werden kann, ist eine der wesentlichen Fragen für Praxis und Forschung. Zu empfehlen ist, dass sich dabei internationale Fachorganisationen gerade im Bereich Rechnungswesen (z.B. CIPFA, IFAC) um die Weiterentwicklung ihrer Governance-Empfehlungen für die öffentliche Hand [3] bemühen.

Zu erwarten ist auch eine Ausdifferenzierung der Technologie in Richtung Plattform- und Service-Infrastruktur [11] mit jeweils wählbaren Technologievarianten. Damit einhergehen muss dann auch die Differenzierung der Governance-Mechanismen, und so werden in [16] z.B. drei Ebenen der Blockchain-Governance unterschieden: Plattform (insbes. Blockchain-Protokolle), Anwendung (z.B. Smart Contracts), technisch-organisatorisches Umfeld insgesamt („ecosystem“). Welche Formen der Governance (oder „Patterns“ [14], s.o.) für welche Ebene angemessen sind und sich als effektiv erweisen, ist eine weiteres Thema für die zukünftige Forschung.

Diverse Aspekte der Zentralstaatlichkeit werden schon länger durch technische Vernetzung und damit einhergehende horizontale Organisations- und Kommunikationsformen in Frage gestellt (z.B. öffentlich-private Partnerschaften, Verwaltungsportale, Interoperabilität, kooperative Leistungserstellung, E-Partizipation). Eine Forschungsagenda zur Blockchain-Technologie im Rahmen von Verwaltungswissenschaft und Verwaltungsinformatik sollte deshalb das der Technologie innewohnende Potenzial zur Disintermediation in den Kontext bereits erfolgter Disruptionen stellen: Das Internet hat radikal neue Möglichkeiten der Bürgerinformation geschaffen, Mobiltechnologie und Sozialen Medien ermöglichen völlig neue Formen der Bürgerkommunikation, und die Blockchain-Technologie öffnet nun ganz neue Formen der Transaktion. In diesem Spannungsfeld von (befürchteter?) Anarchie und (traditioneller) Steuerung muss die öffentliche Verwaltung zunächst ihre eigenen Visionen für die Dezentralisierung entwickeln – in einem Diskurs, der möglichst viele Akteure einbezieht und den die Verwaltungsinformatik befördern sollte.

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A Long and Winding Road? Analyzing E-Government Website Maturity in Germany

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Abstract. The fundamental changes, occurring in modern societies through the digitalization, are also changing the way citizens interact with their governments. With more than 70% of citizens using the internet to retrieve information, websites become a crucial touchpoint for the public's interaction with administrations. The design and quality of these websites and services offered through them may have a considerable impact on the user's willingness to further engage with public administrations online. This article sets out to evaluate the German state capitals' websites with regard to their e-government maturity. We use a maturity evaluation scheme that considers five aspects of e-government: information, communication, transaction, integration, and participation. The results indicate that there is a substantial variety in the websites' maturity, horizontally as well as vertically. All cities perform well in furnishing information and make use of various communication channels. Transactional services, however, are less developed across all analyzed cities.

Keywords: e-government, maturity, citizen, website

1 Introduction

Digitalization, though influencing humanity for decades now, is still a buzzword and object of interest in many societal areas. The tremendous effect of the digitalization has also changed the way governments and administrations work, function and interact with their stakeholders. Understood as the "government's use of ICT [information and communication technologies], particularly Web-based Internet applications, to enhance the access to and delivery of government information and service to citizens, business partners, employees, and other agencies and entities" [1, p. 718], electronic government (e-government) has created large bodies of research on diverse aspects of the digitalization of public administrations and governments.

One major topic for researchers is to assess the maturity and quality of e-government in different contexts and from different perspectives. The main objective of these studies is to measure the development of e-government, compare e-government projects across contexts and to show gaps and areas for improvement [e.g. 2–4]. Knowledge from this line of research can help explaining how stakeholders can be integrated into political processes [e.g. 5] and, ultimately, raise adoption rates of e-

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government services [e.g. 3]. Especially in Germany, approaching e-government diffusion from a maturity perspective might be helpful as adoption rates of e-government by citizens are generally rather low, varying between 41% and 45% over the years [6] .

E-Government can be described as a moving target, something that is in constant development and largely influenced by (changing) politics and even more by policies [e.g. 7, 8]. Therefore, a constant need for measurement arises as well as for small-scale evaluations that do not focus on average values for a nation but that consider and compare smaller entities within each country, e.g. at the state or even the city-level, to come to a more comprehensive understanding of maturity levels.

Against this background, the study at hand sets out to assess and compare the e-government maturity of the websites of the 16 state capitals in Germany. We put forward the research question: *How well do the state capitals' websites perform in terms of e-government maturity?*

To answer the research question, we use the 'criteria model for quantifying the maturity of e-government' as proposed by [5]. This model is based on the works by [9] and [10] and consists of five sections that together make up e-government maturity. While most maturity or development models assume that e-government evolves in stages, the model by [5] comes from the thought that each section can develop on its own and at different paces. The five sections are: information dissemination (I), communication (II), transaction (III), integration (IV), and participation (V). Because this model covers the most important aspects of e-government and is decidedly developed in the context of city websites, we chose this approach as basis for our study.

The remainder of the paper is structured as follows: The next section sheds light on prior research on e-government maturity and the different emphases chosen. Chapter 3 introduces the model and the applied method. After that, in chapter 4, the results are presented and discussed in chapter 5. We conclude with implications for practice and research and a general outlook.

2 Research Background: E-Government Maturity

Although e-government comprises far more elements than websites, the latter can be considered as the most important touch point for citizens. 77% of the German internet users search for information online. Additionally, most e-government services for citizens are provided over the internet. Thus, websites become a crucial point for the success of e-government projects as they presumably are the first touchpoint for those willing to use e-government. If information cannot be accessed with reasonable effort and in an acceptable amount of time, if provided information is not helpful or correct, or if core services cannot be reached, citizens will not adopt e-government. Factors like usability, trust, service or website quality are essential for the successful adoption of e-government [e.g. 1, 11, 12] . The design, structure and content of a website is therefore also important for the overall success of e-government projects.

In this regard, maturity of e-government "may be defined as the extent to which a government has established an online presence […]" [13, p. 416]. To determine this

rather unspecific extent, e-government stage models have been developed that expatiate these varying degrees of maturity, commonly ranging from presenting information online to offering interactional services that integrate several functions [e.g. 14]. While these models offer evaluations on a rather high and generic level, critics have pointed out some weaknesses of these models, especially regarding the stepwise evolution these models suggest. Lately, scholars propose to view the different stages of e-government as evolving simultaneously and as equal in importance [e.g. 15].

Whereas these contributions are more conceptual, another set of studies focuses on the user-perspective, mostly applying surveys [e.g. 16] to estimate the usability or other quality aspects of e-government services, especially of websites. Overlapping with other research fields like adoption research, the studies focus on how e-government is perceived and on the stakeholders' needs or evaluations of the technology [e.g. 17, 18].

Tools to evaluate websites 'objectively' and without relying on perceptions have been proposed to a lesser degree although they offer several advantages: Quality measures are less tied to personal evaluations that may depend on uncontrollable heuristics. They rather provide a description of the current state and show areas for improvement, based on what has commonly been denominated as making up a qualitative and mature website. In contrast, opinion-based approaches like surveys leave room for personal interpretation and the degree to which a certain criterion is evaluated as being fulfilled may depend on experiences with the internet, administrations or e-government or may even depend on criteria that are unrelated to the technology in question. While surveys are to some degree context-sensitive, the chosen approach in this study, based on rather objective measures, is comparable across contexts.

3 Method

In this study we focus on the 16 state capitals' websites in Germany as these cities commonly have more inhabitants (and thus more potential users) and also more resources. Therefore, we assume that these websites should have a rather high quality, high accessibility of information relevant for citizens and that they also provide transactional services.

Starting point of this investigation is the maturity model proposed by [5] that is not only an instrument detached from personal experiences but also focuses on cities. The authors develop a model of e-government that does not contain stages but five different pillars that equally make up e-government, namely *information dissemination, communication, transaction, interoperability,* and *participation* [5]. The evaluation of websites is based on these pillars and consists of analyzing the website's e-government maturity, usability and handling of boundary documents. As discussed earlier, usability aspects are out of scope of this study, wherefore only the proposed maturity instrument was applied. The authors developed several criteria for each segment of e-government and divided a total of 500 achievable points (high maturity) on the segments and criteria (c.f. Table 1) [5].

Table 1. E-Government Maturity Model, adapted from Fietkiewicz et al. 2017 (p. 82)

Pillar	*Maturity aspects*	*Points per criterion*	*Total points*
Information (I)	Availability of press releases, basic information, information on healthcare, politics and on services/information for various user-groups/availability of forms, applications for smartphones, push services, information in English and the languages of the three most important immigrant groups/accessibility via smartphones	8,3	100
Communication (II)	Use of social media/making appointments online/*single government service telephone number/contacting via e-mail/leaving feedback or complaints	20	100
Transaction (III)	Forms can be filled out online/taxes, fees or penalties can be payed online/library services are online/availability of a personal portal	16,6	100
Integration (IV)	Availability of an entry homepage/*links to or integration of agencies at the same level/*links to or integration of agencies at other levels	33,3	100
Participation (V)	Availability of online questionnaires, forums or platforms/possibility to participate in community meetings online, *to launch petitions or referendums online	25	100

To analyze the state capitals' websites, we changed three aspects in the original maturity model (marked with * in Table 1): Instead of asking the administrations themselves to report on vertical and horizontal integration (interoperability), we used the definitions by [5] to operationalize integration as *links to or integration of agencies at other hierarchy levels* (vertical integration) as well as *links to or integration of agencies within the city level* (horizontal integration). This way, we are able to take the user's view, solely focusing on the outer perspective on administrations, while at the same time keeping the measurement as objective as possible. Additionally, we excluded the question of whether e-mails are answered. Both aspects are highly dependent on the administration's willingness share information (interoperability) and on who and which department respectively is contacted (e-mailing). Requests for information on certain topics may not be answered immediately, because of politics, other responses may take longer due to the department's work load. Instead of this measure, we focused on the so called single government service telephone number ("Behördennummer"), a number similar to emergency calls that leads the caller to a call center that either immediately answers the questions and gives basic information on services, e.g. which documents

are needed, or puts the caller through to the respective department. It can be assumed that calling this number may lead to faster results than e-mailing. Finally, we also excluded online voting as an evaluation criterion as currently it is not possible to vote online or electronically in Germany. Instead, we evaluated the possibilities to launch petitions or a referendum.

We analyzed the state capitals' websites using the adapted Table 1 by [5], denoting zero points (criterion not full-filled) or full amount of points (criterion full-filled). For each city, the total amount of points and the points for each category were calculated as indicated in Table 2. The analysis of the criteria always started from the entry page of each city and was conducted in September 2017.

4 Results

Analyzing the German state city's websites shows that the German capital Berlin offers its citizens the most mature website, while Erfurt, capital of the central German state Thuringia, brings up the rear. With a difference of more than 100 points between the two (min=306.5, max=416.5, SD=31.47), the differences between the websites' maturity are in general considerable. It is noteworthy that none of the websites reaches the total of 500 points, which leaves room for improvement for all analyzed websites.

As can be seen from Table 2, mostly all websites perform very well in communication and integration, with a mean of 91.25 and 97.91 points, respectively (see Table 3). 12 cities out of 16 offer their citizens different communication channels like social media, contact through the single government service telephone number, and contacting via e-mail. Also, most websites provide forms to leave feedback or complaints and offer systems to make appointments online. Those cities with less than 100 points in this category do not offer contact to the administration through the nationwide service telephone number or do not integrate feedback options. Additionally, Erfurt does not use social media to communicate with its citizens.

Integration (IV) is the second pillar where all cities, except Schwerin, score very high, but this result should not be overrated. By taking the citizens' perspective on the websites' maturity, we set the demands for this pillar quite low, only evaluating whether offers of other agencies were integrated or at least linked to. The results do not say anything about interoperability.

Regarding the other three pillars, some aspects stand out. First, it seems that each of the sections is developed in parallel rather than successively as is assumed by most e-government stage models [e.g. 14]. Although most models regard information dissemination as the most basic e-government service, the analyzed websites still can improve. Most of the websites with 91.7 points do not provide their websites in the languages of the three most important immigrant groups. Other cities do also not provide information for different user groups. Instead, contents of their websites are rather structured according to different situations in life or broader categories like tourism, economy, businesses and citizens.

Table 2. Evaluation of the website maturity

City (state)	*I*	*II*	*III*	*IV*	*V*	*Total*
Berlin (Berlin)	91.7	100	49.8	100	75	416.5
Stuttgart (Baden-Württemberg)	91.7	100	66.4	100	50	408.1
Magdeburg (Saxony-Anhalt)	91.7	100	33.2	100	75	399.9
Dresden (Saxony)	100	100	33.2	100	50	383.2
Wiesbaden (Hessen)	91.7	80	33.2	100	75	379.9
Bremen (Bremen)	64.3	100	49.8	100	50	364.1
Düsseldorf (North Rhine-Westphalia)	75.1	100	33.2	100	50	358.3
Munich (Bavaria)	83.4	100	49.8	100	25	358.2
Hamburg (Hamburg)	83.4	100	49.8	100	25	358.2
Schwerin (Mecklenburg-Vorpommern)	74.7	100	66.4	66,6	50	357.7
Potsdam (Brandenburg)	83.4	100	16.6	100	50	350.0
Kiel (Schleswig-Holstein)	83.4	100	33.2	100	25	341.6
Saarbrucken (Saarland)	83.4	100	49.9	100	0	333.2
Mainz (Rhineland-Palatinate)	91.7	80	49.8	100	0	321.5
Hannover (Lower Saxony)	100	60	33.4	100	25	318.4
Erfurt (Thuringia)	91.7	40	49.8	100	25	306.5
I=Information; II=Communication; III=Transaction; IV=Integration; V=Participation						

The worst performing city website in this section is the website of Bremen. Bremen as well as Hamburg are city states. Their city government is closely tied to or is the state government at the same time, respectively. Therefore, information especially on the government and administration is not fully listed on the city's website.

Table 3. Descriptive Statistics

Measure	*I*	*II*	*III*	*IV*	*V*	*Total*
SD	9.14	17.28	12.95	8.08	23.18	31.47
Min	64.3	40	16.6	66.6	0	306.5
Max	100	100	66.4	100	75	416.5
Median	87.55	100	49.8	100	50	358.2
Mean	86.33	91.25	4359	97.91	40.63	358.36
I=Information; II=Communication; III=Transaction; IV=Integration; V=Participation						

Second, the section with the most backlog seems to be transaction (III). Here, only one city offers at least four out of six transactional services (Schwerin; filling out forms online, paying fees online (partially), services for libraries, personalized portal). This result is especially important for the citizens' perspective. Repeatedly, researchers have claimed that citizens expect their administrations to provide them with electronic services [19] and that they are presumably the user group getting the most benefits out of e-government [e.g. 20]. Providing services beyond informing the citizenry can therefore be considered as critical for the success of e-government initiatives [14]. Still,

this pillar offers most room for improvement across all city websites, which could be one explanation for why a lot of citizens in Germany still hesitate to use the online channel and rather prefer (or are forced) to go to the office.

Third, the participation section catches one's eye as it is the pillar with the most variation (SD=23.18) and lowest mean (=40.63). While Berlin, Wiesbaden, capital of the middle German state Hessen, and Magdeburg, capital of the eastern state Saxony-Anhalt, perform very well with 75 out of 100 points, seven websites offer no or very few possibilities to participate electronically. Most websites (4 out of 16) offer online questionnaires, but only very few and very infrequently. Those cities with more than 25 points additionally offer platforms or online forums to engage in discussions on city politics and to start initiatives. Few cities also provide the opportunity to launch petitions online or provide interactive portals on participation opportunities.

[5], on whose article this analysis is based, also measured the maturity of Berlin and Munich wherefore a comparison of these two cities and analyses seems appropriate. While Berlin and Munich both range in the middle when compared with other world cities [c.f. 5], Berlin is top-performing when compared to German cities, while Munich is still in the middle. Although we slightly changed the original evaluation scheme, the scores can be compared and it appears that both Berlin and Munich have improved considerably from 310.8 to 416.5 points and from 278.8 to 358.2 points, respectively. Most of the increase in points is due to the improved provision of communication channels. Although we used the availability of the single government telephone number as a measure for communication maturity instead of responses to e-mails, the scores are still comparable and show that both cities have improved the ways citizens can contact the administrations. With regard to the transaction pillar, Munich doubled the scores while Berlin only slightly improved the provision of transactional services. Even though Munich improved in this section, the city's website still only gets roughly half of the available points. While practically no changes can be observed with regard to the integration of services, it is very interesting to see that while Berlin improved e-participation for citizens from formerly 40 points to 75 points, Munich even impairs the score from 50 points to 25 points. Again, although we exchanged one criterion, the scores can be compared and it is surprising that Munich provides less ways to participate in politics than before.

5 Discussion

This article started by asking how well the state capitals' websites perform with regard to e-government maturity. The analysis reveals that there is considerable variance between the cities and also between each of the sections. In the following, the results are discussed in the light of prior research on e-government from the citizens' perspective.

The most obvious result from the analysis is the variation of the cities' performance (vertical). German citizens do not receive the same service level – depending on their residence and their administrations' ability or willingness to provide fully functional e-services. Although Germany has been rated among the leading countries in e-

government development by the United Nations [21], this trend does not account for the complete country. Instead, the provision of e-government seems to depend on local or regional circumstances, such as financial resources, political volition and legal constraints.

Variation also occurs with regard to the cities' performance on a horizontal level. Measured by the scores for each section, the cities' focus still lies more on the provision of information than on the delivery of transactional services (c.f. Table 2). Especially with regard to section IV (integration), it becomes clear that the websites mostly link to other websites instead of integrating different services. Also, even though most cities achieve high scores in the communication section, it remains unclear how the respective channels are used by governments as well as by citizens. In fact, current research indicates that both parties do not fully exploit the potential of social media for example. While citizens are, inter alia, unaware of the governments' social media use [22], governments still use the actually interactive channel to simply disseminate information [23]. Eventually, this leads to only 19% of German citizens actually using social media to get in touch with public administrations [24]. Similarly, it can be assumed that the potential of electronic participation is currently not fully exhausted. 7 out of 16 state capitals do not offer any or only very few possibilities to engage in politics online and even of those cities offering more ways for e-participation, only 3 offer at least three of the required services. Again, this situation is reflected in the actual usage rates of such services – only 22% of the German citizens know about e-participation tools and 10% use them [24].

As already mentioned, the analysis reveals substantial potential for development with regard to transactional services. A core service for citizens is tax filing. 38% of the German citizens use electronic tax filing, 57% intend to do so in the (near) future [24]. Taking this service as an indicator for the citizens' willingness to use e-government services, it can be assumed that citizens actually want to engage with public administrations over the internet but cannot do so due to a lack of services as the website analysis indicates. To give an example, 46% of the citizens would like to pay their penalties online [24], but the analysis revealed that only four cities offers this payment option to their citizens and only for selected services – one city only offers online payment for one single service. Similarly, 71% of the citizens would like to prepare forms online or electronically for their administrative issues, but only 61% are aware of this opportunity and again fewer citizens actually use this option (41%) [24] – although forms are available on every analyzed website. Besides the lack of supply, citizens are perhaps unaware of the various options the cities' administrations currently offer or they need more information and help to find the right forms for their specific matters. What becomes evident, though, is a discrepancy between what citizens expect from and assume about administrations' online services and what the latter in turn actually offer. This incongruity is not only a matter of unfulfilled citizens' expectations, but also a matter of unawareness about e-government services.

Finally, the comparison of the performance of Munich and Berlin between the study at hand and the one by [5] shows improvements in some areas, but it also shows that this development is rather slow as the data of the latter study is from 2012. Five years

later, the situation in both cities has changed but not to the extent one would expect with regard to the general technological developments of the last five years.

Overall, the analysis reveals considerable potential to improve e-government maturity of the German state capitals' websites, even though many of the websites perform very well in some of the analyzed sections. Yet, another aspect surfaces through this analysis, when contrasting the results with current user studies. It is not only the lack of supply (supply-side perspective) that could explain low adoption rates of e-government in Germany. It is also the citizens' unawareness or inaccurate expectancies about the administrations' online presence that leads them to the on-site office rather than to the virtual offices (demand-side perspective). A rationale seems to underlie this situation that prevails on both sides: The administration or government, respectively, is more viewed as service provider (active) and the citizen more as a user (passive). Therefore, provision of information and one-way communication still seems to be the focus of administrations' efforts in developing e-government. At the same time, scholars have recognized that the public can take more than this role when engaging with administrations and becoming more of a partner: "[...T]he provision and the broader pursuit of public ends supposedly occur mostly through networks of private and nonprofit entities, members of the public and governments in a phenomenon that has become known as 'governance' […] As a result, across many or most public services and programs, effective production and delivery require partnering with the public. The effectiveness of most regulations, as one example, depends in part on the cooperation of the regulated […]" [25, p. 788]. Taking the perspective that the public can take different roles and also different roles at the same time, not only requires public administrations to re-think the way they want to develop e-government. It also requires the citizens to re-think their (active) role in shaping this development. While the analysis reveals that at least administrations from their part are on the right track to achieve this goal, it also shows that still a lot has to be done.

6 Conclusion and Outlook

This study set out to answer the question how well German state capitals' website perform with regard to e-government maturity. The analysis of the 16 cities' websites revealed that in some aspects the websites are already quite mature (provision of information, communication, integration). Yet, with regard to the provision of transactional services and ways to participate electronically a backlog has been identified.

From a researcher's point of view, the analysis raises issues that have to be tackled in the future. So far, scholars have been eager to understand under which premises e-government is developed and to understand how e-government is used by its stakeholders. Less attention has been payed to approaches incorporating both perspectives and highlighting discrepancies between expectations, needs and constraints on both sides. The need for such integrative approaches is highlighted when the results of the maturity analysis are contrasted with current user surveys: As pointed out earlier, some e-services already exist but are not used, while some e-services do not

exist but are desired by citizens. To understand what keeps citizens from using certain e-government services is therefore of great importance. In the same way, a deeper understanding of the public's role within public administrations could help fostering sustainable e-government development.

From a practitioner's point of view, the analysis foremost reveals areas for improvement of e-government provision in the state capitals but presumably also in other cities. Taking the maturity evaluation scheme is an easily applicable tool to evaluate any city website with regard to e-government maturity. Moreover, the results could be taken as a reason to reflect the role citizens have in the administration and to re-think ways of administration-citizen interaction to come to a more transparent, accountable and citizen- (or user-) centered administration that makes the most out of the opportunities the digitalization offers.

The results and the respective analysis are, however, limited in their validity. First, we considered the 16 state capitals. Among them are three city states that reduce, due to their special administrative structure, the comparability among the evaluated cities. Additionally, all cities differ with regard to their size for why the comparisons should be treated with caution. Second, the adjusted maturity evaluation scheme used in this study, focuses on the outer perspective on the website and does, for example, not include issues like interoperability or collaboration between different agencies at the same or at other hierarchy levels. Aspects like these should be considered in future research. Third, we encountered the definition of a threshold to be crucial for the evaluation of e-government maturity. For the information pillar, all cities received full points if the website was available in English, although the information density of these translated websites varied from offering only touristic information to providing services for foreign citizens. A differentiation regarding quantity is therefore needed to better compare websites and the e-government supply of different cities. Also, using social media as a communication channel or providing feedback channels on a website does not say anything about how these services are used by the cities and how they respond to the citizens' requests.

In summary, the e-government maturity of the German state capitals' websites is good to medium with a high variety between the top-performers like Berlin and Stuttgart, and the cities at the lower end of the ranking, Hannover and Erfurt. The comparison of Munich and Berlin with the study by [5] indicates some development but also potential for further changes. In fact, it seems as though the cities are on the right track – but the road to a fully functional e-government is still long and winding.

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Entwicklung eines Referenzmodells für die wirtschaftliche Jugendhilfe

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Zusammenfassung. Mit dem Handbuch für Sachbearbeiter/-innen der wirtschaftlichen Jugendhilfe in Verbindung mit dem SGB VIII existiert ein nichtformales, textuelles Referenzmodell für die in Jugendämtern angesiedelten Prozesse der wirtschaftlichen Jugendhilfe. In der vorliegenden Arbeit wird auf dieser Grundlage ein Referenzprozessmodell entwickelt. Die für die Referenzmodellentwicklung relevanten Fragestellungen wurden anhand des Handbuchs abgeleitet, die einzelnen Aufgaben kapitelweise modelliert und anschließend eine zeitlich-logische Reihenfolge entwickelt. Um ein systematisches Vorgehen sowie eine hohe Qualität zu gewährleisten, berücksichtigt die vorliegende Arbeit die neuen Grundsätze ordnungsgemäßer Referenzmodellierung und ein Vorgehensmodell zur iterativ-deduktiven Erstellung von Referenzmodellen. Da nur ein inhaltlich korrektes Referenzmodell einen Empfehlungscharakter besitzt, wurden zwei Validierungsansätze verfolgt und eine fachliche Evaluation mit Experten aus der öffentlichen Verwaltung durchgeführt. Mit dieser Arbeit und dem präsentierten Referenzprozessmodell wird eine zielgerichtete Grundlage für eine prozessorientierte wirtschaftliche Jugendhilfe geschaffen.

Keywords: Referenzmodellierung, Digital Government, prozessorientierte Leistungserbringung, öffentliche Verwaltung, wirtschaftliche Jugendhilfe

1 Einleitung und Zielsetzung

Im Zuge der Digitalisierung streben auch die öffentlichen Verwaltungen die Umsetzung der vorhandenen Potentiale einer digitalen Unterstützung von Geschäftsprozessen an. Dies ist auch dringend notwendig, da sie in Zukunft vor gravierende Herausforderungen gestellt werden. Steigende Schulden in den Kommunen [1] und das Einhalten von Schuldenbremsen schränken vorhandene Budgets und damit Ressourcen zur Erfüllung von Aufgaben ein. Insbesondere Jugendämter werden durch diverse Entwicklungen wie die gestiegene Anzahl von unbegleiteten minderjährigen Asylbewerber/-Innen [2] zusätzlich belastet. So sind bspw. die Ausgaben der Jugendhilfen in

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Baden-Württemberg von 2014 auf 2015 um 10,2% gestiegen und es wird mit weiteren Steigerungen gerechnet [17].

Förderale Strukturen und das Subsidiaritätsprinzip führen dazu, dass identische Aufgaben von diversen Behörden mit unterschiedlichem örtlichem und sachlichem Zuständigkeitsbereich ausgeführt werden. Dadurch entstehen Parallelstrukturen, die eine unterbrechungsfreie Leistungserbringung erschweren [4]. Die Prozesse der wirtschaftlichen Jugendhilfe bilden hier keine Ausnahme. Sie haben Schnittstellen zu zahlreichen anderen Behörden, externen Leistungserbringern sowie den leistungsbeziehenden Bürgern und sollten entsprechend übergreifend betrachtet werden. Die Verwendung eines geeigneten Referenzprozessmodells kann in diesem Zusammenhang die Effizienz dieser Prozesse steigern. Allerdings existiert nach Kenntnis der Autoren des vorliegenden Beitrags kein solches Referenzmodell.

Ein Referenzmodell für die wirtschaftliche Jugendhilfe könnte durch eine Nutzung in vielen Jugendämtern in Deutschland zu einer Vereinheitlichung von Strukturen im öffentlichen Dienst- und relevanter Schnittstellenbeitragen und auf diese Weise die interne und externe Kommunikation verbessern [5]. Es kann somit eine Verbesserung der Prozesse erreicht werden, um so den steigenden Kosten und Fallzahlen zu begegnen und die Wirtschaftlichkeit der öffentlichen Verwaltung zu verbessern. Vor dem Hintergrund eines steigenden Digitalisierungsgrades der öffentlichen Verwaltung kann ein standardisiertes Referenzmodell zudem dazu beitragen, Veränderungsprozesse zu vereinfachen und Transparenz zu erzeugen.

Im vorliegenden Papier werden die Vorgehensweise zur deduktiven Erstellung eines Referenzmodells für die wirtschaftliche Jugendhilfe und zentrale Aspekte des Modells vorgestellt. Darüber hinaus wird erläutert, wie das Modell von Experten auf seine fachliche Richtigkeit geprüft wurde und auf welche Weise das Feedback in die Weiterentwicklung geflossen ist.

Der generelle Erstellungsprozess orientiert sich an dem Referenzmodelllebenszyklus nach Schütte [14], sowie an der Vorgehensweise von Thomas et al. [19]. Abb. 1 zeigt das konkrete Vorgehen zur Erstellung des Referenzmodells. Als Ausgangslage wurde das Handbuch für Sachbearbeiter/-innen zur wirtschaftlichen Jugendhilfe [13] herangezogen. Es beschreibt die Aufgaben und Abläufe innerhalb der Organisationseinheit „wirtschaftliche Jugendhilfe“ nach SGB VIII. Es wurde mit der Intention erstellt, eine praxisorientierte Beschreibung der angewandten Verfahren zu dokumentieren. Das Handbuch dient Jugendhilfen bundesweit als Referenz und Orientierungshilfe und kann somit als textuelles Referenzmodell definiert werden. Die Aufgaben und Abläufe sind jedoch nicht übergreifend in ihrer logischen Reihenfolge beschrieben. Es bedarf einer weiteren Interpretation und Transformation eines Modellierers, um daraus ein semiformales Referenzprozessmodell zu entwickeln (siehe Abb. 2).

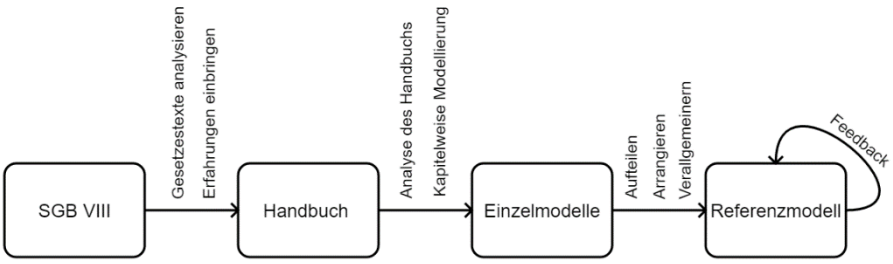


Abbildung 1: Vorgehensmodell in Anlehnung an Thomas et al. [19]

Ausgehend von der textuellen Beschreibung wurde ein semiformales Referenzprozessmodell der wirtschaftlichen Jugendhilfe mit zeitlich-logischem Ablauf erstellt. Zwecks Umsetzung wurde zunächst der Aufbau des Handbuchs analysiert und identifizierte Verfahren anschließend kapitelweise als EPK modelliert. Daraus entstanden thematisch unabhängige Teilprozesse (Tab. 1). Sie werden nach Leistungen aufgeteilt und durch die Anordnung der mit Teilprozessen hinterlegten Funktionen innerhalb der Hauptprozesse in eine zeitlich-logische Reihenfolge gebracht. Um redundante Prozesse zu vermeiden, wurden die Modelle anschließend konsolidiert und es entstanden 8 generische Hauptprozesse für 24 Leistungen der wirtschaftlichen Jugendhilfe. Im folgenden Schritt wurden die entstandenen Modelle von Fachexperten auf Basis ihrer Kenntnisse und Erfahrungen angepasst und daraufhin evaluiert. Mit der Evaluation wird weiterhin der Nutzen für den Anwender untersucht (Feedback) und darauf basierend das Referenzmodell verbessert. Die Referenzmodellierung durchläuft in diesem Zusammenhang weitere Zyklen und steigert i.d.R. mit jeder Iteration den Nutzen für den Anwender. Aktuell befinden sich noch etwa 30% der Teilprozessmodelle in einer Evaluationsphase und 70% konnten bereits finalisiert werden.

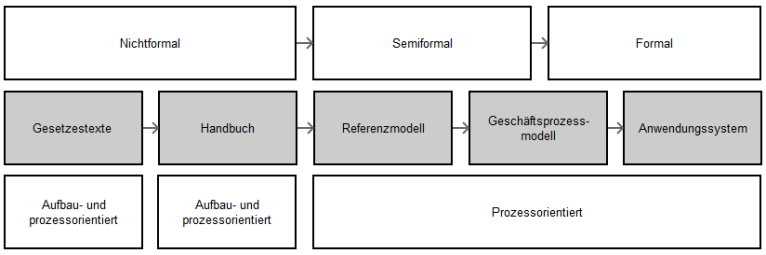


Abbildung 2: Übersicht: vom SGB VIII zur Anwendung, in Anlehnung an Daun et al. [3]

2 Konzeptionelle Grundlagen

2.1 Digital Government

Zu den Zielsetzungen des „Digital Government gehören zum einen die Effizienzsteigerung bestehender Leistungsprofile, zum anderen das Erschließen neuer und bislang

ungenutzter Leistungspotentiale [9]. Einschränkungen zur eigenständigen Weiterentwicklung der öffentlichen Verwaltung zeigen sich insbesondere im direkten Kontrast zur Privatwirtschaft. Externe Effekte müssen im öffentlichen Sektor überdurchschnittlich stark miteinbezogen werden [7]. Traditionell sind die Verwaltungsstrukturen organisatorisch getrennt, so dass jeder Behörde ein konkret abgegrenzter Aufgabenrahmen unterliegt. Um auf benötigte Informationen im Zuständigkeitsbereich anderer Behörden zugreifen zu können, sind Auskunftsverfahren bei diversen Stellen und aufwendige Kontrollen nötig. Daraus folgen organisatorisch getrennte, aber fachlich zusammenhängende Abläufe. Die Konsequenz daraus ist, dass mit der Umsetzung von Digital-Government-Strategien nicht nur bestehende Abläufe und Zuständigkeiten modernisiert werden müssen, sondern eine Vernetzung fachlich zusammenhängender Abläufe zu integrierten Prozessen erforderlich ist [5].

2.2 Referenzmodellierung in der öffentlichen Verwaltung

Referenzmodelle eignen sich besonders für die Anwendung in der öffentlichen Verwaltung, weil hier im Vergleich zur Privatwirtschaft kein direkter Wettbewerb herrscht, der den Informationsaustausch und die gemeinsame Nutzung von Erkenntnissen hemmt. Daneben existieren für viele Behörden und deren Aufgaben vergleichbare Rahmenbedingungen wie bspw. rechtliche Grundlagen [16]. Die Kernprozesse einer Behörde, können einmalig modelliert und dann vielfach als Referenz in anderen Behörden mit vergleichbaren Profilen oder Tätigkeiten wiederverwendet werden. Dabei ist das Referenzmodell als erweiterbare Empfehlung zu verstehen, da die Behörden unabhängig in der Gestaltung der Aktivitäten zur Umsetzung der Gesetze sind [16] und durch die föderale Organisation der Bundesrepublik Deutschland jedem Bundesland Spielräume zur Konkretisierung bundesweiter Vorgaben und Richtlinien zur Verfügung stehen. Vor diesem Hintergrund wurde im Rahmen der vorliegenden Arbeit ein Referenzprozessmodell entwickelt, um die vorgestellte Methode zur gemeinsamen Verbesserung der Ablauforganisation im Bereich der wirtschaftlichen Jugendhilfe anzustoßen. Die einzelnen Schritte der Vorgehensweise erfolgen unter Berücksichtigung der neuen Kriterien der ordnungsgemäßen Referenzmodellierung [14] (Konstruktionsadäquanz, Sprachadäquanz, Wirtschaftlichkeit, Klarheit, systematischer Aufbau und Vergleichbarkeit) und dem Vorgehensmodell zur Transformation von Gesetzen in Prozesse nach Daun et al. [3]. Das Vorgehen sieht 3 Schritte vor. Zunächst wird der gesetzliche Rahmen analysiert, danach ein rechtliches Verfahren mit zeitlichem Bezug erstellt und abschließend auf dieser Basis das Referenzmodell konstruiert.

2.3 Validierung und Evaluation von Referenzmodellen

In dieser Arbeit wird unter der Validierung und Evaluation die Prüfung auf syntaktische und semantische Fehlerfreiheit und die Bewertung des Nutzens für den Anwender verstanden. Die Einhaltung der allgemeinen Regeln des Aufbaus, des Kontrollflusses, der Konnektoren und die fehlerfreie Verwendung aller Elemente werden sichergestellt. Häufige Fehler insbesondere des Kontrollflusses können mit automati-

sierten Verfahren ermittelt werden. Weitere Verfahren beruhen auf der Erkennung fehlerhafter Muster [10] oder erzeugen die Vereinheitlichung von Beschriftungen der Ereignisse und Funktionen [11]. Des Weiteren wird der Nutzen [12] für einen spezifizierten Anwender, also der Eignung für den definierten Konstruktionszweck, überprüft. Außerdem wurde vorab recherchiert, ob für die Fachverfahren der wirtschaftlichen Jugendhilfe bereits Prozess- oder Referenzmodelle vorhanden sind. Hierbei konnten keine Hinweise auf relevante Arbeiten identifiziert werden.

3 Ergebnisse

3.1 Analyse des Handbuchs für Sachbearbeiter/-innen der wirtschaftlichen Jugendhilfe und der Gesetze des SGB VIII – Kinder und Jugendhilfe

Bei dem Handbuch für Sachbearbeiter/-innen der wirtschaftlichen Jugendhilfe [13] handelt es sich um eine Zusammenstellung von Dienstvorschriften und damit um ein nichtformales, textuelles Referenzmodell ohne Beachtung einer zeitlich-logischen Abfolge. Somit sind die ersten zwei Phasen des Referenzmodelllebenszyklus ‚Anforderungsdefinition' und ‚Konstruktion' bereits gegeben [14].

Tabelle 1: Aufbau des Handbuchs für Sachbearbeiter/-innen der wirtschaftl. Jugendhilfe [13]

Kap.	*Bezeichnung*	*Gesetze*	*Leistungen*	*Anzahl der Modelle*
1	Allgemeine Vorschriften	§§ 1, 2, 5, 6, 10 SGB VIII	Grundlagen und Prinzipien	0
2	Leistungen der Jugendhilfe und (vorläufige) Inobhutnahme	§§ 13, 19-35a, 41, 42-42g SGB VIII	Leistungen und Anspruchsberechtigungen: Hilfe zur Erziehung, Inobhutnahme, …	15
3	Leistungen zum Unterhalt	§39 SGB VIII	Sicherstellung des Lebensunterhalts, ...	2
4	Krankenhilfe	§ 40 SGB VIII	Krankenversicherung, Krankenhilfe, …	2
5	Zuständigkeit	§ 69, 85-88 SGB VIII	Örtliche und sachliche Zuständigkeit	11
6	Kostenerstattung	§§ 89-89h SGB VIII	Kostenerstattung zwischen Trägern der Jugendhilfe	3
7	Kostenbeteiligung	§§ 90-97b SGB VIII	Elternbeiträge, Hinzurechnungen, Abzüge,…	9
8	Sonstige Ansprüche	Diverse SGB	Vorrangige Leistungen	1
9	Pflegeversicherung	SGB XI	Anspruch, Sicherstellung, ...	1

Die Anforderungen sind durch die einzelnen Kapitel definiert und geben die Aufgaben und Ziele der wirtschaftlichen Jugendhilfe wieder. Zunächst wurde der Inhalt der Kapitel analysiert. Die verwendeten Gesetze stammen größtenteils aus dem SGB VIII – Kinder und Jugendhilfe. Zur Aufarbeitung des Handbuchs wurden die entsprechenden Gesetze zusätzlich gegengelesen. Jedes der neun Kapitel kann als in sich abgeschlossen betrachtet werden. Kapitelintern werden oftmals mehrere Leistungen eines Themengebietes in einem gewissen zeitlich-logischen Aufbau behandelt, sodass durch eine übergreifende Kombination von Leistungen ein zeitlich-logischer Prozess konstruiert werden kann. So können bspw. im Bereich der Krankenhilfe einzelne individuell zu betrachtenden Leistungen der gesetzlichen und privaten Krankenversicherung, sowie die Krankenbeihilfe unterschieden und separate Prozesse konstruiert werden. Im vorliegenden Referenzmodell wurden die Prozesse an der passenden Stelle im Gesamtprozess unabhängig voneinander hinterlegt. Um die Reihenfolge exakt zu bestimmen, wurden Schlüsselwörter und -formulierungen zum zeitlichen und zum logischen Ablauf gesucht, wie bspw. „sollte immer zuvor geprüft werden“, „neben“ und „wird dann“. Daneben konnten Rückschlüsse aus dem Aufbau des Inhaltsverzeichnisses gewonnen werden. Ergänzend flossen im späteren Verlauf zusätzliche Erkenntnisse aus der fachlichen Evaluation ein. Tab. 1 zeigt die Kapitel des Handbuchs, deren Themengebiet und Inhalt, sowie die Anzahl der abgeleiteten Teilprozesse.

3.2 Konstruktion

In diesem Abschnitt wird beschrieben, wie das Referenzmodell auf deduktive Weise erstellt worden ist. Im ersten Schritt der Konstruktion wurden die Teilmodelle in Anlehnung an die Kapitel des Handbuchs und den jeweiligen Paragraphen im SGB VIII modelliert. Anschließend wurde aus dem Inhaltverzeichnis des Handbuchs eine Modellstruktur erstellt, in der die Teilmodelle integriert und Querverbindungen geschaffen wurden. Es wird ersichtlich, dass nach Leistungen aus §§13,19-35a und 41, der Inobhutnahme, der vorläufigen Inobhutnahme und einmaligen Leistungen differenziert werden muss, da sich ihre benötigten Teilmodelle und -aufgaben klar voneinander abgrenzen. Da alle 18 Leistungen nach §§13,19-35a und 41 ähnlich abgearbeitet werden konnten, wurden diese zu einem generischen Hauptprozess zusammengefasst, während die restlichen Leistungen in separaten Prozessen dargestellt werden. Im Folgenden wird ein Beispielmodell präsentiert und exemplarische Sachverhalte aus dem Referenzprozessmodell illustriert.

Die Inhalte des gezeigten beispielhaften Prozessausschnitts (Abb. 3) werden nun beschrieben. Dieser umfasst die Leistungen nach §§13,19-35a und 41 SGB VIII und muss mit der Bestimmung der sachlichen und örtlichen Zuständigkeit (Kapitel 5) begonnen werden, da ansonsten die Gefahr besteht, zahlreiche Funktionen trotz fehlender Zuständigkeit unnötigerweise durchzuführen. Sollte keine sachliche Zuständigkeit vorliegen, wird der Fall an das Landesjugendamt weitergegeben und der Prozess für die abgebende Organisationseinheit beendet. Bei vorhandener sachlicher Zuständigkeit wird die Berechtigung zur beantragten Leistung geprüft und der Leistungsumfang bestimmt (Kapitel 2 und 3).

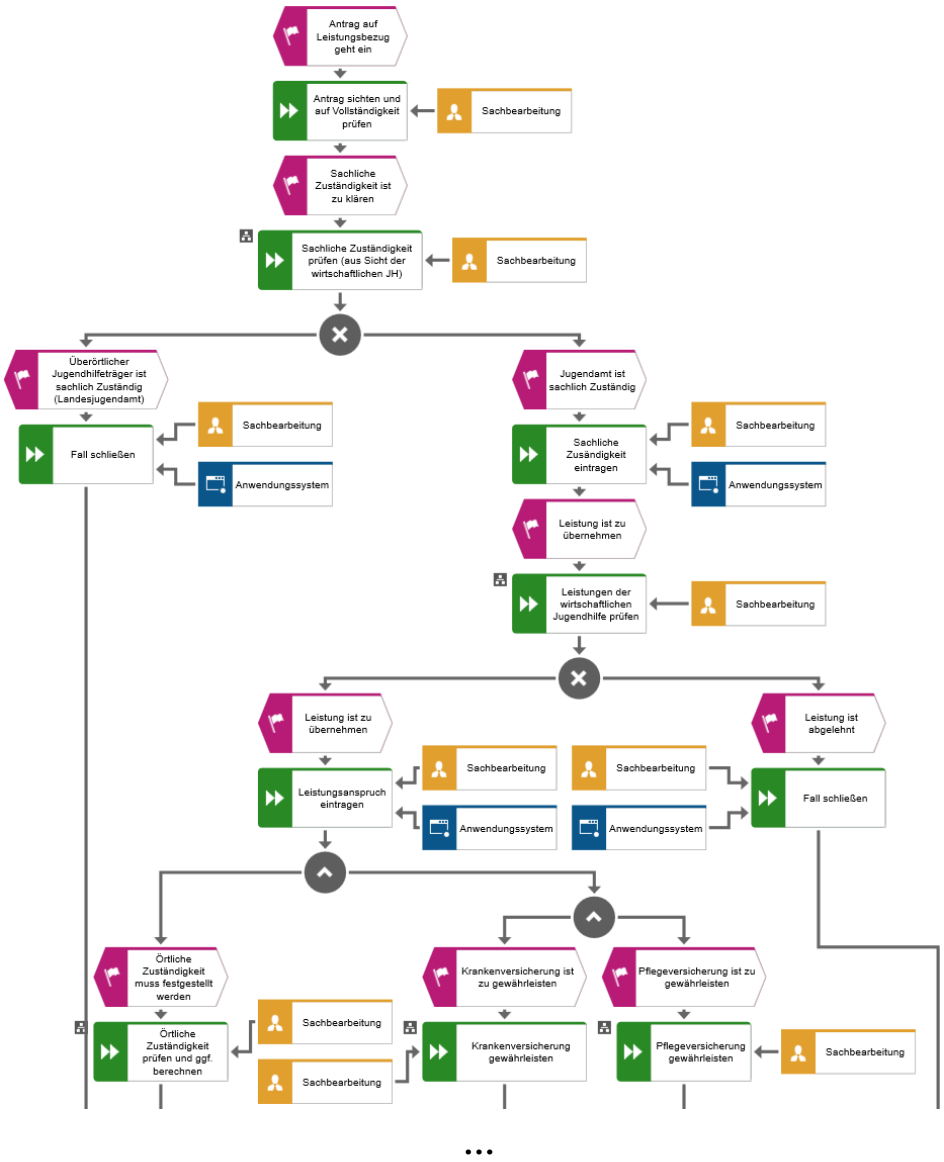


Abbildung 3: Ausschnitt „Antragstellung auf Leistungen nach §§13, 19-35a und 41 SGB VIII“

Sofern eine Leistungsberechtigung besteht, ist der Jugendhilfeträger verpflichtet, zu prüfen, ob ein Krankenversicherungsschutz vorhanden ist. Falls nicht, hat er für die Sicherstellung der Krankenhilfe zu sorgen (Kapitel 4). Gleichermaßen muss auch hinsichtlich der Pflegeversicherung vorgegangen werden (Kapitel 9). Damit stehen alle Leistungen und alle Kosten, die der Jugendhilfeträger übernehmen muss, fest.
Die verursachten Kosten können auf verschiedene Arten an andere Jugendhilfeträger und Sozialbehörden weitergereicht werden. Tritt ein Jugendamt mit einer Leistung in

Vorlage und stellt zu einem späteren Zeitpunkt fest, dass es die Kosten bspw. auf Grund einer verspäteten Klarstellung der örtlichen Zuständigkeit weitergeben kann, so ist es berechtigt, einen vollständigen Ausgleich einzufordern. Der Kostenerstattungsprozess kann ebenso aus Sicht des zahlungspflichtigen Jugendamtes betrachtet werden. In diesem Fall hat das örtlich zuständige Jugendamt nicht geleistet und ein anderes Jugendamt fordert für erbrachte Leistungen eine Kostenerstattung. Beide Sachverhalte sind in Kapitel 6 beschrieben. Da ihr Ablauf aber sehr unterschiedlich ist, wurden sie getrennt modelliert. Dabei ist die Antragstellung auf Kostenerstattung in den Hauptprozess integriert, während die Erstattung von Kosten als eigenständiger Prozess modelliert wurde.
Weitere Hautprozesse sind die Inobhutnahme, die vorläufige Inobhutnahme, die Übernahme von einmaligen Beihilfen, die Erstattung von nachrangigen Leistungen nach SGB II, die Übernahme von Zusatzbeiträgen der Krankenkassen und die Krankenhilfe. Deren Modellierung erfolgte analog zum Vorgehen bei den Leistungen nach §§13, 19-35a und 41 SGB VIII. Haupt- und Teilmodelle wurden iterativ mit den Erfahrungen der fachlichen Evaluation erweitert und ergänzt, sodass insgesamt 52 (Teil-)Modelle entwickelt wurden, 8 davon sind Hauptprozesse, die wiederum 44 hinterlegte Prozesse enthalten. Insgesamt umfassen alle Modelle 829 Ereignisse und 669 Funktionen (siehe Tab. 2). Es ist weiterhin geplant, das Modell nach Abschluss der Untersuchung zu veröffentlichen. Auf Anfrage kann es zur Verfügung gestellt werden.

Tabelle 2: Umfang des Referenzmodells

Bezeichnung	Anzahl
Modelle	52
Hauptmodelle	8
Teilmodelle	44
Ereignisse	829
Funktionen	669

3.3 Validierung und Evaluation

Zur Validierung und Evaluation wurde ein Drei-Stufen-Vorgehen angewandt. Im ersten Schritt wurde bei den Modellen von den Autoren die Verwendung von Konnektoren und damit die Komplexität des Kontrollflusses untersucht. Bei komplexeren Strukturen wurden automatisierte Verfahren zur Prüfung der Validität eingesetzt. Im zweiten Schritt der Validierung wurden die Beschriftungen der Ereignisse und Funktionen in Anlehnung an Gruhn und Laue [11] normalisiert, um eine manuelle Prüfung und ggf. Anpassung der Labels zu ermöglichen. Abschließend wurden Funktionen mit größerer Entscheidungskompetenz betrachtet und bei Bedarf umbenannt.
Der dritte Schritt beschäftigte sich mit der Evaluation des Referenzmodells. Hierbei wurden bestimmte Ergebnisse inhaltlich durch Fachexperten der wirtschaftlichen Jugendhilfe geprüft. Dieser Schritt umfasste die Evaluation von Modellen und ebenso

die Untersuchung des Anwendernutzens. Erste Ergebnisse zeigen nur minimalen Anpassungsbedarf, allerdings liegen aktuell noch nicht alle Prüfungsergebnisse vor. Darüber hinaus wurden Ausschnitte des Referenzmodells bereits in Arbeitsgruppen verwendet, um entwickelte Soll-Konzepte zu geplanten Modernisierungsmaßnahmen im Rahmen eines aktuellen Projektes zu diskutieren. Hierbei wurden die fachlichen Prozesse des Jugendamtes im Ist-Zustand und deren Verbesserungspotenziale aufgezeigt, um die Möglichkeiten einer Umsetzung zu prüfen. Das Referenzmodell kann in diesem Zusammenhang insbesondere Beteiligten, die nicht über detaillierte Kenntnisse der Fachprozesse verfügten, einen umfassenden Überblick bieten.

4 Diskussion

Die vorliegenden Ergebnisse untermauern die These, dass sich die Abläufe der öffentlichen Verwaltung in besonderem Maße zur Referenzmodellierung und der Anwendung von Referenzmodellen eignen. Gesetzliche Grundlagen und Rahmenbedingungen sind für viele Instanzen der öffentlichen Verwaltung oft vergleichbar, sodass Referenzmodelle in Behörden mit homogener Aufgabenstruktur breite Anwendung finden können. Entsprechend ist auch die Transformation in individuelle Geschäftsprozessmodelle schnell und mit wenig Aufwand möglich. Da mit dem Handbuch für Sachbearbeiter/-innen bereits die Mehrheit der erforderlichen Prozessinformationen vorlagen, konnte die Modellierung weitestgehend ohne Zuhilfenahme weiterer Quellen erfolgen.
Im Referenzmodell zur wirtschaftlichen Jugendhilfe konnte die Umsetzung der Grundsätze ordnungsgemäßer Modellierung (GoM) gewährleistet werden. Die Validierung sowie die Evaluation wurden erfolgreich durchgeführt und stellen gepaart mit der Expertise des Modellierers sowohl die semantische als auch die syntaktische Richtigkeit des Modells sicher. Die Grundsätze der Klarheit, Vergleichbarkeit und des systematischen Aufbaus ergeben sich maßgeblich aus der Wahl der Modellierungssprache. Mit der Entscheidung für die Ereignisorientierte Prozesskette wurde eine intuitiv verständliche Darstellung mit geeignetem Komplexitätsgrad zur Abbildung der Fachkonzeptebene gewählt. Dass sich diese Wahl sowohl hinsichtlich der adressatengerechten Abbildung von Sachverhalten als auch der Vergleichbarkeit unterschiedlicher Modellvarianten auszeichnete, wurde im Rahmen verschiedener Workshops zur Neuausrichtung der wirtschaftlichen Jugendhilfe belegt.
Damit der Nutzen eines Referenzmodells mit Blick auf den Anwender erhöht werden kann, sollten die Anforderungen der Adressaten eines Referenzmodells in die Entstehung einfließen [5]. Dies wurde im Rahmen der Modellvalidierung initial angestoßen. Erstrebenswert wäre in diesem Zusammenhang die bundesweite Bereitstellung des Modells, damit die Informationen allen Prozessbeteiligten zugänglich sind und damit eine breit gefächerte Validierung und Weiterentwicklung des Modells ermöglicht wird. Die universelle Verwendbarkeit ist gegeben, da alle Jugendämter in Deutschland an einen vergleichbaren gesetzlichen Rahmen gebunden sind und sich Aufgabenspektrum und Arbeitsweise nicht grundlegend unterscheiden. Ebenso ist damit eine skalierbare Wiederverwendbarkeit sichergestellt, da das Referenzmodell alle Aufga-

benbereiche der wirtschaftlichen Jugendhilfe abdeckt. Es kann somit gezielt auf einzelne Teilbereiche und ebenso großflächig auf die Gesamtheit vorhandener Prozesse angewandt werden.
Als Orientierungshilfe hält das Modell Best-Practice-Aspekte bereit, stellt durch die geeignete Darstellung und Informationsdichte ein sinnvolles Nutzenempfinden des Anwenders sicher und ist durch die hohe Anzahl potentieller Adressaten und Anwendungsszenarien vielfach einsetzbar. Entsprechend sind die drei wesentlichen Kriterien für ein Referenzmodell gegeben [15].
Dennoch bleibt zu beobachten, wie dauerhaft das Modell verwendet werden kann. Es existieren Verfahren, deren Einflussfaktoren von Veränderungen betroffen sein können. So stehen bspw. bei der vorläufigen Inobhutnahme rechtliche Neuregelungen an, die sich unter Umständen auf die Vorgehensweise der wirtschaftlichen Jugendhilfe und damit unmittelbar auf die dokumentierten Prozessdetails auswirken können [13]. Entsprechend kann in unregelmäßigen Abständen der Bedarf zur Aktualisierung von Teilprozessen des Referenzmodells erforderlich sein, um die semantische Richtigkeit zu wahren.
Derzeit bieten die Prozesse des Referenzmodells eine hohe Qualität, die einen entsprechenden Nutzen impliziert. Anwendungsorientiert bietet sich ein sog. „Conformance Checking“ bereits bestehender Geschäftsprozessmodelle von Jugendämtern an. Dazu wird das lokale Geschäftsmodell mit dem Referenzmodell verglichen, um die Gesetzeskonformität, die Prozessqualität und die Geschwindigkeit der Prozesse verbessern und evtl. vorhandene Schwachstellen finden und beseitigen zu können.
Daneben kann die Vernetzung zwischen korrespondierenden Behörden mit diesem Referenzmodell untersucht werden. Der behördenübergreifende Kontroll- und Informationsfluss wird aufgezeigt und erlaubt es, insbesondere die Interoperabilität der öffentlichen Verwaltung zu betrachten und zu verbessern. Des Weiteren wird mit Inkrafttreten des E-Government-Gesetzes 2020 (eGovG) die Prozessdokumentation und -optimierung verpflichtend für alle öffentlichen Ämter. Das Referenzmodell bietet eine Grundlage zur schnellen und qualitätsgesicherten Dokumentation, sowie einer schnellen Prozessverbesserung [15], da es als kompakte, verständliche Vorlage herangezogen werden kann. Dies ist insbesondere in jenen Behörden von Vorteil, wo angewandte Verfahren noch nicht prozessorientiert erfasst wurden.

5 Resümee

Mit dem Handbuch für Sachbearbeiter/-innen der wirtschaftlichen Jugendhilfe besteht ein akzeptiertes textuelles Referenzmodell zur wirtschaftlichen Jugendhilfe. Durch die textuelle, nichtformale Ausführung stellt sie jedoch kein geeignetes Mittel für ein effizientes, prozessorientiertes Management der Verfahren in der wirtschaftlichen Jugendhilfe dar. Aus diesem Grund wurde in dieser Arbeit ein semiformales Referenzprozessmodell entwickelt, validiert, evaluiert und iterativ weiterentwickelt.
Die für die Nutzer interessante Fragestellung wurde anhand des Handbuchs abgeleitet, die Aufgaben kapitelweise modelliert und anschließend die so entstandenen Teilprozessmodelle in eine zeitlich-logische Reihenfolge gebracht. Zwei unterschiedliche

Validationsmethoden und eine fachliche Evaluation konnten die inhaltliche Qualität zusätzlich steigern.
Das entwickelte Referenzmodell erlaubt Jugendämtern eine Orientierung, Beurteilung und Verbesserung angewandter sowie geplanter Verfahren im Zusammenhang mit der Verwaltungsmodernisierung. Entsprechend entfaltet es seinen Nutzen sowohl im Zusammenhang mit eigenverantwortlichen Veränderungsbestrebungen als auch den durch das E-Government-Gesetz bevorstehenden Herausforderungen.
Zusätzlich bietet es eine Grundlage für fortführende oder vertiefende Forschungsansätze wie bspw. der Verwendung induktiver Methoden [20]. Unter bestimmten technischen Voraussetzungen könnten bspw. durch Process-Mining-Strategien zusätzliche Erkenntnisse zu möglichen Verbesserungspotenzialen generiert werden. Gleichermaßen können aber auch Prozessinformationen, die aus Interviews entstanden sind, ähnliche Erkenntnisse bereithalten, wenn Abweichungen zum Referenzmodell identifiziert werden. Eine derart ergänzte Weiterentwicklung, Variation, Ergänzung und Verfeinerung des Modells ist in diesem Zusammenhang sinnvoll und wünschenswert.
Weiterhin stellt das Modell eine geeignete Grundlage für künftige Forschungsvorhaben dar. Interessant wäre bspw. die Prüfung der Prozesse auf Konformität zu den Aspekten des Digital Governments oder den Anforderungen, die aus dem eGovG hervorgehen. Hierbei könnten neben Handlungsempfehlungen und kritischen Schwachstellen auch Muster erkannt werden, die sich unter Umständen in vergleichbaren Fachverfahren wiederfinden und damit gemeinsamen Handlungsbedarf aufzeigen. Somit kann das Referenzmodell zur wirtschaftlichen Jugendhilfe eine anerkannte Informationsbasis bereitstellen, um für Teilbereiche der öffentlichen Verwaltung insbesondere die Potentiale und Herausforderungen der Zukunft durch unterschiedliche Ansätze zielgerichtet zu diskutieren.

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Beteiligung der Beschäftigten bei IT-Projekten in öffentlichen Verwaltungen – Umfrage in deutschen Bundesbehörden am Beispiel der E-Akte

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Abstract. Die Digitalisierung der öffentlichen Verwaltung führt zur Umsetzung verschiedener IT-Projekte wie der Einführung der elektronischen Akte (E-Akte) in deutschen Bundesbehörden. Mit der Einführung der E-Akte verbunden sind technische und organisatorische Herausforderungen, aber auch Auswirkungen auf die Arbeit der Beschäftigten. Ein Erfolgs- und Akzeptanzfaktor für die Einführung von IT-Projekten ist die Beteiligung der Beschäftigten im Einführungsprozess. Dieser Artikel untersucht mit Hilfe einer Online-Umfrage unter Personalräten in deutschen Bundesbehörden die Beteiligung des Personalrats und der Beschäftigten bei der Einführung der E-Akte und die damit verbundenen Auswirkungen. Die Ergebnisse ermitteln den Einführungsstand der E-Akte und zeigen Optimierungspotenzial bei den Beteiligungsmöglichkeiten und bei der Kommunikation über die möglichen Auswirkungen.

Keywords: Beschäftigte, Beteiligung, Bundesbehörden, E-Akte, IT-Projekte.

1 Einleitung

Die Entwicklung der Integration und Nutzung von Informations- und Kommunikationstechnologien in öffentlichen Verwaltungen hat in den letzten Jahren rasant zugenommen [1]. Die Digitalisierung der öffentlichen Verwaltung steht in Strategien und Agenden vieler Regierungen im Vordergrund [2]. So verfolgt auch die Bundesregierung Deutschland mit der Einführung verschiedener IT-Projekte das Ziel, die Verwaltung effektiver und effizienter zu gestalten [3]. Ein Schwerpunkt der Verwaltungsmodernisierung ist die Einführung der elektronischen Aktenführung (E-Akte) [4]. Im Rahmen der Umsetzung des E-Government-Gesetzes in Deutschland soll mit dem Aktionsplan E-Akte der Bundesregierung die Einführung der E-Akte in den Bundesverwaltungen bis 2020 abgeschlossen sein [5]. Mit der E-Akte soll die Verwaltungsarbeit im Vergleich zur Umlaufmappe effektiver und effizienter werden [6]. Die Beschäftigten stellen sich damit auf digitale Medien um, wofür sie gewisse Kompetenzen und Qualifikation aufbauen sollen [7]. Nicht nur auf die Qualifikation der Beschäftigten, sondern auch auf ihre Arbeitsbelastung und Gesundheit kann die Einführung der E-Akte Auswirkungen haben [8]. Weitere Auswirkungen der Digitalisierung stecken in Rationalisierungspotenziale, die bis hin zum Arbeitsplatzverlust reichen können, [9], [10]. Ein

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entscheidender Erfolgs- und Akzeptanzfaktor für die Einführung solcher Digitalisierungsprojekte ist die Beteiligung der Beschäftigten im Einführungsprozess [12]. Die Beteiligung der Beschäftigten sowie Beschäftigtenvertretung soll für eine gute Arbeitsatmosphäre sorgen und die Akzeptanz von Veränderungen erhöhen [13]. Viele Studien berichten über die Wichtigkeit der Beteiligung und die daraus resultierenden Vorteile für die Beteiligten selbst und für die Organisation [14]–[17]. Dabei existieren verschiedene Beteiligungsmöglichkeiten wie beispielsweise Beteiligung durch Teilnahme an Schulungen und Qualifizierungsmaßnahmen [15], [18], Beteiligung durch Beschäftigtenvertretung wie den Personalrat in verschiedenen Projektgruppen [15] und Beteiligung durch Evaluation und Testen der Gebrauchstauglichkeit [19]. Darüber hinaus wird die Nutzung von Beteiligungsinstrumente wie beispielsweise eine Dienstvereinbarung oder Beteiligungsvorlagen von vielen Gewerkschaften empfohlen. Obwohl Beteiligung als signifikanter Faktor für die Akzeptanz von IT-Projekten in öffentlichen Verwaltung gilt und dafür verschiedene Möglichkeiten vorgesehen sind, wurde diese wissenschaftlich bislang nicht untersucht. Es liegen wenig Erfahrungswerte darüber vor, wann und welche Beteiligungsinstrumente von wem genutzt werden und wie diese bewertet werden. Auch im Hinblick auf die mit der Einführung verbundenen Auswirkungen auf die Arbeit der Beschäftigten existieren bislang wenig wissenschaftliche Erkenntnisse. Um diese Forschungslücke zu schließen, adressiert dieser Artikel folgende Forschungsfrage:

Wie werden Beschäftigte und Personalräte bei IT-Einführungsprojekten in öffentlichen Verwaltung beteiligt?

Um diese Forschungsfrage zu beantworten werden am Beispiel der Einführung der E-Akte in deutschen Bundesbehörden folgende Unterfragen gestellt:

- In welchem Stand befindet sich die Einführung der E-Akte in den Bundesbehörden?
- Welche möglichen Auswirkungen hat die Einführung der E-Akte auf die Arbeit der Beschäftigten und wie werden diese von der Dienststelle thematisiert?
- Welche Beteiligungsmöglichkeiten und Beteiligungsinstrumente werden zur Einbeziehung des Personalrats und der Beschäftigten bei der Einführung der E-Akte genutzt und wie werden diese bewertet?

In diesem Artikel liefert Kapitel 2 einen Überblick über den Stand der Forschung zum Thema Beteiligung insbesondere bei der Einführung von IT-Projekten in öffentlichen Verwaltungen. Die verwendete Methodik wird in Kapitel 3 beschrieben, gefolgt von den Ergebnissen in Kapitel 4. Die Ergebnisse werden in Kapitel 5 diskutiert und die Limitationen dieser Studie sowie ein Ausblick auf zukünftigen Forschungsbedarf präsentiert.

2 Stand der Forschung

2.1 Beteiligung

Der Begriff Beteiligung ist in der Literatur synonym vertreten mit dem Begriff Partizipation und beschreibt verschiedene Formen der Einbindung der Mitarbeiterinnen und

Mitarbeiter einer Organisation. Es wird unterschieden zwischen direkter und indirekter Partizipation bzw. formaler und informaler Partizipation [20], [21]. Die direkte Partizipation erfordert die unmittelbare persönliche Beteiligung der Beschäftigten, wohingegen die indirekte Partizipation die mittelbare Beteiligung durch Interessenrepräsentanten charakterisiert [21]. Für die formale Partizipation ist eine gesetzliche Regelung für die Legitimierung notwendig beispielsweise durch einen Vertrag. Die informale besteht mehr aus einem Konsens zwischen den interagierenden Mitgliedern [21]. Weitere Literatur berichtet über das Maß der Beteiligung der Beschäftigten und zeigt die Steigerung von einfach informiert werden, zur Beratung hingezogen werden bis hin zur Mitbestimmung und Steuerung der Entscheidungsfindung [22]. In der deutschen Literatur unterscheidet sich der Begriff Beteiligung vom Begriff Mitbestimmung, der den rechtlichen Anspruch der institutionalisierten Beteiligung durch Vertreter im Betriebs- und Personalrat umfasst [23].

Obwohl Beteiligung als Fachbegriff aus dem Mitbestimmungsrecht gilt, wird in diesem Artikel der Begriff Beteiligung für Partizipation verwendet und bezieht sich sowohl auf die direkte und aktive Partizipation der Beschäftigten als auch auf die indirekte Form durch die Vertretung des Personalrates, ohne dabei auf die Mitbestimmungsrechte einzugehen. Im Hinblick auf das Ziel dieser Studie, wird die Mitbestimmung hier nicht explizit untersucht.

2.2 Beteiligungsmöglichkeiten bei der Einführung von IT-Projekten

Eine Reihe von Beteiligungsmöglichkeiten der Beschäftigten bei einer Änderung in einer Organisation sind zu finden. Eine interessante Perspektive zeigt den Beteiligungsprozess der Beschäftigten an einer Entscheidungsfindung als ein Kontinuum, das die unterschiedlichen Zugänge reflektiert, die die Beschäftigten für diese Entscheidung haben oder davon abhängt, inwiefern die Beschäftigte diese Entscheidung beeinflussen können [21]. Als Beispiel wird es in dieser Studie unterschieden, ob die Beschäftigten (im Voraus) über die Änderung informiert werden oder nicht, ein Veto abgeben können, Änderungswünsche und Feedback der Beschäftigten berücksichtigt werden, und berichtet über weitere Beteiligungsmöglichkeiten wie beispielsweise die Beauftragung bei Routinetätigkeiten, Schulungen oder die Evaluation der zu erwarteten Leistung.

Bei einem IT-Projekt ist die Beteiligung der End-User relevant für die Entwicklung eines verwendbaren Produktes [24], für die Akzeptanz und für den Erfolg des Projektes [25]. Nichtsdestotrotz ist die Beteiligung bei der Entwicklung aller zu erwartenden Nutzerinnen und Nutzer des Produktes nicht möglich und begrenzt sich meistens auf Vertreter der Beschäftigten. Hierbei ist die Auswahl von Beschäftigten mit fachlichen Kompetenzen ein entscheidendes Kriterium für die Beteiligung [24], [26]. Im Hinblick auf die Gebrauchstauglichkeit eines IT-Produktes zeigen viele Studien die Wichtigkeit der Beteiligung der End-User bei der Entwicklung oder auch im Nachhinein, um das Produkt zu testen [28], [19]. Die Durchführung von Benutzerbefragungen als Evaluationsbericht wird empfohlen, um daraus Informationen aus Nutzerperspektive zu gewinnen [19].

Im öffentlichen Sektor sollen mehr Maßnahmen ergriffen werden, um die Beteiligung der Beschäftigten in einem IT-Projekt zu sichern [12]. Ein Praxisleitfaden der

Bundesregierung Deutschland soll das Projektmanagement in öffentlichen Verwaltungen unterstützen und gliedert die Einführung von IT-Projekten in definierte Phasen: Initiierung, Leistungsausschreibung und Vergabe, Entwicklung, Pilotierung und die Phase des Regelbetriebes [28]. Die Initiierungsphase umfasst mehrere Aktivitäten und beginnt mit der Projektidee und endet mit dem Planungsauftrag. Es werden einzelne Mitarbeiterinnen und Mitarbeiter für die Projektgruppen bestimmt und die grobe Projektstruktur wird definiert. In der Ausschreibung und Vergabe werden die Projektanforderungen definiert, die Ausschreibung veröffentlicht und Vergabeentscheidungen getroffen. Die Anforderungen werden in der Entwicklungsphase implementiert und angepasst. Teststellungen mit Testszenarien für die Bewertung der Funktionalitäten des Produktes werden hier für die Pilotierung durchgeführt. Nach erfolgreichen Tests in der Entwicklungsphase werden im Pilotbetrieb echte Daten in eine echte Umgebung (eine bzw. mehreren Dienststellen) eingeführt. Hier wird die Leistung sowie die Gebrauchstauglichkeit getestet. Nach einem erfolgreichen Pilotbetrieb kommt die flächendeckende Einführung zum regulären Betrieb. Weitere Änderungen durch Releases und Updates werden in dieser Endphase der Einführung durchgeführt. Es wird empfohlen, bei der Erstellung der Leistungsausschreibung die End-User einzubinden bzw. ihre Anforderungen dabei zu berücksichtigen [29]. In Deutschland fordern viele Gewerkschaften mehr Beteiligung bei IT-Projekten und stellen Handreichungen und Leitfäden beispielsweise für die Einführung der E-Akte mit Phasenmodellen und Checklisten für Personalräte und Beschäftigte zur Verfügung, um das Thema bei den relevanten Akteuren anzuregen [30], [31]. Trotz den gesetzlichen Vorgaben nach dem §6 EGovG-Bund zur Einführung der E-Akte und die für die Umsetzung gesetzten Fristen der Bundesregierung gibt es bislang keine belastbaren Angaben darüber, inwiefern die E-Akte in den Bundesbehörden eingeführt ist und welche Organisationeinheiten dabei beteiligt sind. Der Aktionsplan E-Akte fördert die Beteiligung des IT-Betriebes und der Organisation bei Sicherheitsmaßnahmen zur Einführung der E-Akte [5], aber bislang wurden die Beteiligungsmöglichkeiten der Beschäftigten bei der Einführung von IT-Projekten im öffentlichen Sektor in der Praxis kaum untersucht. Dieser Studie untersucht die Beteiligung der Beschäftigten bei der Einführung von IT-Projekten in öffentlichen Verwaltung am Beispiel der Einführung der E-Akte in deutschen Bundesbehörden. Im Folgenden wird die methodische Vorgehensweise dieser Studie erläutert.

3 Methodik

Um die Beteiligung der Beschäftigten bei der Einführung von IT-Projekten in öffentlichen Verwaltungen zu untersuchen, wurde in dieser Studie am Beispiel der Einführung der E-Akte in deutschen Bundesbehörden ein Online-Fragebogen auf Grundlage des Forschungsstandes konzipiert. Dabei wurde dem Begriff „E-Akte“ eine Erläuterung hinzugefügt mit Alternativbenennung wie „DMS Dokument Management System“ verwendet, da es unterschiedliche Softwares in den Behörden zur Umsetzung der E-Akte verwendet werden. Die Stichprobe wurde auf Personalräte als Beschäftigtenvertretung begrenzt, da der Zugang zu den Beschäftigten etwas erschwert war.

Der Online-Fragebogen wurde nach einem ausführlichen Pretest mit Experten, Beschäftigten und Personalratsmitgliedern öffentlicher Verwaltungen durch eine E-Mail-Einladung der Gewerkschaften des Deutschen Beamtenbundes[1] und des Deutschen Gewerkschaftsbundes[2] an Personalratsmitglieder in deutschen Bundesbehörden verschickt. Der Fragebogen umfasste wenige offene Fragen und vornehmlich geschlossene Fragen in Form von Aussagen mit fünf Likert-Skalenpunkten (*„Stimme überhaupt nicht zu“* zu *„Stimme voll zu“*) und Ausweichantworten *„Ich weiß es nicht“* und *„Keine Antwort“*. Filterfragen wurden im Fragebogen gesetzt, um irrelevante Fragen zu überspringen und Konsistenz herzustellen.

Fragebögen eignen sich in der empirischen Forschung, um Daten mit vordefiniertem Ziel und Untersuchungsgegenstand zu erheben [32]. Hierfür wurden die Erkenntnisse aus dem Forschungsstand für diese Untersuchung in folgenden Themenbereiche im Fragebogen übertragen:

3.1 Einführung der E-Akte in Bundesbehörden

Der erste Teil des Fragebogens dient als Ausgangssituation, um zu erkennen, in welchem Stadium die Einführung der E-Akte in den befragten Bundesbehörden sich befindet, und um zu identifizieren, welche Organisationseinheiten bei der Einführung beteiligt sind. Hierbei wird die Einführung der E-Akte in Anlehnung an die in 2.2 beschriebenen Phasen unterteilt. Zum Einführungsstand der E-Akte wird untersucht, welche möglichen Auswirkungen die Einführung auf die Arbeit der Beschäftigten hat. Eine Beispielfrage dazu aus dem Fragebogen lautet *„Die Beschäftigten in meiner Dienststelle fühlen sich für den Umgang mit der E-Akte qualifiziert“*. Daraufhin wurde untersucht, ob und wann diese Auswirkungen von der Dienststelle thematisiert werden.

3.2 Beteiligung des Personalrats und der Beschäftigten bei der Einführung der E-Akte und die Bewertung der Beteiligung

Nach dem Stand der Forschung existieren verschiedene Möglichkeiten und Instrumente zur Beteiligung von Beschäftigten und/oder Beschäftigtenvertretern bei der Einführung der E-Akte. Welche davon genutzt werden, wann und wie wirksam sie sind, ist bislang offen. Der Fragebogen unterscheidet zwischen phasenübergreifenden Beteiligungsinstrumenten wie beispielsweise der Erstellung von Schulungskonzepten oder das Abschließen einer Dienstvereinbarung und phasenspezifischen Beteiligungsinstrumente wie beispielsweise der Beteiligung bei der Modellierung von Arbeitsprozessen, die üblicherweise vor dem Pilotbetrieb stattfinden soll. Eine Beispielaussage dazu aus dem Fragebogen lautet *„Beschäftigte mit fachlichen Kompetenzen wurden bei der Gestaltung der neuen Arbeitsprozesse einbezogen“*. Darüber hinaus werden auch explorativ weitere genutzte Beteiligungsinstrumente abgefragt und anschließend die Angemessenheit der Beteiligung bewertet.

[1] http://www.dbb.de/dbb-startseite.html
[2] http://www.dgb.de/

4 Ergebnisse

4.1 Rücklauf und demografische Daten

Die Feldphase fand vom 01.12.2016 bis zum 20.01.2017 statt mit einer Rücklaufquote von 28%. Von 181 Aufrufen des Links zur Umfrage haben 128 Personen an der Umfrage teilgenommen und 50 die Fragen bis zum Ende beantwortet. Durch die Filterfragen ergaben sich unterschiedliche Stichproben „n“, die explizit bei den Ergebnissen erläutert werden. Die Stichprobe setzte sich aus 72% Männer und 26% Frauen zusammen, von denen die Altersgruppe zwischen 50 und 59 Jahren am häufigsten vertreten war. Folgende Tabelle liefert einen Überblick über die Zugehörigkeit zu Bundesbehörden und die Personalrat-Mitgliedschaft:

Tabelle I Zugehörigkeit zu Bundesbehörde und Personalrat-Mitgliedschaft

Bundesbehördenzugehörigkeit	*Nennungen*	*Personalrat-Mitgliedschaft*	*Nennungen*
Oberste Bundesbehörde	13	Hauptpersonalrat	12
Geschäftsbereichsbehörde	22	Örtlicher Personalrat	32
Sonstige Behörden	11	Bezirkspersonalrat	7
Keine Antwort	2		7
Gesamt	48		51

Aus der Geschäftsbereichsbehörde stammen 22 der Befragten und 32 sind Mitglieder örtlicher Personalrat. Bei diesen Fragen waren Mehrfachantworten möglich, aus diesem Grund ist es möglich, dass beispielsweise örtliche Personalratsmitglieder auch im Hauptpersonalrat tätig sind. Zudem liegen bei dieser Studie keine Daten zur Grundgesamtheit vor, was Aussagen über die Repräsentativität der Ergebnisse erschwert.

4.2 Einführungstand der E-Akte und die beteiligten Organisationseinheiten in deutschen Bundesbehörden

Im Hinblick auf die in 2.2 vorgestellten Phasen befindet sich die Einführung der E-Akte in den befragten Bundesbehörden in unterschiedlichen Phasen. Dabei sind 17% aus einer Stichprobe von n=85 in der Initiierungsphase, gefolgt von 5% in der Phase der Ausschreibung und Vergabe, Entwicklung und 7% im Pilotbetrieb. 21% arbeiten bereits regulär mit der E-Akte, wohingegen 15% angegeben haben, dass die Einführung in ihren Dienststellen zurzeit nicht geplant ist. 29% konnten den Einführungsstand nicht ermitteln. Verteilt auf die Bundesbehörden befindet sich der Einführungsstand der E-Akte in der obersten Bundesbehörde am häufigsten in der Initiierungsphase oder im Regelbetrieb und in der Geschäftsbereichsbehörde und in sonstigen Behörden ist die Einführung der E-Akte meistens derzeit nicht geplant. Unterschiedliche Organisationeinheiten sind bei der Einführung der E-Akte beteiligt. In den meisten Fällen sind IT, Organisation und Personal beteiligt, aber auch zusammen mit sonstigen Organisations-

einheiten wie beispielsweise dem Personalrat, den betroffenen Abteilungen (Registratur, Archiv), Datenschutzbeauftragten, Haushalt, Recht und Immobilien. Insgesamt war die IT-Organisationseinheit am häufigsten beteiligt.

4.3 Mögliche Auswirkungen der Einführung der E-Akte und ihre Adressierung durch die Dienststelle

Mit der E-Akte ändern sich auch die Arbeitsabläufe, der Meinung waren fast alle Befragten mit mehr als 80% von 38 Antworten. In Bezug auf ihre IT-Kenntnisse fühlen sich mehr als 50% nicht qualifiziert, mit der E-Akte zu arbeiten. Die Aussage über die Entlastung durch die E-Akte fand von der Mehrheit keine Zustimmung, dagegen fühlen sich mehr als 50% durch die E-Akte belastet. Die Bewertung der Gebrauchstauglichkeit der E-Akte fiel mit mehr als 50% ‚teils-teils' nicht eindeutig aus. 20% halten die E-Akte für nicht gebrauchstauglich. Dabei bezog sich die Gebrauchstauglichkeit auf die Benutzerfreundlichkeit, Anforderungen an den Arbeits- und Gesundheitsschutz und die Ergonomie. Ein eindeutiges Ergebnis ist bei den Aussagen über die Rationalisierungseffekte wie Verlust des Arbeitsplatzes, Verlust an zwischenmenschlichen Kontakten und Zunahme der Arbeitsanforderungen zu finden. Fast die Hälfte der Befragten fürchten diese Rationalisierungseffekte durch die Einführung der E-Akte.

Anschließend an die Fragen zu möglichen Auswirkungen, die die Einführung der E-Akte auf die Arbeit der Beschäftigten in ihren Dienststellen hat, wurden Aussagen darüber getroffen, ob und wann (in welcher Phase der Einführung) diese möglichen Auswirkungen durch die Dienstelle adressiert werden. Sehr wenige (10%) gaben an, dass Rationalisierungseffekte und Belastungsempfinden an unterschiedlichen Zeitpunkten von ihren Dienststellen adressiert werden. Bei den anderen 90% wurden diese bis zum jetzigen Stand, zum Teil bis zum Regelbetrieb in ihren Dienststellen nicht adressiert. Über Qualifizierung und Gebrauchstauglichkeit wird eindeutig mehr kommuniziert (40%).

4.4 Phasenübergreifende Beteiligungsinstrumente für Personalrat und Beschäftigte bei der Einführung der E-Akte und ihre Angemessenheit

Das am häufigsten verwendete Beteiligungsinstrument ist die Bereitstellung von Informationen über die Einführung der E-Akte durch die Dienststelle. Von insgesamt 38 Antworten gaben mehr als 70% an, dass sie am häufigsten in der Initiierungsphase über die Einführung der E-Akte von ihren Dienststellen informiert werden, seltener in der Phase der Leistungsausschreibung und Vergabe oder in der Entwicklungsphase. Weitere genutzte Beteiligungsinstrumente sind die Festlegung der Beteiligungsmöglichkeiten und die Erstellung eines Schulungskonzeptes. Weniger genutzt werden die Auswahl von Multiplikatorinnen und Multiplikatoren für Schulungen, eine Dienstvereinbarung sowie eine formalisierte Beteiligungsvorlage.

Die Bewertung der genutzten Beteiligungsinstrumente ist vorwiegend positiv. Besonders auffällig sind die positiven Bewertungen der wenig genutzten Instrumente wie die Auswahl von Multiplikatorinnen und Multiplikatoren für Schulungen, eine Dienstvereinbarung sowie eine formalisierte Beteiligungsvorlage. Weniger positiv war

die Bereitstellung der Informationen über die Einführung der E-Akte. 40% der Befragten halten sie für nicht hilfreich.

4.5 Phasenspezifische Beteiligungsinstrumente für Personalrat und Beschäftigte bei der Einführung der E-Akte und ihre Angemessenheit

Für jede Phase der Einführung der E-Akte (von der Initiierung bis zum Regelbetrieb) wurden die genutzten Beteiligungsinstrumente zur Einbeziehung des Personalrats sowie der Beschäftigten und deren Angemessenheit abgefragt.

- In der Initiierungsphase gaben mehr als 50% von 38 Befragten an, dass der Personalrat Mitglieder in projektbegleitenden Arbeitsgruppen gestellt hat. Laut knapp 40% der Aussagen hat der Personalrat mit der Dienststelle die Beteiligungsmöglichkeiten in der Projektstruktur festgelegt. Knapp 50% sind der Meinung, dass die Dienststelle nicht dem Personalrat alle relevanten Informationen zur Verfügung gestellt hat. Die Angemessenheit der Beteiligungsinstrumente des Personalrats in der Initiierungsphase wurde von fast 50% der Befragten nicht für angemessen gehalten. Mehr als 50% halten die Beteiligungsinstrumente für Beschäftigten in dieser Phase auch nicht für angemessen. Das häufigste Beteiligungsinstrument für Beschäftigte in dieser Phase ist die Einbeziehung von Beschäftigten mit fachlichen Kompetenzen. Dagegen gab es kaum institutionalisierte Angebote wie z.B. Mitarbeiterportale, Wikis, eingesetzte Beratungsstellen, über die die Beschäftigte selbst Fragen zur Einführung der E-Akte stellen können.
- In der Phase der Leistungsausschreibung und Vergabe gaben mehr als 80% von 26 Befragten an, dass der Personalrat bei der Erstellung der Leistungsausschreibung nicht beteiligt wurde, keine Stellung zu den Ausschreibungsunterlagen wie z.B. dem Leistungsverzeichnis oder den Bewertungskriterien genommen hat, die Bieterpräsentationen nicht begleitet hat und bei der Vergabe kein eigenes Votum abgegeben hat. Die Angemessenheit der Beteiligungsinstrumente des Personalrats in dieser Phase ist mit 71% negativ ausgefallen. Die Beteiligungsinstrumente der Beschäftigten in dieser Phase wurden mit mehr als 80% für nicht angemessen gehalten. Sie beschränken sich auf die Einbeziehung von Beschäftigten mit fachlichen Kompetenzen bei der Erstellung der Leistungsausschreibung.
- Bei der Entwicklung der E-Akte gaben nur fast 30% an, dass der Personalrat bei der Gestaltung von neuen Arbeitsprozessen einbezogen wurde oder dass Änderungswünsche des Personalrats dabei berücksichtigt wurden. Während Beschäftigte stärker einbezogen werden in dieser Phase und ihre Beteiligungsinstrumente in fast 50% der Fälle für angemessen gehalten werden, fällt die Bewertung der Angemessenheit der Beteiligungsinstrumente des Personalrats mit 38% negativ aus.
- Im Vergleich zu den vorherigen Phasen werden im Pilotbetrieb mehr Beteiligungsinstrumente zur Einbeziehung des Personalrats und der Beschäftigten genutzt. Fast 80% von 29 Antworten gaben an, dass der Personalrat über Stand und Verlauf des Testbetriebs/Funktionstests informiert wurde, und fast 60% gaben an, dass sie einen Evaluationsbericht erhalten haben sowie ihre Zustimmung zum Pilot- bzw. Regelbetrieb eingeholt wurde. Mit 60% fällt die Angemessenheit dieser Beteiligungsinstrumente positiv aus. Noch angemessener werden die Beteiligungsinstrumente der

Beschäftigten in dieser Phase mit mehr als 70% beurteilt. 90% gaben an, dass es eine Anlaufstelle für die Fragen der Beschäftigten gab, und 73% haben eine ausführliche Weisung über die Einführung der E-Akte erhalten. Auch eine Evaluation bzw. Checkliste oder Fragebogen für Beschäftigte gab es im Pilotbetrieb.

- Die Angemessenheit der Beteiligungsinstrumente zur Einbeziehung des Personalrats im Regelbetrieb der E-Akte ist von 60% für nicht angemessen erachtet worden. Es findet in dieser Phase fast kaum Beteiligung des Personalrats statt. 80% gaben an, dass sie neue Releases nicht getestet haben, und 70% sind der Meinung, dass es für den Personalrat keine Evaluationen bzw. Umfragen zum Regelbetrieb gab, anders als bei den Beschäftigten mit 60%. Zudem gaben mehr als 80% an, dass die Beschäftigte im Regelbetrieb eine Anlaufstelle für ihre Änderungswünsche und Feedback haben. Zusätzlich stehen EDV-Anwenderbetreuer für die Beschäftigten zur Verfügung. Dementsprechend wurden die Beteiligungsinstrumente zur Einbeziehung der Beschäftigten in dieser Phase mit 83% für angemessen erachtet.

5 Diskussion, Limitationen und Ausblick

Das Ziel dieser Studie war es, die Beteiligung der Beschäftigten und der Personalräte bei der Einführung von IT-Projekten in öffentlichen Verwaltungen zu untersuchen. Dafür wurde am Beispiel der Einführung der E-Akte in deutschen Bundesbehörden zuerst der Einführungsstand der E-Akte und die dabei beteiligten Organisationseinheiten identifiziert und ein Überblick über den Umgang mit möglichen Auswirkungen der Einführung auf die Arbeit der Beschäftigten gegeben. Auf Basis dieses Einführungsstands wurden zunächst phasenübergreifende und anschließend phasenspezifische Beteiligungsinstrumente des Personalrats und der Beschäftigten untersucht und ihre Angemessenheit bewertet. Die Einführung der E-Akte befindet sich in den Bundesbehörden in unterschiedlichen Phasen. Die meisten Behörden arbeiten bereits mit der E-Akte oder befinden sich in der Initiierungsphase. Beteiligt bei der Einführung der E-Akte waren verschiedene Organisationeinheiten. Am häufigsten war die IT-Organisationeinheit alleine oder in Zusammenarbeit mit anderen Organisationeinheiten beteiligt. Erstaunlich gering war die Beteiligung sonstiger Organisationeinheiten wie den betroffenen Abteilungen der Registratur oder des Archivs. Darüber hinaus konnten viele Befragten den Einführungsstand nicht ermitteln, was an der Kommunikation über die Einführung der E-Akte in der Dienststelle liegen könnte. In diesem Zusammenhang wurden in dieser Studie auch die mit der Einführung verbundenen Auswirkungen auf die Arbeit der Beschäftigten untersucht und wie diese von der Dienststelle thematisiert werden. Die Gebrauchstauglichkeit der E-Akte konnten viele nicht einschätzen, was an dem entsprechenden Einführungsstand liegen könnte. Eindeutig sind dagegen die Aussagen über Qualifizierung, Belastung und Rationalisierungseffekte. Viele Beschäftigte fühlen sich nicht qualifiziert, mit der E-Akte zu arbeiten, und benötigen dafür die entsprechenden IT-Kenntnisse. Die angestrebte Effektivität und Effizienz der Verwaltungsarbeit durch die Einführung der E-Akte wird eher als belastend von den meisten Beschäftigten empfunden. Auch Rationalisierungseffekte werden durch die Einführung der E-Akte befürchtet. Im Hinblick auf die Adressierung dieser Auswirkungen ist der Umgang mit

Themen wie Gebrauchstauglichkeit und Qualifizierung deutlich offener als mit sensiblen Themen wie Belastungsempfinden und Rationalisierungseffekten. Nicht nur die Information ist ein Teil der Beteiligung, sondern auch die Kommunikation [23]. Aus dieser Perspektive könnte eine offenere Kommunikation über die Einführung von IT-Projekten und die damit verbundenen Auswirkungen die Befürchtungen der Beschäftigten mildern und ihre Abneigung gegenüber neuer IT-Systeme reduzieren.

Bei der Beteiligung des Personalrats und der Beschäftigten bei der Einführung von IT-Projekten ist Optimierungspotenzial vorhanden. Die Ergebnisse zeichnen ein homogenes Bild über die Beteiligung des Personalrats selbst und die Beteiligung der Beschäftigten bei der Einführung der E-Akte in den Bundesbehörden. Die Beteiligungsmöglichkeiten waren insgesamt in den meisten Phasen begrenzt, und die genutzten Beteiligungsinstrumente wurden überwiegend als unangemessen wahrgenommen. Insbesondere in der Phase der Leistungsausschreibung und Vergabe findet fast kaum Beteiligung statt, aber auch in der Initiierungsphase besteht großer Nachholbedarf. Dabei haben sich selten genutzte Beteiligungsinstrumente wie beispielsweise die Festlegung der Beteiligungsmöglichkeiten oder die Auswahl von Multiplikatorinnen und Multiplikatoren für die Schulung, aber auch die Bereitstellung relevanter Informationen über die Einführung als nützlich erwiesen. Dies deutet darauf hin, dass durch eine verstärkte Nutzung solcher Beteiligungsinstrumente eine höhere Zufriedenheit erzielt werden kann.

Die erhoffte Akzeptanz durch die Beteiligung von Beschäftigten bei der Einführung von IT-Projekten in öffentlichen Verwaltungen könnte nicht am Mangel existierender Beteiligungsmöglichkeiten, sondern eher an deren Nutzung scheitern. Ein prominenter Ansatz der IT-Akzeptanzforschung ist das Technologie-Akzeptanzmodell (TAM), das den Einfluss von wahrgenommenem Nutzen und wahrgenommener einfacher Benutzbarkeit auf die Einstellung gegenüber der IT-Nutzung zeigt. Eine stärkere Einbeziehung des Personalrats und der Beschäftigten im Einführungsprozess insbesondere in den früheren Einführungsphasen durch beispielsweise Beteiligung bei der Erstellung der Anforderungen, Gestaltung der Arbeitsprozesse oder Testen der Gebrauchstauglichkeit könnte solche Faktoren positiv beeinflussen und somit zu höherer Akzeptanz führen.

Diese Studie weist Limitationen auf. Die Ergebnisse dieser Studie können auf Grund der geringen Stichprobe zum einem und der Tatsache zum anderen, dass Einschätzungen des Personalrats über die Meinungen der Beschäftigten eingeholt wurden, nicht generalisiert werden. Zudem wurden auf Grund des Zuganges nur Bundesbehörden bezogen. Zukünftige Forschung könnte sich mehr auf Landes bzw. Kommunale Ebene fokussieren, Beschäftigte direkt befragen und über weitere Kanäle versuchen eine größere Stichprobe zu erzielen. Ebenfalls interessant wäre es, den Zusammenhang zwischen Beteiligung und IT-Akzeptanz der Beschäftigten zu untersuchen, da diese Beziehung bislang kaum empirisch untersucht wurde.

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E-Health - Understanding and Designing the Digital Future of Health

Teilkonferenzleitung

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IT-Benchmarking als Zusammenspiel von Wissenschaft und Praxis - ein Web-Portal zur Dissemination individueller Ergebnisse für Krankenhäuser

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Abstract. Die Verbreitung von Informationstechnologien (IT) im Gesundheitswesen sowie deren Einflussgrößen sind Betrachtungsobjekt der Adoptions- und Diffusionsforschung. Neues Wissen aus diesen Studien wird dabei häufig als summative Umfrageergebnisse disseminiert. Mit dem in diesem Beitrag vorgestellten Web-Portal werden die individuellen Umfrageergebnisse im Vergleich zu einer Referenzgruppe präsentiert. Das erfolgt in flexibler Form unter Verwendung von reliablen und validen Kennzahlen der IT-Prozessunterstützung, die in einer hierarchischen Struktur angeordnet sind. Es werden die Entwicklung des Web-Portals als Benchmarking Instrument, seine Anwendung und eine initiale Evaluation vorgestellt. Es zeigte sich, dass das Web-Portal anhand aktueller Benchmarking-Ergebnisse von 197 Krankenhäusern einsetzbar ist, seine Anwendung als nützlich und die Indikatoren als verständlich eingeschätzt werden.

Keywords: IT-Benchmarking, Krankenhaus, IT-Leitung, Web-Portal, Design Science

1 Einleitung

Krankenhäuser befinden sich in einem zunehmenden Wettbewerb der Digitalisierung, in dem die Leistungserbringung möglichst effizient, bei gleichbleibender hoher Versorgungsqualität, gesteigert werden soll [1]. Die IT unterstützt die Versorgungsprozesse und ist somit ein entscheidender Faktor bei der Verbesserung der Leistungserbringung [2]. Die Adoptions- und Diffusionsforschung untersucht bereits seit einigen Jahren die Auswirkungen von IT auf Kosten und Qualität im

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Gesundheitswesen [3, 4]. Die dabei entstehenden Studienergebnisse werden überwiegend für die wissenschaftliche Zielgruppe in Form von Journal- oder Konferenzbeiträgen disseminiert. Die gestaltungsorientierte Wissenschaft ist mit ihrem konstruktionsorientierten Forschungsansatz dazu aufgerufen, die Ergebnisse auch durch die Bereitstellung von Artefakten und Managementkonzepten in die Praxis zurückzuspielen [5]. In den vergangenen Jahren wurde daher vermehrt das Instrument des Benchmarkings auch von wissenschaftlichen Institutionen genutzt, um anwendungsorientierte, operationalisierbare Ergebnisse und Erfahrungen für die Praxis bereitstellen zu können [6–9]. Das in diesem Beitrag vorgestellte Web-Portal knüpft als Artefakt an diesen Wissenschafts-Praxis Dialog an, indem die Befragungsergebnisse einer quantitativen Befragung (statistisches Benchmarking) für die Teilnehmer so aufbereitet werden, dass sie einem gezielten Feedback dienen. Dadurch soll den an der Befragung teilnehmenden Gesundheitseinrichtungen ein Mehrwert durch die individuelle Beurteilung der eigenen IT und ein Vergleich zu anderen Wettbewerbern in der Referenzgruppe (z. B. Krankenhausgröße, Trägerschaft) geboten werden. Dem hier vorgestellten Benchmarking-Prozess liegen das theoretische Konzept der Informationslogistik [10] und die Diffusion of Innovation Theorie von Rogers [11] zugrunde. Das Konzept der Informationslogistik dient zur Ableitung von Qualitätskriterien und Anforderungen zur Kennzahlenbildung, welche das IT-Potenzial zur Unterstützung klinischer Prozesse messen sollen. Rogers' Diffusion of Innovations Theorie dient zur Einordnung der Benchmark-Teilnehmer hinsichtlich ihrer Innovationsfähigkeit und konkret zur Segmentierung der Ergebniswerte des vorgestellten Kennzahlensystems bezogen auf seine Position im Verhältnis zu der Referenzgruppe [12].

Mit den in diesem Beitrag vorgestellten Artefakten wird das konkrete (Forschungs-)ziel verfolgt, die Implementation und Anwendung eines Web-Portals als Feedbackinstrument für Krankenhäuser darzustellen und in einer initialen Form zu evaluieren. Das Web-Portal soll eine flexible Präsentation unterschiedlicher Grafiktypen für einen Benchmark-Indikator umfassen und eine longitudinale Ergebnisdarstellung, d. h. eine Darstellung über unterschiedliche Benchmark-Zeitpunkte, ermöglichen. Mit einem Web-Portal soll ein dauerhafter Kommunikationskanal zu den Studienteilnehmern für einen langfristigen und nachhaltigen Wissensaustausch eröffnet werden.

In Abschnitt 2 wird der Status Quo der Forschung zur Digitalisierung von Krankenhäuser beschrieben. Anschließend wird in Abschnitt 3 die verwendete Forschungsmethodik vorgestellt. Die aus dem in Abschnitt 4 vorgestellten Kennzahlensystem resultierende Implementierung eines Web-Portals wird in Abschnitt 5 erläutert. Die Evaluation des Web-Portals erfolgt in Abschnitt 6 und schließt mit einer Schlussbetrachtung und einen Ausblick auf weitere Arbeiten in Abschnitt 7.

2 Forschungsstand und Herausforderungen

Durch Gesetzesinitiativen zur Digitalisierung des Gesundheitswesens, wie das bereits seit 2009 in den USA eingeführte Meaningful Use Program [13] soll die Nutzung von moderner IT im Gesundheitswesen vorangetrieben und somit die Qualität und Wirtschaftlichkeit der Gesundheitsversorgung weiter verbessert werden. Auch in Deutschland wurde 2016 ein erneuter Anlauf unternommen, mittels des E-Health-Gesetzes [14] die IT Nutzung im Gesundheitswesen voranzutreiben. Gefördert werden solche Gesetzesinitiativen beispielsweise durch finanzielle Förderprogramme der Bundesregierung [15, 16], die zu einer Intensivierung der digitalen Transformation führen sollen. Da Gesetzesinitiativen unterschiedlich wirken können, sind konkrete Messungen der IT Adoption nötig. Vor diesem Hintergrund gibt es eine breite Forschung zur Adoption und Diffusion von IT im Gesundheitswesen [3], die sich in mehreren systematischen Literaturreviews wissenschaftlicher Adoptionsstudien niederschlägt [3, 17–22]. In einzelnen Studien werden entweder Barrieren und Faktoren hinsichtlich des Einsatzes von IT für eine gesamte Population von Krankenhäuser dargestellt [22] oder es wird exemplarisch an einzelnen Krankenhäusern eine Vorher-Nachher-Studie durchgeführt [3]. Diese wissenschaftlichen Arbeiten sind zum Teil als allgemeine Benchmark-Studien einzuordnen [8, 12, 23], die den Digitalisierungsgrad eines Landes oder einer Region betrachten, jedoch nicht dem einzelnen Studienteilnehmer ein individuelles Ergebnis zurückspiegeln.

Andererseits gibt es Benchmarks aus der Praxis heraus, die sich der Managementmethoden eines Vergleichs von Leistung, Kosten und Qualität bedienen [6, 9]. So haben sich Zusammenschlüsse von Krankenhaus-IT-Leitungen gebildet, in denen ein krankenhausübergreifender Erfahrungsaustausch stattfindet und sich die Krankenhäuser hinsichtlich der eigenen Leistung positionieren können (z. B. [24–26]). Solche Benchmarking-Initiativen finden häufig in einem kleinen, geschlossenen Kreis statt. Sie haben dabei nicht den Anspruch, sich an Theorien und wissenschaftlichen Konzepten zu orientieren. Ihre Indikatoren sind eher pragmatisch angelegt. Handelt es sich bei diesen Ansätzen um ein Benchmarking größerer Gruppen, finden sich Gemeinsamkeiten zu Studien aus dem Bereich der IT-Adoptions- und Diffusionsforschung, z. B. in der Datenerfassung über Fragebögen und dem Betrachtungsobjekt der Verfügbarkeit und Nutzung von IT [6].

Der vorliegende Beitrag schlägt einen anderen Weg ein, indem er beide Welten zusammenführt. Das Benchmarking nutzt Indikatoren, die wissenschaftlich auf Gütekriterien hin untersucht wurden, bringt evaluierte graphische Darstellungen zum Einsatz, greift auf Referenzgruppen zu, die sich in Vorstudien als signifikant erwiesen haben und bettet die Ergebnisse in übergeordnete Konzepte ein [27]. Gleichzeitig werden die individuellen Ergebnisse den Studienteilnehmern zurückgespielt – ähnlich wie in den von der Praxis getriebenen Benchmarkings. Dieser Prozess soll nunmehr durch ein Benchmarking Web-Portal flexibel und erweiterbar gestaltet werden und die bisherigen starren Präsentationsformen der PDF-Dateien ersetzen.

3 Methodische Vorgehensweise

Als methodisches Rahmenkonzept wird zur Entwicklung des Web-Portals nach dem Design Science Ansatz von Hevner et al. [28] vorgegangen. Dabei findet ein kontinuierlicher Austausch zwischen Wissenschaft und Praxis statt, einhergehend mit einem iterativen Prozess zur Weiterentwicklung und Bewertung des Artefakts (s. Abb. 1).

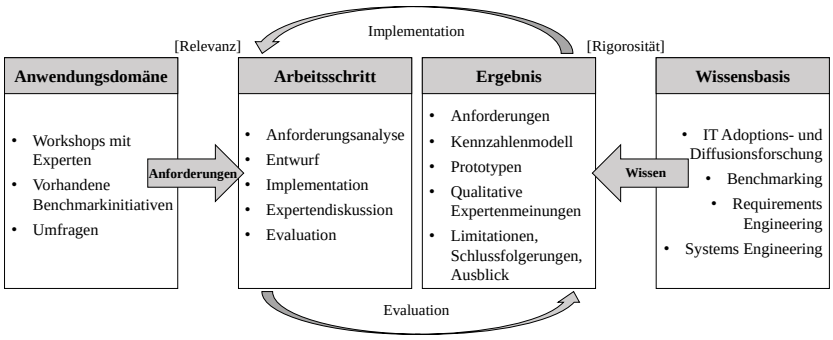


Abbildung 1. Design Science Ansatz nach [28]

Die in Abbildung 1 dargestellten verwendeten Methoden umfassen u. a. Literaturrecherchen [29], Kennzahlenmodellierung [30], die Evaluation mittels qualitativen Expertenworkshops und quantitativer Befragungen [31], sowie die Überführung der Evaluation in neue Konzepte und weiterführende Arbeiten [32]. Das Artefakt des Web-Portals wird dabei entlang der sieben Punkte des Leitfadens des Design Science Ansatzes nach Hevner et al. [28] entwickelt (vgl. Tab. 1).

Tabelle 1. Design Science Ansatz Leitfaden [28]

#	Leitfaden	Beschreibung
1	Artefakt	Die Implementierung des Web-Portals als Instanziierung einer Benchmarking-Plattform ist nach [33] ein Artefakt.
2	Problem-relevanz	Die Relevanz von IT-Benchmarking in Krankenhäusern ist beschrieben in [6].
3	Evaluation	Evaluation mittels Expertenworkshops und Umfragen nach [31].
4	Status Quo	Aktueller Forschungsstand und Herausforderungen beschrieben in Abschnitt 2.
5	Rigorosität	Die methodischen Anforderungen zur Literaturrecherche [29], zur Kennzahlenmodellierung [30], zum Design Science Ansatz [28, 33] und zur Evaluation [31] werden bei der Entwicklung eingehalten.
6	Design als Prozess	Das Web-Portal wird als iterativer Prozess zwischen Implementation und Evaluierung entwickelt. Das Web-Portal umfasst in der ersten Version ein Benchmarking-Kennzahlensystem und soll kontinuierlich weiterentwickelt werden.
7	Dissemi-nation	Die Ergebnisse werden durch die hier vorliegende Arbeit veröffentlicht. Das Web-Portal ist unter folgender Adresse abrufbar: https://tinyurl.com/yc3m6c6a

4 Kennzahlenmodell

Das hier verwendete Kennzahlenmodell erweitert den bisher veröffentlichen Ansatz zur Messung der klinischen Informationslogistik [27] um methodische Aspekte, aktualisierte Items und einen weiteren klinischen Prozess. Zum Aufbau des Kennzahlenmodells wurde zusätzlich der hierarchische Aufbau einer Nutzwertanalyse [34] verwendet und das Konzept der Informationslogistik [10] als konzeptueller Bezugsrahmen genutzt. Damit wird eine strukturelle Grundlage für allgemeingültige Qualitätskriterien und Anforderungen zur Messung des Digitalisierungsgrades eines Krankenhauses geschaffen, der sich auf das Konzept klinischer Informationslogistik stützt: d.h. inwiefern unterschiedliche Systeme den klinischen Anwendern die richtigen Informationen, zur richtigen Zeit, am richtigen Ort in der richtigen Qualität elektronisch zur Verfügung stellen. Das Konzept der klinischen Informationslogistik wurde in einem mehrstufigen Prozess nach MacKenzie et al. [30] bestehend aus Literaturreviews, Experteninterviews, Skalenbildung, Pretests und Skalenvalidierungen in Deskriptoren, klinische Prozesse und Items (Fragen) operationalisiert. Deskriptoren umfassen *Funktionen*, *Daten und Informationen*, *Integration* und *Distribution*. Funktionen wurde definiert als die Bereitstellung, der Einsatz und der Verbreitungsgrad einzelner Funktionen eines oder mehrerer elektronischer IT-Systeme, mit deren Hilfe Aufgaben im klinischen Prozess erfüllt werden können. Daten und Informationen wurden definiert als das Vorhandensein von elektronischen Daten, die zur Aufgabenerfüllung notwendig sind. Integration wurde definiert als die Interoperabilität unterschiedlicher Systeme und Distribution als die Bereitstellung elektronischer Patientendaten zum Zeitpunkt der Leistungserbringung. Auf diesen Konzepten beruhen auch die aktuellen Arbeiten. Die Deskriptoren wurden wiederum den klinischen Prozessen Aufnahme, Visite, OP-Vorbereitung, OP-Nachbereitung und Entlassung zugeordnet, wobei der Aufnahmeprozess neu hinzugenommen wurde. Auf Basis der unterschiedlichen Prozess-Deskriptor Kombinationen wurden nunmehr insgesamt 201 Indikatoren definiert, welche als Items in die Befragung aufgenommen wurden (s. Abb. 2). Die Fragen umfassen neben Themenbereichen wie die grundsätzlichen IT-Strukturen (z. B. Krankenhausinformationssystem-Architektur, Workflow-Management-Systeme, Elektronische Patientenakte (EPA)) und geschachtelten Funktionsgruppen (z. B. klinische Dokumentationsfunktionen, klinische Entscheidungsunterstützung, Leistungsanforderungen und Befundrückmeldung, Patientensicherheit, Schnittstellenfunktionen) auch die Unterstützung hinsichtlich der Prozesse durch IT und Kontextfaktoren wie beispielweise die demographischen Daten des Krankenhauses. Je nach Antwort werden Punkte vergeben, welche wiederum jeweils mit Antworten anderer Fragen zunächst zu dem jeweiligen Deskriptor, dann zu dem Prozess und schließlich zu einer Spitzenkennzahl [27] aufsummiert werden. Die Spitzenkennzahl misst das IT-Potenzial der Unterstützung klinischer Prozesse. Die Items gehen je nach Prozess und Deskriptor mit unterschiedlichen Gewichten [34] in die Kennzahlenberechnung ein. Durch diese hierarchische Systematik wird ebenfalls das IT-Potenzial in einzelnen Prozesse als auch in einzelnen Deskriptoren ermittelt.

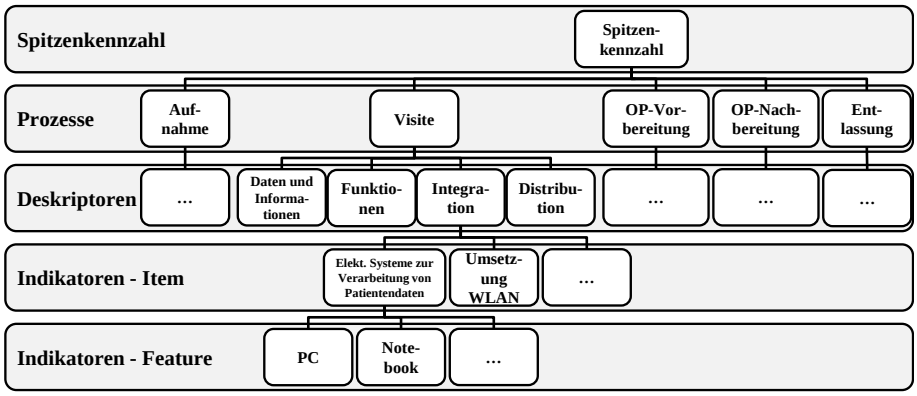


Abbildung 2. Berechnungsmodell der unterschiedlichen Kennzahlenebenen

Zum Vergleich der Ergebnisse werden Referenzgruppen anhand der Ausprägung Trägerschaft (Öffentlich/Freigemeinnützig, Privat) und Bettenanzahl (fünf Bettenklassen) gebildet. Dieses geschieht sowohl auf Ebene der Kennzahlen als auch auf Ebene der Indikatoren, sodass jeder Teilnehmer seine Antwort mit den relativen Häufigkeiten der gegebenen Antworten in seiner Referenzgruppe vergleichen kann. Auf Ebene der Prozess- und Deskriptor-Kennzahlen wird der Median der Referenzgruppe als Vergleichswert ermittelt. Auf oberster Ebene der Spitzenkennzahl werden die relativen Häufigkeiten der Kategorisierung der Anwender in „Innovatoren“, „Frühe Übernehmer“, „Frühe Mehrheit“, „Späte Mehrheit“ und „Nachzügler“ nach der Diffusion of Innovations Theorie von Rogers [11] ermittelt und zugeordnet.

5 Implementation

Die Implementierungen wurden vollständig mit den nachfolgenden genannten Open Source Technologien umgesetzt. Die Kennzahlenberechnung basiert auf quantitativen Umfragedaten, welche mit LimeSurvey 2.54.3 erhoben wurden [35]. Die Datenerhebung erfolgte durch eine Befragung von 224 IT-Leitern und IT-Leiterinnen in deutschen Krankenhäusern, von denen 197 an dem IT-Benchmark teilnahmen. Die Fragen und das bundesweite Befragungsergebnis sind öffentlich einsehbar [35]. Die Items der quantitativen Umfrage dienen sowohl zur Berechnung der Kennzahlen als auch für weitere wissenschaftliche Fragestellungen.

Die Aufteilung der Komponenten (s. Abb. 3) ermöglicht es, mittelfristig das Umfragesystem durch andere Lösungen zu ersetzen oder zu integrieren. Durch die Speicherung in einem zentralen Data Warehouse (PostgreSQL 9.6 Datenbank auf einem Ubuntu Server 16.04) als Forschungsdatenbank ist eine Erweiterung des Web-Portals um weitere Daten möglich, weil beispielsweise Legacy Datenquellen wie SPSS Umfragedaten aus früheren Befragungen oder weitere Datenquellen wie die Qualitätsberichte der Krankenhäuser persistiert und konsolidiert werden können. Die Imputation, Bewertungsmetriken und Normalisierung der Daten hin zu der

Berechnung der Kennzahlen sowie die Referenzgruppengrenzen und statistischen Kenngrößen von Verteilungen (z. B. Median) werden mit Python 3.6 erstellt und über eine REST-Schnittstelle dem Frontend bereitgestellt. Um das individuelle Ergebnis eines Teilnehmers zusammen mit den aggregierten Werten der Referenzgruppe darstellen zu können, wurde die Bibliothek D3.js zur Visualisierung der Daten verwendet. Zum Aufbau der Weboberfläche wurde das TypeScript-basierte Webframework Angular (Version 4) verwendet. Dadurch können gleiche Visualisierungen der unterschiedlichen Ebenen des hierarchischen Kennzahlenmodells wiederverwendet werden.

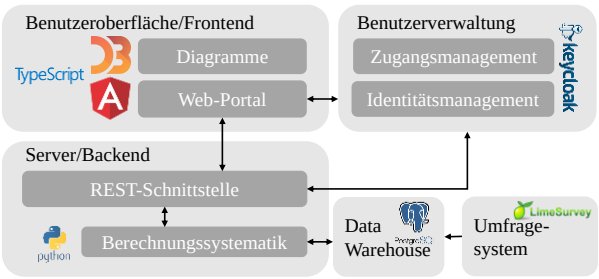


Abbildung 3. Komponentenübersicht

Im Fokus des Web-Portals steht die Spitzenkennzahl der IT-Prozessunterstützung zur Messung der klinischen Informationslogistik. In dieser können maximal 100 Punkte erreicht werden (s. Abb. 4).

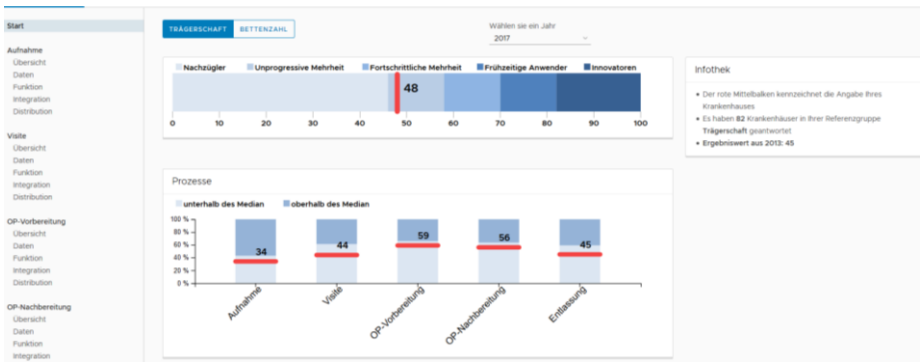


Abbildung 4. Spitzenkennzahl der IT-Prozessunterstützung und Prozesskennzahlen

Die Kennzahl kombiniert die Angaben in den einzelnen Prozessen Aufnahme, Visite, OP-Vorbereitung, OP-Nachbereitung und Entlassung. In den Prozessen werden Spezifikationen zu einzelnen IT-Anwendungen (Funktion, Daten und Information) und allgemeine Angaben zur Infrastruktur und der Krankenhausinformationssystem-Architektur (Integration, Distribution) erfasst. Der individuelle Wert des Krankenhauses wird als roter Balken dargestellt. Die Spitzenkennzahl wurde im Vergleich zu den Werten der jeweiligen Referenzgruppe nach der Diffusion of

Innovation Theorie von Rogers in fünf Stufen klassifiziert [11]. Je Referenzgruppe bilden die 2,5 % der Krankenhäuser mit dem höchsten Ergebnis die höchste Stufe „Innovatoren“. Die unterste Stufe bilden 16 % der Krankenhäuser mit den niedrigsten Punktwerten als „Nachzügler“ (34% „Späte Mehrheit“, 34% „Frühe Mehrheit“ und 13,5% „Frühe Übernehmer“). Die Klassenbreiten werden auf Basis des Mittelwerts und der Standardabweichung segmentiert. Dieses kann beispielsweise dazu führen, dass die Kennzahl des Teilnehmers absolut betrachtet im Mittelfeld liegt, jedoch im Verhältnis zu der Referenzgruppe im oberen Drittel. Eine hohe Punktzahl bedeutet, dass ein Krankenhaus bereits in vielen Prozessen durch IT unterstützt wird und die Interoperabilität der Systeme stark ausgeprägt ist.

Durch die Darstellung der Prozess-Kennzahlen - ebenfalls in einem Vergleich zum Median der jeweiligen Referenzgruppe - wird dem Krankenhaus direkt angezeigt, in welchem Prozess eine niedrigere IT-Unterstützung vorliegt (s. Abb. 4). In den Prozessen kann weiter in die Deskriptoren navigiert werden, um zu erkennen, wie der Prozesswert durch einzelne Werte in den Indikatoren zustande kommt. Auf Indikatorebene wird die eigene Ausprägung in Relation zu den relativen Häufigkeiten der Referenzgruppe gesetzt (s. Abb. 5).

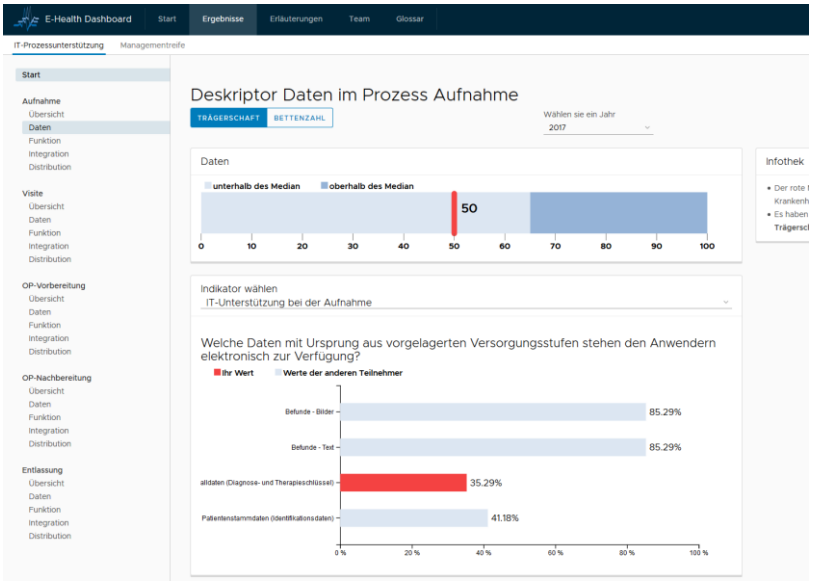


Abbildung 5. Unterste Kennzahlenebene mit auswählbaren Einzelindikatoren

Auf jeder Ebene des hierarchischen Kennzahlensystems ist es also möglich, die eigenen Werte mit den aggregierten Werten anderer in der Referenzgruppe befindlichen Krankenhäuser zu vergleichen. Neben den eigens entwickelten Kennzahlen-Darstellungen für die Spitzenkennzahl, die Prozesse und die Deskriptoren (s. Abb. 5) können auf unterster Ebene die Indikatoren als Netzdiagramm, Balkendiagramm oder Performance-Bar dargestellt werden. Die Grafiken können exportiert werden und stehen damit zur Weiterverwendung bereit.

Zu jedem Zeitpunkt ist es möglich, zwischen den Referenzgruppen Bettenanzahl und Trägerschaft zu wechseln. Haben Teilnehmer in weiteren Befragungsrunden teilgenommen, können die Ergebnisse verglichen und Trends abgebildet werden. In einer Infothek werden dazu neben der Größe der Referenzgruppe die Kennzahlen vorheriger Jahre direkt hinterlegt. Dadurch kann der Benutzer diese Information schnell wahrnehmen, ohne komplett in ein anderes Jahr navigieren zu müssen.

6 Evaluation

Vom 01.12.2016 bis zum 14.05.2017 wurde eine bundesweite Online-Umfrage (Fragebogen) an IT-Leiter/Innen deutscher Krankenhäuser durchgeführt. Von 1224 angeschriebenen IT-Leitungen haben 224 Personen (Rücklaufquote 18,3%) geantwortet. Davon nahmen 197 Personen am Benchmark teil. Dementsprechend liegen 197 Datensätze bestehend aus 201 Variablen bzw. Indikatoren vor, die in dem Web-Portal angezeigt werden können. Am 13.06.2017 wurde eine prototypische Implementierung des Web-Portals mit Beispieldaten in einer Expertenrunde bestehend aus 3 IT-Leitungen, 2 Vertretern von IT-Lieferanten, 4 Wissenschaftlern und 2 Vertretern von Gesundheits-Netzwerken vorgestellt. In dieser eintägigen Workshop-Runde hatten die Experten die Möglichkeit, Nutzenaspekte und Verbesserungspotenziale des Web-Portals in freier Form zu diskutieren. Die Antworten wurden aufgezeichnet und nach der Methode der induktiven Kategorienbildung zusammengefasst. Die Experten bezeichneten das Web-Portal im Vergleich zu einer statischen PDF als „flexibles Instrument zur Darstellung der vielen Visualisierungen und Kennzahlen unterschiedlicher Ebenen“. Die Orientierung an dem Konzept der Informationslogistik und die Segmentierung nach Rogers Diffusion of Innovations [11] wurden als „konzeptionell nachvollziehbar“ und als praxisbezogen eingestuft. Allerdings wurde auch eine deutlichere Einbindung von Handlungsempfehlungen als Verbesserungspotentiale genannt, z. B. „auffällige Indikatoren dynamisch auf Kennzahlenebene anzeigen“ oder „explizit Handlungsempfehlungen benennen“. Im Anschluss an diese initiale semi-formale Einschätzung des Web-Portals wurden die Indikatoren und Diagramme des Benchmarks einer quantitativen Evaluation unterzogen. Ein online Fragebogen bestehend aus 27 geschlossenen Fragen wurde den 197 Benchmark-Teilnehmern 3 Monate nach Erhalt des Benchmarks zugeschickt. Davon beteiligten sich 52 Teilnehmer (26,4%). Fast alle Teilnehmer (93,6 %) schätzten die Indikatoren als „sehr verständlich“ oder „verständlich“ ein. Als Grund für die Teilnahme und als Einsatz für die Ergebnisse wurden folgende Aussagen in einer Mehrfachauswahl angegeben: „Zur generellen Einschätzung des IT-Reifegrades in unserem Haus“ (96,8 %), „Erkennen von Ansatzpunkten für die Weiterentwicklung der IT“ (83,87 %), „Zur Einschätzung des Entwicklungsstandes anderer ähnlicher Krankenhäuser“ (87,1 %) und „Argumentationsgrundlage für zukünftige Projekte“ (67,74 %). Fast alle (96,88 %) bewerteten die unterschiedlichen Visualisierungsformen der Indikatoren als „verständlich“ oder „sehr verständlich“. Mit dieser ersten Einschätzung des Web-Portals, der angezeigten Indikatoren und ihrer Visualisierung liegen brauchbare

Hinweise für eine Weiterentwicklung und eine weitere Evaluation, z. B. Usability des Web-Portals, vor.

7 Schlussbetrachtung und Ausblick

Das in diesem Beitrag vorgestellte Web-Portal bietet einen Ansatz, wissenschaftlich entwickelte und auf Güte getestete Kennzahlen flexibel und individualisiert in die Praxis zu überführen. Krankenhäuser können die für sie interessanten Werte auswählen, direkt mit einer Referenzgruppe vergleichen und über die hierarchische Gliederung Stärken und Schwächen auf den unterschiedlichen Ebenen identifizieren.

Das Web-Portal wurde unabhängigen Stakeholdern im Rahmen einer Expertendiskussion vorgestellt und ein erster Eindruck erfasst. Der Mehrwert der individualisierten Ergebnisdarstellung wurde erkannt. Ferner zeigte sich aus der Befragung der Benchmark-Teilnehmer, dass die Indikatoren und ihre Visualisierung beibehalten werden sollten. Es zeigte sich auch, dass die IT-Leiter/Innen mehrheitlich gute Gründe für eine Teilnahme an einem solchen Benchmark besaßen. Als Limitation ist allerdings zu nennen, dass sich die Evaluation noch am Anfang befindet und weitere Evaluationsschritte nötig sind, um eine abschließende Bewertung vorzunehmen. Aus Sicht des Wissenschafts-Praxisdialogs liegt in einem Benutzerkonto-gebundenen Web-Portal der Vorteil, dass ein direkter Kommunikationskanal zu den Praktikern aufgebaut werden kann, der über die Indikatoren hinaus handlungsorientierte Informationen bereitstellen kann so wie es von den Experten angeführt wurde, bislang aber noch nicht realisiert worden war. Diese Handlungsempfehlungen können dabei ihrerseits mittels statistischer Verfahren aus den Benchmark-Datensätzen ermittelt oder aus der wissenschaftlichen Literatur entnommen worden sein. Damit kann der Einfluss unterschiedlicher Indikatoren und Einflussgrößen direkt auf Ebene der Kennzahlen dynamisch dargestellt werden.

Zukünftig sollen über das Web-Portal weitere Umfragen durchgeführt werden und um zusätzliche Zielgruppen wie die der Geschäftsführung und der klinischen Anwender erweitert werden. Dabei soll das gleiche Prinzip verfolgt werden, Daten für wissenschaftliche Forschungsfragen zu erheben und gleichzeitig einen Mehrwert durch das individuelle zurückspielen von Ergebnissen zu liefern. Bei Einwilligung der Teilnehmer können Informationen unterschiedlicher Akteure zusammengeführt werden, sodass beispielsweise ein IT-Leiter/In die Anwender-Zufriedenheit mit bestimmten IT-Anwendungen und ihrer Prozessunterstützung zusätzlich zu seinen eigenen Angaben angezeigt bekommt. Daher verfügt der aktuelle Fragebogen für die IT-Leitung bereits über eine Einverständniserklärung. Die dafür notwendige Anwenderbefragung wurde Mitte 2017 gestartet und wird aktuell abgeschlossen.

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Conceptualizing User Choice as Motivational Factor in Ad-Hoc Tumor Board Scheduling Applications

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Abstract. We address the theory-driven design of ad-hoc tumor board scheduling applications for improving cancer therapy by developing and testing a theoretical model of the relationship between user choice, autonomy gain, and voluntary use. Physicians' motivation and voluntary use are crucial for the success of these applications. Current theory holds that user choice is instrumental in fostering perceived autonomy and creates intrinsic motivation to use systems. We argue that this effect has boundaries particularly relevant to the hospital context: Under high social and cognitive demands, frequently found in cancer therapy, user choice and resulting autonomy have less motivational effects. Results of a sequential mixed methods study with students and experienced physicians support our research model. This study adds to theory on the motivational effects of user choice by identifying an important boundary condition of extant theory, namely social cognitive constraints, and provides direct design implications for ad-hoc tumor boards scheduling applications.

Keywords: Tumor boards, Self-Determination Theory, User choice, Autonomy, Voluntary use

1 Introduction

Tumor boards constitute an essential element in the diagnosis and treatment process for patients with cancer, a group of diseases that currently accounts for more than 600,000 yearly deaths in the US alone [1] while the number of new cases is expected to grow dramatically [2]. Tumor boards are multi-disciplinary meetings of specialists from different medical fields that holistically discuss single cancer patients' medical situation and decide about recommended treatment plans for each patient [3]. Due to their importance for life-threatened cancer patients, tumor boards are subject to heavy scrutiny by regulators and ethical review committees. For example, they may only give treatment recommendations if medical specialists of sufficient rank from all relevant disciplines are present during a tumor board meeting and declare their consent with the recommendations [3-4]. To ensure that all necessary roles are present and to balance the workload of their specialists, hospitals currently schedule tumor boards well in advance, often one week or more [3]. From a patient's perspective, however, this lead time results in delayed treatment, causes increased stress and anxiety, and carries the risk of the disease progressing further during the delay [5-7]. One way to address these

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issues lies in the arrangement of ad-hoc tumor boards during physicians' daily routine. They enable hospitals to conduct tumor boards more frequently, and patients benefit from the time savings. This requires, however, information systems (IS) that support the arrangement of ad-hoc tumor boards. Otherwise, taking care of the large quantity of heterogeneous information regarding the patient cases and physicians' availabilities would counteract the desired time savings.

From a job perspective, this entails significant changes for physicians who participate in tumor boards: Whereas traditional tumor board arrangements achieve coordination of multiple specialists' heavily loaded schedules by planning well in advance, ad-hoc tumor board arrangements require communication and fast mutual adaptation from the specialists to come to possible appointments. Through this profound change, various challenges arise. First, physicians may perceive such mutual adaptation as cumbersome effort given a full schedule. Secondly, the comparatively high speed of arrangements of ad-hoc tumor boards completely relies on the voluntary participation of physicians as the hospitals' possibilities to control and enforce participation in the arrangement process are very limited. If not countered, such information asymmetry and effort perceptions can trigger physicians' resistance against new IS [8]. Therefore, successful implementations of ad-hoc tumor boards need to aim to motivate physicians to voluntarily participate in the arrangement process. More precisely, physicians have to be motivated intrinsically for a voluntariness-based scheduling process to remain sustainable. Prior work has shown that voluntary action and intrinsic motivation can generally be fostered through providing choice possibilities and thereby enhancing individuals' feeling of autonomy [9-10]. However, recently scholars have called into question whether more choice has generally a motivating effect. In particular, users may possibly suffer from too much choice as it strains their cognitive resources [11-12] and not everybody responds positively to offered choices [13-14]. This is particularly relevant for physicians as their working context is often both physically and mentally exhaustive [15], and previous work has even suggested to reduce user choice in supporting IS for healthcare to a minimum [12]. Since it is important to foster physicians' motivation to voluntarily participate in scheduling ad-hoc tumor boards by using appropriate IS, it appears crucial to better understand such effects. We consequently aim to answer the following research questions:

1. *Why and how does user choice provided to physicians lead to increased motivation for voluntary use in a hospital context?*
2. *How can ad-hoc tumor board scheduling applications be designed to leverage user choice as an intrinsic motivating factor for using the applications?*

While we are engaged in a larger design science project to develop a full ad-hoc tumor board solution, we approach these two important research questions primarily from a theory-driven empirical perspective. Nonetheless, it is one major goal to develop clear and context-specific design implications for ad-hoc tumor boards. In this research we therefore aim to (1) develop a research model that provides a more differentiated understanding of the contingencies influencing the motivational effects of user choice and their boundaries; and (2) contextualize and test the model in the domain of voluntary use of IS for scheduling ad-hoc tumor boards. By answering these research

questions, we add to current theory on the motivational effects of user choice [10] and provide guidelines for developing ad-hoc tumor board systems that stimulate physicians' voluntary use with a personalized level of user choice that is adapted to the level of social cognitive constraints (SCC). Ultimately, this will hopefully contribute to quicker tumor board decisions and thereby faster therapy for cancer patients.

2 Theoretical background

Tumor boards: Tumor boards constitute an essential part of the diagnosis and treatment plan of cancer patients. Physicians, specialized in different medical disciplines, review and discusses the further treatment and diagnosis steps of a cancer patient. There are different types of tumor boards for different tumor entities that involve physicians from different, pre-defined medical disciplines. For this reason, and depending on other factors like hospital size and availability of physicians, the meeting frequency of individual tumor board types often varies from once a week to once a month in developed countries [3]. A group of physicians in a tumor board is only entitled to make medical decisions if physicians of predefined medical disciplines are involved in the decision making process and agree with the final decision [3-4]. On the one hand, this increases the decision quality as physicians participate only in tumor boards where they hold specialized expertise. On the other hand, it also increases the complexity of coordinating the schedules of different specialists which results in longer planning periods and delays in patient treatment. Especially for cancer patients, however, this is valuable time connected with more individual stress, anxiety and the risk for the tumor to metastasize [5-7]. Reducing the planning time before tumor board has, therefore, essential impact on the patient's treatment success.

There are only limited technical solutions to accelerate the tumor board planning process. Solutions such as daily tumor boards for all tumor entities or general tumor boards with no specialization are not feasible. These solutions come with high risks to waste the physicians valuable time (e.g. if physicians reserve time for a meeting and there are no cases available) and are not realizable as there are more than a dozen different tumor boards for different tumor entities. Due to US and EU regulations, the involvement of different, specific medical disciplines is mandatory for any treatment recommendation [16-17]. Hence, the only option we currently see to accelerate tumor board planning and execution are ad-hoc tumor boards. In contrast to traditional tumor boards, ad-hoc tumor boards are planned immediately when a request arrives and held within a few minutes or hours in contrast to several days. As participants are not determined beforehand, the available physicians have to volunteer and quickly form a competent group. However, planning ad-hoc tumor boards bears a lot of complexity due to the large amount of participants, their different specializations and schedules, the regulatory tumor board constraints and the hospital environment itself, which is often hectic and unpredictable, putting high cognitive and emotional demand on physicians [15]. This results in less motivation to voluntarily engage in additional activities such as ad-hoc tumor boards. Besides, particularly physicians are known for their heavy resistance to technologies and process changes that distract them from their

primary tasks or impair their autonomy [18-19]. From a requirements perspective, it is therefore essential to build an application which fosters the motivation to volunteer in a tumor board and at the same time fits into the clinical environment.

User choice and Self-Determination Theory: A particularly prominent way to motivate users to engage in voluntary action is satisfying their need for autonomy by giving them choice in what they do [10], [13]. According to the Self-Determination Theory (SDT) [10], autonomy is defined as the need of having the perception of control over the situation and having the possibility to decide and influence the outcome according to one's preferences [20-21]. Literature indicates, that autonomy can be accomplished by an IS design, which provides the user with flexibility and options of choice [10], [22].

Particularly autonomy and user choice are closely related: Having options of choice increases intrinsic motivation and benefits performance [23] and being deprived of options decreases motivation and can even result in reactance [14], [24]. However, the positive effects of choice are limited [25] and research indicates that there may also be negative effects of user choice: It can lead to information overload [26-27], feelings of constraint and effort [11], [28] as well as individual stress and performance decrease [26]. Concluding, too much choice can overwhelm the user. Moeller et al. [9] try to integrate the positive and negative motivational effects of choice by arguing that only choice which is perceived as autonomous is motivating. The authors define autonomous choice as a choice with an internal locus of causality, meaning that individuals have the perception of actively influencing the outcome of the choice [9]. However, this explanation has two major limitations: first, it does not explain why there are situations, e.g. in healthcare, in which less choice can be more motivating than more choice [12] and second, it is too unspecific to be translated into design implications.

3 Theoretical model

In order to improve our understanding of when user choice benefits intrinsic motivation and voluntary actions and to provide theoretical insights with direct design implications, we developed a context-specific theoretical model for the voluntary use of ad-hoc tumor boards by physicians. Following the reasoning of SDT, we argue that more user choice provided by applications, is generally perceived as a gain in autonomy and increases the intrinsic motivation to use these applications [13]. We theorize that individual autonomy gain does, however, not always lead to voluntary use, since individuals need to have social influence on the outcome and enough resources to process the options of choice. Hence, we argue that SCC negatively moderate this relationship.

To contextualize this high level theory [29] to the specific domain of physicians' voluntary use of tumor board software, we apply this theoretical reasoning to the design of user interfaces for making appointments for ad-hoc tumor boards. In more detail, user choice is contextualized to display options for meeting timeslots. The theoretical model is depicted in Figure 1 and developed subsequently.

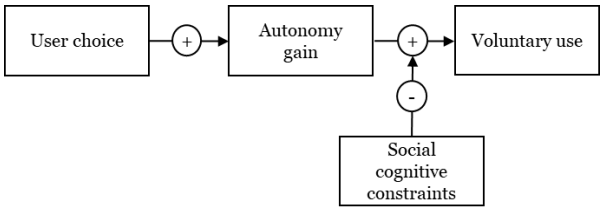


Figure 1. Research Model

User choice: Following SDT, we argue that more user choice leads to more perceived autonomy [10]. Our model is based upon the assumption, that the provided choice has both high relevance and a positive subjective value add so that it can lead to autonomy gain and volunteering [13]. We operationalize user choice with number of options and agency, both design elements for the user interface.

First, user choice has to contain more than one option of choice. Literature indicates that if individuals are deprived of options, they experience reactance [24] and in extreme, even a feeling of helplessness [30]. Besides, a meta-analysis shows that comparing options of choice against no options of choice has the largest effect on intrinsic motivation [23]. In general, more options provide a higher chance that at least one option meets the user preferences increasing the user's perceived autonomy.

Second, individuals can be allowed to exert agency to differing degrees where high degrees of agency lead them to firmly believe they are making a choice themselves, meaning that they are the agent of the choice [11], [31]. For example, receiving a list of possible appointment times to choose from provides less chances to exert agency than being asked to proactively suggest a list of possible time slots for others to choose from. Individuals arguably perceive a choice as increasing their own autonomy more if they are provided with more chances to exert agency. If, on the other hand, a choice is forced on them by someone else individuals would not experience any feeling of autonomy [9]. We therefore theorize:

H1: More user choice, i.e. more available options and more possibilities to exert agency, leads to more perceived autonomy

Perceived Autonomy: Following the reasoning of the SDT, we argue that if user choice leads to an autonomy gain, it increases the user's intrinsic motivation, which leads to more voluntary usage [10], [31]. Especially for physicians, autonomy is an important driver for action [19]. Hence, information systems research identified perceived threat to physicians' autonomy as one important source of their resistance against new technology [19], [33]. So, we argue:

H2: The more users perceive an autonomy gain the higher their propensity to voluntarily use the application

Social cognitive constraints: However, in a hospital context, physicians have only limited resources they can spend on different choices. Relevant to this context, we argue that the perceived autonomy of individuals does not always lead to more motivation

but that this relationship depends on the context individuals are facing. In a high SCC context, individuals may prefer less choice and less autonomy, while in a low SCC context, individuals may prefer more choice and more autonomy. We define SCC as the degree to which the social context and cognitive situational demands constrain the individual's scope of action, by limiting individuals influence on the outcome and reduce their available resources. Individuals' perceived influence on the outcome can be defined as the degree to which individuals perceive to have an effect on the outcome through their own actions (also known as locus of causality [9]). It is thereby different from the objective possibility to exert agency and influenced by a number of factors. For instance, in strong hierarchical work settings, such as in hospitals, low-ranking individuals have less influence on the meeting schedule than in settings with less hierarchy. That is, even though they may have a user interface in which they can propose time slots, they may know that their superior's availability fully overrules their preferences. Being provided with more possibilities to exert agency or more options to choose from does consequently not make any difference for them because they feel that they do not have control over the outcome. Literature further indicates that under high time pressure [34] and cognitive load [26], conditions which are often present in hospitals [15], individuals have less perceived control over choice outcomes. Additionally, individuals have only limited available cognitive and emotional resources which they can allocate for the task. We define resources as cognitive capacity to process information [26-27] and the capacity to volunteer [35]. More autonomy in choosing requires more of the individuals' resources to evaluate the possibilities, such as more time and more cognitive capacity. Too many options of choice can result in choice overload [36]. Besides, under high time pressure individuals have to choose fast without much consideration and are often relying on automatic processes such as habits and heuristics [37]. Especially in the hospital context, physicians have to make fast decisions and have only limited spare resources for the ad-hoc tumor board scheduling application. Accounting for the perceived outcome of choice and the available resources we therefore theorize:

H3: Social cognitive constraints have a negative effect on the relationship between autonomy and voluntary use

4 Research Design

Development of user interfaces: For our research design, we systematically developed a set of six user interfaces. For tumor board meetings user choice is limited to the questions of if and when to attend the tumor board meeting since the scheduling algorithm will determine the participants, patient case and place. So, we systematically developed six user interfaces varying the number of options of choice and the degree of agency creating low and high user choice designs (see Table 1 and Figure 2).

Table 1. Interface Design (Designs, see also Figure 2)

	Low degree of user choice	*High degree of user choice*
Options of choice	One timeslot and limited answer options (Designs 1 to 3)	Multiple timeslots and answer options such as prioritize alternatives (Designs 4 to 6)
Agency	Users receive timeslot suggestions (Designs 1 to 4)	Users can propose timeslots by themselves (Designs 5 and 6)

Research context: Our research takes place in a full care public hospital in Germany with more than 1,300 beds. The research is embedded into a multidisciplinary project that aims to develop innovative technologies and methods for cancer treatment. In this hospital, more than 10 different tumor boards take place on a weekly basis.
Furthermore, physicians' day to day work is highly demand driven and varies in time pressure as well as in number of parallel decisions, all reducing physicians' available resources [15]. This unique context offers the opportunity to compare variances in SCC, based on hierarchy levels and resource capacity. Hence, we used this context for the mixed methods evaluation of our proposed theoretical model and to derive design implications.

Research design: We use a mixed-method design of sequential quantitative and qualitative investigations [38] to test our theoretical model and to systematically derive design implications for the tumor board scheduling application.
First, we evaluated the developed user interfaces with a quantitative measure, an online survey, with a group of students (n=44, age M=24.6, SD=4.4; 45% female). Students are usually flexible in their daily schedule and have therefore low levels of SCC. This makes them a suitable SCC neutral group to evaluate our user interfaces. For the analysis, we excluded 5 participants due to not complying with a filter question. The students were introduced to the setting of the tumor board application with an introduction text. Then all students rated the user interfaces on the variables autonomy and effort expectancy on a 5-point Likert like scale ranging from 1 being "Strongly Disagree" to 5 "Strongly Agree". The items are displayed in Table 2. Afterwards, the students had to rank the designs according to their intention to use it for scheduling an ad-hoc tumor board.

Second, we gathered qualitative data from 11 radiologists (age M=33.9, SD=4.4; 55% female) who are participating in tumor boards on a regular basis. We showed the physicians four interfaces (Designs 2, 3, 4 and 6) and had them choose the interface they would use and one they would definitely not use. Furthermore, we asked the physicians to provide qualitative information about why they have made this choice. Besides, we evaluated the SCC on a 7-point Likert scale (see items in Table 2) and conducted in-depth interviews with multiple physicians from different hierarchy levels.

Table 2. Items

Autonomy [39]	I would have more control over my meetings while using this app This app gives me more chances to control my meetings This app provides me more opportunities to manage myself
Effort expectancy [40]	The interface is easy to learn The interface is simple I can put data quickly using the interface
Social cognitive constraints adapted from [41]	I can choose the time for tumor boards I can choose if I want to participate in a tumor board Overall I have low control over my daily schedule Fixed schedules are structuring my day
Voluntary use	Please rank the user interfaces according to your preferences (student study) Please select the user interface you would prefer to use for scheduling tumor board meetings (physicians)

5 Results

User choice leads to more autonomy. In the quantitative study, all students evaluated the user interfaces with different user choice levels according to autonomy and effort expectancy. The differences (t-tests) between the user interfaces were all highly significant (Means see Figure 2, $p<.001$). Hence, we confirmed hypothesis 1 that designs with more user choice lead to higher perceived autonomy.

Autonomy leads to more voluntary use. Students have high scheduling flexibility and no constraints, thus a low SCC context. In the survey we asked the students to choose the user interface which they would use for scheduling ad-hoc tumor boards. Designs with high user choice, designs 4, 5 and 6, were preferred by 70% of the students supporting hypothesis 2 that higher autonomy leads to more voluntary usage. However, design 4 alone was preferred by most students (36%). Hence, autonomy gain appears to be only beneficial for voluntary usage if it does not impair usability (See Figure 2).

Effect of low or high SCC in the hospital context: In our second study, we expanded our proposed model by taking into account the specific hospital context with different levels of SCC for physicians. All radiologists (n=11) strongly agreed (M=5.8, SD=1.2) on a 7-point Likert-scale that tumor boards are highly important.

We asked about the design preference of the physicians to assess the relationship between autonomy and voluntary usage. The majority of physicians (54%) indicated that they would use the low user choice designs (2 and 3) for the tumor board scheduling application and design 3 alone was preferred by 45%. These designs provided the physicians with the "best balance between choice and simplicity" (Interview data).

Design 6, the one with the highest user choice, was only preferred by the outstandingly high-ranking physician. For all other physicians this design was “too complex” and two third indicated that they would definitively not use this interface. The high-ranking physician later explained, that he preferred this user interface since it allows him to fit ad-hoc tumor boards with his schedule. He indicated having a lot of control over his daily schedule and being able to choose the timeslots for the tumor boards by himself. Hence, the high-ranking physician faced low SCC and had similar preferences as the student sample.

All other physicians faced high SCC. On a 7-point Likert scale from 1 being “strongly disagree” and 7 being “strongly agree”, the other physicians indicated not being able to choose the timeslot for tumor board meetings (M=6.9, SD=0.3), not being able to decide if to participate in tumor board meetings (M=5.9, SD=1.9), generally having low control over their schedule (M=5.0, SD=1.3) and having the feeling that tumor boards help to structure their day (M=4.5, SD=1.3). One physician, who preferred design 3, explained that design 6 would not work in his daily routine since he could not plan his schedule freely and that he received a lot of urgent last minute requests. After he would have indicated a time span there could always be an important surgery spontaneously scheduled exactly in this time span. For him, fixed time slots for the tumor board helped him to structure his day, decreased his effort for organizing meetings and increased predictability and autonomy. Especially during high stress situations, he indicated, he would prefer a simpler design. This confirms hypothesis 3 that high SCC negatively affect the relationship between autonomy and voluntary use.

Overall, the results show that SCC influences the relationship between autonomy and voluntary use. When physicians have low influence on the outcome and restricted resources they prefer to use a simpler design with less user choice and less autonomy.



Average	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6
Autonomy	2.83 (0.97)	2.27 (0.97)	2.75 (0.71)	4.03 (0.70)	4.05 (0.71)	4.07 (0.63)
Effort expectancy	4.27 (0.91)	4.73 (0.41)	4.68 (0.50)	4.35 (0.68)	3.95 (0.80)	3.84 (0.91)

Figure 2. Mean values and standard derivations of developed user interfaces (designs)

6 Discussion and Contributions

This study contributes to literature on the motivational effects of user choice in general [13], [23] and on the role of user choice in motivating highly skilled healthcare personnel in particular [8], [12]. While user choice is a known stimulant for perceived

autonomy and intrinsic motivation [23], prior research has suggested that this effect may not infinitely increase with growing user choice [8], [13], [36]. Although physicians are known to resist new processes and IS particularly when they feel constrained by them [18], little research has investigated why and how IS may be designed to increase physicians' autonomy perceptions and motivation [8]. We close a gap in literature about how users' context influences voluntary use [42-43] by developing and testing a research model based on SDT that provides a more differentiated understanding of the contingencies and boundaries of the motivational effects of user choice.

From a theoretical perspective, our results show that more options of choice and agency are associated with autonomy gains that lead to a higher degree of voluntary use only when users are not constrained in their resources or social structures. This suggests that those who recommend to keep user choice in IT healthcare preferably at low levels [12] should take SCC more into account. More user choice may actually be preferable in little constrained hospital contexts in order to keep, for example, physicians from resisting technology adoption and systems change [8]. Contrastingly, in highly constrained situations, a reduction of user choice may indeed be necessary.

From a practical perspective, this has clear design implications. As such, IS that aim to motivate voluntary use in different contexts should rely on personalized and context-aware adaptations to the SCC of the user. We aim to incorporate our findings into the design of an application that motivates physicians to voluntarily use it for arranging and conducting ad-hoc tumor boards. Two user interfaces are planned that allow for adapting the amount of user choice to situations of physicians with either high or low SCC. This is expected to aid in effectively scheduling ad-hoc tumor boards and making their success possible. A consequent reduction of the delay before cancer patients receive their treatment plan may well save many lives in the future.

We show initial positive results of the proposed research model in a mixed methods study with students and expert physicians that often attend tumor boards. However, our work has limitations that need to be acknowledged. In future work, the empirical basis of this model has to be extended by first, increasing the sample size and secondly by including physicians from further medical specialties such as oncology and surgery. To understand how variations in SCC influence the relationship between autonomy and voluntary use, a field experiment would be interesting. There, options of choice and agency can be systematically varied in the user interface. Furthermore, voluntary use can be assessed by real usage behavior. In the presented study we could not fully rule out individual level biases that can affect physicians' system use such as their value systems or their integration with their hospital [44]. In the future field experiment, we will be able to control for such potentially biasing factors.

7 References

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Digitalisierung in der psychotherapeutischen Versorgung - ein Literatur-Review zum Status quo internet- und mobilbasierter Versorgungsprogramme und Ableitung einer Klassifizierung

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Abstract. Aktuell gibt es in Deutschland einen großen Bedarf an psychologischen Dienstleistungen, allerdings erhält nur ein geringer Anteil der Bevölkerung eine adäquate Behandlung. Die geringe Behandlungsquote psychischer Leiden wird auf strukturelle Versorgungsprobleme und große Hemmschwellen seitens der Patienten zurückgeführt. Internetbasierte Systeme besitzen das Potential, die Patientenversorgung psychisch Erkrankter zu verbessern und finden in der Prävention, Therapie und Rückfallprophylaxe psychischer Leiden Anwendung.
Der vorliegende Beitrag beinhaltet eine systematische Aufarbeitung des aktuellen Forschungsstandes in Form eines strukturierten Literatur-Reviews. Zunächst wird der Status quo internetbasierter Psychotherapien identifiziert und anschließend erfolgt eine Klassifizierung von internet- und mobilbasierten psychologischen Versorgungsprogrammen, die aus der Literatur abgeleitet wurde. Dabei konnten sieben Hauptkategorien ermittelt werden.

Keywords: Literatur-Review, E-Health, online Psychotherapie, Klassifikation internetbasierter Versorgungsprogramme, psychische Erkrankungen

1 Einleitung

Der Begriff Psychotherapie allgemein beschreibt nach J. Lang eine Möglichkeit „unter besonderen Bedingungen neue Beziehungserfahrungen machen zu können, Rückmeldung über das eigene Verhalten zu bekommen, zu Formen der Realitätstestung angeregt zu werden und neue Kompetenzen einüben zu können“ [1].
Trotz gut aufgestellter Gesundheitssysteme werden viele psychische Erkrankungen nicht therapiert. So erhalten in Deutschland 44% aller behandlungsbedürftigen depressiven Personen keine Therapie [2]. Etwa ein Viertel aller Jugendlichen hat bereits depressive Verstimmungen erlebt, allerdings beginnt davon nur etwa ein Fünftel eine Behandlung [3]. Dies wird damit begründet, dass vor allen Dingen junge Menschen abgeneigt sind, den klassischen Weg einer Psychotherapie zu gehen [4]. Berufstätige

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Betroffene haben oft keine (zeitlichen) Freiräume für eine Therapie [3] und strukturelle Versorgungsprobleme wie lange Wartezeiten oder mangelnde Verfügbarkeiten von Behandlungsangeboten vor allem in ländlichen Gebieten führen zu einer unzureichenden Behandlung psychischer Leiden [2]. Auffallend sind die niedrigen direkten und hohen indirekten Kosten, die mit den niedrigen Behandlungsquoten und der unvollkommenen Versorgung erklärt werden. Die schlechte Therapiesituation psychischer Störungen sowie die enorme Krankheitslast könnten durch Forschung zu Prävention, Früherkennung und Therapie psychischer Leiden verbessert werden. Die Nutzung digitaler Möglichkeiten steht dabei insbesondere im Fokus der Forschungslandschaft [5].
Unter internet- und mobilbasierten psychologischen Versorgungsprogrammen werden Selbsthilfeinterventionen, die Integration von internetbasierten Therapieelementen in eine klassische Psychotherapie bis hin zur reinen psychologisch-therapeutischen Behandlung über das Internet ohne direkten persönlichen Kontakt verstanden. Sie verfolgen das Ziel, Betroffene bei der Bewältigung einer psychischen Symptomatik zu unterstützen oder ihr präventiv entgegenzuwirken, indem sie Informationen zu Ursachen, Symptomen und Verläufen von Erkrankungen vermitteln und Interventionen beinhalten, die auf psychotherapeutischen Techniken basieren [2]. Besonders gut erforscht sind diesbezüglich die Behandlung von Depressionen und Angststörungen [6]. Diverse Studien zeigen, dass internetbasierte Methoden zur Behandlung psychischer Erkrankungen angesichts der genannten Probleme Potenzial besitzen, die Patientenversorgung und -gesundheit zu verbessern und eine effektive und kosteneffektive Behandlungsoption darstellen können (beispielsweise [3, 7–9]). Internet- und mobilbasierte Interventionen gewinnen zunehmend an Bedeutung [2], verursachen geringere Kosten als eine herkömmliche Therapie und stellen für die Patienten eine kleinere Hürde dar, eine Therapie zu beginnen [3].
Das Medium Internet wird nicht nur zur Weitergabe von gesundheitlichen Informationen genutzt, sondern dient ebenso als Kommunikationsmittel. Dadurch wird direkte Unterstützung von professionellen Helfern möglich und der Kontakt zwischen Patient und Therapeut kann medienvermittelt von statten gehen [10]. In Anbetracht der fortschreitenden Technologisierung und Digitalisierung ist anzunehmen, dass sich internetbasierte Interventionsangebote zunehmend verbreiten werden und auch deren Akzeptanz weiter steigen wird [2].
Im Folgenden wird die Methodik des vorliegenden Beitrages erläutert und eine Klassifikation von internet- und mobilbasierten Versorgungsprogrammen abgeleitet. Anschließend werden die Chancen und Grenzen von Internettherapien aufgezeigt und die Rolle der therapeutischen Beziehung im Rahmen der Digitalisierung diskutiert. Schließlich rundet eine Zusammenfassung den Beitrag ab.

2 Methodik

Um die relevante Literatur zum Status quo internetbasierter psychotherapeutischer Plattformen zu sammeln, erfolgte eine strukturierte Vorgehensweise nach dem gängigen Vorgehen von Webster und Watson [11]. Es wurde eine elektronische

Datenbankrecherche in den etablierten Datenbanken Web of Science, PsyIndex und PubMed vorgenommen, sodass sowohl interdisziplinäre als auch psychologische und medizinische Datenbanken berücksichtigt wurden. Bei der Suche standen die Themenbereiche Systeme, Methoden und Konzepte internetbasierter Psychotherapien im Fokus. Die Literaturrecherche erfolgte anhand einer Freitextsuche mittels Kombination folgender Suchbegriffe: „psychotherap*“ und „digital“, „internet*“, „internet-based“, „online-therapy“, „online-counseling“, „mobile apps“, „computer-based“. Darüber hinaus erfolgte die Durchsicht der Referenzen relevanter systematischer Übersichtsarbeiten per Handsuche. Die ersten Suchanfragen ergaben 1701 Treffer. Anschließend wurden nur englisch- und deutschsprachige Original- sowie systematische Übersichtsarbeiten des Veröffentlichungszeitraums von 2008 bis 2017 in die weitere Literaturanalyse integriert. Ältere Artikel wurden nicht betrachtet, da die Themenbereiche Internettherapie, mobile Anwendungen und Apps erst ab dem Jahr 2008 mit einer zunehmenden Durchdringung assoziiert werden und ältere Studien nicht auf die heutige Ausgangssituation übertragbar sind. Damit verringerte sich die Trefferzahl auf 1451. Nach einer Überprüfung der Titel wurden von 124 Veröffentlichungen ihre Zusammenfassung gelesen. Daraus mündete eine vollständige Überprüfung des gesamten Textes von 49 Artikeln, wobei nach einer Beurteilung ihrer Relevanz anhand des Inhalts, der Qualität und der Zitierhäufigkeit 26 Beiträge in die weitere Analyse eingegangen sind. Ein weiteres Kriterium für die Berücksichtigung von Studien war das Vorliegen eines randomisiert, kontrollierten Studiendesigns, da dieses eine geeignete Studienart darstellt, um therapeutische Interventionen darzulegen und auf Basis erhobener Daten Nutzen, Chancen und Risiken zu vergleichen.
Die im folgenden Kapitel dargestellten Kategorien sind vollständig aus der Literatur abgeleitet. Um eine kategorienbasierte Darstellung und Auswertung zu entwickeln, wurden die in der Literatur thematisierten Systeme systematisch auf Eigenschaften untersucht und inhaltliche Unterscheidungsmerkmale aufgegriffen. Schließlich sind in einem mehrstufigen Verfahren Kategorien entwickelt und ausdifferenziert worden, die im folgenden Kapitel vorgestellt werden. Die Literaturrecherche und –analyse zeigte, dass es bislang keine Übersichtsarbeiten zur Klassifizierung internet- und mobilbasierter Versorgungsprogramme gibt.

3 Klassifikation

Internetbasierte Versorgungsprogramme lassen sich nach verschiedenen Kategorien klassifizieren. Zunächst unterscheiden sich die aktuellen Angebote im Ausmaß menschlicher Beteiligung [12]. Einige Plattformen stellen eine Ergänzung und Vertiefung zu einer bestehenden, herkömmlichen Psychotherapie dar und können vom Therapeuten bearbeitet und angepasst werden. Andere sind vollständig losgelöst von einer Therapie und können entweder online medizinisch begleitet sein oder vollständig online ohne menschliche Unterstützung angewendet werden [13]. Im ersten Fall kann die Unterstützung von einem Therapeuten, Facharzt oder medizinisch geschulten Personal geleistet werden, die Aktivitäten und Krankheitsverläufe der Patienten verfolgen und nach Bedarf Anregungen und Feedback geben [14]. Sie begleiten den

Genesungsprozess mehr oder weniger intensiv und setzen Impulse sowie Denkanstöße, um mithilfe von bewährten, psychologischen bzw. psychotherapeutischen Techniken aktiv emotionale und kognitive Lernprozesse beim Patienten auszulösen [6]. Je nach Bedarf können Therapeuten aus kompletten Therapiemodulen einzelne Behandlungsbausteine integrieren oder ausschließen und somit eine auf die Bedürfnisse des Patienten individuell abgestimmte Therapie zusammenstellen, die entweder vollständig online oder in Integration mit der herkömmlichen, persönlichen Therapie erfolgt [12]. Findet das Programm vollständig ohne menschliche Beobachtung und Rückmeldung statt, handelt es sich um ein reines Selbstmanagement-Tool, das den Patienten befähigen und Hilfestellungen geben soll, selbstständig den eigenen Gesundheitszustand zu verstehen und zu verbessern. In diesem Fall arbeiten die Patienten autonom standardisierte und als wirksam erwiesene Interventionen durch [15]. Studien haben gezeigt, dass Behandlungsmodelle mit menschlichem therapeutischen Kontakt bessere Behandlungserfolge erzielen als solche ohne Begleitung. Dies zeigt sich vor allen Dingen in den hohen Abbruchquoten bei unbegleiteten Programmen [16].
Tabelle 1 listet die zuvor erläuterte Kategorie „Ausmaß menschlicher Beteiligung“ mit ihren jeweiligen Subkategorien und deren Beschreibung auf.

Tabelle 1. Ausmaß menschlicher Beteiligung

Subkategorien	*Beschreibung*	*Referenzen*
Kombiniert mit konventioneller Therapie	Als zusätzliche Begleitung einer herkömmlichen Psychotherapie	[2, 7, 10, 14, 16–19]
Begleitet	Therapeutischer Kontakt über die Plattform zur Steuerung der Bewältigung der Beschwerden bzw. der Erkrankung	[2, 6, 10, 12–18, 20, 21]
Unbegleitet	Patienten erarbeiten selbstständig Informations-, Dokumentations- und Interventionsangebote	[2–4, 6, 8–10, 12, 13, 15, 16, 19–21]

Des Weiteren können internetbasierte Versorgungsprogramme danach klassifiziert werden, in welcher Phase innerhalb der gesundheitlichen Versorgungskette sie eingesetzt werden [16]. Internetgestützte Screening-Verfahren identifizieren Risikofaktoren für eine psychische Erkrankung, sodass es aufgrund frühzeitiger Kenntnis gar nicht erst zu einer voll ausgeprägten psychischen Störung kommt. Diese Programme sind dem präventiven Bereich zuzuordnen [6]. Demgegenüber stehen therapeutische Angebote, die bereits vorhandene psychische Störungen anhand von online zur Verfügung gestellten Interventionen und Hilfestellungen therapieren. Im Anschluss einer erfolgten Therapie können internetbasierte Versorgungsprogramme mit niedriger Intensität zur Erhaltung des Gesundheitszustandes und zur Vermeidung eines Rückfalles dienen [2]. Tabelle 2 listet die zuvor erläuterte Kategorie „Phase innerhalb der gesundheitlichen Versorgungskette“ auf.

Tabelle 2. Phase innerhalb der gesundheitlichen Versorgungskette

Subkategorien	*Beschreibung*	*Referenzen*
Präventiv	Screening zur frühzeitigen Erkennung einer psychischen Störung	[2, 6, 15]
Therapeutisch	Störungsbezogene Programme zur Genesung der Erkrankten	[2–4, 6–10, 12, 13–22]
Rückfall-prävention	Stabilisierend und zur Erhaltung des aktuellen Gesundheitszustandes	[2, 6]

Insbesondere für Depressions- und Angsterkrankungen gibt es bereits einige krankheitsspezifische Plattformen, die auf die jeweilige Erkrankung und den entsprechenden Symptomen ausgerichtet sind [13]. Im Gegensatz dazu können unspezifische Versorgungsprogramme abgegrenzt werden, die unabhängig von der vorliegenden Erkrankung psychologische und psychotherapeutische Anreize und Hilfestellungen zur Verfügung stellen [17]. Tabelle 3 listet die zuvor erläuterte Kategorie „Spezifität“ auf.

Tabelle 3. Spezifität

Subkategorien	*Beschreibung*	*Referenzen*
Krankheits-spezifisch	Interventionen sind auf ein bestimmtes Krankheitsbild ausgerichtet	[2–4, 6–10, 12, 13, 16, 19, 20, 23]
Krankheits-unspezifisch	Interventionen sind nicht auf ein bestimmtes Krankheitsbild ausgerichtet	[13, 15, 17, 18, 21, 22, 24]

Vorhandene internetbasierte Interventionsangebote unterscheiden sich zudem in ihrer technischen Umsetzung. Einige Anbieter stellen Programme bereit, die in eine Webseite eingebettet sind oder auch in Form einer App auf das mobile Endgerät heruntergeladen werden können. Ebenso können E-Mail, chat- oder videobasierte Kommunikationsmodelle in die Therapie eingebettet sein [22]. Tabelle 4 listet die zuvor erläuterte Kategorie „Technische Umsetzung“ auf.

Tabelle 4. Technische Umsetzung

Subkategorien	*Beschreibung*	*Referenzen*
Programme innerhalb einer Webseite	Der Nutzer kann Therapien über eine Webseite aufrufen und bearbeiten	[2, 4, 8, 9, 12, 13, 15–20, 22]
App-Anwendung	Der Nutzer kann eine App auf sein Smartphone herunterladen und darüber Therapien aufrufen und bearbeiten	[2, 12, 14-16, 22]
E-Mail-, chat-, videobasiert	Die Kommunikation zum Therapeuten erfolgt über E-Mail, Chat oder Video	[2, 7, 10, 13–18, 20, 22, 24]

Wenn ein entsprechender Austausch mit einem Therapeuten vorgesehen ist, lässt sich zwischen synchroner und asynchroner Kommunikation unterscheiden [12]. Zu synchroner Kommunikation zählen alle Medien, bei denen Informationen in Echtzeit ausgetauscht werden. Das therapeutische Feedback kann beispielsweise über Internetanrufe oder Chats vonstattengehen. Bei asynchronen Medien wie zum Beispiel E-Mail werden Nachrichten hingegen zeitversetzt versendet [24]. Tabelle 5 listet die zuvor erläuterte Kategorie „Kommunikationsform“ auf.

Tabelle 5. Kommunikationsform

Subkategorien	*Beschreibung*	*Referenzen*
Synchron	Austausch in Echtzeit	[6, 7, 10, 16, 21, 22, 24]
Asynchron	Zeitversetzter Austausch	[2, 6, 10, 12, 14, 16–18, 21, 22, 24]

Der Großteil aller internetbasierter Therapieverfahren orientiert sich an kognitiv-verhaltenstherapeutischen Ansätzen [16]. Allerdings können auch andere therapeutische Grundsätze wie interpersonelle Psychotherapie, Psychoedukation sowie psychodynamisch orientierte Therapieansätze die medizinisch-psychologische Grundlage der Interventionen darstellen [2]. Tabelle 6 listet die zuvor erläuterte Kategorie „Therapieverfahren“ auf.

Tabelle 6. Therapieverfahren

Subkategorien	*Beschreibung*	*Referenzen*
Kognitive Verhaltens-therapie	Verhalten und Kognitionen sind die Schlüsselfaktoren der therapeutischen Veränderung [25]	[2–4, 6–10, 12, 13–20, 22]
Interpersonelle Psychotherapie	Im Vordergrund steht der zwischenmenschliche Kontext, in dem sich die gegenwärtige Krankheitsepisode entwickelt hat [26]	[2, 27]
Psychoedukation	Patienten werden über die Krankheit und ihre Behandlung informiert und das Krankheitsverständnis und die Krankheitsbewältigung gefördert [28]	[6, 10, 12]
Psychodyna-mische Therapie	Bezug auf die Psychoanalyse als Referenzsystem [29]	[2, 27]

Psychische Krankheitsbilder werden mit bestimmten nonverbalen Signalen assoziiert. Eine weitere Kategorie besteht in der Unterscheidung, ob im Rahmen der Internettherapie soziale und nonverbale Signale wie beispielsweise Körpersprache oder Augenkontakt integriert werden. Demnach zeigen beispielsweise depressive Menschen häufig einen neutralen Gesichtsausdruck, starren, zeigen weniger Emotionen sowie Mundbewegungen und vermeiden direkte Augenkontakte [30]. Nur ein kleiner

Bruchteil der derzeit vorhandenen Systeme greift auf die Methoden des Affective Computings zurück, wobei computergestützt das emotionale Wohlbefinden erkannt, vermessen und quantifiziert wird. In der Regel scannen Kameras und Sensoren das nonverbale Verhalten und erkennen klinisch relevante Informationen [31]. Tabelle 7 listet die zuvor erläuterte Kategorie „Nonverbale Signale“ auf.

Tabelle 7. Nonverbale Signale

Subkategorien	*Beschreibung*	*Referenzen*
Keine Einbindung	Nonverbale Signale werden nicht erfasst und nicht berücksichtigt	[3–4, 6–9, 12–14, 16–22, 24, 32]
Einbindung	Nonverbale Signale werden erfasst und berücksichtigt	[2, 10, 23, 30, 31, 33]

Die Literaturanalyse zur Klassifikation internet- und mobilbasierter psychologischer Versorgungsprogramme hat gezeigt, dass die verschiedenen Subkategorien unterschiedlich stark untersucht und beforscht sind. Abbildung 1 stellt einen morphologischen Kasten dar, der aufzeigt, wie häufig die einzelnen Kategorien in der Literatur thematisiert werden. Stark untersuchte Themenfelder sind grün unterlegt, häufig thematisierte gelb und solche mit einer schwachen Durchdringung rot.

Tabelle 8. Durchdringung der Kategorien in der Literatur

Kategorien	*Subkategorien*			
Ausmaß menschlicher Beteiligung	Kombiniert mit konventioneller Therapie	Begleitet	Unbegleitet	
Phase innerhalb der gesundheitlichen Versorgungskette	Präventiv	Therapeutisch	Rückfall-prävention	
Spezifität	Krankheits-spezifisch	Krankheits-unspezifisch		
Technische Umsetzung	Programme innerhalb einer Webseite	App-Anwendung	E-Mail-, chat-, videobasiert	
Kommunikations-form	Synchron	Asynchron		
Therapieverfahren	Kognitive Verhaltens-therapie	Interpersonelle Psychotherapie	Psycho-edukation	Psychody-namische Therapie
Nonverbale Signale	Keine Einbindung	Einbindung		

selten thematisiert (weniger als 6 aus 26 analysierten Beiträgen)
häufig thematisiert (zwischen 6 und 10 aus 26 analysierten Beiträgen)
sehr stark thematisiert (mehr als 10 aus 26 analysierten Beiträgen)

Begleitete und unbegleitete therapeutische Lösungen, die auf ein bestimmtes Krankheitsbild zugeschnitten sind, asynchrone Kommunikation mit einem Therapeuten beinhalten, auf kognitiv-verhaltenstherapeutische Verfahren beruhen und keine nonverbalen Signale auswerten, werden am meisten in der Literatur thematisiert. Systeme, die präventive Ziele verfolgen oder der Rückfallprävention dienen, sind bisher hingegen sehr wenig untersucht worden. Auch werden alternative Therapieverfahren neben der kognitiven Verhaltenstherapie wenig diskutiert.

4 Chancen und Grenzen

Die im vorigen Kapitel klassifizierten Lösungsansätze versprechen diverse Vorteile, die im Folgenden dargelegt werden sollen. Zum einen können Wartezeiten bis zum Beginn einer Therapie und auch solche zwischen einem Krankenhausaufenthalt und ambulanter Therapie verringert werden, da onlinebasierte Systeme ständig zur Verfügung stehen [18]. Je nach Ausmaß menschlicher Beteiligung (Kategorie 1) entstehen keine oder nur wenige Verzögerungen, da die Verfügbarkeit von medizinischem Personal weniger kritisch ist als bei einer herkömmlichen Therapie [9]. Da sich Therapeut und Patient zum gegenseitigen Austausch nicht an demselben Ort befinden müssen, können Reisekosten und –zeiten reduziert werden [18]. Dies gilt sowohl für synchrone als auch für asynchrone Kommunikationsformen (Kategorie 5). Speziell in strukturschwachen Regionen mit niedriger Versorgung oder bei Mobilitätseinschränkungen wird der Vorteil der Zeit- und Ortsunabhängigkeit internetbasierter Interventionen deutlich [2]. Anlässlich der hohen Flexibilität und des leichten Zugangs kann die Reichweite psychotherapeutischer Maßnahmen deutlich gesteigert werden [7]. Zum anderen versprechen internettherapeutische Lösungen aufgrund des hohen Selbstmanagement-Anteils große Potenziale, erlernte Fähigkeiten praxisnah und effektiv in das alltägliche Leben zu integrieren [12]. Sie verursachen weniger Kosten als eine herkömmliche Psychotherapie mit je einem Therapeuten pro Erkrankter, da die Kontaktzeiten deutlich kürzer sind [4]. Zeitintensive Routineaspekte wie Vermittlung von Störungswissen oder Anleitung zur Selbstkonfrontation können je nach technischer Umsetzung mithilfe von Webseiten, Apps, Videos oder Chats (Kategorie 4) an internetbasierte Konzepte delegiert werden [6]. Aufgrund der ausgeprägten Anonymität verfügen internetbasierte Plattformen aus Patientensicht über eine niedrigere Hemmschwelle, professionelle Hilfe in Anspruch zu nehmen und Therapieangebote wahrzunehmen [4].

Die Akzeptanz neuer, internetbasierter Plattformen unterscheidet sich je nach Krankheitsbild [24] und wird seitens der Patienten als moderat bis niedrig eingeschätzt. Allerdings ist eine Erhöhung durch kurze akzeptanzfördernde Maßnahmen möglich [2]. Auch die Ärzte und Therapeuten stehen den neuen Technologien und Therapiemöglichkeiten größtenteils skeptisch gegenüber [22] und befürchten eine Bedrohung der eigenen persönlichen Arbeit [16]. Die Offenheit für onlinebasierte Unterstützung unterscheidet sich bei den Therapeuten je nach therapeutischer Ausrichtung (Kategorie 6) und Erfahrungen im Bereich der Internettherapie. So sind

Therapeuten der kognitiven Verhaltenstherapie offener gegenüber internetbasierter Unterstützung als ihre Kollegen anderer Fachrichtungen oder mit weniger bzw. keiner Erfahrung in internetgestützter Therapie [24]. Des Weiteren existieren zurzeit keine ausgereiften Möglichkeiten, auf Notfälle und Suizidalität adäquat zu reagieren und zuverlässige, empirische Kontraindikatoren internetbasierter Interventionen zu erkennen [6]. Eine exakte Einschätzung des Krankheitsbildes und der Suizidgefahr über das Internet sind gesetzlich und ethisch problematisch [24] und internetbasierte Systeme blenden das nonverbale Verhalten des Patienten größtenteils aus (Kategorie 7) [30]. Es ist fraglich, ob Selbstdiagnosen über internetbasierte Systeme strukturierte, diagnostische Interviews und die anschließende fachliche Auswertung eines Therapeuten in gleicher Qualität ersetzen können [16].

5 Diskussion

In einer herkömmlichen Therapie erfährt der Patient direkte, zeitliche und physische Nähe zu seinem Therapeuten [22] und die dabei entstehende Beziehung zwischen Patient und Therapeut stellt einen der bisher bekannten Hauptwirkfaktoren einer Psychotherapie dar [6]. Daher steht die therapeutische Beziehung besonders im Mittelpunkt der Diskussion um internetbasierte therapeutische Programme. Bei ihnen fallen soziale und nonverbale Signale wie beispielsweise Körpersprache oder Augenkontakt weg oder finden nur wenig Beachtung, weshalb Experten bezüglich der online-Nutzung eine Verschlechterung der therapeutischen Beziehung hin zu einer unpersönlichen und instabilen Beziehung von nur geringer Intensität befürchten [10, 12]. Die Frage, ob über internetbasierte Therapieverfahren eine positive und tragfähige Beziehung aufgebaut werden kann und ob diese einen vergleichbaren Einfluss auf die Wirksamkeit wie in einer traditionellen Therapie erlangen kann, ist noch weitgehend ungeklärt [2]. Vereinzelt weisen erste Studien darauf hin, dass auch über das Internet eine therapeutische Beziehung aufgebaut werden kann und dem Faktor Mensch ebenfalls eine wichtige Rolle zukommt [2]. So konnten randomisiert-kontrollierte Erhebungen eine positive Einschätzung der medienvermittelten therapeutischen Beziehung nachweisen [23, 33]. Da die Verbreitung von Telemedizin und anderen virtuellen Interventionen das nonverbale menschliche Verhalten zunehmend ausblenden, sollte weitergehend erforscht werden, inwieweit selbstlernende Systeme, die nonverbales Verhalten integrieren, Vorteile für die psychische Gesundheit und das emotionale Wohlbefinden mit sich bringen können [30].

Bislang konnte zwar nachgewiesen werden, dass nicht alle Patienten gleichermaßen von internetbasierten Therapien profitieren, allerdings ist weitgehend ungeklärt, für welche Patientengruppen sie am besten wirken [16, 17]. Daher sind Nachfolgestudien von Interesse, die untersuchen, welche Patienten mit welchen Eigenschaften mehr oder weniger Nutzen aus internetbasierten Therapieangeboten ziehen können [18]. Es wäre denkbar, Wirksamkeitsstudien entlang der sieben in diesem Beitrag entwickelten Hauptkriterien zu strukturieren, um in einem zweiten Schritt die Kategorien um ihre jeweilige Wirksamkeit zu erweitern. Auch der Mechanismus der erzielten psychologischen Effekte sowie die Faktoren, die die Ergebnisse von onlinebasierten

Behandlungsmethoden beeinflussen, sind weitgehend unbekannt [17]. Insbesondere die Frage nach den Elementen, die die Compliance der Patienten verbessern können, ist offen. Ein Faktor könnte das Ausmaß der professionellen Begleitung darstellen (Kategorie 1), wobei tiefergehende Untersuchungen in Bezug auf Wirksamkeit und Kosteneffektivität der optimalen Menge an Anleitung im zeitlichen Verlauf der Erkrankung fehlen [21].

6 Zusammenfassung

Laut aktueller, einschlägiger Literatur besteht Bedarf, psychisch Erkrankten neben dem herkömmlichen Weg einer klassischen Psychotherapie weitere Therapiewege anzubieten. Um einen langfristigen Therapieerfolg mit Gesundheit und Zufriedenheit zu erzielen, ist es entscheidend, die Behandlung frühzeitig zu beginnen. Die vorherrschenden mangelnden Kapazitäten und Verfügbarkeiten an Therapeuten führen zu langen Wartezeiten und verzögertem Therapiebeginn. Digitale Techniken können zur Optimierung psychischer Gesundheit und emotionalem Wohlergehen beitragen. Sie ermöglichen, Behandlungswege zu standardisieren und auch diejenigen Patienten anzusprechen, die einer herkömmlichen Therapie gegenüber abgeneigt sind. Zahlreiche Wirksamkeitsstudien belegen das große Potenzial von internetbasierten Therapiekonzepten. Vor allem die Orts- und Zeitunabhängigkeit und die damit verbundene ständige Verfügbarkeit sowie die Einsparung von Wartezeiten und Kosten lassen auf diverse Vorteile schließen. Demgegenüber steht die Limitation, dass digitale Techniken nicht in der Lage sind, eine derart vertrauensvolle, zwischenmenschliche Atmosphäre und Bindung herzustellen, wie es zwischen Patient und Therapeut in persönlichen Therapiesitzungen möglich ist.
Es bestehen diverse Systeme, wobei die Literaturanalyse dieses Beitrages ergab, dass sich internet- und mobilbasierte psychologische Versorgungsprogramme nach den sieben Hauptkriterien (1) Ausmaß menschlicher Beteiligung, (2) Phase innerhalb der gesundheitlichen Versorgungskette, (3) Spezifität, (4) technische Umsetzung, (5) Kommunikationsform, (6) Therapieverfahren und (7) nonverbale Signale klassifizieren lassen.

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Gestaltungsraum für proaktive Smart Homes zur Gesundheitsförderung

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Abstract. Smart Homes sammeln eine Fülle von Daten über ihre Bewohner. Gut genutzt werden diese allerdings nicht. Smart Homes sind im Wesentlichen reaktiv. Im Hinblick auf die Gesundheitsversorgung ist der Wandel zu proaktiven Smart Homes vielversprechend. Um proaktive Smart Homes Wirklichkeit werden zu lassen, sollte zunächst ein vollständiges Bild dieser komplexen und ressourcenreichen Umgebung gezeichnet werden. Das Ziel dieser Arbeit ist es, einen Gestaltungsraum für proaktive Smart Homes aufzuspannen. Ausgehend von den neun Elementen des Work System (WS) Rahmenwerks, werden Bausteine eines proaktiven Smart Homes identifiziert, beschrieben und analysiert sowie Gestaltungsfragen daraus abgeleitet, die bei einer Instanziierung eines proaktiven Smart Homes beantwortet werden müssen. Diese Arbeit bereitet einen fruchtbaren Nährboden für die zukünftige Gestaltung IT-gestützter proaktiver Lebenswelten, in denen die Gesundheit durch den Einsatz verschiedenster Systemressourcen proaktiv gefördert wird.

Keywords: Gestaltungsfragen, Gestaltungsraum, Gesundheitsförderung, Proaktive Smart Homes.

1 Einleitung

Der Anteil der älteren Menschen an der Gesamtbevölkerung steigt an; diese Entwicklung ist auf eine alternde Bevölkerung, rückläufige Geburtenraten und eine zunehmende Lebenserwartung zurückzuführen [1]. Mit zunehmendem Alter steigt die

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Prävalenz von chronischen Erkrankungen [4, 5]. Zudem sind ältere Menschen vermehrt multimorbide und haben aufgrund altersbedingter Funktionsdefizite teilweise höhere Erkrankungsrisiken [4, 6]. Aufgrund von physischen, mentalen und psychosozialen Herausforderungen können ältere Menschen in ihrer Aktionsfähigkeit eingeschränkt sein. Das kann zur Folge haben, dass sie dann evtl. alltägliche Aktivitäten, z. B. in ihrem Haushalt, nicht mehr selbstständig ausüben können [1, 4, 7]. Daraus resultieren komplexe Bedürfnisse, die dazu führen, dass ältere Menschen medizinische Dienstleistungen nachfragen, die durch verschiedenes medizinisches Fachpersonal in unterschiedlichen Gesundheitseinrichtungen erbracht werden [1, 6–8]. Die Erbringung dieser Dienstleistungen ist mit Belastungen und Kosten für unser Gesundheitssystem verbunden [1], insbesondere chronische Erkrankungen tragen zu einem Anstieg der Gesundheitskosten bei [9]. Darüber hinaus fordert die Pflege älterer Patienten auch informelle Helfer (Familienangehörige, Freunde und Nachbarn) [1, 4].

Parallel zu den sozioökonomischen und demografischen Herausforderungen läuft die Entwicklung von Informations- und Kommunikationstechnologien (IuK) [10]. Die Digitalisierung der häuslichen Umgebung skizziert die Entstehung der sogenannten Smart Homes [11–14]. Damit bergen Smart Homes das Potential eine weitere Einrichtung des Gesundheitswesens zu werden. Diese Entwicklung ist von besonderer Bedeutung für ältere Menschen, da ihr Zuhause nun Teil eines Gesundheitsinformationssystems werden kann [15]. Vorausgesetzt, dass dieses Potential genutzt wird, kann dazu beigetragen werden, dass ältere Menschen in ihrem eigenen Zuhause unabhängig und selbstständig leben können sowie die informelle Helfer entlastet werden [16].

Allerdings sind Smart Homes häufig im Wesentlichen reaktiv. In einem Wandel zu proaktiven Smart Homes sehen wir ein klares Potential, die Gesundheitsversorgung weiter zu verbessern. Bei proaktiven Smart Homes ist die Interaktion zwischen Smart Home und Bewohner proaktiv. Proaktive Interaktion bedeutet, dass das Smart Home, sofern gewünscht, die Initiative ergreift, um die aktuell gegebenen Bedingungen zu verbessern oder neue Bedingungen zu schaffen. In proaktiven Smart Homes suchen die Interaktionspartner nach Informationen und Möglichkeiten, um Dinge zu verbessern. Im Gegensatz zu Interaktionspartnern in reaktiven Smart Homes, warten sie nicht darauf, dass Informationen und Möglichkeiten zu ihnen kommen [17].

Die Herausforderungen für die Realisierung von proaktiven Smart Homes wurden bereits in der Literatur diskutiert (siehe [15]). In dieser Arbeit wird das Gestaltungswissen für die Realisierung von proaktiven Smart Homes vertieft. Konkret besteht das Ziel dieser Arbeit darin, drei grundlegende Entwicklungen für proaktive Smart Homes (Assistierende Gesundheitstechnologien in sensorerweiterten Informationssystemen, Active Learning und nutzerorientierte Informationssystemgestaltung) kurz einzuführen und, aufbauend auf den neun Elementen des Work System (WS) Rahmenwerks [18], eine Übersicht über die Komponenten von proaktiven Smart Homes sowie deren Zusammenspiel zu schaffen. Damit stellt diese Arbeit einen ersten Schritt auf dem langen Weg der Realisierung von proaktiven Smart Homes zur Gesundheitsförderung dar [19]. Mit dieser Arbeit schaffen wir einen fruchtbaren Nährboden für die zukünftige Gestaltung IT-gestützter proaktiver

Lebenswelten, in denen die Gesundheit von Personen durch den Einsatz verschiedenster Systemressourcen proaktiv gefördert wird.

2 Grundlagen

2.1 Assistierende Gesundheitstechnologien in sensorerweiterten Informationssystemen des Gesundheitswesens

Assistierende Gesundheitstechnologien (AGT) sind IuK mit dem Ziel der Schaffung von nachhaltigen Bedingungen für ein aktives, selbstständiges und selbst gestaltetes Leben [12, 14]. Mittels Sensoren können durch AGT-Systeme gesundheitsrelevante Werte gemessen und dann analysiert werden [20, 21]. Solche Sensoren können körperbezogen am Körper (bspw. in Form einer Pulsuhr, eines Beschleunigungssensors oder eines Mobiltelefons) oder im Körper (bspw. in einem Herzschrittmacher oder in einer Kniegelenksprothese) oder raumbezogen in der Wohnung einer Person oder im persönlichen Umfeld (z. B. im Auto, in der Arbeitsstelle, während eines Einkaufs) Daten aufnehmen, analysieren und ggf. weiterleiten. Gemessen wird eine Vielzahl von Signalen. Hierzu zählen elektrische Signale (z. B. des Herzens, EKG, Herzfrequenz) oder Druck- oder Temperatursignale (z. B. Körpertemperatur), akustische oder optische Signale. In besonderer Weise können über Sensoren Aktivitäten gemessen werden. Neben bekannten Sensoren wie Bewegungsmeldern, Türkontakten und Erschütterungssensoren (die bspw. das Öffnen von Schubladen erkennen können) spielen Sensoren zur Messung von Beschleunigung (Accelerometer) und zur Lokalisation des Ortes (z.

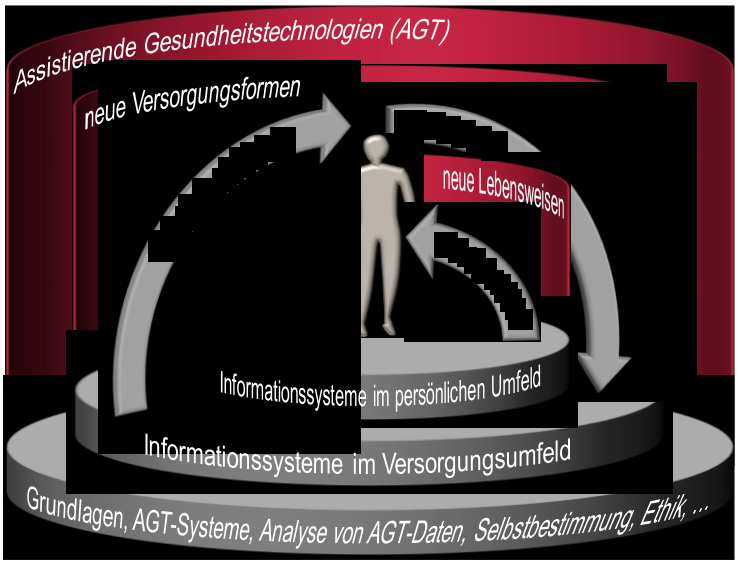


Abbildung 1. Doppelkreislauf zu assistierenden Gesundheitstechnologien (Grafik entnommen aus der Vorlesung assistierende Gesundheitstechnologien an der TU Braunschweig, vgl. auch [2, 3]).

B. über GPS) eine immer größere Rolle bei der Bestimmung von Aktivitäten. Nicht zuletzt sollen noch Stromsensoren genannt werden, die neben dem Stromverbrauch (Smart Metering) ebenfalls zur Identifikation von Verhaltensmustern genutzt werden können [12, 22].

Solche assistierenden Gesundheitstechnologien können als Komponenten für neue Lebensweisen gesehen werden, die auch und insbesondere in Smart Homes eingesetzt werden. Sie können zudem Teil neuer Versorgungsformen sein, um dann insbesondere bei der ambulanten Versorgung zusätzliche Daten in den so entstandenen sensorerweiterten Informationssystemen des Gesundheitswesens [23] liefern zu können [24, 25]. Der dargestellte Doppelkreislauf visualisiert diese duale Nutzung [2, 3] (Abbildung 1).

2.2 Active Learning

Active Learning ist ein Teilgebiet des Machine Learnings [26]. Ein Lernalgorithmus ist in der Lage, aus Trainingsbeispielen eine Gesetzmäßigkeit zu erkennen. Trainingsbeispiele bestehen aus einem Muster (Transaktion) und einem Zielwert (Klasse). Ein aktiver Lernmechanismus hat die Möglichkeit, für einen Teil der Muster die korrekten Zielwerte (Labels) zu erfragen. Dabei ist die Grundidee, dass der Algorithmus die Muster bestimmt, welche einen hohen Informationsgewinn versprechen, um die Anzahl der Anfragen an das Orakel[1] (beziehungsweise den Experten) möglichst klein zu halten. Ziel ist es also, mit Hilfe von gelabelten (kodierten) Mustern automatisiert Modelle zu erlernen. Dabei müssen nicht alle Muster auf einmal ausgewählt werden. Vielmehr kann man den Lernprozess in einzelne Iterationen aufspalten, wobei in jeder Lerniteration ein neues Muster aufgrund der in den vorherigen Iterationen gelabelten Muster ausgewählt wird. Dieser Prozess der Einflussnahme auf die Selektion von neuen Mustern unterscheidet das Active Learning von anderen Machine Learning Verfahren. Die Grundidee besteht darin, durch eine gezielte Auswahl von Mustern, möglichst viele neue Information für ein Klassifikationsmodell zu erhalten. Dadurch soll der gewünschte maximale Generalisierungsfehler[2] mit möglichst wenigen Mustern unterschritten werden. Der Aufbau der Selektionsfunktion, welche die Muster wählt, ist dabei maßgebend für die Güte. Diese Selektionsfunktion ist für die gezielte Auswahl von Mustern zuständig. Anders als beim passiven Lernen wird in jeder Lerniteration ein Muster durch die Selektionsfunktion ausgewählt, dann durch das Orakel gelabelt, zur aktuellen Menge der gelabelten Muster hinzugefügt und abschließend der Lernalgorithmus neu trainiert. Jedes neue Label modifiziert das bestehende Modell, und beeinflusst wiederum die Selektionsfunktion [27]. Übertragen auf den Kontext proaktiver Smart Homes bedeutet dies, dass das Active Learning darin unterstützen kann häusliche Umgebungen zu

[1] Das Orakel ist dabei der Mensch oder eine andere Informationsquelle von der das wahre Label (Zielwert) – unter Einsatz von Ressourcen – erhalten werden kann.

[2] In dieser Arbeit wird der Begriff Generalisierung als Fähigkeit des Lernalgorithmus, auf bislang ungesehenen Testdaten eine gute Performanz zu erreichen, aufgefasst.

realisieren, die auf die Bedürfnisse und Wünsche älterer, evtl. multimorbider Bewohner individuell eingehen können [28].

2.3 Nutzerorientierte Informationssystemgestaltung

Proaktive Smart Homes bringen IuK in das private Lebensumfeld ihrer Bewohner. Dementsprechend kommt der Berücksichtigung von Nutzerbedürfnissen eine zentrale Rolle zu. Dies geht weit über funktionale Anforderungen der Bewohner heraus. Ein besonderes Augenmerk ist auf Fragen der Benutzerfreundlichkeit [29] aber auch des Datenschutzes zu legen [30]. Proaktive Smart Homes können erst dann ihr volles Potential entfalten, wenn ihre Bewohner in die IuK vertrauen, nicht von unadressierten Informationssicherheitsrisiken abgeschreckt werden, ermächtigt sind die Informationsverarbeitung so zu steuern, dass sie ihren Erwartungen entspricht und wenn die Bewohner auch das Potential, das ihnen ein proaktives Smart Homes bietet, erkennen, verstehen und zielführend nutzen können. IuK für die Gesundheitsversorgung ist in komplexe Netzwerke eingebettet [31]; hier gilt es die Komplexität schon in der Gestaltungsphase zu berücksichtigen, sodass das vielsprechende Potential von proaktiven Smart Homes auch genutzt werden kann. Bei IuK für die Gesundheitsversorgungen weichen Nutzererwartungen oftmals von dem ab, was medizinisches Fachpersonal, Entwickler oder die Betreiber von IuK als sinnvoll erachten würden [32]. Diese Konflikte gilt es früh zu identifizieren und zu adressieren. Proaktive Smart Homes können die Anforderungen von medizinischem Fachpersonal sowie IuK-Betreibern und Entwicklern nicht vernachlässigen, aber im Endeffekt sind es die Bewohner, die mit proaktiven Smart Homes zufrieden sein müssen, damit diese auch genutzt werden.

3 Vorgehensweise

In dieser Arbeit werden proaktive Smart Homes aus der Perspektive der WS Theorie betrachtet [18]. Die WS Theorie bietet eine Perspektive, um Systeme in Organisationen, ob diese Systeme IT nutzen oder nicht, zu verstehen [18]. Damit findet diese Theorie im Kontext von Organisationen Anwendung. Dabei beschreibt die organisationale Sicht die Systemkomponenten und seine Beziehungen [33]. Unter dem Begriff WS verstehen wir ein System, in dem Menschen und Maschinen Arbeit verrichten (Prozesse und Aktivitäten), um Dienstleistungen für interne Kunden (hier: Bewohner) zu produzieren [18]. Unter dem Begriff Arbeit wiederum verstehen wir den Einsatz von Informationen, Technologien und anderen Ressourcen, mit dem Ziel Dienstleistungen zu erbringen [18]. Damit vermitteln die Ausführungen zu WS eine Denkweise über Systeme innerhalb von Organisationen und über deren Grenzen hinweg [18]. Wir definieren proaktive Smart Homes zur Gesundheitsförderung als eine Einrichtung bzw. Organisation innerhalb unseres Gesundheitssystems, denn immer mehr Arbeiten werden aus den traditionellen Gesundheitseinrichtungen in die häusliche Umgebung ausgelagert. Dies impliziert, dass das grundlegende Verständnis eines WS, wie es durch den WS Rahmenwerk vermittelt wird, auf proaktive Smart Homes anwendbar ist,

obgleich proaktive Smart Homes ihr eigenes Vokabular haben. Bei proaktiven Smart Homes handelt es sich um komplexe Umgebungen, in denen verschiedenste Systemressourcen eingesetzt werden, bspw. Akteure, Informationen und Technologien, mit dem Ziel Gesundheitsdienstleistungen für die Bewohner (interne Kunden) zu erbringen. Im Rahmen dieser Arbeit identifizieren und charakterisieren wir die Bausteine eines proaktiven Smart Homes auf Basis der neun Elemente des WS Rahmenwerks.

Ein WS erbringt Dienstleistungen für seine Kunden (hier: die älteren Bewohner des proaktiven Smart Homes) [18, 34]. Die Komponenten eines WS gliedern sich in drei Kategorien: (1) Akteure, Informationen, Technologien, Prozesse und Aktivitäten, (2) Kunden und Dienstleistungen sowie (3) Umwelt, Infrastrukturen und Strategien. Die Elemente aus der ersten Kategorie befinden sich innerhalb des WS (siehe die graue Schattierung in Abbildung 2). Akteure, Informationen und Technologien werden als Ressourcen betrachtet [35] und kommen als solche in Prozessen und Aktivitäten[3] zum Einsatz. Prozesse wiederum dienen dazu Dienstleistungen für die Kunden des WS zu erbringen. Die Elemente aus der zweiten Kategorie können sich teils inner- und teils außerhalb des WS befinden, bspw. kann ein Kunde in die Prozesse zur Erbringung einer Dienstleistung involviert sein. Die Elemente aus der dritten Kategorie befinden sich außerhalb des WS. Umwelt, Infrastrukturen und Strategien beeinflussen als Systemumgebung das WS direkt [18].

[3] Im weiteren Verlauf wird nur noch von Prozessen gesprochen [18].

Innerhalb des WS Rahmenwerks müssen verschiedene Elemente aneinander angeglichen werden (siehe die Pfeile in Abbildung 2). Innerhalb eines WS muss eine Angleichung von Akteuren und Prozessen, Informationen und Prozessen sowie Technologien und Prozessen vorgenommen werden. Eine Abstimmung zwischen Akteuren und Informationen, Informationen und Technologien sowie Akteuren und Technologien ist nicht Bestandteil des WS Rahmenwerks und wurde in dieser Arbeit ergänzt [18].

Die Basis für den Gestaltungsraum von proaktiven Smart Homes ist die Identifikation, Beschreibung und Analyse der Bausteine eines proaktiven Smart Homes. In einem ersten Schritt werden die neun Elemente auf ein proaktives Smart Home im Kontext des deutschen Gesundheitssystems angewandt. Aufbauend auf den Bausteinen eines proaktiven Smart Homes leiten wir sieben Gestaltungsfragen ab.

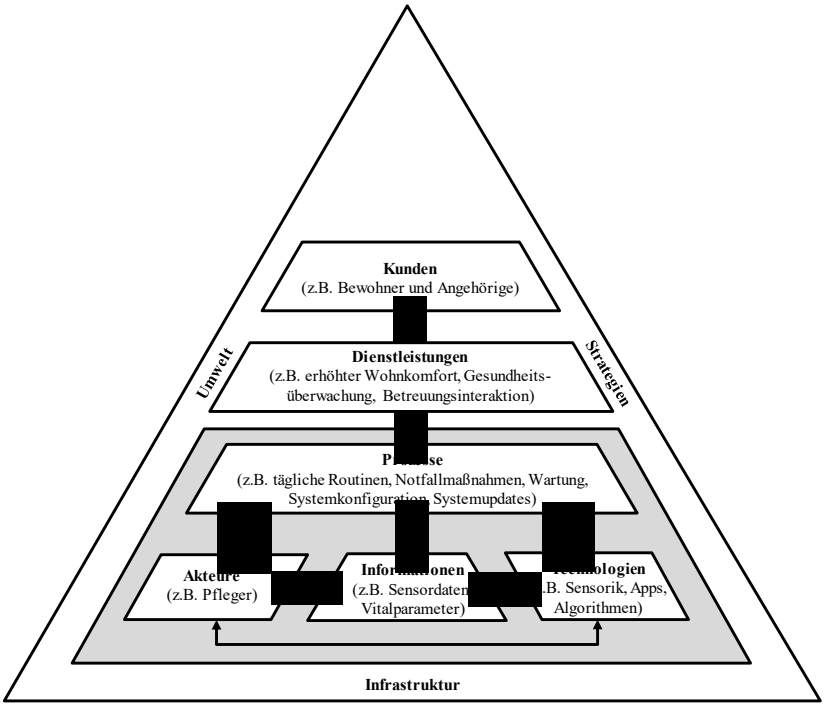


Abbildung 2. Gestaltungsraum für ein proaktives Smart Home (eigene Darstellung, in Anlehnung Alter [18]). Diese Abbildung zeigt die Bausteine eines proaktiven Smart Homes. Das Zusammenspiel dieser Bausteine wird durch Pfeile dargestellt. Die Bausteine innerhalb des proaktiven Smart Homes sind grau schattiert.

4 Gestaltungsfragen für Proaktive Smart Homes

4.1 Akteure, Informationen und Technologien

Akteure verrichten Arbeit innerhalb des proaktiven Smart Homes [18]. Der Begriff Akteur schließt sowohl diejenigen ein, die IuK verwenden, als auch diejenigen, die keine IuK verwenden [18]. Übertragen auf den Kontext von proaktiven Smart Homes bedeutet dies, dass ein breites Spektrum unterschiedlicher Akteure abgedeckt werden muss. Grob gliedern sich die Akteure in die Gruppen Leistungsempfänger, Leistungsträger (oder -erbringer) und Kostenträger [36]. Zwischen diesen Akteuren finden Informations- und Kommunikationsflüsse statt [37]. Information ist eine Ressource [35], die in den Prozessen und Aktivitäten eines proaktiven Smart Homes erzeugt und verwendet wird [18].[4] Es wird unterschieden in technologiegestützte Informationen, die von einer Technologie, wie bspw. einem Computer, erfasst und verarbeitet werden und in nicht technologiegestützte Informationen, wie bspw. Gespräche zwischen Akteuren, die nicht aufgezeichnet wurden [18]. Mobile Endgeräten oder Wearables erfassen und übertragen verschiedene Informationstypen. Zu diesen Informationstypen zählen bspw. Vitalparameter (z. B. die Pulsfrequenz) und das Gewicht [38]. Informationstypen hängen von anderen Bausteinen ab, bspw. den Potentialen einer eingesetzten Technologie. Eine Technologie ist eine Ressource [35], die sich in die Kategorien Geräte und automatisierte Agenten aufteilt. Geräte können von Akteuren (insb. in der Rolle eines IuK-Nutzers) verwendet werden (z. B. ein mobiles Endgerät oder ein Wearable). Bei automatisierten Agenten handelt es sich um Hardware-/ Softwarekonfigurationen, deren Aufgabe darin besteht vollautomatisierte Aktivitäten auszuüben [18]. Im Hinblick auf Akteure, Informationen und Technologien, müssen für proaktive Smart Homes die folgenden Gestaltungsfragen (GF) geklärt werden: *Welche Akteure sind in die Prozesse involviert? Welche Informationen werden in den Prozessen wozu verwendet? Welche Technologien werden in den Prozessen von wem eingesetzt?*

4.2 Prozesse

Prozesse innerhalb eines proaktiven Smart Homes zielen darauf ab, Gesundheitsdienstleistungen für ältere Bewohner bereit zu stellen [18]. In diesen Prozessen spielen sowohl die IuK als auch der Mensch eine wichtige Rolle [39]. Daher setzen sich Prozesse aus den folgenden Interaktionen zusammen: (1) Mensch-Mensch-Interaktion, (2) Mensch-Maschine-Interaktion und (3) Maschine-Maschine-Interaktion. In dieser Arbeit bezieht sich der Begriff Smart Home auf mit Sensorik ausgestattete Lebenswelten (bspw. Wohnungen oder Betreuungseinrichtungen), in denen Informationen über seine Bewohner gesammelt und aggregiert werden. Übertragen auf den Kontext Gesundheit bedeutet dies, dass einerseits Informationen, z. B. zur Beobachtung von Schlafphasen, Bewegungsabläufen, Ernährungsverhalten

[4] Eine Unterscheidung in Daten und Informationen ist für ein grundlegendes Verständnis eines WS bzw. eines proaktiven Smart Homes nicht erforderlich [18].

sowie sozialer Interaktion gesammelt und aggregiert werden, um so Muster in der tagtäglichen Routine der Bewohner identifizieren zu können, bspw. Aufstehen / zu Bett gehen und, dass andererseits durch Beobachtung verschiedenste Vitalparameter erhoben werden, bspw. Herzfrequenz, Atemfrequenz, Puls oder das Gewicht. Unter der Prämisse, dass die etablierten Muster mit den erhobenen Vitalparametern korrelieren, wird nach Veränderungen in der tagtäglichen Routine (bspw. ein vermehrtes Aufsuchen der Toilette in der Nacht) gesucht, sodass bspw. eine Infektion frühzeitig erkannt werden kann [16]. Die Prozesse eines proaktiven Smart Homes involvieren die oben präsentierten Akteure sowie deren Interaktion und Kommunikation [37]. Die daraus abgeleitete GF lautet: *Welche Prozesse finden innerhalb eines proaktiven Smart Home statt?*

4.3 Gesundheitsdienstleistungen

In dieser Arbeit wird unter dem Begriff Gesundheitsdienstleistung eine Handlung verstanden, die für jemand anderen erbracht wird, einschließlich der Bereitstellung von Ressourcen, die jemand anderes nutzen wird [35, 40]. In einem proaktiven Smart Home ist die Erbringung einer Bandbreite unterschiedlicher Gesundheitsdienstleistungen denkbar, bspw. zur Förderung von Gesundheit oder Steigerung der Fitness. Die Auswirkung einer Gesundheitsdienstleistung wird durch verschiedene andere Bausteine determiniert, bspw. durch die eingesetzte Technologie. Im Umkehrschluss bedeutet dies, dass nicht erwartet werden kann, dass der Einsatz ganz unterschiedlicher Technologien zu den gleichen Auswirkungen führt. Beispiele für Auswirkungen sind Hinweise, die zu einer frühzeitigeren Diagnose einer Erkrankung führen können oder ein verbesserter Informationsfluss verbunden mit weniger Behandlungstagen in einer stationären Versorgungseinrichtung [41]. Die daraus abgeleitete GF lautet: *Welche Gesundheitsdienstleistungen werden in einem proaktiven Smart Home erbracht?*

4.4 Kunden

Im Kontext von proaktiven Smart Homes sind die Bewohner die Empfänger der Gesundheitsdienstleistungen [18]. Als eine Besonderheit sind in einem proaktiven Smart Home die Empfänger von Gesundheitsdienstleistung selber als Akteure in die Erbringungsprozesse involviert (sogenannte Ko-Produktion) [18]. Kunden sind in proaktiven Smart Homes nicht einfach als die Empfänger einer Dienstleistung zu sehen [42]. Eine solche Sichtweise würde unberücksichtigt lassen, dass es sognannte zahlende Kunden gibt, bspw. eine Krankenkasse, die die Kosten für eine Gesundheitsdienstleitung übernimmt, oder Akteure, die die Entscheidungen der Bewohner beeinflussen oder gar mittragen können, wie z. B. ihre Angehörigen [42]. Letztere können einen Nutzen von der erbrachten Gesundheitsdienstleistung haben. Angehörige profitieren bspw. davon, dass die Bewohner fit, gesund und selbstständig bleiben [42]. Die daraus abgeleitete GF lautet: *Wer sind die Kunden und Nutznießer einer Gesundheitsdienstleistung?*

4.5 Umwelt, Infrastruktur und Strategien

Umwelt, Infrastruktur und Strategien befinden sich außerhalb des proaktiven Smart Homes und beeinflussen es unmittelbar [18]. Ein proaktives Smart Home zur Gesundheitsförderung kann nicht erfolgreich entwickelt werden, ohne dass das bereits existierende traditionelle Gesundheitssystem berücksichtigt wird. Dazu müssen das proaktive Smart Home und seine Systemumgebung koordiniert und integriert werden [43]. Ein Beispielszenario wäre, dass bei Veränderungen in den tagtäglichen Routinen der Bewohner eine Pflegekraft oder ein Angehöriger per E-Mail informiert wird und mit dem Bewohner Kontakt aufnimmt, um bspw. in einem Notfall zu intervenieren. Im Rahmen dieser Arbeit wird von der Systemumgebung abstrahiert. Die daraus abgeleitete GF lautet: *In welchen Kontext muss das proaktive Smart Home eingebettet werden?*

5 Diskussion und Limitationen

Aufbauend auf dem WS Rahmenwerks [18], stellt diese Arbeit einen ersten Schritt dar einen Gestaltungsraum für ein proaktives Smart Home zu entwerfen sowie erste GF zu formulieren, die – vor dem Hintergrund der mit proaktiven Smart Homes verbundenen Herausforderungen [15] – die Realisierung proaktiver Smart Homes zur Gesundheitsförderung unterstützen sollen. Zum einen erhoffen wir uns mit dieser Arbeit einen fruchtbaren Nährboden für Diskussionen anzustoßen und zum anderen empfehlen wir der zukünftigen Forschung mithilfe des WS Metamodells [18], eine detailliertere Skizze eines proaktiven Smart Homes anzufertigen. Proaktive Smart Homes sind eine Entwicklung, die bisher vor allem technologiegetrieben war. Proaktive Smart Homes sind vielversprechend zur Förderung der Gesundheitsversorgung, aber auch soziotechnische Systeme, die nicht einfach umsetzbar sind. Insbesondere liegt die Herausforderung bei proaktiven Smart Homes darin die Daten und Algorithmen so einzusetzen, dass sie für Endnutzer nutzbar sind [44]. Im Rahmen dieser Arbeit haben wir die GF identifiziert, die für die Realisierung von proaktiven Smart Homes beantwortet werden müssen. Zentrale Komponenten von proaktiven Smart Homes sind die Bewohner, die Sensoren und die Datenverarbeitung. All das zu integrieren und daraus vielversprechende Gesundheitsdienstleistungen zu generieren ist eine Aufgabe, die nicht einfach zu lösen ist. Eine zielführende Gestaltung von Smart Homes für die Gesundheitsversorgung erfordert eine intensive Betrachtung des technologisch Machbaren sowie der Bedürfnisse und Wünsche der Bewohner [45]. Der Gestaltungsraum für die hier vorgestellten Smart Home Anwendungen sollte auch hinsichtlich tragfähiger Geschäftsmodelle untersucht werden [19]. Smart Homes bieten eine Fülle von Daten, die bislang nicht genutzt werden. Methoden des Active Learnings sind ein vielversprechender Ansatz, um Smart Homes so zu gestalten, dass nicht nur auf die Bedürfnisse der Nutzer reagiert wird, sondern IuK so gestaltet wird, dass proaktiv auf die Nutzerbedürfnisse eingegangen werden kann. Die GF, die dafür bedacht werden müssen, wurden im Rahmen dieser Arbeit abgeleitet. Somit liegt der Beitrag dieser Arbeit nicht nur darin aufzuzeigen, was prinzipiell machbar ist, sondern auch was bedacht werden muss, um proaktive Smart Homes zielführend zu gestalten.

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Auf dem Weg zum digitalen Krankenhaus: Eine empirische Analyse über die gemeinsame Wirkung von Intrapreneurship und Informationsmanagement

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Abstract. Das Informationsmanagement steht im Zentrum erfolgreicher eHealth-Innovationsprozesse von Krankenhäusern. Im Kontext komplexer, zum Teil tradierter Krankenhausstrukturen kann die Gestaltungsfähigkeit des Informationsmanagements durch eine ausgeprägte Intrapreneurship-Kultur erhöht werden, wovon vermutlich auch der Digitalisierungsgrad der Einrichtungen profitiert. Vor diesem Hintergrund verfolgte die vorliegende Studie zwei Forschungsfragen: (1.) Welche Effekte hat Intrapreneurship auf den Digitalisierungsgrad der Krankenhäuser und (2.) inwiefern werden diese Effekte durch das Informationsmanagement beeinflusst? Zur Beantwortung der Forschungsfragen wurde ein konzeptionelles Untersuchungsmodell entwickelt, welches mit Daten von 224 IT-Leitern evaluiert wurde. Die Ergebnisse bestätigen, dass Intrapreneurship die Umsetzung von eHealth-Anwendungen positiv beeinflussen kann. Die identifizierten Effekte waren jedoch vorwiegend indirekter Art, vermittelt durch den Professionalisierungsgrad des Informationsmanagements. So kann Intrapreneurship auf IT-Leiter-Ebene und auf Ebene der Gesamtorganisation zu einer Professionalisierung des strategischen Informationsmanagements führen. Auf Ebene der IT-Abteilung profitiert vor allem das operative Informationsmanagement von einer ausgeprägten Intrapreneurship-Kultur.

Keywords: Intrapreneurship, Informationsmanagement, Digitalisierungsgrad

1 Einleitung

Krankenhäuser befinden sich in einem zunehmenden Wettbewerb um die effizienteste Leistungserbringung, die höchste Versorgungsqualität und die ansprechendsten Serviceleistungen [1]. eHealth-Innovationen berühren aufgrund ihrer vielfältigen Vernetzungs-, Automatisierungs- und Datennutzungspotenziale die Kompetitivität der Einrichtungen in jedem dieser Wettbewerbsfelder [2]. Insbesondere im Rahmen des gesetzgeberisch intendierten Kostenwettbewerbs, der die Einrichtungen zu einem optimierten Kapazitätsmanagement und einer Verschlankung von Zentral- und Supportbereichen anhält, ermöglichen eHealth-Anwendungen die Identifikation und Nutzung vielfältiger Effizienzreserven [3]. Dies gilt sowohl für den administrativen

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Bereich, indem bspw. das digitale Fall-Handling die Erlössicherung vereinfacht, als auch für klinische Sekundärprozesse, indem u.a. die Befundanforderung und -rückmeldung automatisiert werden kann [4]. Noch größere Potenziale ergeben sich innerhalb des Qualitätswettbewerbs, der als harmonisierende Zielgröße zum Kostenwettbewerb eine sichere und hochwertige Patientenversorgung fokussiert [5]. Hier versprechen eHealth-Innovationen weitreichende Qualitätssprünge in Richtung einer fehlerfreien, kontinuierlichen und patientenzentrierten Versorgung [3-6]. So können einerseits Monitoring- und Trackingfunktionen frühzeitig unerwünschte Ereignisse im Behandlungsverlauf erkennen und anzeigen, andererseits erlauben mobile Endgeräte die ständige Verfügbarkeit evidenzbasierter Schlüsselinformationen zu Diagnosen, Medikation und Therapien am Point of Care [6].

Die Realisierung dieser und ähnlicher Wettbewerbsoptionen gehört zu den Kernaufgaben des Informationsmanagements (IM) [7]. Ausgehend von den einrichtungsspezifischen technischen und organisatorischen Vorbedingungen muss es hierfür kontinuierlich innovative eHealth-Anwendungen identifizieren, implementieren und in den Regelbetrieb der klinischen Praxis überführen [8]. Der dabei benötigte Gestaltungsraum wird in der Krankenhausrealität jedoch häufig von zwei gegenläufigen Handlungsimperativen begrenzt: Während das IM auf der einen Seite dem hohen Erwartungsdruck wissensintensiver Expertenorganisationen gerecht werden soll, sieht es sich auf der anderen Seite mit einer hohen berufsständischen Autonomie, tradierten Silohierarchien sowie diversen gesetzlichen und ökonomischen Herausforderungen konfrontiert [9].

Vor diesem Hintergrund verdichten sich die Hinweise, dass eine ausgeprägte Intrapreneurship-Kultur die Entscheidungs- und Handlungsfähigkeit des IM positiv determinieren kann [8-11]1. Obwohl sich hierdurch erste Hinweise auf wesentliche Begleitumstände der Krankenhausdigitalisierung ergeben, ist bis Dato unklar, inwiefern Intrapreneurship und IM gemeinsam die technische Verfügbarkeit von eHealth-Innovationen im Sinne des Digitalisierungsgrades determinieren. Vor diesem Hintergrund verfolgt die vorliegenden Studie zwei Forschungsfragen: (1.) Welche Effekte hat Intrapreneurship auf den Digitalisierungsgrad von Krankenhäusern und (2.) inwiefern werden diese Effekte durch die Ausprägung des IM beeinflusst? Mit der Beantwortung dieser Forschungsfragen knüpft die Studie an eine vorausgegangenen Arbeit von Liebe et al. (2017) an, in der eine positive Wechselwirkung zwischen IT-Governance, Intrapreneurship und dem Professionalisierungsgrad des IM nachgewiesen wurde [9]. Der hierbei gewonnene Erkenntnisstand soll in dreierlei Hinsicht erweitert werden: Zum einen soll das unter [9] vorgeschlagene Untersuchungsmodell mit dem Digitalisierungsgrad um eine dritte Betrachtungsebene ergänzt werden. Hierdurch können die Wechselwirkungen organisatorischer und technischer Aspekte im Verlauf von Innovationsprozessen näher spezifiziert werden. Zum anderen soll verstärkt eine reliable und valide Operationalisierung der betrachteten Konstrukte forciert und im Rahmen einer erneuten Krankenhaus-Befragung getestet

[1] Intrapreneurship beschreibt in diesem Zusammenhang, inwiefern Krankenhausmitglieder auf verschiedenen Organisationsebenen proaktiv den Einsatz innovativer eHealth-Technologien zur Optimierung der administrativen und klinischen Abläufe forcieren [9,10,12].

werden. Schließlich soll das Zusammenspiel zwischen Intrapreneurship und Informationsmanagement durch die Betrachtung indirekte Effekte berücksichtigt werden.

2 Konzeptionelle Entwicklung des Untersuchungsmodells

2.1 Digitalisierungsgrad

Der Digitalisierungsgrad einer Organisation lässt sich über den relativen Anteil an unternehmerischen Aufgaben und Prozessen definieren, die bereits informationstechnologisch ausgeführt bzw. unterstützt werden [13]. In Krankenhäusern beschreibt der Digitalisierungsgrad somit nicht alleine die technische Verfügbarkeit und den Einsatz einzelner eHealth-Technologien, sondern vielmehr die Summe und die flächendeckende Umsetzung von Applikationen, die zur Unterstützung der mitunter stark unterschiedlichen klinischen Aufgaben und Abläufe zum Einsatz kommen. Dieses Verständnis entspricht empirischen Erkenntnissen über die effizienz- und effektivitätssteigernde Wirkungsweise komplexer Krankenhausinformationssysteme, deren originäre Eigenschaften in einer Metaanalyse von Chaudhry et al. (2006) wie folgt zusammengefasst werden: „All the systems were multifunctional [...] and all had capabilities added incrementally over several years" [4]. Vor diesem Hintergrund lassen sich Digitalisierungstendenzen in Krankenhäusern entlang von Primär- und Sekundärprozessen ausdifferenzieren [6]. Die IT-Unterstützung administrativer und klinischer Sekundärprozesse bezieht sich vor allem auf die Vor- und Nachbereitung medizinischer, pflegerischer und therapeutischer Kerntätigkeiten [4-6]. Beispiele für solche Basisfunktionen sind das stationäre und ambulante Patientenmanagement, die Leistungsanforderung, die Erzeugung und Archivierung von Bilddokumenten und die Dokumentation [5]. Die digitale Unterstützung klinischer Primärprozesse greift hingegen stärker in die medizinisch-pflegerische Behandlungstätigkeit ein [6]. Anwendungsbeispiele für diese fortgeschrittenen Systeme sind die medizinische Entscheidungsunterstützung, Alarmfunktionen oder Funktionen zur Arzneimittelgabe. Bei entsprechenden Funktionen handelt es sich zumeist um technologisch anspruchsvollere Anwendungen, die in der Fläche bis dato weniger stark umgesetzt sind [4-5].

2.2 Informationsmanagement

Das Informationsmanagement eines Krankenhauses beschreibt alle planerischen, steuernden und überwachenden Aktivitäten, welche in Bezug auf den IT-Betrieb der Einrichtung auf operativer, taktischer und strategischer Ebene durchgeführt werden [7]. Eine zentrale Aufgabe des strategischen IM ist die Entwicklung und kontinuierliche Anpassung der IT-Strategie. Die IT-Strategie ist idealerweise mit der Krankenhausstrategie abgeglichen und wird in eine Finanz- und Investitionsplanung und in ein längerfristiges Projektportfolio überführt [7]. Durch regelmäßige Evaluationen stellt das IM auf strategischer Ebene sicher, dass alle

Digitalisierungsprojekte mit den Unternehmenszielen des Krankenhauses korrespondieren, dass Fehlentwicklungen gegengesteuert werden kann und dass die langfristige Routinisierung innovativer eHealth-Anwendungen erfolgreich verläuft [7]. Die Aktivitäten des taktischen IM befasst sich unter anderem mit der Überführung der IT-Strategie in konkrete Projekte, wobei insbesondere Aktivitäten rund um die Analyse, Auswahl, Spezifikation, Einführung und Evaluation von eHealth-Innovationen stattfinden. Das operative IM beschäftigt sich schließlich mit dem alltäglichen IT-Betrieb [7]. Zu den typischen Aktivitäten gehören die Überwachung der IT-Infrastruktur und der Netzwerke, die Applikationsbetreuung und -wartung, der Betrieb des Helpdesks sowie Anwenderschulungen [7]. Der Professionalisierungsgrad des IM kann neben der Art und Anzahl der durchgeführten Aktivitäten auch durch die Regelmäßigkeit und den Formalisierungsgrad ihrer Durchführung definiert werden [9]. Die Orientierung an IT-Governance-Rahmenwerke erlaubt einerseits die Etablierung von Best-Practices, andererseits ermöglichen entsprechende Regelwerke ein nachhaltiges und strategisches Alignment der IM-Aktivtäten an die Unternehmensziele des Krankenhauses [7,11]. In der vorliegenden Arbeit wird davon ausgegangen, dass der Professionalisierungsgrad des IM darüber entscheidet, inwiefern einzelne Phasen von eHealth-Innovationsprozessen in Krankenhäusern erfolgreich durchgeführt werden. Während bspw. eine optimale Abstimmung von IT-Investitionen und Krankenhausstrategie die Weichen für eine erfolgreiche Initialisierung stellen, ist die Implementierung neuer Technologien von einer professionellen Projektplanung abhängig. Das operative IM trägt schließlich zu einer erfolgreichen Institutionalisierung bei, indem Anwenderbedürfnisse frühzeitig aufgenommen und Lösungsmöglichkeiten (bspw. in Form von Schulungen) angeboten werden [7]. Ausgehend von diesen Vorüberlegungen wird folgende Hypothese aufgestellt:

H1: Je höher der Professionalisierungsgrad des Informationsmanagements in einem Krankenhaus ausgeprägt ist, desto höher ist auch der Digitalisierungsgrad der Einrichtung ausgeprägt.

2.3 Intrapreneurship

Intrapreneurship bezieht sich auf das unternehmerische Denken und Handeln von Organisationsmitgliedern und drückt sich in einer aktiven und visionären Mitgestaltung von Produkten, Prozessen oder Serviceleistungen aus [12]. Gegenüber dem Digitalisierungsgrad, der als manifestes Merkmal bspw. über die Anzahl umgesetzter IT-Funktionen quantifiziert werden kann, handelt es sich bei Intrapreneurship um eine latente Ausprägung der Organisationskultur. In komplexen Organisationen wie Krankenhäusern kann Intrapreneurship auf unterschiedlichen Organisationsebenen den Erfolg von eHealth-Innovationen determinieren. Auf Ebene der Gesamtorganisation zeichnet sich eHealth-bezogener Intrapreneurship bspw. durch eine hohe Wandlungsbereitschaft und durch eine innovationsfreundliche sowie unterstützende Krankenhausleitung aus. Auch eine organisationsübergreifende Zukunftsvision, welche die kontinuierliche Exploration und Nutzung innovativer Technologien umfasst, ist Ausdruck von Intrapreneurship [9,10]. Auf Ebene der IT-Abteilung zeigt

sich Intrapreneurship bspw. über freie, eigenverantwortliche Arbeitsweisen und einem ausgeprägten Zusammengehörigkeitsgefühl zwischen den Teammitgliedern. Ein starkes Gemeinschaftsgefühl kann den Grundstein für synergetische Arbeitsweisen bilden, sodass Teammitglieder gegenseitig auf Ideen aufbauen und sich um eine gemeinsame Zielerreichung, gute Serviceleistungen und ein hohes Maß an Teamreflexion bemühen [14]. In diesem Zusammenhang kann eine autonome und selbstbestimmte Arbeitsweise dazu führen, dass IT-Mitarbeiter auch einmal etablierte Lösungswege verlassen, sobald sich effizientere oder effektivere Gestaltungsoptionen eröffnen [14]. Auf Ebene des IT-Leiters zeichnet sich Intrapreneurship durch ein besonders unternehmerisches Denken und Handeln aus [9]. IT-Leiter mit ausgeprägter Intrapreneurship-Persönlichkeit verfügen über weitreichende Kenntnisse pflegerischer und medizinischer Behandlungsabläufe und sehen sich als Ideengeber für die Optimierung administrativer und klinischer Abläufe. Gleichzeitig forcieren sie eine enge Abstimmung der IT-Strategie mit der Unternehmensstrategie und suchen fortwährend den Austausch mit der Krankenhausleitung [11]. Ausgehend von diesen Vorüberlegungen wird davon ausgegangen, dass eine ausgeprägte Intrapreneurship-Kultur die professionelle Durchführung von IM-Aktivitäten erleichtert und somit indirekt auch den Digitalisierungsgrad der Einrichtungen positiv beeinflussen kann. Entsprechend werden folgende Hypothesen aufgestellt:

H2: Je höher die Intrapreneurship-Kultur in einem Krankenhaus ausgeprägt ist, desto höher ist auch der Professionalisierungsrad des Informationsmanagements ausgeprägt.
H3: Je höher die Intrapreneurship-Kultur in einem Krankenhaus ausgeprägt ist, desto höher ist auch der Digitalisierungsgrad des Krankenhauses ausgeprägt.

In Abbildung 1 werden die aufgestellten Hypothesen in Form eines Untersuchungsmodells visualisiert. Das Modell verdeutlicht, dass ein indirekter, durch das Informationsmanagement mediierter Effekt des Intrapreneurship auf den Digitalisierungsgrad vermutet wird.

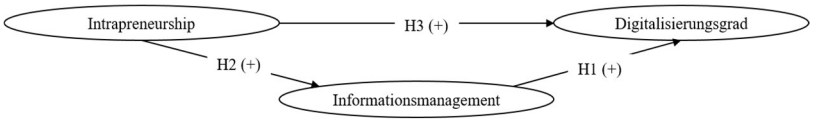


Abbildung 1. Untersuchungsmodell

3 Methode

3.1 Operationalisierung und Datenerhebung

Zur Operationalisierung des Untersuchungsmodells wurde ein Fragebogen entwickelt, dessen Items weitestgehend aus existierenden Erhebungsinstrumenten abgeleitet und bei Bedarf an das krankenhausspezifische Untersuchungsfeld angepasst wurden. Die Ausprägung der Intrapreneurship-Kultur wurde über insgesamt 22 Items erfasst. In

Anlehnung an das *Corporate Entrepreneurship Assessment Instrument* (CEAI) von Hornsby et al. (2002) wurden acht Items entwickelt, die sich auf den organisationsweiten Intrapreneurship bezogen [16]. Zur Erfassung des Intrapreneurships auf Ebene der IT-Abteilung wurden in Anlehnung an das *Team-Klima-Inventar* (TKI) fünf Items entwickelt [14]. Ausgehend von Patterson et al. (2009) wurden schließlich neun Items zur Erfassung der Intrapreneurship-Persönlichkeit des IT-Leiters entwickelt [15]. Alle Items wurden als Aussagen formuliert, die über eine Vier-Punkte-Skala von „Stimme überhaupt nicht zu“ bis „Stimme voll und ganz zu“ eingeschätzt werden konnten. Die Ausprägung des Professionalisierungsgrades des IM wurde in Anlehnung an Liebe et al. (2017) über 15 Items erfasst [9]. Die Durchführung der IM-Aktivitäten wurde auf einer Vier-Punkte-Skala von „Nein, diese Aktivität wird nicht durchgeführt“, bis „Ja, diese Aktivität wird regelmäßig und formalisiert nach einem IT-Governancerahmenwerke“ erfasst. Zur Erhebung des Digitalisierungsgrades wurden in Anlehnung an den *OECD Guide to Measuring ICTs in the Health Sector* 33 Items entwickelt [17]. Hiervon bezogen sich 24 Items auf die Umsetzung von Unterstützungsfunktionen klinischer Sekundärprozesse (Basisfunktionen) und neun Items auf die Umsetzung fortgeschrittener Systeme (bspw. Entscheidungsunterstützung). In Anlehnung an die englischsprachige Version des Inventars wurde der Umsetzungsgrad der Funktionen über eine Fünf-Punkte-Skala von „Nicht umgesetzt“ bis „Vollständig umgesetzt in allen Einheiten“ abgefragt.

Der Fragebogen wurde in dem Umfrageinstrument LimeSurvey integriert und drei Pretests unterzogen, in denen die inhaltliche und technische Plausibilität des Erhebungsinstruments überprüft wurde. An den Pretests beteiligte sich eine heterogene Gruppe aus fünf IT-Leitern, 11 Wissenschaftlern aus dem Bereich der Medizinischen Informatik und einem Klinker. Der Link zu dem Online-Fragebogen wurde Anfang Dezember 2016 via E-Mail an insgesamt 1349 IT-Leiter deutscher Krankenhäuser geschickt (zuständig für 1950 Krankenhäuser). Die E-Mailadressen der IT-Leiter wurden in einer vorgeschalteten Internet- und Telefonrecherche erfasst.

3.2 Datenanalyse

Zur Überprüfung des Untersuchungsmodells wurde ein dreistufiger Analyseprozess durchgeführt. Mit dem Ziel einer induktiven Identifikation empirischer Beschreibungsgrößen des Untersuchungsmodells wurde in einem ersten Schritt eine Hauptkomponentenanalyse mit SPSS23® durchgeführt. Die Eignung der Daten wurde über das Kaiser-Meyer-Olkin-Maß (KMO) und mit dem Bartlett's-Test auf Sphärizität geprüft. Komponenten mit einem Eigenwert von mindestens 1 wurden beibehalten und per Varimax rotiert. Items, deren Faktorladung unter 0,4 lag und solche, die nicht eindeutig einer Komponente zugeordnet waren, wurden aus dem Modell entfernt. In einem zweiten Analyseschritt wurde die Reliabilität der extrahierten Item-Sets mittels Cronbach’s Alpha (α) getestet. Einzelne Items wurden im Hinblick auf die weiteren Analyseschritte herausgenommen, wenn hierdurch die Reliabilität erhöht werden konnte. Als Vorrausetzung für die Herausnahme der Items wurde festgelegt, dass hierdurch die Validität der Konstruktmessung nicht beeinträchtigt werden darf. In

einem dritten Schritt wurde eine Pfadanalyse zur Überprüfung des aufgestellten Untersuchungsmodells mit AMOS® berechnet. Bei Pfadanalysen handelt es sich um einen Spezialfall von Strukturgleichungsmodellen, in denen partielle Mediator-Effekte von einem oder mehreren Merkmalen überprüft werden können. Zur Bestimmung direkter Effekte wurden standardisierte Regressionskoeffizienten (β) berechnet. Indirekte Effekte wurden berechnet, indem die direkten Effekte mit den indirekten Effekten multipliziert wurden. Die totalen Effekte ergaben sich aus der Summe der direkten und indirekten Effekte. Zur Überprüfung der Modellanpassung wurde der Root Mean Squared Error of Approximation (RMSEA) ermittelt [18].

4 Ergebnis

4.1 Stichprobe

Insgesamt 224 IT-Leiter nahmen an der Umfrage teil, was einer Rücklaufquote von 18,3% entspricht, da 125 E-Mails unzustellbar waren. Zur Überprüfung der Repräsentativität wurde die Stichprobe in Anlehnung an Köbler et al. (2010) nach Größe und Trägerschaft segmentiert und mit der Population deutscher Krankenhäuser verglichen [11,19]. Gegenüber der Grundgesamtheit waren kleinere Krankenhäuser mit weniger als 200 Betten leicht unterrepräsentiert und entsprechend mittlere und größere Krankenhäuser überrepräsentiert. Hinsichtlich der Trägerschaft waren private Einrichtungen unter- und öffentliche, sowie freigemeinnützige Krankenhäuser überrepräsentiert.

4.2 Hauptkomponentenanalyse

Das ermittelte KMO-Maß von ,79 ergab, dass sich die Daten zur Durchführung einer Hauptkomponentenanalyse eigneten. Der Bartlett's-Test auf Sphärizität war signifikant ($p < ,01$). In Tabelle 2 werden die Items-Sets der extrahierten Komponenten sowie die jeweiligen Faktorladungen dargestellt. Die Reliabilitätswerte wiesen auf eine ausreichend bis zufriedenstellende interne Konsistenz der Daten hin ($\alpha < ,60$). Die Faktorladungen der sieben Item-Sets lagen zwischen ,42 und ,81, so dass auf eine ausreichend hohe Konstruktvalidität geschlossen werden konnte. Zur Beschreibung der Intrapreneurship-Kultur konnten drei Komponenten identifiziert werden: Intrapreneurship auf organisationaler Ebene ($\alpha = ,79$), Intrapreneurship auf Ebene der IT-Abteilung ($\alpha=0,69$) und Intrapreneurship auf Ebene des IT-Leiters ($\alpha = ,67$). Zur Beschreibung des IM ergaben sich zwei Komponenten. Diese bezogen sich auf die Durchführung strategischer IM-Aktivitäten ($\alpha = ,72$) und auf die Durchführung operativer IM-Aktivitäten ($\alpha = ,78$). Für den Digitalisierungsgrad ergaben sich schließlich zwei Komponenten, die zum einen die Umsetzung klinischer Basisfunktionen (insb. Reporting und Kommunikation) ($\alpha = ,79$) und zum anderen die Umsetzung fortgeschrittener klinischer Funktion Funktionen (insb. Entscheidungsunterstützung, Arzneimitteltherapie- und Patientensicherheit) beschrieben ($\alpha = ,77$) (vgl. Tabelle 2).

4.3 Strukturgleichungsmodell

Insgesamt lag eine gute Anpassung des Strukturmodells vor (RMSEA < ,05). In Tabelle 1 werden die direkten, indirekten und totalen Effekte der Intrapreneurship-Komponenten dargestellt. Zusammengenommen waren die totalen Effekte auf Ebene der Organisation am höchsten und auf Ebene des IT-Leiter am geringsten ausgeprägt. Auf organisationaler Ebene zeigte Intrapreneurship geringere direkte als indirekte Effekte auf den Digitalisierungsgrad. Nur auf Ebene der IT-Abteilung war der direkte Effekt des Intrapreneurships etwas höherer als der indirekte Effekt. Dies galt für beide Komponenten des Digitalisierungsgrades. Auf Ebene des IT-Leiters ergaben sich negative direkte Effekte. Diese waren jedoch nur im Hinblick auf die Umsetzung klinischer Basisfunktionen signifikant. In Abbildung 2 wird das berechnete Strukturgleichungsmodell dargestellt. Die Stärke der direkten Effekte wird durch die standardisierten Regressionskoeffizienten (ß) angezeigt. Ebenfalls wird die erklärte Varianz (r^2) der Mediatorvariablen und der abhängigen Variablen beschrieben. Demnach liegt die Varianzaufklärung des strategischen IM durch die Intrapreneurship-Komponenten bei 33% (p < ,01) und die Aufklärung des operativen IM bei 21% (p < ,01). Die Komponenten des Digitalisierungsgrades werden jeweils zu 27% durch die Ausprägung des IM erklärt (p < ,01).

Tabelle 1. Direkte (DE), indirekte (IE) und totale Effekte (TE) (n= 224)

	Organisation			IT-Abteilung			IT-Leiter		
	DE	IE	TE	DE	IE	TE	DE	IE	TE
Klinische Basisfunktionen	,15	,16	,31	,14	,09	,23	-,16	,13	-,03
Fortgeschrittene klin. Funktionen	,09	,16	,25	,12	,08	,20	-,08	,13	,05
Operatives IM	,19	-	,19	,21	-	,21	,23	-	,23
Strategisches IM	,40	-	,40	,11	-	,11	,26	-	,26

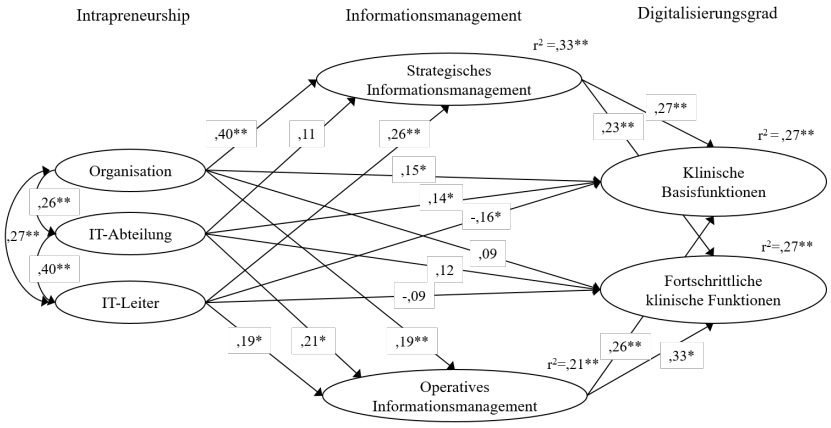


Abbildung 2. Strukturgleichungsmodell (n= 224; *p < ,05; **p < ,01)

Tabelle 2. Ergebnisse der Hauptkomponentenanalyse (n=224)

Komponenten	1	2	3	4	5	6	7
Intrapreneurship auf Ebene der Organisation							
"Bezüglich neuer IT ist unser Krankenhaus agil und flexibel."	,71						
"Für neue IT-Projekte erhalten wir ausreichende Ressourcen."	,68						
"Neue IT-Projekte werden bei uns offen kommuniziert."	,67						
"Bei uns herrscht eine Art IT-bezogene Zukunftsvision."	,67						
"Unsere Krankenhausleitung fördert aktiv neue IT-Projekte."	,65						
Intrapreneurship auf Ebene der IT-Abteilung							
"Kreativität wird in unserer IT-Abteilung groß geschrieben."		,72					
"In unserem IT-Team herrscht ein starker Zusammenhalt."		,69					
"Kreative Ideen werden in unserem Team offen diskutiert."		,64					
"Meine Mitarbeiter brauchen Freiheiten für gute IT-Lösungen."		,44					
Intrapreneurship auf Ebene des IT-Leiters							
"Ich genieße die intellektuelle Herausforderung meiner Arbeit."			,74				
"Ich spreche regelmäßig mit externen über neue IT-Lösungen."			,62				
"Ich denke regelmäßig über IT-basierte Optimierungen nach.“			,54				
"Ich muss alle klinischen Prozesse unbedingt kennen."			,42				
Strategisches Informationsmanagement							
Wertbeitragsermittlung				,69			
Strategische Steuerung (bspw. Projekt-Priorisierung, -Initiierung)				,64			
Strategisches Sicherheits- und Risikomanagement				,64			
Erstellung und Weiterentwicklung einer IT-Strategie				,63			
Operatives Informationsmanagement							
Steuerung und Überwachung der technischen Performance					,81		
Applikationsbetreuung und –wartung					,74		
Betrieb eines Helpdesk / Servicedesk					,59		
Schulung von Nutzern					,50		
Klinische Basisfunktionen							
Wunddokumentation						,71	
Konsile (Leistungsanforderungs- und Befundrückmeldung)						,69	
Elektronische Untersuchungen (Leistungsanforderungs- und Befundrückmeldung)						,65	
Hygienedokumentation						,57	
Dokumentation der Therapieberufe (z. B. Physiotherapie)						,57	
Telemedizin (bspw. Teleradiologie und Telekonsultation)						,55	
CIRS (Critical Incident Reporting System)						,54	
Fortgeschrittene (bzw. in der Krankenhaus-Population weniger verbreitete) klinische Funktionen							
Arzneimittelgabe (eMAR)							,64
Medikation (Leistungsanordnung)							,63
Arzneimittelverfolgung (von der Apotheke bis zur Gabe)							,60
Entscheidungsunterstützung für Diagnostik, Therapie und Pflege							,60
Unterstützung der Arzneimitteltherapie (Wechselwirkungsprüfung)							,57
Klinische Erinnerungsfunktionen							,55
Pflegedokumentation							,52
Alarmfunktionen (z. B. Laborwerte außerhalb des Normbereichs)							,46

5 Diskussion

In Krankenhäusern gilt das IM als Dreh- und Angelpunkt für eine erfolgreiche Digitalisierung. Intrapreneurship kann die Gestaltungsfähigkeit des IM erhöhen und somit vermutlich auch den Erfolg von eHealth-Innovationsprozesse positiv beeinflussen. Tatsächlich konnte dieser Effekt jedoch bis dato nicht empirisch nachgewiesen werden. Vor diesem Hintergrund verfolgte die vorliegenden Studie zwei Forschungsfragen: (1.) Welche Effekte hat Intrapreneurship auf den Digitalisierungsgrad und (2.) inwiefern werden diese Effekte durch das IM beeinflusst?

Zur Beantwortung der Forschungsfragen wurde ein hypothesengeleitetes Untersuchungsmodell entwickelt und anhand der Daten von 224 IT-Leitern überprüft. Die Ergebnisse bestätigten das aufgestellte Modell und können in zweierlei Hinsicht zum Verständnis von eHealth-Innovationsprozessen beitragen: So wurden einerseits valide und reliable Beschreibungsgrößen für die Ausprägungen des Intrapreneurships, den Professionalisierungsgrad des IM und des Digitalisierungsgrades identifiziert. Andererseits konnte erstmals empirisch nachgewiesen werden, dass sich Intrapreneurship besonders dann positiv auf die Verwirklichung von eHealth-Innovationen auswirkt, wenn es von einem professionell agierenden IM begleitet wird.

Ein differenzierteres Bild über die Wirkungsweise des Intrapreneurships liefert das aufgestellte Strukturgleichungsmodell. So deuten die Ergebnisse darauf hin, dass Intrapreneurship auf organisationaler Ebene die Digitalisierung unterstützen kann, indem die strategische Gestaltungsfähigkeit des IM durch eine besonders wandlungsfähige und zukunftsorientierte Ausrichtung der Organisation erleichtert wird. Hierdurch können vermutlich berufsübergreifende Zieldivergenzen harmonisiert und Abstimmungsprozesse verkürzt werden. Auch die Unterstützung einer innovationsfreundlichen Führungsebene und etablierte Kommunikationskanäle zwischen den Organisationseinheiten scheinen das strategische IM und somit indirekt auch eine krankenhausweite Diffusion von eHealth-Innovationen zu erleichtern. Weiterhin zeigen die Ergebnisse, dass Intrapreneurship auch auf Ebene der IT-Abteilung Digitalisierungsvorhaben erleichtern kann, indem ein starkes Zusammengehörigkeitsgefühl und eigenverantwortliche Arbeitsweisen eine kreative und zielorientierte Durchführung operativer Managementaktivitäten bedingt. Anders als erwartet waren die direkten Effekte der Intrapreneurship-Persönlichkeit des IT-Leiters auf den Digitalisierungsgrad negativ. So scheint es sich für die erfolgreiche Umsetzung von eHealth-Innovationen erst in Verbindung mit einem professionellen IM auszuzahlen, wenn der IT-Leiter intrinsisch motiviert ist, proaktiv nach neuen eHealth-Lösungen sucht und sich als kreativer Ideengeber für die Optimierung der klinischen Praxis versteht. Schließlich konnte gezeigt werden, dass die gemeinsame Wirkung von Intrapreneurship und IM nicht zwischen der Umsetzung klinischer Basisfunktionen und der Umsetzung fortschrittlicher Systemen differenziert. Dieser Befund könnte darauf hindeutenden, dass sich Intrapreneurship auf den gesamten Innovationsprozess auswirkt, indem einerseits die Initiierung und Implementierung neuer bzw. innovativer Systeme erleichtert wird und andererseits die Institutionalisierung bestehender Anwendungen gefördert wird.

5.1 Limitationen und Ausblick

Bei der Interpretation der Ergebnisse müssen verschiedene Limitationen berücksichtigt werden. Zum einen kann es aufgrund der Stichprobenauswahl zu systematischen Verzerrungen kommen, da kleinere und private Krankenhäuser in der Stichprobe unterrepräsentiert waren. Die einseitige Befragung der IT-Leiter kann zudem einen Selbsteinschätzungs-Bias hervorgerufen haben, der in anknüpfenden Forschungsvorhaben durch die Befragung weiterer IT-Stakeholder (insb. der Krankenhausleitung, Ärzte, Pflege) vermieden werden kann. Die Reliabilitätswerte deuten darauf hin, dass die Verlässlichkeit der genutzten Items-Sets weiter optimiert werden kann. Der Digitalisierungsgrad wurde in einem additiven Ansatz operationalisiert, der die multifunktionale Ausgestaltung von Krankenhausinformationen berücksichtigt. Zukünftige Ansätze könnten neben der Funktionsbreite auch anderer Beschreibungsmerkmale der Krankenhausdigitalisierung berücksichtigen. Beispiele hierfür sind die Mobilität und die Integrationstiefe von IT-Funktionen sowie die Verfügbarkeit von elektronischen Patienteninformationen in den klinischen Prozessen. Schließlich betrachtet das vorgeschlagene Untersuchungsmodell vermutlich nur einen Teil der relevanten Wirkungsdimensionen, welche zur Erklärung von eHealth-Innovationsprozessen herangezogen werden können. Weiterführende Arbeiten könnten neben den Effekten auf die Krankenhausdigitalisierung auch Effekte der Digitalisierung selbst berücksichtigen. Vielversprechende Outcomegrößen wären bspw. die Patientensicherheit oder Durchlaufzeiten.

5.2 Conclusio

In der vorliegenden Studie wurde erstmals der gemeinsame Effekt von Intrapreneurship und IM auf den Digitalisierungsgrad der Krankenhäuser empirisch nachgewiesen. Zusammenfassend deuten die Ergebnisse darauf hin, dass eine ausgeprägte Intrapreneurship-Kultur die Handlungs- und Entscheidungsfähigkeit des IM insbesondere auf operativer und strategischer Ebene fördert. Die Ergebnisse können das Verständnis über die Entstehung von eHealth-Innovationen in Krankenhäusern erweitern und ganz allgemein das theoretische Wissen über die Wirkungsweisen einer Intrapreneurship-Kultur anreichern. Darüber hinaus konnte in der Studie ein reliables und valides Messinstrument erarbeitet werden, welches im Rahmen weiterführender Forschungsaktivitäten zur Erfassung zentraler Wirkungsdimensionen in eHealth-Innovationsprozessen genutzt werden kann.

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Adapting a Business Model Ontology to the Application Case of Health Information Technology

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Abstract. Health information technology (HIT) assists in implementing comprehensive care approaches to deal with challenges like demographic changes. The change processes driven by IT are also challenging the healthcare field. Business Models (BMs) as an analytical tool representing an organization's business activities are a mean to achieve valuable and long-lasting solutions by combining technical and domain-specific perspectives. Business model representations (BMRs) ease the handling of BMs. BMRs are conceptual models that systematically and formally depict BMs. Conceptual and terminological uncertainties hamper the progression of the research field. Heterogeneous notations and concepts with insufficiently described semantics are a result. An ontological description of the relations between the BM's components ensuring its problem adequacy and validity is needed to come to the desired common ground. Furthermore, focusing on a distinct domain is necessary to guide the development and use of HIT solutions. So, a first attempt of an ontology that can be the basis for a respective HIT-BMR will be proposed.

Keywords: Business Model, Ontology, Health Information Technology

1 Introduction

Health information technology (HIT) assists in improving or implementing comprehensive care approaches to deal with major challenges like the demographic changes of (western) societies [1]. The increasing professional use of Information and Communication Technologies has considerably changed the business landscape in general [2] and the healthcare environment in particular [3]. So, IT is a major driver of innovations in healthcare. The accelerating change process also challenges this quite conservative and regulated environment [4]. Too much technology-driven solutions come together with partly reluctant users [5]. As a result, the transition of promising pilot projects to successfully commercialized ones often fails [6].

Long-lasting and valuable solutions require the adequate combination of the technical basis and domain-specific knowledge. Here, the concept of Business Models (BMs) comes into play [7]. These are condensed representations of an organization's business activities. BMs have gathered rising interest from research and practice [8]. Visualized BMs can be more easily communicated [9], innovating BMs is fostered [10] and this allows the derivation of the underlying information systems' design [11]. This

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leads to the concept of Business Model Representations (BMRs). BMRs are conceptual models that systematically and formally depict BMs. Here, neither information systems nor processes themselves, but business logics are in focus for modelling [12, 13]. Conceptual and terminological uncertainties hamper the progression of the research field of representing BMs [6–9, 14]. This applies both for the concept of BMs itself and for the extend of and means used for representing these in terms of BMRs [14, 15]. Major issues are the independence and the heterogeneity of the approaches. Conceptual inconsistencies result in heterogeneous notations and concepts with often only implicitly or insufficiently described semantics [16]. Additionally, there is no sufficient basis for describing and constructing structured and comparable BMs capturing the specifics of concrete business cases [7, 8]. In this regard, an *ontology* is a mean to come to the desired common ground and to describe the relations between the BMs' components ensuring its problem adequacy and validity [9]. There are other research papers (e.g., [17, 18]) that use ontologies to structure the field of BMs in general. By focusing on the domain of HIT solutions, the fit between the BMR as a visual representation and the task of representing the value network is significantly increased [19]. Further, the development and use of respective HIT solutions can be sufficiently guided [7]. So, the present paper aims to propose an ontology for HIT-BMs that can be the basis for a respective HIT-BMR [5–7, 14, 17, 18].

The paper contributes to the scientific understanding as well as to practical issues: Research calls for measures to conceptualize BMs to allow a deeper understanding of these (e.g., see the research agenda by [7]). The need for elaborating on more systematically derived BMs is also evident from the viewpoint of the practice [13, 14].

The outlined aim sets the structure of the remaining paper: Within section 2, theoretical background regarding the topics of BMs, BMRs and ontologies is given. Section 3 is twofold. Firstly, it comprises the analysis of the related work regarding ontologies for HIT-BM(R)s or descriptive approaches in this field at all. Secondly, this basis is used to propose extensions of a BM ontology so that the HIT-specifics are reflected. The final section 4 provides a conclusion and a discussion on open issues.

2 Theoretical Background

2.1 Business Models

Despite the fact that BMs have gained rising interest since the end of the 1990s and the dot-com bubble, the literature in the field is quite heterogeneous [14]. There are no commonly accepted and clearly explicated definitions. This hampers the progression and the coherence of the research field [14, 15]. However, there is a partial consensus that BMs provide insights in the core logic of businesses and its interrelation from a processual as well as from a static point of view [2, 14, 15]. BMs are separated from and an intermediator between the organization's strategy (the overall aims) and business processes (the concrete functioning of a solution) [2, 15]. BMs translate the highly aggregated strategic considerations into highly detailed business processes. BMs show the way of value creation within the value network and the coordination of the

organizational resources implementing the strategic precepts. Business process models describe the concrete organization's workflows and processing steps on that basis [15]. Overall, three major interpretational lines of BMs have been emerged in literature [14]:

1. BMs as *attributes of real firms*: This refers to the concrete way how firms do business and the BM's major roles and effects by using BM patterns or archetypes.
2. BMs as *cognitive/linguistic schemas*: Here, mental models how the ways firms do business (1) are interpreted by the members of the organization. In this sense, BMs are the dominant thinking pattern regarding the business logic.
3. BMs as *formal conceptual representations*: This relates to the question how the firm's attributes (1) and schemas (2) could be represented. Unspoken, tacit contexts are now explicated, formally or uniformly depicted.

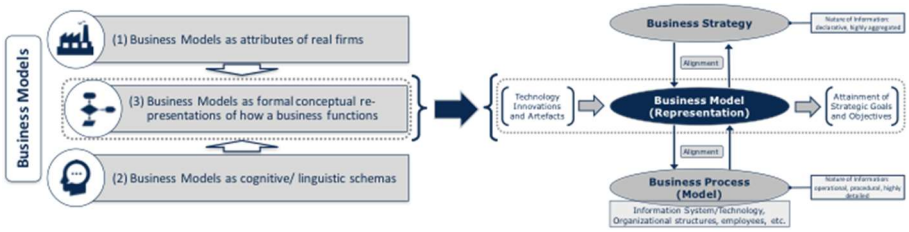


Figure 1. Three main BM understandings [14] and BMs as an intermediate business layer [15]

The present article focusses on the third way of interpretation (*the BMRs*). The BMRs articulate, transfer and recombine the (tacit) knowledge of (implicitly) embedded manifestations of BMs within organizations. This assists to a model-based understanding of the business logic [9] (see Figure 1 for an interim conclusion).

2.2 Business Model Representations

For concrete BMRs, a wide range of content-related and formal basics can be observed: There are classical conceptual models with distinct syntax and semantics; some use morphologic or tabular concepts [7, 16]. The approach by [20] is under the most prominent ones. Here, interrelated organizational building blocks form the *Business Model Ontology (BMO)*. On that basis, the author created the well-known map-like *Business Model Canvas (BMC)* [20]. The *e³-value* model by [21] is a diagrammatic conceptual model with a respective ontology. Inter-network working principles (stakeholders generating, exchanging and consuming value) of e-business cases are depicted [21]. The *STOF model* (acronym for the covered domains: service, technology, organization, financials) by [22] pursues a quite comprehensive view on BMs. It was primarily designed for mobile BMs and specifically looks on technical details. The four domains interact with each other and lead to the value provision [22]. Summing up, an inconsistent picture has to be given. But in general, the conceptualizations of BMs in literature can be divided into BM-archetypes for specific domain/application fields, BMs as a tool for strategic analyses of the value network or for economic analyses. A trend towards an overarching understanding of BMs and more profound reflections on

the value creation in complex networks can be observed [14]. For this, HIT-specific aspects have to be broadly considered within BMRs [5–7].

2.3 Ontologies

Typically, an ontology has (more or less formally defined) syntax and semantics that specify it. An ontology also has a pragmatic function as it is a suitable mean to represent the knowledge, the most important concepts together with the relevant vocabulary and the interrelations between these of a specific domain. An ontology eases communication, interoperability and trustworthiness as it embodies the consensus on a distinct topic. The reuse of the represented concepts is possible and the requirements analysis is eased by utilizing the common understanding [23, 24].

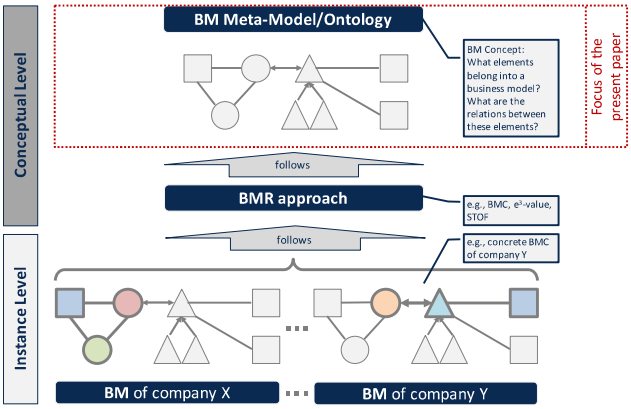


Figure 2. BM Concept Hierarchy [9]

Combing the thoughts so far, BMs and ontologies both are suitable and complementary means to build a business knowledge base and represent business logics [17]. In fact, ontologies can be used to describe the elements and their relations a BMR should consist of and to formally and explicitly conceptualize it. This fulfills the function of a meta-model allowing to describe an unlimited number of BMs [25]. A sound basis to build up (or instantiate) BMs is given [9, 18]. Prominent BMR approaches like by [20] or [21] use an ontology to describe what the BM(R) actually is [25]. But these are mostly very heterogeneous and incompatible. Instead, BM ontologies that allow an easier, more (domain-) specific and more effective use and exchange are needed [17].

The ontology presented below can be used to represent the knowledge on BMs and their depiction (BMRs) in the case of HIT solutions. So, an approach analogously to domain-specific modeling languages (DSML) in comparison to general purpose modeling languages is pursued. An efficient basis for domain-specific BMRs of distinct BMs of HIT solutions will be provided [26]. So, the present paper is located at the conceptual level within Figure 2. For the present case, we will make use of a lightweight ontology that is primarily for informing people and not for machine-machine

communication. Here, only a limited number of concepts, relationships and axioms are in use. In turn, the *UML*'s class models are suitable as well [25, 26].

3 Analysis

3.1 Related Work

There are studies that use ontological descriptions for generalized BMs. E.g., [18] analyzed existing BMR approaches like BMC or e^3-value. The result is a universal BM ontology in terms of an UML class model. [17] comes up with a unified general BM vocabulary in the shape of an OWL model. However, we argue that it is more promising and beneficial to have a focus on a distinct domain [5–7, 14].

To get an overview of approaches for the (ontological) description of HIT-BM(R)s, we conducted a respective literature search. For this, we used relevant major literature databases like Academic Source Complete, Science Direct or IEEE Xplore searching for the combination of HIT solutions (plus synonyms), BMs and ontologies. After search term refinement, eliminating duplicates and irrelevant articles (by checking titles and abstracts), we got a final set of 18 articles. These articles were analyzed in detail. The most relevant result again was the missing consensus. Many different approaches with different conceptual backgrounds are in use to describe HIT-BMs. The BMC, the e^3-value model and the STOF model are the most common approaches.

Along the same lines, the literature review by [27] investigated on a description frame for BMs of mobile health solutions. The relevance of the BMC and the STOF model for HIT cases is underlined. The authors also found no common way or method how such BMs can be described. Further, domain-specifics are not sufficiently considered so far. In turn, this may hamper the adequate shaping of the BMs' components [27]. Therefore, the authors made some suggestions for respective refinements that will be an input for our further considerations.

Finally, [28] investigated the understanding of BMs for HIT solutions. Again, non-uniformity could be observed. Further, the author also derived requirements that have to be fulfilled for HIT-BMRs. These requirements have been used to assess selected BMRs (including the BMC, e^3-value and STOF model). These BMR approaches have been used for HIT cases, but the fit with the healthcare domain is not fully given [28].

These findings militate for the approach to propose a specific ontology HIT-BMRs can base on. Not the BMRs as concrete models but the ontologies in terms of the meta-model should be amended (see again Figure 2 above; [9, 18]).

3.2 Outline of a HIT-specific BM Ontology

Based on the aforementioned findings, the HIT-specific BM ontology shall be outlined in the following. For this, we follow the approach by [29]: (1.) The domain and the extent of the ontology have to be determined. This is already done by focusing on BMs for HIT solutions (see section 2). (2.) Regarding the principle of reuse, we argue that it is reasonable to take the BMO by [20] and add the HIT-specifics. The BMO/BMC is

well-known and accepted in the scientific community and practice (in general and in the healthcare field) [27, 30]. Here, we follow a different approach as for example [18] did. We will not design a totally new ontology that is not known by the practice. Elements of the STOF or e^3-value model will also be considered for the addition. Steps (3.) to (7.) of the approach by [29] include to name the most important terms of the ontology (partly done above) and to determine the classes and the relations between these (done below). The basis for this is the standard BMO (sketched in Figure 3).

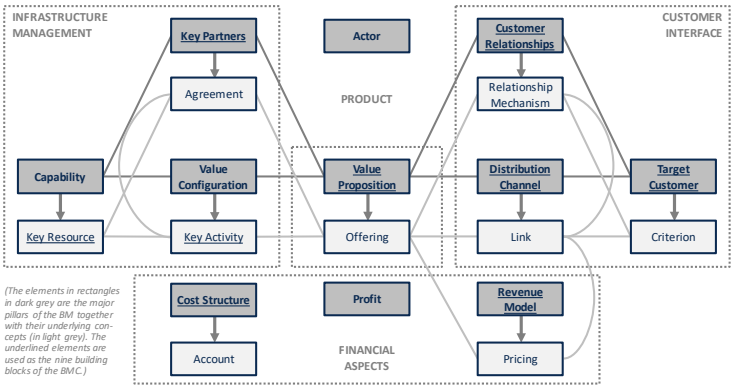


Figure 3. Simplified overview outline of the BMO [20]

Not all relations between the BMO's elements are shown, some classes and attributes are missing here for simplification reasons but are described by [20]. These descriptions have to be translated into a UML class model (full model not shown). In the following, deeper insights in the HIT-specific extensions of the BMO will be given. Major inputs and the basic classes and structure come from the reflections by [20]. Where needed, HIT-specific modifications were made on the basis of the theoretical investigations from the literature research (see above). This led to major reorganizations and a higher complexity compared to the standard BMO. Therefore, different views on the model will be provided. This improves the understanding of the model's and the domain's complexity and allows an aspect-specific use of the model. This is why some classes will be repeated in the model snippets. Actually, this would not be allowed or reasonable in general, but it is done here to overview smaller parts of the model without losing the overall context [31]. Further hierarchy levels do also exist but are also not always shown for simplification reasons.

Firstly, when aiming for an overarching or integrated care by making use of HIT solutions, an even more diverse field of *actors* can be observed. There are not just customers, suppliers or retailers as for consumer goods. The idea is that the gain of efficiency promised by HIT solutions helps to deal with that more complex situation [1, 3, 34]. Figure 4 shows the extensions that are necessary to reflect these actor relations. One major point is the differentiation of *private customers* or citizens and *care service providers*. Actors may also play different *roles*. E.g., a hospital is a *provider* of HIT solutions to patients or a *distribution channel* or a *customer* when the hospital buys the solution for use. The distinction of *patients* and *relatives* is relevant

as well, because these might be directly (influence in the treatment procedure) or indirectly (easing for burdened relative) effected. *Controllers & Supporters* (in diverse organizational forms or roles) are actors that look after administrative issues or after the costs of the mostly publicly funded or controlled healthcare systems but are not directly involved in the HIT solution's value creation [33]. This also includes actors like *health insurances* and the *lawmaker* that mostly have a high impact on the shape of the healthcare field [27, 28, 32]. The *value network* consists of diverse *actors* with heterogeneous *strategies* [18]. This reflects the situation of mostly inter-organizational settings coming to an efficient care support [28].

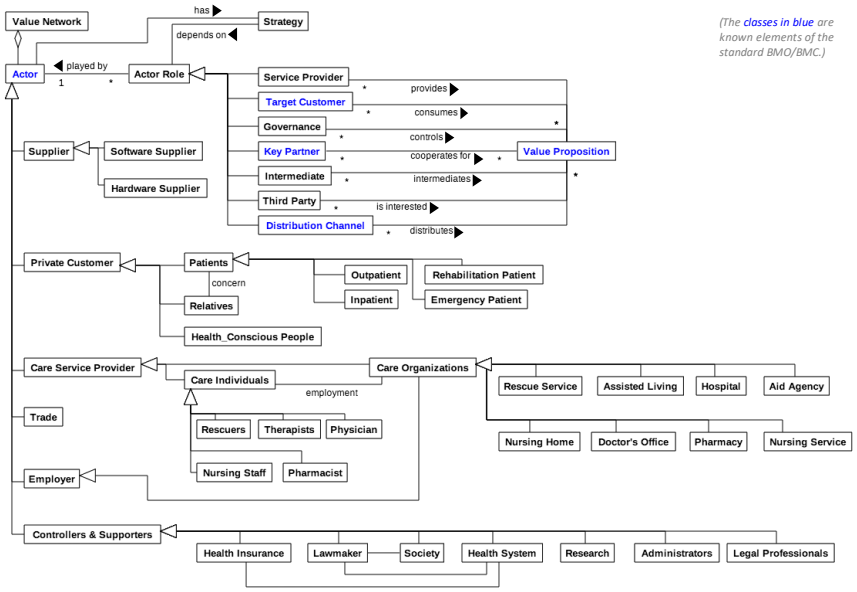


Figure 4. Extensions for the *Actor* element of the BMO, based on [18, 27, 28, 32, 33]

The next shown snippet of the extended BMO is its upper right corner (see again Figure 3 above). These parts are highly connected with the *actor* and are essential parts of the BMO at all (see Figure 5). The actor class is connected to the other major classes fulfilling the different roles that are possible. Other stakeholders that cannot concretely act (like the *society*) or *distribution channels* were added. The latter ensures the delivery of the actors' *value proposition* to the *target customers*. Actors (as *intermediates*), but also the work with or on HIT solutions can be regarded as (direct) ways for *customer relationship management*. A HIT-specific BMO should also not only include generic but HIT- or healthcare-specific *value propositions* [5, 28, 35]. Furthermore, the concrete form of the value proposition depends on the one that consumes it. For patients and care service providers both improved efficiency might come together with cost reductions. But a reduced waiting time might be more relevant for the patient, whereas the service provider is more interested in an optimized resource utilization etc. [27].

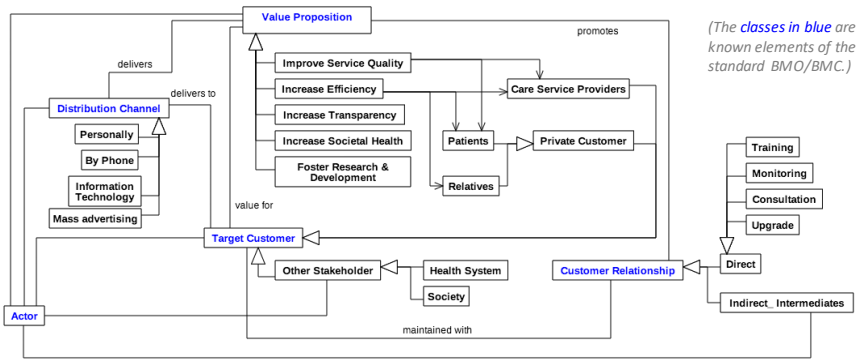


Figure 5. *Product* and *Customer Interface* view on the extended BMO, based on [5, 27, 28, 35]

The *Key Resources* and *Key Activities* (see Figure 6) are also worthwhile to be discussed. The *knowledge* a valuable HIT solution relies on is very heterogeneous. So, it has to be conceptually split up. At the one hand, there is the *medical knowledge*. Learning processes, the integration of new medical studies etc. and former experiences with patients have to be reflected within the HIT solution and the BMR [28, 32]. On the other hand, there is the *technical knowledge*. This builds the basis to reasonably shape the *technical architecture* and in turn the *technical infrastructure* of the solution [27]. For this, the STOF model's *technology domain* provides valuable insights [22].

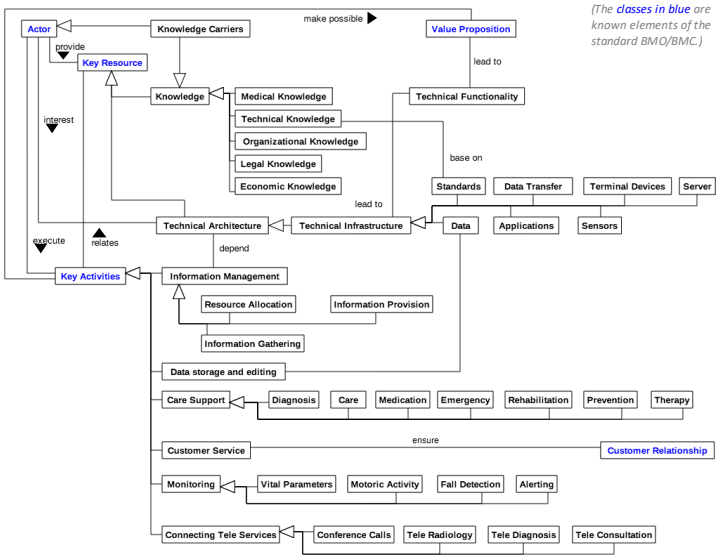


Figure 6. *Key Resources* and *Key Activities* from the extended BMO, based on [22, 27, 28, 35]

Furthermore, the technical infrastructure is the basis for the *technical functionality* that in turn leads to the intended value proposition of the HIT solution. Further, *legal*, *organizational* and *economic knowledge* is needed as well. Such knowledge cannot exist completely detached from distinct (human) *knowledge carriers* and has to be shared by interaction [27, 36]. Again, linking the stakeholders' needs and abilities is highly relevant [32]. A BMR should support such [14, 28]. Furthermore, the *actors* have an interest in the *technical architecture* and are the executors of the *key activities*. In turn, these make the realization of the *value proposition* possible. The key activities include *information management* aspects like the proper *provision* and *gathering* of information. These are closely connected to the *technical architecture*. The core functionality of the HIT solution that is the *care support* in a broader sense includes *monitoring* (e.g., motoric activity), *storage* of the medical data, *tele-services* or *connecting services* like tele-diagnosis. The concrete shape of this aspects depends on the concrete application scenario, the addressed stage within the overall care procedure, the kind of the care provider and on the technical aspects. In turn, this is a major contributor to the overall *value proposition* of the solution. Further, *key partners* are also relevant. In a broader sense, these cooperate with the focal actors. They are not directly involved in the value creation but provide essential basics to be able to achieve the value proposition for the *target customers*. Such *key partners* include standardization organizations (e.g., for HL7), telecommunication service providers, sales partners or hardware and software suppliers [27, 33, 35].

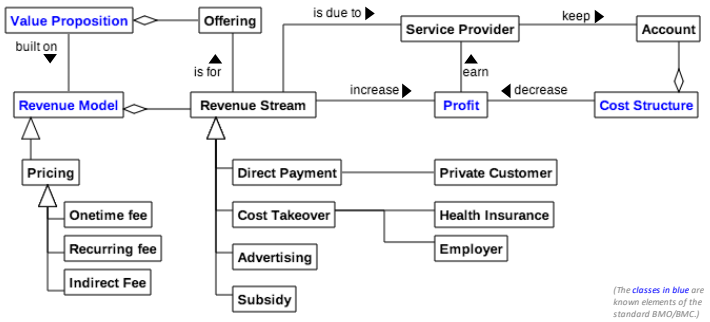


Figure 7. *Financial Aspects* from the extended BMO, based on [5, 27, 28, 35]

Within the healthcare systems, the *financial aspects* are also quite special compared to other market segments (see Figure 7). *Direct payers* (by *private customers*) and *cost takeovers* (by *health insurances* or the *employer*) as well as *advertising* or *subsidies* (from diverse funding bodies) have to be differentiated as possible sources of the *revenue streams*. The role of the payer (be it the patients or a health insurance) might as well come together with a will to shape the HIT solution. Onetime or periodically *pricing* might be possible [5, 28, 35]. *Indirect fees* that are not paid in every case like *freemium* business models or in terms of access to customers or their data could also be chosen. Diverse payment schemes and BMs to cover the HITs' costs are possible here [37]. The *cost accounts* that are kept by the *service provider* may include expenditures for materials, marketing, facilities, legal issues or software development [5, 27].

Some further special aspects have to be considered for the HIT-BM(R) that are not part of the standard BMO at all. For example, the approach might be different with regard to *socio-cultural* and *disease-related aspects*. For example, an 80-year-old patient with motion restrictions is of course a different case as a 21-year-old patient with diabetes. *Ethical aspects* and *data protection* issues are especially relevant for the highly sensitive data and interventions that directly affect the patients [27 , 32].

4 Conclusion & Outlook

The advantageousness of HIT solutions has to be fully exploited against the background of the challenges of the (western) healthcare systems. The digitalization spares no-one. The chances of this change process have to be fully utilized. Often, too much technology-driven HIT solutions end as successful pilots. The business or the user needs are often not sufficiently considered. The concept of BMs is a suitable mean to bring together these different perspectives. BMRs are ways to visualize BMs. Again, the specifics of the healthcare domain have to be broadly taken into consideration. The observed implementation barriers of HIT solutions could be diminished by gathering a sufficient part of the domain knowledge and in turn increasing the organizational fit [38]. An ontology is a reasonable mean to ensure this. In the present paper, we have shown how the BMO as the ontological basis of the well-known BMC could be prototypically extended to reflect HIT-specifics. This compilation of relevant semantic constructs forms the basis for a suitable HIT-BMR [19]. Processual aspects (which are central in the e^3-value model for example) have to be considered as well. Other BMR approaches may also hold worthwhile concepts. Admittedly, the network of relationships of the presented classes bases on theoretical investigations in terms of the outlined literature study. Nevertheless, these have to be investigated more deeply. E.g., this could be done by conducting case studies using practice-oriented HIT solutions. Moreover, the interdependencies on the different model levels should be considered in more detail. So, the question is which effect has a change within the ontology or meta-model on the distinct BMR. Here, transfer rules have to be investigated in future research. Due to the primary user group of BMRs that is the management or strategic-oriented employees, the relation between the meta-model or ontology level and the graphic representation is more loose compared to classical enterprise modeling [12]. Furthermore, the use of meta-models is not common in areas outside ISR like management [19]. That makes it even harder to assume and substantiate a formal relation with the background of the use case. So, it is not exactly clear or conclusive what change in the BMC would be induced by changing the BMO. But for example, our proposal for concretizing the *Key Activities* related to HIT solutions has to be eligible when compiling the BMC for a distinct HIT solution.

Overall, a HIT-specific BMC, a HIT-BMR or a graphical approach in general is needed to let the practice benefit from the suggested ontology modifications and apply these. Having that, it could be used by stakeholders in the healthcare field to describe what a HIT solution should provide or how the value for the stakeholders can be derived [5, 13]. Further, a demonstration using a concrete HIT solution would be possible and

useful. A HIT-BMR could be evaluated by comparing the cases of having such with having none or having only a generic BMR approach. It could be assessed whether a higher effectiveness in describing or understandability of the HIT solution's value creation principles could be reached [20]. Respective investigations and evaluation procedures would be needed.

Thinking visionary, a broadly substantiated and domain-specific BMR (having a broad set of agreed semantic constructs) would allow a stronger or unrestrained connection to the classical approaches of enterprise/business process modelling [19]. The communication gap between the medically trained and the management or IS employees within healthcare organizations could be reduced [9, 34]. This would also support innovative overarching care concepts. BMRs can contribute to such an aspiration as this requires methodical and technical support with a coherent set of methods and models allowing the stakeholders to connect, align and collaborate [34].

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Is Open Always Better? - A Taxonomy-based Analysis of Platform Ecosystems for Fitness Trackers

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Abstract. The wearable fitness technology sector is growing steadily as a result of the increasing miniaturization of sensors and the rapid rise of the mobile internet. In this context the use of fitness trackers promises the consumer the provision of personalized health services. This additional value cannot be achieved by a single company but is realized by a multitude of different actors that collectively create value within platform ecosystems. In order to understand their structure and properties and get a current market overview, a taxonomy to analyze wearable fitness technology platform ecosystems is developed following the methodology by Nickerson et al. [1]. The empirical-to-conceptual approach is conducted by applying the flagship fitness tracker of the ten highest rated manufacturers as a fundamental platform technology. Using the taxonomy four clusters could be identified that primarily distinguish the fitness tracker companies regarding their openness to consumers and developers.

Keywords: Fitness tracker, wearable fitness technology, platform ecosystem

1 Introduction

Fitness tracker offer the potential to provide personalized and ubiquitous health services to consumers [2]. Through their numerous sensors and functions, they enable and empower users to track and change their habits to lead a healthier lifestyle. This can be either done for private application by using an app to analyze the recorded health data or in context with medical treatment where the physician receives the collected health data to improve the care of the patient. Global market revenue for fitness applications and wearables is estimated to be $ 9.6 million by 2021 [3] with a total number of 581.23 million users [4]. At this the greatest interest of consumers is in the area of wrist-worn fitness wearables with integrated sensors and medical devices that enable the transmission of health data [5]. The wearable fitness technology market is composed of different manufacturers and third party suppliers which creates interdependencies within the value chain on the one hand but also causes divergent requirements for transmission standards and operating system compatibility on the other hand. The market will continue to grow further which opens up a high potential in the wearable fitness technology sector and offers the actors involved the opportunity to contribute to

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an improvement in digital health care [6]. Often, the consumer is in the focus, whose use is to be enhanced by the application of fitness trackers and health apps in a prosperous ecosystem.

To understand the necessary activities a company needs to perform in order to create value, usually the underlying business model is analyzed. In the case of fitness trackers, the business model approach cannot be limited to the value creation of one individual company. Instead, the shared but distributed creation of value must be captured within a platform ecosystem and its complementors.

In the literature there are numerous models for business model analysis, such as the frequently used business model canvas [7], but these primarily consider the value that is added within a company or by cross-company collaboration, but do not take into account the specific characteristics of the wearable fitness technology sector. Here, platform-specific aspects [8] as well as special features of business ecosystems [9, 10] have to be integrated into the analysis. To the best of our knowledge no taxonomy could be identified in the scientific literature, that also includes both platform and ecosystem aspects in connection with the wearable fitness technology sector.

2 Theoretical Background

In this work fitness trackers serve as a practical example to analyze platform ecosystems. The term wearable fitness technology is thereby understood as applications which are related to the healthcare sector while they are operated on mobile devices such as wearables, smartphones or tablets [6]. This enables and empowers the consumer to care about personal health independently by overcoming geographical, temporal and organizational boundaries [11].

2.1 Platform Ecosystem

Platform ecosystems change the way competition takes place on the market. This implies that the most successful company is not inevitably the manufacturer of the best technological product but rather the holder of a superior platform strategy that is part of a prosperous ecosystem [12]. To be precise this means a set of actors whose interaction takes place based on a technological platform which results in a number of application and service solutions [13]. New networks are created which do not only comprise different business units of a single company, but rather involve multiple business units of external companies as well. Consequently, the consideration of the entire ecosystem including external entities is necessary to guarantee superior business performance. These external entities or third party suppliers are called complementors and offer products or services that are based on the platform technology and increase its value [12]. In this context the existence of a common platform technology is essential to enable successful cooperation between different entities [14].

The platform architecture influences the degree of collaboration within the ecosystem and the design of the technological basis affects how well the surroundings respond to the platform [8]. If a company wants to make its platform technology prevalent within the industry the technology must be open to complementors.

Furthermore, incentives for companies to join the associated ecosystem need to be given [12]. On the one hand, this openness is defined by the property rights of the platform technology and on the other hand by the possibility to use, modify, extend and spread these platform assets [15]. In this context, the concept of network effects explains how an increased user base enhances platform attractiveness for developers, leading to an increased offering of products and services which in turn stimulates user growth [12].

Once the consumer joined the platform, there can be barriers and switching costs which lock the consumer in due to the incompatibility of the platform technology [16]. This can be intended by the platform leader to bind the consumer to the technology and keep him inside the provided ecosystem. Another way to control the platform ecosystem lies in the management of boundary resources [17]. In digital ecosystems these are often represented by Application Programming Interfaces and Software Development Kits which are the tools that enable developers to create complementing applications. Thereby the design of boundary resources is a difficult decision for the platform leader between motivating external developers to enter the platform and retain platform control [18]. This also refers to the feature of digital innovation in platform ecosystems and the concept of generativity which is defined as the platform's ability to generate change that was not anticipated and is caused by the contribution of a wide and diversified audience whose actions are not filtered [19].

2.2 Fitness Tracker

The easiest and prevalent way for consumers to track their personal fitness level and health condition is by using fitness trackers. They help to collect, track and monitor health data which enables private users to prevent health problems and integrate a healthy lifestyle into their daily routine [20]. In this work a fitness tracker is defined as wrist-worn wearable fitness technology that uses integrated sensors to collect health data of the carrier [21]. The wearable device itself is complemented by a companion application that makes it develop its full functionality by synchronizing the data to the smartphone and performing aggregation and analysis activities as well as showing the health data history. For this reason, the mobile application is also part of the analyses. The fitness tracker is the first contact point of the consumer who wants to track fitness and activity data and make use of personalized health services. For this reason, it defines the technological basis of further integration possibilities with additional products and services as well as interaction activities with other users or medical professionals.

3 Research Methodology

The purpose of this taxonomy is to contribute to scientists' understanding of wearable fitness technology platform ecosystems. The conducted analysis is coming from a fitness tracker point of view, which builds the starting point of the interaction from the consumer with the ecosystem. From a one-dimensional perspective, in which only the

classification of a single fitness tracker model is considered, the taxonomy serves to get an overview of the surrounding ecosystem of a fitness tracker and which value is offered to the consumer, from the wearable manufacturing company itself as well as from the complementary ecosystem. A multi-dimensional perspective, in which the classification of different fitness wearable manufactures is compared to each other, helps to analyze the current market situation and to determine different structures and strategies of wearable fitness technology platform ecosystems.

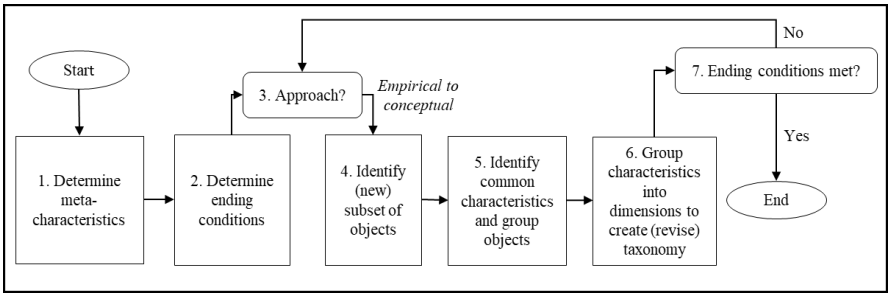


Figure 1. Methodology for taxonomy development [1]

The process of taxonomy development thereby follows the methodology defined by Nickerson et al. [1], who developed a method that is especially suited for taxonomy development in information systems. Based on the aforementioned purpose of the taxonomy, the features of fitness trackers concerning technology and services build up the meta characteristics of the taxonomy. The ending condition is set by the objective that a representative sample of objects has been examined. The approach that is followed is empirical-to-conceptual because a lot of data about fitness trackers is available. The subset for this approach is defined of the ten highest rated fitness trackers. These are the most successful wearable technology devices on the market for which a lot of detailed information is accessible. Having reviewed this representative sample of fitness trackers, the ending condition of the taxonomy development process is met.

The systematic sample of the fitness tracker sector was conducted by combining the market and consumer point of view. To do so the market share of wearable fitness technology manufacturers from the first quarter 2017 was taken as a basis [22] and complemented by the first ten results of a Google search for the term “fitness tracker rating 2017” where magazines, fitness bloggers or consumers evaluate fitness trackers regarding their functionality. The selection was made on basis of the manufacturing company and not on the foundation of single fitness tracker models. For every (single and multiple) fitness tracker model reference in one of the reviews each manufacturer obtained one point on the consumer side. The manufacturer with the highest market share obtained ten points, the second highest nine points, etc. on the market side. So in each category ten points maximum could be reached. Finally, the ten highest assessed manufacturers were selected. Subsequently the official website or web shop of the manufacturer was used to identify the flagship fitness tracker of the company which means the device with the highest range of functionality and a price limit of 400€ so it still comes within the field of the average health-oriented consumer who is not

professionally obliged to track fitness and activity data. Furthermore, we assume that the flagship fitness tracker includes the same functionality and more than the models with a lower range of functionality do. Figure 2 illustrates the sample of the ten highest rated manufacturers as well as their identified flagship fitness trackers.

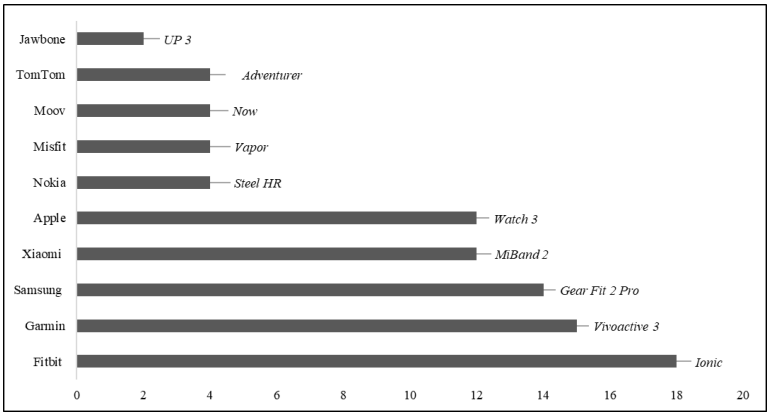


Figure 2. Rating of fitness tracker manufacturers and choice of fitness tracker model

The next step in an inductive taxonomy development process, is the analysis of these empirical cases to define common characteristics which are matching the predefined meta characteristics. To do so the flagship fitness tracker model was analyzed in an online research process which was conducted during September 2017. The evaluated data is publicly available and comes from a variety of online sources which comprise the manufacturer website, user guide, privacy policy, technology and fitness blogs, fitness tracker tests, video reviews, press articles, developer guidelines and the test of the fitness tracker companion app itself. Sources that comprise official information from the manufacturer were preferred to e.g. fitness blogs which may be subjectively biased by the author. Only if the services and functions are officially supported by the manufacturer they are taken into account for the data collection. For each fitness tracker model the meta characteristics were collected and thereby common characteristics of the objects were identified. Following the selected set of characteristics was grouped into dimensions which were each considered to be mutually exclusive and collectively exhaustive [1].

Subsequently the established framework for analyzing the layered modular architecture of digital technology created by Yoo et al. [23] is used to further classify the derived dimensions. The framework serves to analyze the new organizing logic of digital innovation and thereby focuses on product innovation, which means that a novel good is produced by combining physical and digital elements in a new and yet unknown way. The new combination has to be based on digitization and make the firm reconsider existing structures regarding its organization and information technology. Fitness tracker fulfil these given requirements and thereby meet the criteria to be defined as a digital innovation. For this reason, the layered modular architecture of digital technology is taken as a further classification of the derived taxonomy dimensions for platform ecosystems in the field of wearable fitness technology. Additionally, we

distinguish between platform and ecosystem characteristics. The resulting taxonomy is displayed in Table 1. The dimensions colored in dark and mid grey represent the categories that were adopted from Yoo et al. [23].

Table 1. Taxonomy for the analysis of platform ecosystems for fitness trackers

Dimension		Platform sub dimension	Platform characteristics	Ecosystem sub dimension	Ecosystem characteristics
Device layer	Logical capability	Native operating system	*Available*	Mobile operating system	*iOS* *Android* *Windows Mobile*
			Unavailable	Stationary operating system	*MacOS* *Windows* *Linux* *Browser*
	Physical machinery	Display technology	*Digital colour display* *Digital monochrome display* *Analog display* *No display*	External accessories	*Health accessory (blood pressure sensor, sleep sensor, scale)* *Lifestyle acccessory (smart button, lights, intelligent personal assistant)* *Music accessory (bluetooth headhpones, bluetooth speaker)* *Sports accessory (cadence sensor, heart rate chest strap)* *Fashionable accessory (jewelry straps, necklaces)* *Pet accessory (smart collars)*
		Service life	*1-3 days* *3 - 7 days* *1-2 weeks* *more than 2 weeks*		
		Water resistance	*Available* *Unavailable*		
		Integrated sensors	*Optical heart rate sensor* *Bioimpedance sensor* *Accelerometer (linear acceleration)* *Gyroscope (angular acceleration)* *Magnetometer/compass* *GPS sensor* *Altitude sensor/altimeter/barometer* *Temperature sensor* *Ambient light sensor* *SpO2 sensor* *Capacitive sensor*		
		Interaction functionality	*Microphone* *Vibration motor* *Voice feedback* *Haptic feedback/taptic engine*		
		Proprietary technologies	*Available* *Unavailable*		
		Internal music storage	*Available* *Unavailable*		
		Accessories	*Health accessory (blood pressure sensor, sleep sensor, scale)* *Lifestyle acccessory (smart lights, intelligent personal assistant)* *Music accessory (bluetooth headhpones, bluetooth speaker)* *Sports accessory (cadence sensor, heart rate chest strap)* *Fashionable accessory (jewelry straps, necklaces)* *Pet accessory (smart collars)*		
		Storage duration of health data on device	*1-3 days* *3 - 7 days* *1-2 weeks* *More than 2 weeks*		
Transmission layer		Transmission standard	*Cellular (LTE/UMTS)* *Bluetooth (BLE/Smart)* *WiFi* *NFC* *ANT/ANT+*	Transmission standard	*Cellular (LTE/UMTS)* *Bluetooth (BLE/Smart)* *WiFi* *NFC* *ANT/ANT+*
Service layer		***Customer***		***Developer (private)***	
		Native application	*Available* *Unavailable*	Application Programming Interface	*Available* *Unavailable*
		App store for native apps	*Available* *Unavailable*	Software Developmet Kit	*Available* *Unavailable*
		Mobile application	*Distributed functionality* *Central functionality*	Native app programming language/standard	*JavaScript* *Java* *Swift 4* *HTML5* *CSS/SVG*
		Application functionality	*Basic functionality (display of health data)* *Medium functionality (consolidation and aggregation of health data)* *High functionality (interpretation of health data and additional services)*	Tutorials and documentation	*Available* *Unavailable*
		Smartphone notifications	*Available* *Unavailable*	Developer community	*Available* *Unavailable*
				External company (corporate)	
				External application	*Competing functionality* *Complementary functionality*
Contents layer		Memory location of user data	*Offline - local storage* *Online - cloud storage*	Integration of external databases/app data	*Available* *Unavailable*
		Data export	*Available* *Unavailable*		

4 Findings

The dimensions and characteristics of the derived taxonomy serve to categorize different wearable fitness technology platform ecosystems and therefore show the differences in properties from which strategies of companies can be inferred. But while building the dimensions of the taxonomy some characteristics occurred to be identical for all fitness trackers, their companion app or the complementing ecosystem. These are not part of the final taxonomy because they cannot be used to distinguish between companies though still provide an indication which characteristics are taken as basic prerequisites in the wearable fitness technology sector.

4.1 Market findings – Similarities

The first similarity is noticed in the field of user data collection and data security. There is a necessity to create a user account to use the fitness tracker and application. Also the activities of data usage and data collection which are conducted on the personal data associated to the user account as well as on anonymous data (according to the privacy policy of the company) are very similar among the evaluated manufacturers. All companies offer or enforce to store the health data in the cloud. There is no company that guarantees the server location for data storage is in Germany, which means data protection laws from different countries, mostly America, can apply.

The second characteristic all ecosystems have in common is the integration of Social Media services as well as the offering of additional community or blog services. Usually the companion app offers the function to post personal activity or workout data by an in-app button on Facebook or Twitter. Also every company offers a community or blog function where users can interact with each other or get additional information regarding fitness, health or technology related topics.

The third similarity is the untethered transmission of health data. Obviously all fitness trackers in the wearable fitness technology sector offer wireless transmission from the device itself to a smartphone or tablet. The transmission standard that is used on every device and thereby represents the norm is Bluetooth, in most cases in the version Bluetooth Low Energy/Bluetooth Smart.

4.2 Clustering the Market based on Distinctive Characteristics

The final taxonomy was completed for every manufacturer to derive clusters of wearable fitness technology platform ecosystems. For this purpose, a consolidation of the sub dimensions in which the wearable fitness technology platform ecosystems differ noticeably was conducted. Figure 3 shows the aggregated sub dimensions and the aggregation logic to derive cluster archetypes. Based on this, Figure 4 depicts the resulting clusters. These consider two main dimensions, *openness to consumer* and *openness to developer*. That is, because the success of a platform highly depends on its surrounding ecosystem [24] which is defined by external companies that need to be incentivized to create complementing products and services [12]. There are two different strategies to open the platform: (1) open-up the market and grant access to the

platform to reach further consumer segments or (2) give up control of the platform itself [25].

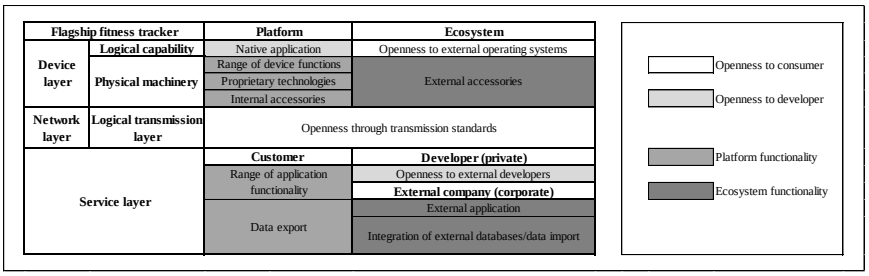


Figure 3. Aggregated taxonomy to derive platform ecosystem clusters

The first cluster dimension, *openness to consumer*, shows the interoperability with external operating systems and transmission standards which determine the way and by whom fitness trackers and their companion application can be used and thereby shows how open the market is. Wearable fitness technology platform ecosystems that are very open to consumers can be used without any prerequisite regarding operating system or transmission standard and are positioned on the right side of the cluster. Those that are closed are depicted on the left side of the cluster and impose some technological and software requirements which makes them just available for a limited audience.

Second, *openness to developer* is defined by opening the possibility for developers to program native and mobile applications complementing the fitness tracker and its application's functionality. In connection with this there is a native operating system, native and mobile app store [24], native programming language as well as API and SDK. For this reason, independent and external developers are able to program applications that natively run on the fitness tracker itself and use its collected sensor data so the platform owner partly gives up control. Companies that offer many possibilities for external developers to design complementing applications are located at the top of the cluster, the ones that do not offer them at the bottom.

Additional to this dimensions, Figure 4 displays the range of functionality that is offered to the consumer through the platform itself and the surrounding ecosystem. For the platform point of view this means the range of functionality of the fitness tracker and the companion application, existence of proprietary technologies and internal accessory as well as the possibility to export the data. From the ecosystem perspective it is defined as the range of functionality of external accessory, the existence of complementary external applications as well as the possibility to integrate data from external databases or apps. The platform's own range of functionality is represented by the dark blue colored circuit. The ecosystem's range of functionality is depicted by the size of the light blue colored circuit. The overall size of both circuits together shows the range of functionality that the platform ecosystem as a whole offers to the consumer.

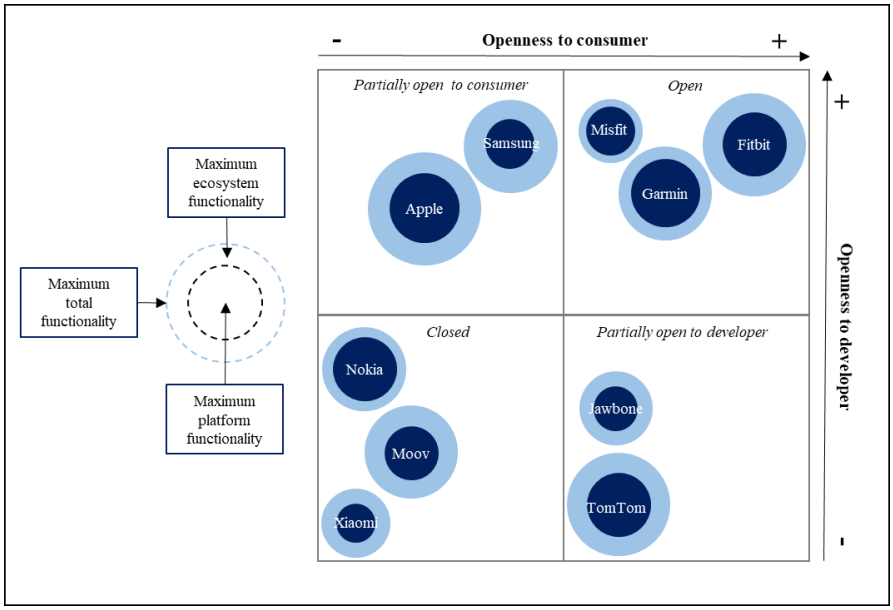


Figure 4. Four cluster of wearable fitness technology platform ecosystems

The first cluster is represented by Samsung and Apple. Their fitness trackers are surrounded by a large ecosystem and equipped with a native operating system but they only open their platform to complementary products and services that are based on their "own" mobile operating system which is iOS for Apple and Android for Samsung. Both companies are originally not located in the wearable fitness technology sector and therefore could be influenced by their already established ecosystem that they try to expand further.

The second cluster encompasses Garmin, Fitbit and Misfit. All three company strategies follow the proposition for platform producers by Cusumano and Gawer [26] to not develop own complementary products if the capabilities to compete in this area are not present by designing the parts of the platform ecosystem themselves where they already own or gained special knowledge. Fitbit bought Pebble [27] a company that formerly designed smartwatches so they are able to introduce their own native operating system, Fitbit OS and thereby open up their platform even more to external developers. Misfit decided to equip its newest fitness tracker with Android Wear 2.0 and not a proprietary native operating system as planned earlier. By doing so Misfit is able to appropriate the value that is already existing and take advantage of the network effects [12] of the Android Wear developer community and native app store. Garmin originally comes from the navigation sector and derives benefit from existing knowledge in the

area of positioning by offering detailed GPS and compass functionality as well as features like golf course maps.

The third cluster includes Jawbone and TomTom. Both companies are open to consumers by being interoperable with different external operating systems and transmission standards but are still closed for external developers only offering an API and some developer support.

Xiaomi, Moov and Nokia form the fourth cluster. All companies are not open to all popular operating systems nor do they offer native operating systems. While Xiaomi and Moov only offer one fitness tracker, which in case of Xiaomi is very limited in device functionality, Nokia still lacks in external accessory additionally to the own health and lifestyle accessory that was acquired from Withings [28].

5 Discussion

Applying the taxonomy, market findings could be derived that mainly support the theories in platform ecosystem literature. Basole and Karla examined the structure of mobile platform ecosystems and concluded that although many new platforms have emerged no dominant and market wide standard could be established [24]. In the wearable fitness technology sector some recurring and market wide patterns regarding transmission standards, user data management and social interaction functions could be identified but there is still a high fragmentation in the area of fitness trackers and applications themselves. Furthermore, the strategy of manufacturers highly differs in their degree of openness to consumers and developers.

The choice of clusters can be validated by looking at the range of functionality of the platform ecosystems. Based on the assumption that (1) the range of an ecosystem's functionality determines platform success [24] and (2) the more open a platform is designed the more complementing innovation is developed by its ecosystem [25], the most successful companies should be rated high for at least one dimension of openness. In this context successful companies are defined as those who offer a high range of total platform ecosystem functionality to their consumers. In Figure 4 this applies most of the time with the largest circuits being placed in the *open* or *partially open to consumer/developer* cluster. Outliers can be identified looking at Misfit and Jawbone. For Misfit the small ecosystem can be explained because they just opened their platform by using Android Wear 2.0 as a native operating system for their newest fitness tracker. The benefits of the network effects of the Android developer community still need to be realized to appropriate value in the future. Jawbone is open to all popular operating systems and offers an API as well as developer support but lacks in the functionality of the fitness tracker itself. Still the device does not have a display and is only equipped with three internal sensors. So the core architecture of the product itself is not developed which is necessary to become successful and attract innovative complementors [26].

6 Conclusion

To summarize, we proposed a taxonomy for the analysis of platform ecosystems for fitness trackers. It was derived using empirical data of the ten highest rated flagship fitness tracker models. The completed taxonomies show that while some similarities exist the market is still fragmented. Furthermore, we proposed a cluster that considers two main dimensions, *openness to consumer* and *openness to developer*. It displays that companies differ in their degree of openness and there is no prevalent market strategy. In addition, we rated the total range of functionality that is offered by the fitness tracker manufacturers. Relating this to the openness of the platform ecosystem we could observe that companies which are considered open in at least one dimension offer a higher range of functionality overall. Assuming that the range of functionality equates consumer benefit we propose that companies which pursue an open strategy are more successful.

The limitations of the study are the selection of manufacturing companies and fitness tracker models. Given our sample size of ten devices the wearable fitness technology market cannot be represented completely. The assignment of characteristics may be biased by subjective interpretation of the researcher.

Further research could increase the sample size of evaluated fitness trackers and number of coding researches. Additionally, the link of certain platform ecosystem structures to market performance indicators of the manufacturer could be addressed and success factors derived. In doing so some structures could be identified as more effective than others. Furthermore, there is the opportunity to include also accessory and complementing apps of a third, fourth, etc. tier. This would result in a large interrelated network of fitness products and applications and also show the cooperation and interrelation of the analyzed companies in-between each other.

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Patientenkompetenz durch Online-Portale – Eine Funktionsanalyse

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Abstract. Patientenportale spielen eine zentrale Rolle bei der Umsetzung von patientenzentrierter Versorgung. Um die intendierten Effekte einer aktiven Patienteneinbindung zu erreichen, ist die bedarfsgerechte, am Krankheitsbild orientierte Gestaltung von Patientenportalen essentiell. Einen Aspekt bildet dabei funktionale Ausgestaltung. Bislang existieren jedoch wenige Untersuchungen zu möglichen Patientenportalfunktionen. Dies kann zu Spezifikationslücken bei der Anforderungserhebung für neue Portale führen. Die Arbeit adressiert diese Problematik, indem bestehende Patientenportale auf ihre funktionale Ausgestaltung untersucht werden. Auf Basis einer qualitativen Analyse konnten 40 Funktionen aus 27 Patientenportalen identifiziert werden, die zu acht Funktionskategorie zusammengefasst wurden. Dadurch kann die Anforderungserhebung für Patientenportale durch einen Funktionskatalog unterstützt werden.

Schlüsselwörter: Patientenportal, Funktionen, Patient Engagement, Patient Empowerment, Patientenkompetenz, Qualitative Inhaltsanalyse.

1 Einleitung

Patienten spielen in modernen Versorgungsszenarien als aktiver Partner eine wichtige Rolle. Die Beteiligung von Patienten insbesondere in der einrichtungsübergreifenden medizinischen Versorgung rückt dabei zunehmend in das Betrachtungsfeld der professionellen Gesundheitsdienstanbieter [1]. Das Spektrum der Patientenbeteiligung erstreckt sich heute vom informierten und motivierten Patient bis zum Patient als Manager der eigenen Erkrankung mit einem hohen fachspezifischen Wissen. Eine oft genannte Differenzierung findet sich in den Begriffen des Patient Empowerments und des Patient Engagements. Patient Empowerment zielt auf die Ermächtigung des Erkrankten an seiner Gesundheitsversorgung mitzuwirken und spiegelt somit Fähigkeiten und Kapazitäten des Patienten wider [2]. Patient Engagement beschreibt nach DEERING UND BAUR die Motivation und Unterstützung des Patienten an der Verbesserung seines Gesundheitszustandes mitzuarbeiten und aktiv Einfluss auf diesen zu nehmen [3]. Verbunden mit der stärkeren Einbindung des Patienten sind häufig partizipative Entscheidungsprozesse [4]. Grundsätzlich besteht jedoch zwischen Arzt und Patient Informations- und Wissensasymmetrien. Ärzte verfügen über Expertenwissen, welches sich al-

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lenfalls Patienten mit einer längeren Krankheitshistorie und hoher Selbstkompetenz erschließt [5]. Um Patientenbeteiligung zu ermöglichen und Informationsasymmetrien abzubauen, wird aktuell die Rolle von Patientenportalen diskutiert [6] und prototypische Anwendungen in Gesundheitsregionen [7, 8] umgesetzt.

Die Gestaltung bedarfsgerechter Patientenportale stellt eine Herausforderung für Systementwickler und medizinische Fachexperten dar. Vor allem in Bezug auf Funktionalität stellt sich die Frage, welche Funktionen im Kontext eines bestimmten Krankheitsbildes benötigt werden. So ist der Bedarf eines Diabetes-Patienten, für den Informationen zur Medikation und Lebensführung wichtig sind [9], ein anderer als der für einen Patienten mit Herzinsuffizienz, die vor allem am Symptommanagement seiner Erkrankung interessiert ist [10]. Auch die Patientenkompetenz ist nicht für jeden Patienten identisch und bildet eine höchst individuelle Eigenschaft [5]. Entwickler von Patientenportalen sind mit dem Anspruch konfrontiert, dem Patienten eine versorgungsrelevante und individuelle Funktionalität zur Verfügung zu stellen, ohne dass dabei die medizinische Güte beeinträchtigt werden darf. Existierende Arbeiten fokussieren dabei primär die Fragen der Architekturgestaltung und die Bereitstellung der elektronischen Patientenakte [8, 11]. Die Möglichkeiten der funktionalen Ausgestaltung sind jedoch breiter. Ein Überblick über mögliche Portalfunktionen existiert bislang nicht. Dadurch können bei der Neukonzeption und der Anforderungserhebung notwendige Funktionsbedarfe unerkannt bleiben, da sie durch den Patienten oder Ärzte als Anforderungen nicht geäußert und durch den Anforderungsanalysten nicht erfragt werden. Es entsteht das Risiko, Patientenportale am Patientenbedarf vorbei zu entwickeln. Dieses Phänomen ist auch als Spezifikationslücke bekannt [12]. Diese wird durch die erwähnte Informationsasymmetrie zwischen Arzt und Patient noch verstärkt, da Patienten nicht zwangsläufig wissen, welche krankheitsbezogenen Funktionen ein Patientenportal aufweisen sollte, um eine erfolgreiches Selbstmanagement sicherzustellen.

Das vorliegende Papier adressiert diese Lücke. Auf Basis einer qualitativen Auswertung 27 existierender Patientenportale wurden 40 versorgungsrelevante Funktionen identifiziert. Diese Funktionen wurden in acht Funktionskategorien systematisiert. Dadurch entsteht ein Katalog für Patientenportalfunktionen, der bei der Neukonzeption die funktionale Anforderungsanalyse unterstützen kann. Somit kann die Arbeit zu einer bedarfsadäquaten Gestaltung von Patientenportalen beitragen und das Risiko für Fehlentwicklungen senken.[1]

Die vorliegende Arbeit ist wie folgt strukturiert: In Abschnitt 2 stellt die Grundlagen vor. Insbesondere werden Portale als Werkzeug des internetbasierten Informationsmanagements diskutiert und die sich daraus ergebenden Potentiale für die Patientenbetreuung eingeführt. Weiterhin gibt Abschnitt 2 einen kurzen Exkurs zu Bedeutung von Softwarefunktionen im Bereich der Anforderungsanalyse. Abschnitt 3 stellt Erhebungs- und Analysemethode für Patientenportale vor und erläutert die Analyseeinheiten. In Abschnitt 4 werden die Ergebnisse der Analyse dargestellt und zu einem Funktionskatalog zusammengefasst. Abschnitt 5 beschreibt die Einordnung der Ergebnisse in ein Patient Engagement Framework und geht auf Restriktionen der Studie ein. Abschnitt 6 schließt mit einem Fazit und Forschungsperspektiven.

[1] Dieser Beitrag entstand im Rahmen der EFRE-geförderten Projekte „IBMS“ und „Tele-NePS“.

2 Grundlagen

2.1 Portale als Werkzeug des internetbasierten Informationsmanagements

Digitale Portale werden als besonders flexibles Werkzeug zum internetbasierten Informationsmanagement genannt [13]. Ein Portal ist „eine personalisierte, benutzerfreundliche Website, mit deren Hilfe diverse Informationen und Funktionen zugänglich sind und die von einer Vielzahl menschlicher Benutzer […] zum Einstieg in einen bestimmten Bereich des World Wide Web benutzt wird“ [14]. Dabei sind drei Kriterien für die Portaleigenschaft ausschlaggebend: die Nutzungsintensität, der Funktionsumfang und die Personalisierbarkeit [14]. Die Personalisierbarkeit lässt sich als Unterscheidungsmerkmal zwischen Portalen im weiteren und Portalen im engeren Sinn nutzen [15]. Portale im weiteren Sinne dienen lediglich als Einstiegsseiten zu speziellen Themenbereichen (Gateway) [15]. Portale im engeren Sinn stellen durch ihre Personalisierbarkeit ein für den Benutzer individualisiertes Funktionsportfolio zur Verfügung [16].

Eine Differenzierung zwischen Portalen kann anhand des abgedeckten Themenspektrums vorgenommen werden. So kann zwischen horizontalen und vertikalen Portalen unterschieden werden [14]. Vertikale Portale sind im Gegensatz zu horizontalen auf bestimmte Interessen oder Themen fokussiert und führen zu spezifischen Informationen oder Funktionen [14]. Weiterhin lassen sich Portale hinsichtlich ihres Nutzerkreises unterschieden. Offene Portale offerieren ihr Informations- und Funktionsangebot der Öffentlichkeit und sind nicht auf Nutzergruppen beschränkt. Damit verbunden ist nicht zwangsläufig die Existenz eines Registrierungsprozesses. Vielmehr weisen Nutzergruppen eines geschlossenen Portals ein gemeinsames Populationsmerkmal auf [14].

2.2 Patientenportale – Stand der Forschung

Über ein Patientenportal soll ein Nutzer seine persönlichen Gesundheitsinformationen einsehen und verwalten sowie auf deren Grundlage individualisierte Services anwenden können [17]. Sie erfüllen daher das Kriterium der Personalisierbarkeit und können als Portale im engeren Sinn verstanden werden. Die Breite der erreichbaren Themengebiete ist durch die Orientierung an der medizinischen Versorgung begrenzt, wodurch Patientenportale eher dem Wesen eines vertikalen Portals entsprechen. Die Intention der Portalbetreiber entscheidet daher den Nutzerkreis des Portals. Nutzer eines Patientenportals erhalten ihren Zugang über das Internet und greifen auf Ressourcen zu, die ihnen ebenfalls über das Internet bereitgestellt werden. Zumeist fokussieren die Portale dabei spezifische Krankheitsbilder (z. B. [18]) oder andere medizinische bzw. administrative (z.B. Kassenmitgliedschaft) Populationsmerkmale, sodass es sich eher um Portale mit geschlossenen Nutzerkreisen handelt. Eine weitere Differenzierung kann nach Patient-Patient-Portale und Patient-Arzt-Portale vorgenommen werden [19]. Als Patientenportale zählen in der vorliegenden Arbeit webbasierte Anwendungssysteme, die ein persistentes als auch personalisiertes Informations- und Funktionsangebot für die individuelle Gesundheitsversorgung anbieten.

Im Zuge einiger Fachbeiträge werden Patientenportale mit den Themen „Electronic Health Record” (EHR) oder „Personal Health Record” (PHR) vermischt [20]. Zwar

kann eine thematische Verknüpfung unterstellt werden, jedoch sollten sie nicht als Synonyme gelten. EHR steht für die integrative und kooperative Digitalisierung der patientenbezogenen Daten- und Informationsflüsse zwischen allen Beteiligten der Gesundheitsversorgung [20]. PHR fügt dieser Idee den Aspekt der Selbstbestimmung des Patienten hinzu, indem er seine persönlichen Gesundheitsdaten aus diversen Quellen bezieht, sammelt, in Verbindung setzt und nach eigenem Ermessen mit anderen Personen teilt [3]. Ein Patientenportal muss nicht zwangsläufig dem Wesen eines PHR oder EHR entsprechen. Gleichwohl kann es aber als „Einstiegstor" zu eben jenen Diensten ausgelegt werden. Grundlegend stehen Aspekte der Entwicklung oder Evaluierung von Patientenportalen oder ihren Funktionen im Fokus aktueller Forschung. Dabei steht ihr Mehrwert sowohl in der Versorgungsqualität als auch in der ökonomischen Effizienz im Vordergrund [20]. Insbesondere im Kontext von chronischen Krankheiten wird Patientenportalen großes Potenzial zugesprochen [21]. Die stetige technologische Entwicklung des Themengebiets äußert sich in unterschiedlichen Funktionsportfolios und Einsatzkontexten. Aus diesem Grund ist es für die Wissenschaft schwierig, die Effektivität und Effizienz nachzuweisen [3]. Im Allgemeinen wird ihnen aber durch eine verbesserte Arzt-Patienten-Kommunikation eine Schlüsselrolle bei der Umsetzung von Patient Empowerment und Patient Engagement zugesprochen [3].

Funktionsorientierte Untersuchungen finden sich in der aktuellen Forschung vor allem mit Bezug zu Einzelfunktionen. HAACK ET AL. besprechen beispielsweise die Entwicklung eines Themenmoduls zu Darmkrebsfrüherkennung für das Frauengesundheitsportal der Bundeszentrale für gesundheitliche Aufklärung (BZgA) [22]. HONEKAMP entwickelte einen Prototyp zur anamnesebezogenen, internetbasierten Information von Kopfschmerzpatienten und bestätigte seine Effektivität [23]. Die funktionale Ausrichtung von Patientenportalen schließt auch weitere, nicht-krankheitsbildspezifische Aspekte ein. So existieren Internetportale zur Krankenhausauswahl, in welchen die Institutionen anhand qualitativer Kriterien bewertet werden können [24]. Ebenfalls kann die Kostenperspektive für den einzelnen Patienten eine entscheidende Rolle spielen. So ermöglichen Patientenportale beispielsweise den Kostenvergleich zahnmedizinischer Leistungen [25].

2.3 Softwarefunktionen als Erkenntniseinheit

Die Funktionen einer Software resultieren aus den Anforderungen, die in einem konkreten Nutzungskontext unter Erwartung eines konkreten Ergebnisses und eines konkreten Systemverhaltens an diese formuliert werden [26]. Das Verständnis, was eine Funktion im Kontext von Software ist, unterscheidet sich je nachdem, ob man sich im Bereich der Programmierung, Softwaretechnik oder der Anforderungsanalyse bewegt. Nach IEEE kann eine Softwarefunktion als Zusammenhang mehrerer Funktionen im Sinne einer Produktfunktion verstanden werden. Dagegen adressiert nach IEEE der Begriff „Funktion" das Basisverhalten einer Software[27]. Nach dieser Definition kann zum Beispiel die Patientenverwaltung als Produktfunktion verstanden werden und die Möglichkeit zum Löschen eines Patienten als Funktion. Im Zuge des vorliegenden Papiers wird jedoch Funktion und Softwarefunktion synonym zu Produktfunktion verwendet, da der Fokus der vorliegenden Untersuchung auf den Produktfunktionen von

Patientenportalen liegt. Beispielsweise wird die Möglichkeit zur Dokumentation der eigenen Krankheitsgeschichte im Rahmen des vorliegenden Papiers als Softwarefunktion eines Patientenportals verstanden.

3 Methode

Zur Erhebung von Patientenportalfunktionen wurde eine qualitative Inhaltsanalyse nach MAYRING durchgeführt [28]. Sie gliedert sich in sieben Arbeitselemte (siehe Abbildung 1). Als Ausgangspunkt wurden folgende Forschungsfragen formuliert:

1. Welche elektronischen Patientenportale existieren derzeit am Markt?
2. Welche Funktionen bieten existierende Portale dem Patienten und wie lassen sich diese systematisieren?

Die Erhebung des Ausgangsmaterials fand im vierten Quartal 2016 statt. Initial wurde eine Auflistung von 120 Portalen sowohl über eine Recherche in wissenschaftlichen Datenbanken (EBSCO Health, JMIR, Google Scholar) als auch über Suchanfragen via Google-Suchmaschine ermittelt. Als Suchbegriffe wurden „Patientenportal", „Gesundheitsportal" und ihre englischen Synonyme gewählt. Aus dieser Menge ergab sich eine finale Selektion von 27 Portalen anhand zweier Kriterien: Erstens wurde die Personalisierbarkeit als Kriterium festgelegt. Es muss sich um ein Portal im engeren Sinne handeln und somit patientenindividuelle Funktionen aufweisen. Zweitens musste das Kriterium der medizinischen Versorgungsrelevanz erfüllt werden. Wellness- und Fitnessportale, die den gesunden Bürger adressieren, wurden somit ausgeschlossen. Das Analysematerial setzt sich aus den Texten der Portalwebsite sowie ggf. begleitenden Informationsdokumenten und wissenschaftlichen Beiträgen zusammen.

Da das Ziel die Identifikation der patientenseitigen Portalfunktionen war und existierende Funktionskataloge nach dem Wissen der Autoren noch nicht vorlagen, wurde die qualitative Inhaltsanalyse mittels induktiver Kategorienbildung durchgeführt [28]. Als Kodiereinheit wurde ein einzelnes Wort, als Kontexteinheit die Gesamtheit an Materialien bzgl. eines Portals und als Auswertungseinheit die jeweiligen Fundstellen im Ausgangsmaterial festgelegt.

MAYRING sieht zur Strukturierung der Analyseergebnisse „Kategorien" vor [28]. Dem folgend bilden im Rahmen dieser Arbeit die versorgungsrelevanten Portalfunktionen diese Kategorien ab. Nach Analyse etwa eines Fünftels des Ausgangsmaterials wurden die identifizierten Funktionen anhand des Forschungsziels überprüft. Anschließend wurde der finale Materialdurchgang durchgeführt. Den Abschluss bildeten die inhaltliche Interpretation der Funktionen sowie ihre Zusammenfassung zu Funktionskategorien. Diese stellen verschiedene abstrakte Einbindungskonzepte für Patienten innerhalb der medizinischen Versorgung dar. Insbesondere bei Materialdurchgang, Interpretation und Zusammenfassung arbeiteten die Autoren erst unabhängig voneinander und glichen ihre Ergebnisse nachträglich ab. Eine inhaltsanalytische Kritik finalisiert sowohl das Vorgehensmodell als auch dieses Papier.



Abbildung 1. Arbeitselemente der qualitativen Inhaltsanalyse nach MAYRING [28]

4 Ergebnisse

Korrespondierend zu den Forschungsfragen dieser Arbeit werden im Folgenden die Ergebnisbestandteile präsentiert. Erstens werden die identifizierten Funktionskategorien und Funktionen (siehe Tabelle 1) erläutert. Zweitens werden die identifizierten Portale anhand dieser Funktionskategorien beschrieben (siehe Tabelle 2). Damit wird eine Übersicht über die versorgungsrelevanten Portalfunktionen gegeben, welche bereits in der Praxis implementiert sind.

4.1 Identifizierte Portalfunktionen und Funktionskategorien

A - Nicht-personalisierte Gesundheitsinformationen*:* Patientenportale charakterisieren sich durch individualisierte Funktionalitäten, trotzdem werden auch nicht-personalisierte Gesundheitsinformationen angeboten. Dazu gehören journalistische Beiträge, Wissensmedien (Grafiken, Animationen, etc.), Lexika und Glossen sowie Angaben über Umweltdaten wie bspw. Pollenflugprognosen. Ebenfalls ordnen sich Downloadbereiche, welche das Speichern nicht-personalisierter Dateien erlauben und Datenrechner zur Ermittlung von Gesundheitswerten ein. Auch interaktive Lernprogramme sind dieser Kategorie zuzuordnen. Zwar entscheidet der Patient über den Verlauf des Lernprogramms, die Inhalte sind aber nicht patientenindividuell. Lernprogramme, die anhand von Patienteninformationen automatisiert Inhalte anpassen, sind denkbar, wurden jedoch innerhalb der durchgeführten Analyse nicht erkannt.

B - Dokumentation: Funktionen, die dem Patienten den Zugriff auf seine medizinischen Daten oder die Integration seiner individuellen Gesundheitsinformationen ermöglichen, können als Dokumentationsfunktionen verstanden werden. Die Informationsflüsse sind hier eher unilateral. Dazu zählen zum einen jene Funktionen, bei denen der Leistungserbringer für die Erstellung verantwortlich ist (z.B. die Bereitstellung von Befunden, Medikationsplänen und Zusammenfassungen von Arztgesprächen). Zusätzlich werden auch die patientengeführten Dokumentationsfunktionen „Verwaltung persönlicher Vitaldaten” sowie „Gesundheitliche Beschwerdeberichte” hierunter verstan-

den. Diese Funktionen entsprechen dem Prinzip des EHR. Die Funktion „Gesundheitsstatus“ spielt eine Sonderrolle. Hier wird u.a. auf Basis der eingebundenen Dokumentation ein aktueller Überblick über die Gesundheit des Patienten ermittelt.

C - Anamnese: Selbsttests und Symptomchecks dienen der Präzisierung der Beschwerden sowie der Erfassung und Berücksichtigung persönlicher Umstände. Damit ähneln sie einer initialen Anamnese. In den untersuchten Portalen wurden diese Funktionen nicht als umfängliches Substitut der Fachanamnese eines ausgebildeten Arztes verstanden. Sie dienen eher dem Verständnis der eigenen Erkrankung sowie der Edukation und sollen dem Patienten zur Vorbereitung von Arztgesprächen dienen.

D - Therapie: Die in existierenden Portalen angebotenen Entscheidungshilfen unterstützen den Anwender bei der Wahl zwischen Therapiealternativen. Automatisierte Handlungsempfehlungen weisen den Patienten an, erste Maßnahmen zur Verbesserung des Gesundheitszustandes zu unternehmen. Die Anwendung von Tutorials und Übungen adressieren eine mögliche Verbesserung der Krankheitsumstände oder deren Symptome. Diesen drei Funktionen ist eine therapeutische Ausrichtung gemein.

E - Kommunikation: Portale weisen Funktionen auf, die auf den individuellen Fachaustausch zwischen Patient und Arzt oder Patient und Patient abzielen. Der Austausch zwischen Personen mit vergleichbarer Krankheitsgeschichte wird in einigen Portalen durch Patientenforen realisiert. Analog können Patienten in Expertenforen ihre Probleme öffentlich mit Fachleuten teilen und besprechen. Ebenfalls werden Nachrichtendienste zur Kommunikation mit dem eigenen Gesundheitsteam angeboten. Eine weitere Funktion in dieser Kategorie bildet die Befundauswertung. Verschiedene Portale ermöglichen den Upload von Befunden oder Bildern (z.B. dermatologische Symptome) mit einer erläuternden Rückantwort durch einen medizinischen Fachexperten.

F - Administration: Patientenportale erlauben auch Einfluss auf die administrativen Prozesse zu nehmen. Dazu gehört die Möglichkeit medizinische Dienste zu identifizieren und Termine zu organisieren. Auch Terminerinnerungen und die Vorbereitung von Ein- bzw. Überweisungen wurden bereits in Patientenportalen implementiert.

G - Heilmittelversorgung: Die thematische Verbundenheit zwischen den Funktionen Rezeptverschreibung, Ausstellung von Folgerezepten, Medikamentenversand und Versand von Medizinprodukten wird in der Funktionskategorie Heilmittelversorgung zusammengefasst. Ebenfalls wird die fachbezogene Verordnung unter dieser Hauptkategorie verstanden. Dadurch soll die Entscheidungsgewalt des medizinischen Leistungserbringers über die Einnahme von Medikamenten oder der Nutzung anderer medizinischer Güter in dieser Kategorie Betonung finden.

H - Selbstbestimmung: Verschiedene Portale implementieren Funktionen, die den Entscheidungsprozess des Patienten unterstützen. Auch eigene Initiativen des Patienten (Zweitmeinung, Freigabe von medizinischen Dokumenten) werden durch Funktionen abgedeckt. Beispielsweise werden dem Patienten in einem Vorsorgerechner medizinische Leistungen angezeigt, die unter Berücksichtigung der krankheitsspezifischen Umstände angemessen sein können. Die Möglichkeit, die Zugriffsberechtigungen über seine medizinischen Daten zu verwalten, verlagert die Datenhoheit in Richtung des Patienten gemäß des PHR-Prinzips und ist daher auch den Funktionen zur Selbstbestim-

mung zuzuordnen. Online eine zweite Fachmeinung für die persönliche Entscheidungsfindung einzuholen, reduziert die Barrieren einen zweiten Arzt zu kontaktieren und stärkt dadurch die Patientenautonomie.

Tabelle 1. Gebildete Funktionskategorien (A – H) und zugeordnete Portalfunktionen

A - Nicht-Personalisierte Gesundheitsinformationen	*B - Dokumentation*	
1 Journalistische Beiträge	8 Verwaltung persönlicher Vitaldaten	15 Epikrisen
2 Wissensmedien	9 Gesundheitliche Beschwerdeberichte	16 Medizinische Bilder
3 Lexika & Glossen	10 Gesundheitsstatus	17 Medikationsplan
4 Materialdownloads	11 Allergieübersicht	18 Zusammenfassung von Arztgesprächen
5 Umweltdaten	12 Test- & Laborergebnisse	19 Behandlungspläne & -verläufe
6 Datenrechner	13 OP-Berichte	20 Atteste
7 Lernprogramme	14 Befunde	
C - Anamnese	*D - Therapie*	*E - Kommunikation*
21 Selbsttests	23 Tutorials & Übungen	26 Befundauswertung
22 Symptomchecks	24 Automatisierte Handlungsempfehlungen	27 Expertenforum
	25 Entscheidungshilfen	28 Patientenforum
		29 Nachrichtendienst
F - Administration	*G - Heilmittelversorgung*	*H - Selbstbestimmung*
30 Serviceverzeichnis	34 Rezeptverschreibung	38 Vorsorgerechner
31 Terminplanung	35 Ausstellung von Folgerezepten	39 Verwaltung von Zugriffsberechtigungen
32 Terminerinnerung	36 Medikamentenversand	40 Einholen von Zweitmeinungen
33 Vorbereitung von Einweisungen	37 Medizinprodukteversand	

4.2 Repräsentation der Funktionen in den untersuchten Portalen

Die Kontribution der untersuchten Patientenportale und ihr jeweiliges Funktionsangebot verdeutlicht einerseits die Heterogenität der funktionalen Ausrichtungen [6]. Andererseits erlaubt sie, Gemeinsamkeiten von Portalen mit vergleichbarer Zielstellung zu erkennen. Hieraus lässt sich ableiten, welche Funktionen bzw. Funktionskategorien die Erreichung eines spezifischen Versorgungsziels unterstützen.

Die wenigsten Patientenportale sind monofunktional. Es existieren jedoch einige Portale, die sich auf bestimmte Funktionen spezialisiert haben. Krankheitsbildorientierte Portale zur therapeutischen Begleitung (z. B. Blutdruckdaten, Esysta) konzentrieren sich auf die patientenseitige Dokumentation der Krankheitsumstände sowie die Kommunikation dieser Informationen.

Für Krankenkassen (z. B. Barmer GEK Gesundheit), Fachverbände (z. B. DMSG) oder staatliche Institutionen (z. B. MyMicroMacro) dienen Patientenportale eher der Aufklärung und Edukation sowie als Medium zum fachlichen Austausch. Folglich umfasst das Funktionsportfolio insbesondere die Bereitstellung von nicht-personalisierten Gesundheitsinformationen sowie Funktionen der Kommunikation.

Patientenportale von amerikanischen Klinikverbänden (z. B. Cleveland Clinic MyChart, MyUPMC) verfolgen intensiver das Prinzip des EHR, um sowohl patientenseitige als auch Vorteile für die eigene Arbeitsorganisation zu gewährleisten. Dabei fällt

auf, dass insbesondere Funktionen der Dokumentation, der Kommunikation sowie der Administration etabliert sind.

Tabelle 2. Funktionsumfang der untersuchten Portale

Portal	*A*	*B*	*C*	*D*	*E*	*F*	*G*	*H*
Barmer GEK Gesundheit	1,4			23	27,29	30		
Blutdruckdaten	3,6	8		24			37	
Cleveland Clinic MyChart	1,3	10,12,14-18	22		29	31,33	35	39,40
DMSG	1-4,7	8,9		23	27,28	30		
Duke MyChart		10,12,14, 15,17-19			29	31	35	
Esysta	6	8			29			39
Gesundheit.gv.at	1-6	14,17	21	23		30		39
Healthsafe24	1,2	8,10,13-17	22			32		39
INFOPAT		10,12,14-17						
Kaiser Permanente	1,2,3	12,18,19	22	24	29	31	35	
Medgate		19,20			26,29		34,36	
Steiermärksche KAGes		14,16				31		
Mein Schmerz		9,19	22		28			39
MyGeisinger	2	10,12,14, 15,17,18			29	32,33	35	
MyGroupHealth		8,10,12,14, 15,17,18		25	29	31	35	38
MyHealthat-Vanderbilt		10,12,14,15			29	31		
MyHealtheVet	1,2,3	8,10,12, 14,15,17	22		28,29	30,31	35	
MyMercyHealth		10,12,14, 15,17,18			29	31,32	35	
MyMicroMacro	1,2,4				27-29	30		
MyUPMC		10-17			29	31	35	
Partners Patient Gateway	1,2	11,12,17,18			29	30-32	35	
Reproduktionsmedizin München	6	14				31	35	
Patientsite		12,17,18			29	31,32		
Psychenet	1,2,4		21	23,25	27-29	30		
Samedi					29	31,32		
Viomedo						30		
Was hab' ich?	4	14			26			

5 Diskussion

Die identifizierten Funktionskategorien lassen sich verschiedenen Aspekten des Patienteneinbezugs zuordnen. Dies lässt sich beispielsweise am Framework von CARMAN ET AL. verdeutlichen [29]. Das Framework beschreibt drei Ebenen des Patient Engagements: Direktversorgung (Direct Care), Organisationale Gestaltung (Organisational

Design and Governance) und Regelgestaltung (Policy Making). Orthogonal dazu wird das Kontinuum des Engagements beschrieben. Dieses reicht von der Konsultation (Consultation) über den Einbezug (Involvement) bis zur Partnerschaft und geteilten Führung der Behandlung (Partnership & Shared Leadership). Das untere Ende dieses Kontinuums ist durch unilaterale Informationsflüsse gekennzeichnet, wogegen Partnerschaft und geteilte Führung umfangreiche bilaterale Informationsflüsse vorsieht [29]. Die identifizierten Funktionskategorien lassen sich alle in der Dimension der Direktversorgung einordnen (Tabelle 3). Diese begründet sich durch die Auswahl von Portalen mit Versorgungsfokus. Anhand der Informationsflüsse lassen sich die Funktionskategorien dem Kontinuum des Engagements zuordnen.

Tabelle 3. Einordnung der Funktionskategorien in die Direct Care-Dimension des Patient Engagement Framework nach Carman et al. [29]

	Continuum of Engagement		
	Consultation	*Involvement*	*Partnership & shared leadership*
Direct Care	A, B (9 – 20)	B (8), C, D (23, 24), E, F, G	D (25), H

Die Arbeit basiert wesentlich auf Informationen, welche die Herausgeber der Portale veröffentlicht haben. Begleitdokumente sowie deskriptive Forschungsarbeiten wurden hinzugezogen. Auf eine Registrierung in den Portalen wurde verzichtet, wodurch evtl. nicht beworbene Funktionen eines Portals nicht berücksichtigt wurden. Auch ist keine Aussage über die Reife der einzelnen Portalfunktionen in existierenden Patientenportalen möglich. Die Zusammenhänge und Abhängigkeiten zwischen den angebotenen Funktionen wurden nicht untersucht. Es ist jedoch davon auszugehen, dass Abhängigkeiten existieren. Beispielsweise ist die Bereitstellung von Dokumentationsfunktion eine Grundlage für die Ableitung von patientenindividuellen Handlungsanweisungen.

Aufgrund der qualitativen Orientierung der vorliegenden Arbeit müssen Einschränkungen in ihrer Objektivität berücksichtigt werden. Einerseits unterliegt methodenbedingt die Funktionsidentifikation den Portalherausgebern, welche von der ontischen Realität abweichen können. Autorenseitig, ist die Konsolidierung in Funktionskategorien subjektiv beeinflusst. Durch die Einordnung der Funktionskategorien in ein Patient Engagement Framework wird diesen Einflüssen jedoch entgegengewirkt.

6 Fazit

Ziel der vorliegenden Arbeit war die Identifikation von Portalfunktionen für Patientenportale auf Basis etablierter Systeme. Durch die Interpretation der 40 identifizierten Funktionen konnten acht Funktionskategorien induktiv erschlossen werden. Die entstandene Einteilung kann einen Beitrag zum besseren Überblick über existierende Portalfunktionen liefern. Die Funktionskategorien repräsentieren die Aspekte der Patienteneinbindung und ermöglichen so eine Identifikation von potentiellen Funktionen für

konkrete Patienteneinbindungsszenarien. So stellt die Bereitstellung von Dokumentationsfunktionen im Sinne eines EHR eine wichtige Basisfunktion dar, da sie eine direkte und unabhängige Information des Patienten über sein Krankheitsbild ermöglicht.

Die vorliegenden Ergebnisse können als Grundlage für die Entwicklung von patientenportalspezifischen Techniken der Anforderungsanalyse dienen. Beispielsweise bilden die Kategorien einen Ausgangspunkt für die Entwicklung halbstandardisierter Interviewleitfäden. Dadurch kann innerhalb einer Anforderungserhebung sichergestellt werden, dass weniger funktionale Aspekte unberücksichtigt bleiben. Ein einheitlicher Funktionskatalog kann zudem als Vergleichsrahmen verwendet werden, um strukturelle Unterschiede von Patientenportalen zu erkennen. Dies kann vor allem bei evidenzbasierten Studien unterstützend wirken, da vorher die Patientenportale auf strukturelle Ähnlichkeiten überprüft bzw. explizite Funktionalitäten adressiert werden können.

Weitere Forschungsansätze ergeben sich vor allem in der bisher unberücksichtigten Reifebewertung einzelner Funktionen. Einen weiteren Forschungsaspekt bildet die Beurteilung der Eignung verschiedener Funktionen für die Versorgung spezifischer Krankheitsbilder. Weiterhin muss der Zusammenhang zwischen Funktionen herausgearbeitet werden. Dies kann als Basis für die Beschreibung von Referenzarchitekturen von Patientenportalen dienen.

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Einsatz von Unternehmenssoftware in der Lehre

Teilkonferenzleitung

Harald Kienegger

Teaching Business Process Change in the Context of the Digital Transformation: A Review on Requirements for a Simulation Game

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Abstract. This paper analyzes requirements for a simulation game to teach Business Process Change (BPC) in the context of the digital transformation. First, the necessity of a simulation game to teach BPC as part of the digital transformation of enterprises is presented. Afterwards, a literature review and focus group discussions are conducted to analyze the requirements for teaching BPC. Finally, the resulting requirements are presented within a framework that describes the learner specification, pedagogy, context, and mode of representation for a simulation game to teach BPC. The presented study contributes to theory by providing a starting point for further research regarding the teaching of BPC in the context of the digital transformation. It further contributes to practice as the provided requirements can be used as basis to implement a simulation game to teach BPC.

Keywords: Business Process Change, Digital Transformation, Teaching, IS Curriculum, Simulation Games.

1 Introduction

Digital technologies are becoming crucial to sustain the efficiency of a company's business processes. The impact that technologies have on the enterprises and economy is also defined as "digital transformation", which is "concerned with the changes digital technologies can bring about in a company's business model, which result in changed products or organizational structures or in the automation of processes" [1]. This often comprises decisions with regard to the implementation of digital technologies, and a core characteristic when digital technologies are implemented in an organization are business process changes [2, 3]. Therefore, business processes are one of the main drivers for the digital transformation of businesses, which makes it necessary to successfully manage this transformation for an organization to stay competitive [4, 5]. Hence, Business Change Management including Business Process Change (BPC) can be seen as a major competency when you want to manage the digital transformation of enterprises [6]. In general, BPC presents a management concept that involves any type of process change, either revolutionary or evolutionary [7]. Previous research on skills and

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competencies for the digital transformation already emphasized the relevance of Business Change Management and BPC for future employees [6, 8]. Therefore, it is an important topic, which should be addressed in Information Systems (IS) education.

However, in current IS education, an overall teaching concept for BPC in the digital transformation is still missing. Previous research on the general impact of BPC focuses on the success of BPC projects [9] or the complex relationships between their important constructs [10, 11], which is rather geared towards researchers and practitioners. When the topic is addressed in education, it is limited to a static view on business processes as an ordered set of activities, but without considering any business process changes [12]. Furthermore, there is only little research in general that shows the impacts of digital technologies on the business processes of an enterprise [13]. However, with regard to the digital transformation, especially a view on business process changes is important for students to understand the impact of digital technologies. A solution to this problem could be the use of business simulation games, as they are intended to improve the learning experience for students [14, 15]. Still, current simulation games focusing on business processes, such as the ERP Simulation Game called ERPsim [16], are also rather geared towards static business processes and are not intended for scenarios simulating business process changes. Hence, there is a need to analyze what is required to teach BPC in the context of the digital transformation of enterprises successfully.

In order to address these issues, this paper analyzes the requirements for a simulation game to teach BPC as part of the digital transformation of enterprises. Previous research on dynamic complexities of BPC projects already proposed to integrate the findings into a simulation game [17]. In general, such a game models a part of the reality and simulates dynamic situations based on the model [18]. In the context of BPC, a simulation game would provide the possibility to simulate the central business process changes and would allow to understand its effects. Moreover, it is an interactive method to convey knowledge about BPC. Therefore, this paper addresses the following research question: *What are the requirements for a simulation game to teach BPC in the context of the digital transformation of enterprises?*

By analyzing the requirements for such a simulation game, we lay the foundation for BPC education and the development of BPC simulation games in the context of the digital transformation. For this, the remainder of paper is structured as follows: first, the methodology to analyze requirements for a simulation game to teach BPC is described. Afterwards, general requirements for teaching BPC in the context of the digital transformation as analyzed in the literature and with focus group discussions are presented. Finally, specific requirements for a simulation game to teach BPC are proposed based on a framework for simulation games.

2 Methodology

2.1 Literature Review

To analyze the requirements for a simulation game to teach BPC, we conducted a systematic literature review according to the guidelines of Webster and Watson [19] and vom Brocke et al. [20]. The main objective of the literature review was to identify and

categorize requirements for a simulation game to teach BPC in the context of the digital transformation. Therefore, we searched by using the following keywords: "Teaching" or "Education" or "Learning" or "Training" or "Course" or "Lecture" or "Skills" or "Competencies" or "Curriculum", in conjunction with “Business Process" or "Business Process Management" or "Business Process Change". Additionally, we included the keywords "Digital Transformation" or "Digitization" or "Industry 4.0" or "Industrie 4.0" or "Internet of Things" or "IoT" or "Cyber Physical Systems" or "CPS". With this amount of keywords, we aimed to conduct an exhaustive literature search.

For our search, we chose the databases ACM Digital Library, EBSCOHost, IEEE Xplore and Scopus, as they cover publications from IS, Economics, Computer Science, and Engineering. Furthermore, they contain many Education outlets and outlets focusing on Business Process Management (BPM), such as the BPM journal. Our search included all articles published until July 2017. All hits were initially screened based on title and abstract. Afterwards, the whole articles were investigated in detail. In addition, we conducted a Google Scholar search to discover relevant articles that were not included in the chosen databases. For this, we sorted the articles by relevance and screened the first 20 hits for each search string. Thereby, we found two additional articles. Moreover, following the guidelines of Webster and Watson [19], we conducted a backward and forward search on the articles. Thereby, we found two more papers.

Overall, we considered all articles as relevant that contained requirements for teaching in the area of business processes, BPC, or BPM, and that additionally mentioned the digital transformation, digitization, or a similar trend. In total, we had 269 hits in our database search, from which 18 were finally chosen for a detailed analysis. This small number shows that only little research exists so far for teaching BPC in the context of the digital transformation. Hence, the literature review only provides a first overview of the topic. From each document, we extracted requirements for a simulation game to teach BPC in the context of the digital transformation. Finally, we consolidated equivalent requirements mentioned in different articles and assigned them to eight subject areas overall.

2.2 Focus Groups

In order to evaluate and extend the results from the literature review, we additionally conducted focus group discussions according to Krueger and Casey [21]. We assembled three focus groups, with a number of around ten participants per group. The discussions lasted 50 minutes on average. The participants were lecturers with previous experience in university teaching and education in the areas of IT, IS, Economics, and Engineering. Some participants additionally had professional working experience. Overall, from 35 participants in the three focus groups, 13 were university professors, while the rest were university lecturers or school teachers. We addressed this target group due to their general understanding in teaching business processes from their previous teaching experience in this topic. All three focus groups consisted of lecturers from the EMEA region. The discussions were conducted at the Technical University of Munich as part of train-the-trainer workshops on business processes with SAP systems. Using this workshop setting was beneficial since the groups already got to know each

other during the workshop and therefore were prepared to discuss in an open way. They also had time to discuss topics related to business processes and teaching during the workshops in advance to the focus group discussion as teaching business processes was the main content of their workshops. Thereby, they already were in the right mindset to build up new ideas.

All focus groups were moderated by the same person, a co-author of the paper. We used semi-structured interview guidelines in each focus group to ensure that the findings are comparable. Furthermore, we applied the critical incident technique [22] to our interview guidelines in order to derive new requirements for teaching BPC in the context of the digital transformation. First, the participants were presented with simulation games as a modern teaching method for business processes. Then, we presented typical teaching scenarios for business processes in the context of the digital transformation, and asked how these are already considered in their curricula. Finally, we asked them about desirable content, technology, and didactical requirements for a simulation game to teach BPC in the context of the digital transformation.

In order to capture the focus group discussions, they were recorded and transcribed. The transcripts were coded using the software MAXQDA, and were analyzed based on the previously found requirements in the literature. If a new requirement was mentioned, it was added to the overall requirements catalog. The coding was conducted by two different researchers, and the found requirements were compared and discussed until a common decision on their relevance was reached. This resulted in a final requirements catalog for a simulation game to teach BPC in the context of the digital transformation.

3 Requirements for Teaching Business Process Change in the Context of the Digital Transformation

3.1 Requirements Identified in the Literature

The goal of the literature review was to identify requirements for a simulation game to teach BPC in the context of the digital transformation. Based on the literature, various requirements could be found. We grouped them by eight different subject areas, which were initially analyzed according to the number of papers per subject area mentioning requirements. While the main focus in the literature is on topics required for teaching BPC in the digital transformation, also didactic aspects such as learning goals, teaching scenarios and teaching methods contain important requirements. Software and tools rather play a subordinate role in the literature, as well as methods and principles. Fig. 1 gives an overview of the most mentioned requirements grouped by their appearance per subject area. This is followed by a more detailed description of the requirements in the mentioned as part of the different subject areas.

Overall, the authors mention various **topics** that are important when teaching BPC in the context of the digital transformation. First, with regard to digitization, the Internet of Things (IoT), Cyber-Physical Systems (CPS), Product Service Systems (PSS), and digital technologies such as sensors are central topics that should be considered [2, 13,

23–26]. These trends can also be summarized under the term Industry 4.0 and play an important role in the education of the future workforce in general [6]. Therefore, it is no surprise that several authors mention them as important topics when teaching BPC. Second, the authors consider various topics from the BPM area. This comprises general business process terminology, business process reengineering, the optimization of business processes and also their transformation [2–4, 12–14, 24, 27–30]. Third, digital business models are emphasized as important topic when teaching BPC [23, 24, 30, 31]. This is most likely due to the strong connection between the establishment of new business models and the resulting changes of the underlying business processes [24]. In addition to the various topics, the authors further mention some **methods** and **principles** that should be taught as part of BPC in the context of the digital transformation. This comprises business process modelling [3, 12, 28], standardization [13], and multidisciplinarity [4].

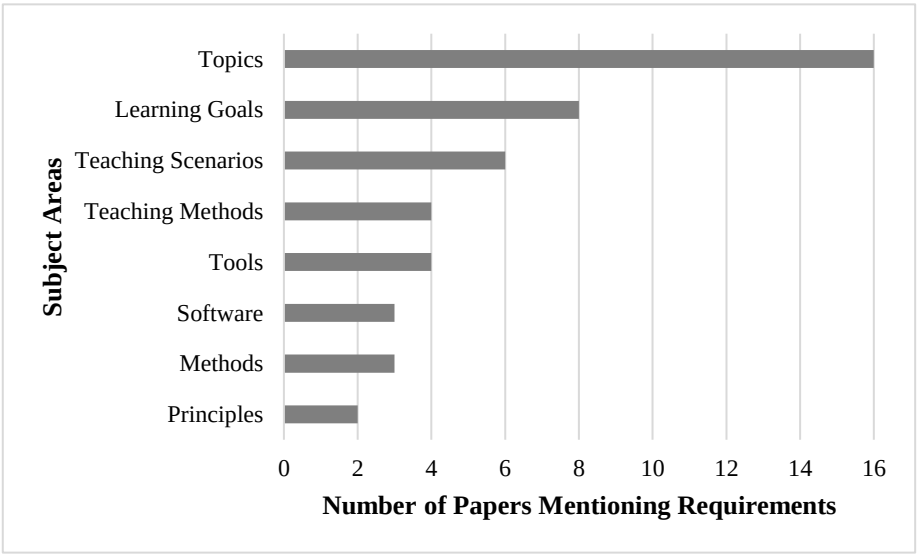


Figure 1. Requirements per Subject Area for Teaching BPC in the Digital Transformation (Source: Own Illustration)

Regarding **software** for teaching BPC in the context of the digital transformation, the usage of an Enterprise Resource Planning (ERP) system is a central requirement [3, 14, 23]. As a company's business processes are usually implemented in an ERP system, these systems are often used in higher education as a means to teach business processes [14]. Thereby, they are also suitable tools for teaching changes in business processes, e.g. as a result of the digital transformation of an enterprise. Furthermore, the usage of process modelling tools and the Business Process Model and Notation (BPMN) are mentioned as important **tools** when teaching BPC in the context of the digital transformation [3, 12, 28]. This is probably due to the fact that process modelling is a popular method in the IS education to visualize business processes. Therefore, it often serves as a first step when you want to retrace changing business processes [32].

The authors further mention various requirements regarding **learning goals** when teaching BPC in the context of the digital transformation. On the one side, this comprises the understanding of business concepts [14] and the function of BPM in an organization [2–4, 33]. On the other side, applying soft skills such as team communication, problem solving, critical thinking, and decision making is also considered as important [3, 26, 29, 33, 34]. In addition, several **teaching methods** are mentioned as requirements for reaching the learning goals. The methods range from individual teaching methods such as self-learning or homework [2, 3, 12] over group teaching methods such as group work or discussions [12, 33] to newer approaches such as experimental learning or course development by students [12, 14]. According to the mentioned authors, choosing the right teaching method highly depends on the **teaching scenario** a teacher is using. For this, also specific examples are mentioned in the literature. The authors emphasize traditional approaches such as practical exercises or case studies [3, 12, 26, 34] as well as more sophisticated mixed scenarios such as starting with theoretical lectures, going over to hands-on experience with practical exercises and ending with own decision making for the students, e.g. through game-based learning [2, 14]. Altogether, the mentioned teaching scenarios are rather unspecific and always depend on the previously defined learning goals and methods. Hence, an overall teaching concept is necessary to teach BPC in the context of the digital transformation successfully.

3.2 Requirements Identified in Focus Groups

In general, the focus group discussions confirmed the requirements for teaching BPC found in the literature. However, some of the aspects mentioned in the literature were described in more detail by the participants, and were further combined with new aspects.

The participants agreed that digital technologies are an important topic that should be considered as requirement for teaching BPC in the context of the digital transformation. However, they also mentioned that it is important not to focus on any specific digital technology, as this would limit the long-term usage of such teaching materials, e.g.: "*If I was to teach digitization, I would not link it to any specific topic such as IoT, but rather mention examples from digitization and allow the students to come up with their own investigation and opinions about these topics*". Concerning process management topics, the most important content according to the participants is to teach the end-to-end process that creates value in an organization. This should contain the communication with suppliers and customers, the in-house supply chain management, and also focus on the primary and support activities in an organization, as proposed by Porter [35]. Furthermore, the participants mentioned that the implementation of business processes in ERP systems should be part of teaching BPC: "*for me, the students have to understand three levels in the system, which is the organizational structure, the master data, and transactional data*". Thereby, they also understand the advantages of an ERP system. In addition to these topics, the participants also confirmed the importance of including process modeling as method for teaching BPC, whilst also mentioning Event-

Driven Process Chains (EPC) and BPMN as concrete modelling languages. In this context, process models can provide a benefit as they help comparing processes before and after the change.

Regarding the required software, the participants went more into detail with concrete examples of software that should be used to teach BPC in the context of the digital transformation. Most of the participants emphasized the need of a cloud-like solution that can be accessed via web browser. Some directly mentioned SAP S/4HANA as the next generation ERP system, which was designed to fit the needs of the digital transformation and which can be accessed through the new browser-based interface SAP Fiori. Another participant stated his desire to use modern devices and interfaces: "*I want to use smartphones, tablets and mobile browsers. They are easy-to-use and the focus should be on the processes and not on the technology*". The participants further mentioned some details of how this could be implemented within a simulation game. The main user interface should contain a process map, and several apps to manage the different sub-processes of an enterprise. Additionally, there should be an input help, glossary, and links to further information on the processes and on how to use the interface. Altogether, it should be possible to execute and monitor all tasks in the game through this single interface.

Regarding the required learning goals, both soft skills and the knowledge of business concepts were mentioned, equivalent to the findings from the literature. Concerning the teaching methods, the participants emphasized the importance of group teaching compared with individual teaching methods: "*my experience is that teamwork and competition really motivate the students when using a simulation game*". Additionally, the participants mentioned the positive effect of competition in a simulation game as a way to motivate the students.

However, most of the contributions in the focus group discussions referred to different teaching scenarios that can be taken as recommendation for teaching BPC in the context of the digital transformation. In general, the participants discussed both the advantages and disadvantages of teaching in block courses compared with weekly courses, agreeing on the fact that this mainly depends on the goal of the course or is restricted by guidelines from the participants' schools or universities, which serves as basis for designing a teaching scenario. They also mentioned combinations of both: "*I would start with a simulation game as teaser and afterwards explain what happened in theory*". In this way, it would be possible to present theoretical methods and content and further experience reasons and scenarios for business process changes in enterprises based on practical exercises, case studies, or teaching cases. Overall, the participants emphasized their desire for a curriculum that can be used in class without extensive adaptions, but which is still customizable to the lecturers' needs: "*it should have a stable basis, but still with open interfaces*". When discussing this on the concrete example of a simulation game, they mentioned that there should be different variants for a simulation game to teach BPC, which can be adapted based on the scope of the course. Such a game should comprise both strategical and operational tasks, e.g. by providing different roles and tasks to the players. Furthermore, there should be ways for the students to monitor the effects of their decisions, and provide the possibility for the lecturer to evaluate and compare the students' performance. Finally, all participants of the focus

groups agreed that a great teaching scenario would be to start with the process as is, allow the students to make decisions that change the process, and evaluate the process before and after the change. This should be accompanied by theoretical foundations of process modeling, the presentation of a proper teaching case, and the illustration of the processes before and after the change.

4 Applying a Framework for Simulation Games to Structure Requirements for Teaching Business Process Change

In our research, we elaborated several general requirements for teaching BPC in the context of the digital transformation from the literature. Additionally, in three focus group discussions, we evaluated and extended these requirements based on the opinions of lecturers who teach business processes. In order to structure the requirements, we arranged them according to the four-dimensional framework for simulation games by de Freitas and Oliver [36]. This framework serves as basis for developing and evaluating simulation games and consists of the following four parts: learner specification, pedagogy, context, and representation [37]. The learner specification considers the attributes of the particular learner, such as age, level, or their learning background. The pedagogy focuses on the process of learning, which includes teaching methods, materials, and supporting technologies for teaching. The context considers time and location where the learning takes place, and the mode of representation includes the level of fidelity, interactivity, and immersion used in the game [36]. Fig. 2 shows how the requirements analyzed in the previous step were structured according to these four dimensions.

Regarding the **learner specification**, we first decided to focus on IS education, as the focus group discussions emphasized the importance of BPC as part of IS curricula. Furthermore, group-based learning and individual homework will be combined, as both ways were described as very important for teaching BPC in the literature [2, 3, 12, 14, 33] as well as in the focus group discussions. Additionally, especially the focus groups showed that competitions in class increase the learning effects for the students, therefore student presence should be part of the learner specifications. Finally, the literature [12, 33] as well as the focus groups mentioned the importance of group work. Hence, group work and inner-group collaboration will also be included as necessary components of the simulation game.

Regarding the **pedagogic considerations**, understanding BPC as it is induced by the digital transformation is defined as a central learning outcome of the simulation game. This includes topics about the digital transformation [2, 13, 23–26] as well as topics about the whole BPM area [2–4, 12–14, 24, 27–30], as they were described as requirements in the literature. The central learning activities for the students, which were mainly derived from the focus group discussions, will be decision making with respect to the design, execution and redesign of business processes. This includes role-based tasks for the individual students, but each decision will influence the success of the whole team. For instance, if there is a manager role and the role of a clerical assistant, management decisions will influence the tasks the clerical assistant has to do. Finally,

there is a briefing and debriefing included in the pedagogical considerations, which means that there will be a theoretical introduction to the game and its content, and several post-activity reflections during the game. This is important to help the students understand the effects of their decisions and therefore increase their learning success.

Learner Specification	**Pedagogic Considerations**
• Information Systems education • Mixture between group-based learning and individual homework • Competing groups of students • Inner-group collaboration required to successfully manage the game	• Learning Outcome: Understanding BPC induced by the digital transformation • Learning Activities: Decision making regarding design, execution, and redesign of business processes • Role-based tasks for individual students • Decisions of individuals influence the whole team success • Briefing/debriefing: Theoretical introduction and post-activity reflection
Context	**Mode of Representation**
• University education • Classroom-based courses, incl. homework • Interaction with information systems • Embedding of theoretical and practical content in an overall curriculum	• Work with a modern ERP system • Work with modern devices and user interfaces • High-level of interaction

Figure 2. Applied Framework for a Simulation Game to Teach Business Process Change (Source: Own Illustration based on de Freitas and Oliver [36])

Regarding the **context** of the game, we mainly extracted the findings from the focus group discussions. This leads to university education as target group of the game, since the focus groups showed that BPC induced by the digital transformation is an important topic in this context. Furthermore, we defined classroom-based courses as context, as the previously described learner specifications and pedagogic considerations imply that attendance is necessary for collaboration and communication between the students. Finally, the interaction with information systems is seen as very important by the participants of the focus group discussions, as well as the embedding of the theoretical and practical game content in an overall curriculum. This will provide the possibility to use and adapt the game according to the lecturers' needs, which is an essential requirement according to the focus groups.

Regarding the **mode of representation**, also the focus group discussions provided specific requirements. The participants emphasized the importance of work with a modern ERP system, and also with modern devices and user interfaces such as smartphones

or tablets. Additionally, there should be a high-level of interaction with these systems, since business processes are a topic which has to be taught in a practical way according to the focus group discussions. Therefore, combining the theoretical content with practical exercises in a system is a central requirement for a simulation game to teach BPC.

5 Discussion and Conclusion

This paper analyzes requirements for a simulation game to teach BPC in the context of the digital transformation. With a structured literature review and focus group discussions, we first extracted and evaluated general requirements for teaching BPC. Afterwards, these requirements were structured according to the four-dimensional framework for simulation games by de Freitas and Oliver [36]. Thereby, important aspects for teaching BPC were analyzed and presented. The main findings are based on the fact that teaching BPC in the context of the digital transformation requires a different approach to cover all parts of this novel topic. Central requirements according to our analysis are the work with a modern ERP system and own decision making with regard to BPC. Hence, traditional teaching methods are not sufficient for education in this topic. Therefore, we propose a simulation game as method for teaching BPC induced by the digital transformation. This game should focus on soft skills, such as group work, decision making and collaboration, as well as on business process knowledge, which comprises BPM, BPC, and the implementation of processes in information systems. Overall, the main focus of teaching should be on the effect of digital technologies on the business processes of an enterprise. As the literature review and focus group discussions showed, there are several ways how this can be taught. Therefore, the framework analyzed these requirements in a general way and serves as basis for future research.

However, especially the focus group discussions showed that there are highly different opinions how BPC should be taught as part of the university education. While some lecturers desire to integrate the newest technologies, devices, and a high level of interaction into their lectures, there are also some who still prefer traditional teaching methods such as frontal teaching. When designing a simulation game to teach BPC in the context of the digital transformation, it is important to consider these different teaching methods and make the simulation game adaptive to the different needs of the lecturers by providing standardized and still customizable teaching scenarios.

Overall, the analyzed framework can be considered for future research regarding the teaching of BPC in the context of the digital transformation, e.g. by extending the framework with more detailed requirements or by developing detailed teaching scenarios for BPC. Furthermore, it can be taken as basis for the design and development of a simulation game to teach BPC in the context of the digital transformation. However, for this, the technical requirements have to be defined prior to the implementation. So far, the requirements are limited to the analysis in the literature and the focus group discussions with lecturers, which mainly address aspects apart from the technical implementation. In a next step, a simulation game to teach BPC in the context of the digital transformation can be implemented based on the requirements as analyzed within this paper.

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Vermittlung von Datenkompetenzen in der Hochschullehre im Fokus der Digitalisierung – Bestandsaufnahme und Anforderungen am Beispiel wirtschaftswissenschaftlicher Studiengänge

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Abstract. Die fortschreitende Digitalisierung, die besonders mit den Schlagworten Digitale Transformation und Industrie 4.0 in Verbindung steht, führt zu einem unaufhaltsamen Wandel in der Arbeitswelt. Neue Kompetenzen, vor allem im Bereich des Umgangs mit Daten und der Anwendung von IT-Systemen, schlagen sich in Jobprofilen und Ausschreibungen nieder. Die anwendungsorientierte Ausbildung an Hochschulen sollte diese Veränderungen auch aufnehmen und Grundlagen wie auch berufsfeldspezifische Ausbildung stärker an diesen Themen ausrichten. Der Beitrag liefert einen Überblick darüber, welche Datenkompetenzen in der Lehre eine Bedeutung haben. Ferner sind für die anwendungsorientierte Ausbildung praktische Anforderungen von Belang, die durch eine Stellenanzeigenanalyse erfasst werden. Schließlich wird im weiteren Verlauf der aktuelle Stand der Umsetzung dieser Bedarfe am Beispiel wirtschaftswissenschaftlicher Studiengänge vorgenommen. Aus diesen Erkenntnissen abgeleitete Handlungsempfehlungen und eine Zusammenfassung runden den Beitrag ab.

Keywords: Datenkompetenzen, Digitale Transformation, Industrie 4.0, Lehre

1 Einführung, Problemstellung und Ziele

Die Wirtschaft befindet sich in einem Umbruch, welcher im deutschsprachigen Raum vor allem unter dem Begriff Industrie 4.0 diskutiert wird. Im Zentrum dieser Umwälzung steht die Nutzbarmachung von Datenmengen, welche durch die Vernetzung von Maschinen und deren Kommunikation stetig ansteigen und durch die Integration in betriebswirtschaftliche Prozesse zunehmende Bedeutung erhalten [1–3]. Noch ganzheitlicher werden diese Umwälzungen unter den Begriff der Digitalen Transformation (DT) subsummiert. Diese umfasst im unternehmerischen Kontext alle Veränderungsprozesse von der softwarebasierten Gerätesteuerung bis hin zur Kreierung digitaler Geschäftsmodelle [4]. Die DT ist ein Eingriff in zentrale Leistungsfelder von Unternehmen und

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ermöglicht diesen, neue Dienstlungen und Produkte anzubieten [5]. Ein weites Verständnis zur DT beinhaltet, dass hierdurch eine Vernetzung aller Bereiche in Wirtschaft und Gesellschaft stattfindet. Damit einher geht auch das Erfordernis neuer Fähigkeiten, die die Gewinnung und den Austausch von Daten betreffen [6].

Daraus folgend lässt sich davon ausgehen, dass aufgrund der DT eine Veränderung auf dem Arbeitsmarkt und in Jobprofilen eintritt oder bereits eingetreten ist. Die Kompetenzprofile von Arbeitsplätzen müssten sehr viel stärker IT-orientierte Facetten beinhalten und insbesondere datenbezogene Kompetenzen erfordern. Dass derartige Veränderungen anstehen, wird vielfach – insbesondere im Kontext von Industrie 4.0 – thematisiert. Kargermann und Wahlster (2013) beschreiben unter anderen die Arbeitsorganisation und –gestaltung sowie die Aus- und Weiterbildung als ein zentrales Handlungsfeld der Industrie 4.0 [7]. Auf europäischer Ebene existieren diese Forderungen ebenso, wie ein in Auftrag gegebener Forschungsbericht des Europaparlaments (2016) zeigt [8]. Erol et al. (2016) stellen dazu fest, dass aufgrund der Veränderungen durch die Digitalisierung sowohl persönlich-soziale Kompetenzen einem Wandel unterliegen, als auch problemorientierte Kompetenzen, insbesondere im Kontext von Daten, wie etwa die Datenanalyse und Dateninterpretation durch zugehörige Methoden und Tools [9]. Da die Förderung derartiger Kompetenzen an Dringlichkeit gewinnt, existieren bereits Ansätze und Modelle, wie diese in die Ausbildung einbezogen werden können [10, 11]. Wenn die Forderung besteht, die neuen Themenfelder der Digitalisierung auch in der Ausbildung zu forcieren, müssten sich zukünftig auch Curricula von Studiengängen verändern oder bereits einem Wandel unterliegen. Die DT erfordert Fähigkeiten, die die Gewinnung und den Austausch von Daten, deren Nutzung und Umwandlung in Informationen beinhalten [12]. Wenn die Auswirkungen der DT und Industrie 4.0 in alle Bereiche der Unternehmung hinwachsen, müssten auch bisher nicht IT-nahe Arbeitsbereiche einem Wandel unterliegen. Zusammenfassen lassen sich an dieser Stelle zunächst folgende Problemstellungen (P).

P 1. DT und Industrie 4.0 rufen einem grundsätzlichen Wandel in Wirtschaft und Gesellschaft hervor, dessen Auswirkungen sich auch in den Curricula von Studiengängen widerspiegeln müssten.
P 2. Der Bedeutungszuwachs von Daten führt zu einem Erfordernis datenbezogener Kompetenzen in vielen Arbeitsbereichen.
P 3. Die Ausbildung an den Hochschulen forciert diese neuen Kompetenzen noch nicht flächendeckend.

Um eine möglichst praxisorientierte Ausbildung zu erreichen, scheint es sinnvoll, die Erfordernisse von Unternehmen, deren Vorstellungen und Kompetenzprofile bei der Planung und Realisierung von Curricula zu berücksichtigen. Es kann davon ausgegangen werden, dass Absolventen in Wirtschaftsinformatik (WI) über ausreichende Kompetenzen verfügen, um den Herausforderungen der Digitalisierung gewachsen zu sein oder zumindest geeignete Methoden beherrschen, um Problemlösungen zu entwickeln. Der Beitrag fokussiert deshalb den wirtschaftswissenschaftlichen Bereich, also Studi-

engänge in Betriebswirtschaftslehre (BWL), Volkswirtschaftslehre (VWL) oder Wirtschaftswissenschaften. Der Beitrag beantwortet hierzu vorrangig zwei Fragestellungen (F):

F 1. Welche Datenkompetenzen werden von Unternehmen besonders nachgefragt?
F 2. Genügen die Curricula wirtschaftswissenschaftlicher Studiengänge den zunehmenden Herausforderungen der Digitalisierung?

Zunächst ist ein Begriffsverständnis für Datenkompetenzen zu erarbeiten, um folglich diesbezügliche Ansätze in der Lehre aufzuzeigen (Abschnitt 2.1). Die theoretische Betrachtung beinhaltet zudem den Forschungsstand zu Datenkompetenzen in der Lehre. Eine Literaturrecherche dient zur Erfassung vorhandener Konzepte zu Datenkompetenzen im Fokus der Lehre und Ausbildung (Abschnitt 2.2). Der Antwort zu F 1 widmet sich das Kapitel 3. Um eine Einbeziehung praxisrelevanter Inhalte zu gewährleisten, soll eine Stellenanzeigenanalyse Auskunft darüber geben, ob die Einbeziehung von Datenkompetenzen in die Lehre sinnvoll ist und welche konkreten Anhaltspunkte für die Ausgestaltung von Inhalten zur Datenkompetenzen existieren. Zur Beantwortung von F 2 dient eine Inhaltsanalyse von wirtschaftswissenschaftlichen Studiengängen (Kapitel 4). Auf der Grundlage der Auswertung von Abschlusszeugnissen und Leistungsübersichten lässt sich eine Aussage darüber treffen, wie Datenkompetenzen oder grundsätzlich auch IT-bezogene Kompetenzen in die genannten Studiengänge integriert sind. Schließlich können daraus Handlungsempfehlungen abgeleitet werden (Kapitel 5).

Der Beitrag unterstreicht die Rolle der WI als Integrationsdisziplin. Die Vermittlung von Datenkompetenzen und deren Anwendung gehören zu Kerninhalten der Ausbildung in der WI. Da die WI als Bindeglied zwischen den Wirtschaftswirtschaften und der Informatik gesehen wird, ist es auch deren Aufgabe, das Wissen und die Methoden zum Datenmanagement sowie zu Datenkompetenzen im Allgemeinen in die wirtschaftswissenschaftliche Ausbildung zu transferieren. Der Beitrag soll insgesamt aufzeigen, ob eine stärkere Integration von Inhalten der WI im Allgemeinen und datenbezogenen Inhalten im Speziellen im Zuge der fortschreitendenden Digitalisierung sinnvoll ist.

2 Grundlagen und Stand der Forschung

2.1 Begriffsverständnis Datenkompetenz

Der Begriff Kompetenzen findet sich in äußerst vielen Fachrichtungen, was zu einer Vernebelung der Begrifflichkeit führt und in unterschiedlichen Fachdisziplinen teilweise sehr unterschiedliche Auffassung zur Folge hat [13]. Ältere Sichtweisen bringen Kompetenzen vor allem mit persönlichen, individuellen Eigenschaften und Gewohnheiten in Verbindung [14]. Modernere Begriffsbestimmungen heben einen multidimensionalen Charakter von Kompetenzen hervor. Diese sind oftmals als Sammlung oder Verknüpfung von individuellen Fähigkeiten charakterisiert, die auf unterschiedlichen

Ebenen – des Individuums oder der Organisation – existieren [15]. Im wirtschaftswissenschaftlichen Kontext stehen Kompetenzen oft im Zusammenhang mit ressourcenbasierten Ansätzen des strategischen Managements. Rasche (1994) betont den immateriellen Charakter von Kompetenzen und bezeichnet diese als eine nicht tangible, wissensbasierte Ressource, welche aufgrund ihres einzigartigen Charakters keine oder nur sehr unvollständige Faktormärkte besitzt [16]. Unter Berücksichtigung anderer Kompetenzen, wie Informationskompetenz oder Medienkompetenz, wird Kompetenz häufig mit dem Term *literacy* in Verbindung gebracht [17, 18]. Im Kontext ressourcenbasierter Managementansätze findet sich wesentlich häufiger *capabilities*. Im Bildungsbereich wird vor allem der Begriff data literacy verwendet und dessen Einordnung bzgl. anderer Kompetenzen, wie information literacy und statistical literacy, diskutiert [19, 20]. Calzada Prado und Marzal (2013) beschreiben data literacy als eine Ansammlung spezieller Kompetenzen, wie Datenerhebung oder –generierung [19]. Auch Schield (2004) beschreibt data literacy als Zusammenfassung mehrerer Einzelkompetenzen [20]. Sie heben damit den mehrdimensionalen Charakter von data literacy hervor, was mit der Begriffsauffassung von Kompetenzen korrespondiert. Die Definition von Datenkompetenzen dieses Forschungsbeitrags orientiert sich an der Begriffsauffassung von data literacy als jegliche Art von Fähigkeiten und Kenntnissen im Umgang mit Daten. Hierin einschlossen sind ebenso Fähigkeiten und Kenntnisse im Kontext von Anwendungssystemen, wenn diese einen Datenbezug aufweisen.

2.2 Stand der Forschung zu Datenkompetenz in der Lehre

Das Vorgehen orientiert sich an den grundlegenden methodischen Ausführungen zum Literature Review von Webster und Watson (2002) [21] sowie zum State of the Art von Fettke (2006) [22]. Bevor eine Suche nach Fachbeiträgen stattfindet, ist das Ziel der Literaturrecherche festzuhalten und zu klären, welche Fragenstellung zur Beantwortung steht. Die Recherche gibt einen Aufschluss darüber, welche Datenkompetenzen im Kontext der Lehre bisher betrachtet wurden. Ferner gilt es zu untersuchen, ob diese in sinnvolle Kategorien und Kompetenzfelder gliederbar sind. Die Festlegung der Suchterme ergibt sich aus dem vorherigen Kapitel. So kommen „data literacy“, „data capability“, „data skill“ und „data competence“ jeweils im Singular und Plural in Frage. Hinzu tritt eine Einschränkung des Fokus‘ der Suche, der sich aus der Problemstellung ergibt. Durch den Booleschen Operator „AND“ wurden für alle vorhergenannten Begriffe Kombinationen mit „student“, „employee“, „digit*tion“, „industry 4.0“ und „job“ gebildet. Zur Recherche dienten neben Google Scholar die Datenbanken Academic Search Premier, Computer Source, Education Source und ERIC. Aus der Suche resultierten insgesamt 485 potenziell relevante Beiträge. Dabei konnte zunächst eine Vielzahl an Artikeln aufgrund von Titel oder Abstract ausgeschlossen werden, wenn diese inhaltlich nicht in den Fokus des Forschungsbeitrags – Datenkompetenzen in der Lehre – passen. In die weitere Betrachtung sind außerdem nur Beiträge aus wissenschaftlichen, hinreichend fundierten Publikationen eingeflossen. Von der ursprünglichen Anzahl an Beiträgen lassen sich vorerst 20 Beiträge als thematisch relevant einstufen. Diese Paper konnten anschließend einer genaueren Überprüfung hinsichtlich genannter Datenkompetenzen unterzogen werden. Für die weitere Betrachtung sind alle

Beiträge relevant, die konkrete Kompetenzen oder Kompetenzfelder aufzeigen. Aus der Sichtung ergaben sich acht wesentliche Kompetenzfelder. Deren Abgrenzung ist nicht trennscharf möglich, da beispielsweise „Daten managen“ auch übergeordnet alle anderen Kompetenzen beinhalten kann. Eine Aussage darüber, welche untergeordneten Fähigkeiten zu den einzelnen Feldern gehören, ist freilich nicht möglich. Die Tabelle 1 fasst die Ergebnisse der Literaturrecherche zusammen.

Tabelle 1. Ergebnis der Literaturrecherche

Datenkompetenz	*Quelle*
Daten verstehen, interpretieren, beurteilen	[19], [23], [24], [25], [26], [27]
Daten ermitteln	[19]; [23], [20], [24], [28]
Daten managen	[19], [20], [28], [26]
Daten analysieren	[19], [28], [29], [25], [26]
Daten nutzen (Entscheidungsunterstützung)	[23], [24], [29]
Daten visualisieren	[20], [24], [27]
Daten manipulieren	[20]
Nutzung von Tools zur Analyse/Manipulation	[20], [28]

Die Ergebnisse stammen ausschließlich aus dem Bereich der Bildung. Ein Mangel zeigte sich hinsichtlich von Beiträgen, die sich auf Anforderungen von Unternehmen hinsichtlich der geforderten datenbezogenen Fähigkeiten und Kenntnisse beziehen. Das folgende Kapitel dient dazu, diese Forschungslücke weiter zu schließen und liefert gleichzeitig weiterführende Erkenntnisse für eine Ausgestaltung praxisorientierter Studiengänge in den Wirtschaftswissenschaften. Die hier aufgezeigten Datenkompetenzen dienen außerdem im Folgenden als Grundlage zur Kategorisierung der ermittelten Anforderungen an Datenkompetenzen durch die Praxis.

3 Anforderungen an Datenkompetenzen durch die Praxis

3.1 Überblick und Vorgehen

Um einen Überblick zu erhalten, welche Datenkompetenzen für eine praxisorientierte Ausbildung relevant sind, folgt in diesem Kapitel die Zusammenfassung einer Stellenanzeigenanalyse. Die Stellenanzeigenanalyse ist eine eigenständige Methodik, die Auskunft über aktuell und zukünftig verlangte Fähigkeiten und Kenntnisse von Arbeitgebern gibt [30–32]. Vorteilhaft ist zudem, dass der Zugang zu den Informationen sehr einfach ist. Nachteilig ist, dass hierfür kein standardisiertes Vorgehen existiert, allerdings Erhebungs- und Auswertungsverfahren bestehender Arbeiten genutzt werden können [33, 34]. Das Vorgehen zur Stellenanzeigenanalyse folgt einer Dokumentenanalyse nach Mayring [35]. Diese kann auf alle Arten von Dokumenten, etwa Filme oder Texte, angewandt werden. Im Wesentlichen folgt diese Analyse den nachfolgenden vier Schritten:

1. Definition der Fragestellung.
2. Bestimmung und Erfassung des Ausgangsmaterials.

3. Einschätzung des Aussagegehalts der Dokumente.
4. Auswertung und Interpretation des Materials.

Die Fragestellung ist aus den vorherigen Ausführungen abzuleiten. Im Kern geht es um die Beantwortung der Frage, welche konkreten datenbezogenen Fähigkeiten und Kenntnisse in Jobprofilen der Zielgruppe Betriebswirte, Volkswirte und Wirtschaftswissenschafter relevant sind. Das Ausgangsmaterial bilden Stellenanzeigen. Eingeflossen sind nur online verfügbare Stellenangebote, welche verhältnismäßig einfach zu beschaffen und in eine Datenbasis integrierbar sind. Zur Recherche dienten die Online-Stellenportale Absolventa und Stepstone. Stepstone gehört zu den größten Anbietern mit mindestens 60.000, in der Regel aber über 80.000 Stellenanzeigen – wie Stichproben zeigten. Absolventa bietet mit ca. 6000 bis 7000 Anzeigen zwar deutlich weniger als der Konkurrent. Allerdings ist die Zielgruppe auf Akademiker eingeschränkt, was sich für die vorliegende Fragestellung als vorteilhaft erweist. Im Anforderungsprofil der Stellenanzeigen muss ersichtlich werden, dass die Jobangebote der Zielgruppe entsprechen. Die Stelle muss folglich für Absolventen im Studiengang Wirtschaftswissenschaften, BWL oder VWL ausgeschrieben sein. Zur Auswertung der Anzeigen dient eine Inhaltsanalyse [30–32], welche das Ziel hat, Textbestandteile herauszufiltern, die für die Beantwortung der Fragestellung in Betracht kommen. Die Auswertung konnte durch Text Mining umgesetzt werden. Nach Hippner und Rentzmann sind die Dokumente durch die Techniken des Natural Language Processing aufzubereiten [36]. Als Tool diente hierzu Rapid Miner mit der Erweiterung Text Processing. Daraus resultierte zunächst eine Wortliste mit den absoluten Häufigkeiten der jeweiligen Begriffe in den untersuchten Anzeigen. Nach der Filterung von Stoppwörtern können N-Gramme gebildet werden. Es resultieren Wortgruppen, die häufig in den Anzeigen auftreten und im Zusammenhang mit Daten stehen. Der Faktor N der N-Gramme stellt eine frei wählbare positive Zahl dar, welche die Obergrenze bezüglich der Anzahl der Wortkombinationen bildet. Zur Analyse wird N gleich drei gewählt. Das bedeutet, es werden Kombinationen aus zwei und drei Wörtern gebildet. Die Zahl ist sinnvoll, da eine mögliche Vielfalt an Kombinationen erfasst werden soll, aber ein zu hoher N-Wert nicht unbedingt zu einem umfassenderen Ergebnis führen muss. Die mittels Rapid Miner erzeugte Wortliste kann für weitere Auswertungen in Microsoft Excel exportiert werden, um daraus Datenkompetenzen gemäß der Schrittfolge in Abbildung 1 zu ermitteln.

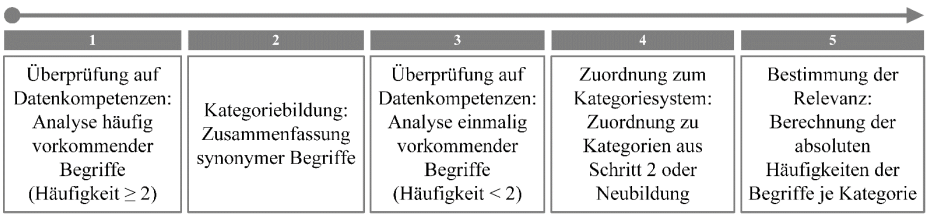


Abbildung 1. Vorgehen Auswertung Stellenanzeigen

3.2 Durchführung und Ergebnisse

Auf der Grundlage der genannten Einschränkungen konnten 134 Anzeigen identifiziert werden. Die vergleichsweise geringe Anzahl an Treffern ist durch relativ starke Filterung zu begründen. Häufig landen Jobangebote in der Trefferliste, die ausschließlich eine Berufsausbildung erfordern und folglich nicht einzubeziehen sind. Ein weiterer Grund für die Reduzierung der Anzahl von Anzeigen ergab sich aus der Streichung von Stellen, die explizit ein Studium in WI voraussetzen, das jedoch nicht dem der Zielgruppe entspricht. Die nachfolgenden Ausführungen resultieren aus der Auswertung der Wortliste. Nach der Analyse ergeben sich insgesamt über 25.000 individuelle Wörter und Wortkombinationen, wovon sich 1162 auf Daten beziehen. Die datenbezogenen Begriffe und Begriffskombinationen konnten mithilfe eines Filters – dem Wort „Daten" – ermittelt werden. Begriffe sind in den anschließenden Ausführungen jedes Wort oder jede Wortkombination.

Ein erster Befund ist, dass 103 der 134 Anzeigen einen Bezug zu Daten aufweisen. Das heißt, dass in knapp 77 Prozent der Anzeigen Daten in einer beliebigen Begriffskombination auftauchen. Dieses Ergebnis ist in Abbildung 2 auf der linken Seite dargestellt. Im nächsten Schritt konnten 79 datenbezogene Begriffe bestimmt werden, die mehr als einmal in den Stellenanzeigen erschienen. Gemäß der Begriffsauffassung von Datenkompetenz, sind hieraus 26 Datenkompetenzen abzuleiten. Weiterhin ließen sich diese in acht Kategorien einteilen. Unter Kategorien sind Datenkompetenzbereiche zu verstehen. So sind Begriffe wie „analyse_daten", „datenanalyse" und „analyse_großen_datenmengen" der Kategorie „Daten analysieren" zuzuordnen. Die Anzahl datenbezogener Begriffe, die nur einmal in der Wortliste vorkommen, beträgt 1083. Daraus ergeben sich 85 Datenkompetenzen, die den bestehenden Kategorien zuzuordnen sind. Konnte keine Zuweisung zum bisherigen System erfolgen, ist eine neue Kategorie zu bilden. Es ergeben sich daraus 111 Datenkompetenzen, gemäß den Ablaufschritten in Abbildung 1. Zur weiteren Verdichtung sind alle Begriffe, die nur eine Erweiterung eines bestehenden Begriffes darstellen, ohne eine neue Aussage zu liefern, auszuschließen. Der Schritt ist wichtig, da sonst bei der Berechnung der Häufigkeiten je Kategorie ein verzerrtes Bild entsteht. Nach diesem Schritt sind die bestehenden Kategorien darauf zu überprüfen, ob eine Zusammenfassung sinnvoll ist. Begriffliche Konstrukte, wie beispielsweise Daten sammeln, gewinnen, erheben, auswählen und recherchieren, sind der Kategorie Datenbeschaffung zugeordnet. Final konnten zwölf Kategorien identifiziert werden, die in Abbildung 2 auf der rechten Seite dargestellt sind. Es zeigt sich, dass Daten analysieren die am meisten erwähnte Datenkompetenz in den Stellenanzeigen ist. Kenntnisse in Datenanalyse, der Datenaufbereitung und der –bereitstellung sind für Absolventen wirtschaftswissenschaftlicher Studiengänge durchaus relevant und eröffnen berufliche Perspektiven. Dagegen werden Datenarchivierung und Datenmodellierung nur selten genannt und sind damit als sehr spezifische Anforderung einzuschätzen.

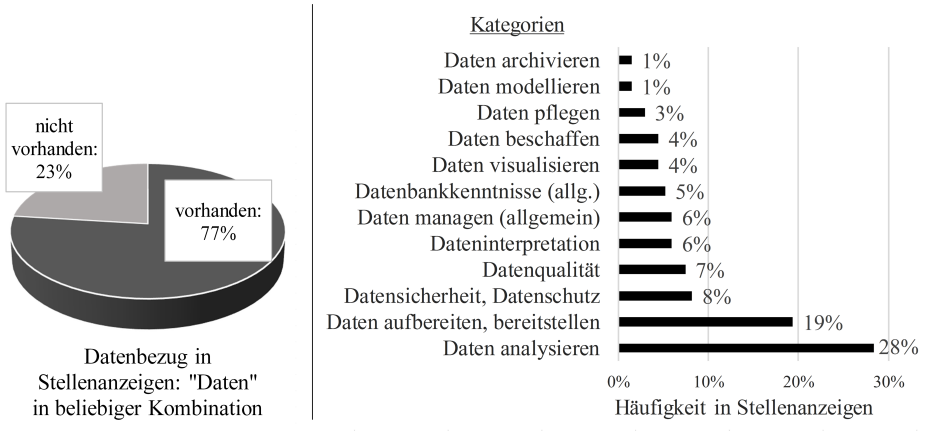


Abbildung 2. Auswertung Stellenanzeigenanalyse

4 Status quo der Vermittlung Datenkompetenzen in der Lehre

4.1 Überblick und Vorgehen

Um festzustellen, wie die für die Problemstellung relevanten Studiengänge im Zeitalter der DT aufgestellt sind, muss zunächst eine strukturierte Betrachtung der Studieninhalte vorgenommen werden. In Deutschland existieren zurzeit rund 420 Hochschulen mit 106 Universitäten und 216 Fachhochschulen oder dualen Hochschulen [37]. Diese bieten gemäß einer Suche im Hochschulkompass 75 Studiengänge in Wirtschaftswissenschaften sowie 116 in BWL und 23 in VWL an. Der Großteil hiervon sind Bachelorstudiengänge. Hinzu kommen zahlreiche neue Bezeichnungen für diese drei klassischen Studiengänge [38]. Das Auffinden und Auswertung einer möglichst repräsentativen Auswahl an Modulbeschreibungen ist mühsam, sodass die Auswertung der Inhalte anhand von Abschlusszeugnissen und Leistungsübersichten erfolgte. Diese Auswertung war möglich, da im Rahmen der Bewerbungsverfahren für wirtschaftswissenschaftliche Masterstudiengänge eine Vielzahl derartiger Dokumente vorlag, auf die ein Teil der Autoren im Rahmen ihrer Tätigkeit als Mitglieder des Prüfungsausschusses Zugriff hatte. Aus allen Bewerbungen wurden zunächst diejenigen mit den betreffenden Studiengängen herausgefiltert. Die Leistungsübersichten lagen als PDF Dateien vor und konnten somit gesichtet werden. Ziel war es, alle diejenigen Credits zu erfassen, die einen Bezug zur WI oder Informatik aufweisen. Dabei sind die Modulnamen oder Veranstaltungsbezeichnungen mitsamt der Creditanzahl festgehalten worden. Im Anschluss daran erfolge eine Zusammenfassung der Inhalte zu sinnvollen Inhaltsblöcken – beispielsweise die Zusammenfassung von „Datenmanagement“ und „Datenbanksysteme“ und die Berechnung der Creditzahlen.

4.2 Ergebnisse

Als Datenbasis lagen aus dem Jahr 2016 und 2017 insgesamt 260 Bewerbungen vor. Die Filterung erfolgte in einem ersten Schritt anhand der Studiengänge. So kamen nur Studiengänge infrage, die in ihrer Bezeichnung Wirtschaftswissenschaften, BWL, VWL, Business Administration oder Economics enthielten. Insgesamt wurden 57 unterschiedliche Kombinationen von Studiengang und Hochschulstandort identifiziert, deren Unterlagen zu einer detaillierten Sichtung vorlagen. Insgesamt zeigt sich, dass 31 der untersuchten Studiengänge eine Grundlagenveranstaltung in WI anbieten. Darüber hinaus sind einzelne Inhalte allerdings nur sporadisch vertreten. Nur vier Mal können konkrete Inhalte im Bereich Datenmanagement aufgefunden werden. Zudem beinhalteten drei Studiengänge Veranstaltungen zu Business Intelligence. Es kann davon ausgegangen werden, dass insbesondere in den Grundlageveranstaltungen Datenbanken und Datenmanagement enthalten sind. Allerdings lässt sich resümieren, dass die Studiengänge weit von einer gezielten Schwerpunktsetzung entfernt sind. Die kompletten Ergebnisse der inhaltlichen Analyse sind in der Abbildungen 3 zusammengefasst.

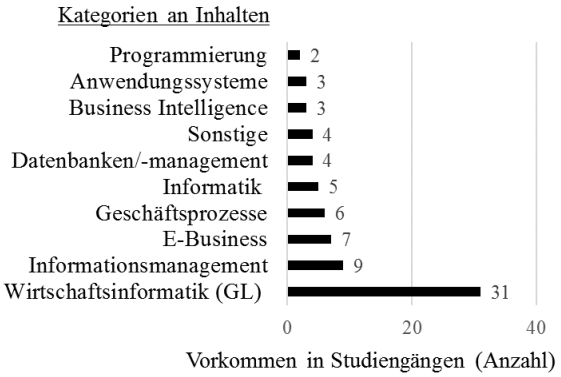


Abbildung 3. Thematische Schwerpunkte der Wirtschaftsinformatik und Informatik in den untersuchten Studiengängen

Darüber hinaus sind Aussagen zur Gesamtwürdigung der Inhalte der WI in den untersuchten Studiengängen möglich. Zehn der Studiengänge enthielten überhaupt keine Inhalte der WI. Ein Großteil weist Inhalte zwischen 1 und 10 Credits auf, was ein oder zwei Veranstaltungen entspricht. Creditzahlen, die weit darüber liegen, sind die Ausnahme und nur dann zu finden, wenn Studierende explizit Inhalte der WI wählten. Das Ergebnis ist der nachfolgenden Abbildung 4 zu entnehmen.

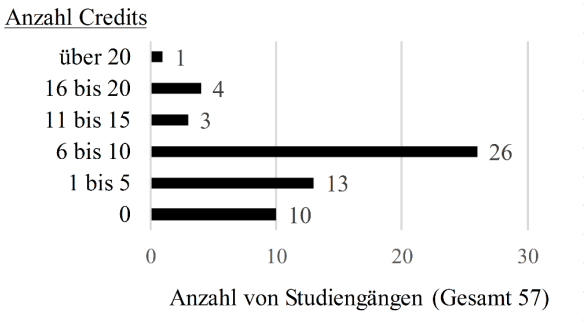


Abbildung 4. Anteil von Inhalten der Wirtschaftsinformatik in den untersuchten wirtschaftswissenschaftlichen Studiengängen

5 Handlungsempfehlungen und Zusammenfassung

Um Handlungsempfehlungen für die Gestaltung von Curricula zu definieren, empfiehlt sich zunächst eine Erfassung der Begriffsdimension. Curricula beschreiben alle Regelungen für ein ordnungsgemäßes Studium und umfassen mehrere Gestaltungsbereiche: die zu erwerbenden Kompetenzen, konkrete Lerninhalte, Studienabläufe, spezifische Lehrangebote sowie Lehr- und Lernformen [39–41]. Dabei ist zu beachten, dass Studiengänge grundsätzlich entweder forschungs- oder anwendungsorientiert ausgerichtet sein können. Allerdings sollten alle Studiengänge sowohl Anforderungen der wissenschaftlichen Gemeinschaft als auch der konkreteren Berufsfelder erfüllen [39]. Allgemein verfolgen wirtschaftswissenschaftliche Studiengänge größtenteils eine anwendungsorientierte Ausrichtung. Da der Fokus des Beitrags im Bereich der Kompetenzen liegt, ist es nicht das Ziel, konkrete Aussagen zu Studienabläufen oder Lehr- und Lernformen zu machen. Da sich allerdings die Erfüllung berufsfeldspezifischer Anforderungen als eine der grundsätzlichen curricularen Gestaltungsprinzipien erweist, stellt sich die Frage, ob diese Studiengänge den neuen praktischen Herausforderungen überhaupt noch gewachsen sind. Zwar lässt sich festhalten, dass wirtschaftswissenschaftliche Studiengänge die Veranstaltung Grundlagen der WI fast flächendeckend beinhalten und damit eine grundlegende Vermittlung von Datenkompetenzen in aller Regel erfolgt, allerdings mit höchst unterschiedlicher Schwerpunktsetzung. Zudem fehlen in 10 der 57 untersuchten Studiengänge vergleichbare Inhalte vollständig. Das heißt, dass in 17 Prozent der mutmaßlich anwendungsorientierten Studiengänge überhaupt keine Vermittlung datenbezogener Kompetenzen oder allgemeiner IT-Kompetenzen stattfindet. Bezogen auf die anwendungsorientierten Anforderungen von Curricula zeigen sich hier Versäumnisse. Folglich existiert selbst im Grundlagenbereich Handlungsbedarf. Vertiefende Veranstaltungen gehören kaum zum Pflichtprogramm der Studiengänge. Zwar gibt es oft die Möglichkeit, Schwerpunkte in WI zu setzen. Diese sind jedoch nicht flächendeckend gegeben. Der Bedeutungszuwachs von Daten und Datenmanagement im Arbeitsumfeld ist nur punktuell erkennbar. Ein Großteil der Hochschulen scheint den praxisorientierten Anforderungen in grundständigen Studiengängen im

Moment nicht nachzukommen. Da praktisch alle beruflichen Tätigkeiten mit Informationssystemen und Daten konfrontiert sind, müssten derartige Inhalte inzwischen wie Buchführung, Kostenrechnung oder Statistik zur Propädeutik wirtschaftswissenschaftlicher Studiengänge gehören. Damit einher geht ein Bedeutungszuwachs der WI im Allgemeinen. Es ist die Aufgabe dieser Disziplin, diese Inhalte in die ökonomische-betriebswirtschaftliche Ausbildung zu transferieren und vermehrt Angebote dahingehend zu unterbreiten.

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Developing an Evaluation Model for Information Systems Curricula

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Abstract. In this paper, we develop an evaluation model for Information Systems (IS) curricula. Existing evaluation models for curricula are analyzed and extended with IS-specific success criteria, such as a possibility to apply the learned skills in a student project. These success criteria are extracted from a literature review. As a result, we propose a model that can be adapted and applied to different curricula for Information Systems that cover various topics from IT, Business, Management, and Economics and include theoretical and practical learning methods. The findings can be applied in universities for evaluating new curricula as well as as serve as a starting point for further research. With this work, we offer a first step in defining an evaluation model that is specific for Information Systems by including the relevant success criteria.

Keywords: curriculum, evaluation, Information Systems, evaluation model.

1 Introduction

Quality assurance, continuous improvement, and optimization of the content and measures are important aspects of university curricula [1]. Therefore, curriculum evaluation is considered the last step of curriculum development. In many universities, a curriculum evaluation is conducted at the end of every semester and the reasons for this are manifold. While some institutions conduct evaluation to determine the success of a curriculum or a lecture [2], others perform the evaluation to assure that the topics covered in the curriculum correspond to the demands of the industry, as described by Snoke and Underwood [3]. Didactic researchers, such as Schaperunter et al. [1], Biggs and Tang [4], or Tyler [5] put a strong emphasis on curriculum evaluation. Thus, different evaluation models have been developed over the years. Stufflebeam and Coryn [6] define an evaluation model as "[...] idealized conceptualization for conducting program evaluations". These models address various aspects including the lecturers' behavior, spatial and structural aspects of the learning process, characteristics of the event [7], or the output of a curriculum [1].

However, the methods and frameworks mentioned are of a general and holistic nature. The authors suggest evaluation models by following the principle – one size fits all. They consider learning as an identical process in all disciplines and areas. Therefore, they suggest evaluation models that are universal and could be applied

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across disciplines [6]. While we agree that university learning is a cognitive process and people often learn in very similar ways independently from the discipline, we think that there are some differences through the disciplines in how the learning process is organized and conducted. This is especially true for interdisciplinary areas such as Information Systems (IS), where a combination of Computer Sciences, Business, Management, and Economics happens. University curricula in IS have specific requirements, since the discipline combines different areas of studies and includes a broad spectrum of teamwork as well as technical, and theoretical learning events. Therefore, the presented evaluation models are not perfectly tailored for the discipline of IS [3, 7].

This paper aims at addressing this gap by offering an evaluation approach that is suitable to the characteristics and needs of IS. We conduct a literature review to extract the success criteria of IS curricula. Based on these results, existing evaluation models for curricula are combined and extended in order to offer an evaluation model for IS curricula.

2 Background

The concept of a "curriculum" is broad and widely used in teaching and education. While some authors define a curriculum as the collection of learning and teaching materials for a single course, others include also the applied tools and methods in a course, or define a curriculum as the structure and content of a whole course of studies. For example, Ebert et al. [8] define a curriculum as "means and materials with which students will interact for the purpose of achieving identified educational outcomes". Another definition is provided by Offorma [9]: A curriculum is a "[...] document, plan or blue print for instructional guide, which is used for teaching and learning to bring about positive and desirable learner behavior change." For the purpose of this paper, we will use the following definition: A "curriculum typically refers to the knowledge and skills students are expected to learn, which includes the learning standards or learning objectives they are expected to meet; the units and lessons that teachers teach; the assignments and projects given to students; the books, materials, videos, presentations, and readings used in a course; and the tests, assessments, and other methods used to evaluate student learning." [10]

In order to evaluate a curriculum, measures and instruments are applied to judge or asses its level. Subah [11] describes evaluation as "a study that is designed and conducted to assist some audience to judge and improve the worth of some educational object". One of the definitions, provided by White [12], implies that evaluation is "a phase in the process of constructing and reconstructing curricula. Its purpose is to see whether curriculum objectives are being, or have been, achieved — so that modifications in them can be made if necessary." In contrast to this, in this paper, we will define evaluation as a process of collecting feedback about different aspects of the curriculum from the relevant stakeholders in order to assure the goal fulfillment and to identify the improvement potential.

Over the years, various evaluation models to assess curricula have been developed. Alazani and Fardoun [13] have described an evaluation model they use at their university. It focuses on evaluating the IS program based on student outcomes. For the direct measure, they map the student outcomes to the exam questions and look at the percentage of the students that answer it correctly. They also give a survey to the students for an indirect assessment. However, this survey is mainly focused on the student outcomes as well. While this model is used for this one specific IS curriculum, its application is very narrow. It is useful for evaluating the achieved level of learning objectives, but does not consider any other possible success criteria such as evaluation of the learning materials or the evaluation of the instructor.

Another evaluation model is proposed by Martínez-Caro et al. [14]. This model is not specific for IS, and can be used broadly. The authors claim, based on a literature search, that the student satisfaction can be evaluated with four dimensions: student-student interaction, student-teacher interaction, content, and system flexibility and convenience. They also provide a questionnaire that they gave to their students during the evaluation, with an exact mapping between the questions and the dimensions. This model is applicable in our context, but it is focusing only on feedback from students, without taking into account any objective measures, like grades, into consideration.

Other authors focus on evaluation models that do not consider the whole curriculum or its learning units, but only specific elements. For example, Wilson and Randall [15] evaluate a newly designed learning room where the course takes place. The model of Escudeiro and Escudeiro [16] focuses on evaluating the software. Its application has been shown by Reis and Escudeiro [17]. The authors suggest evaluating the learning software based on three dimensions: functionality, adaptability, and efficiency. For each dimension, they also provide a set of factors, such as ease of use, to be analyzed and the survey questions they use to perform the evaluation. Both models are not specific for IS, and can be applied broadly. However, like the one that we have described first, they are too narrow and do not evaluate the whole curriculum. Despite that, we can use them, if we determine that learning software or the learning room are among the success criteria.

Another evaluation model is the Kirkpatrick's 4-level evaluation [18]. It suggests evaluating the curriculum based on four levels: reaction, learning, behavior, and results. *Reaction* evaluation aims at determining how well the participants did, how the students, lecturers, and other involved stakeholders feel about the course as well as their reactions to it. It is possible to ask them about their satisfaction with every aspect of the curriculum. The second level is *Learning* and the evaluation on this level aims at determining whether the participants have mastered the learning objectives of the course and to what extent they did. The third level, *Behavior* aims at understanding to what extent the participants were capable to apply the knowledge in their job areas. The evaluation at *Result* level measures the effect of the training on in the working environment. The effect is captured by various key performance indicators such as non-compliance decrease or standard achievements. Since this model is flexible and easily adaptable, it was taken as a basis for this work and adapted and extended with elements of the other models as well as with success criteria, elicited from literature. These criteria are mapped to the corresponding evaluation level of the Kirkpatrick's model.

At each level, we provide the evaluation methodology that is extracted from the specialized models mentioned above.

3 Methodology

To determine the success criteria for IS curricula, we conducted a systematic literature review, following the recommendations of vom Brocke et al. [19] and Webster and Watson [20]. We searched in major databases, namely IEEE, ACM Digital Library, EBSCOHost, AISeL and SpringerLink. The reason for this choice is that these databases cover many IS publications. Furthermore, they also include relevant education outlets. By doing so, we could cover the research areas both, of IS and education.

Next, we defined a search query, which we than used throughout all the databases. This query is (curriculum OR teaching OR learning OR training in abstract) AND (success in abstract) AND ("Information Systems"). The first two parts of the query included the keywords that should occur in the abstract, as they describe the actual content of the publications that we were looking for. Thus, they should be included in the short summary. For the term “Information Systems”, we searched the whole text, as there are publications that describe the success criteria of a course that is taught to IS students, but this is not explicitly mentioned in the abstract, e.g., Ikonen and Kurhila [21].

After choosing the databases and keywords, we started with the literature search process. Searching the mentioned databases produced 3,290 hits. After the first screening, which included reading the paper titles and the abstracts and considering whether they were relevant in our case, only 79 papers have been considered for the further analysis and synthesis. Such a small number can be explained by the fact that the words “learning” and “training” are often used in other contexts, such as machine learning. In a second screening, we read the complete articles and decided if they handled success criteria and therefore should be considered relevant for our research. After this step, only 43 papers that contained statements that can be interpreted as success criteria for a curriculum were selected.

Based on the analysis of these papers, we elicited 19 success criteria for IS curricula. These criteria were combined, categorized and further used to extend the evaluation model of Kirkpatrick’s. In the next chapter, we will present them and suggest measures and tools for the concrete evaluation.

4 Results

4.1 Success Criteria

We elicited a total of 19 success criteria from the literature. In this section, we will explain them, and provide a short summary for every success criterion in Table 1. Many authors mention that the *Student Performance* in terms of grades is an important success

criterion [22-32]. It intends that students have achieved grades with a higher mean than a given threshold. Other authors have the opinion that just looking at the grades is not enough. They consider *Mastering of the Learning Objectives* of the curriculum, that have been defined while developing the curriculum, a success criterion [25, 33, 34]. Anderson and Krathwohl define learning objectives as: "[...] both the kind of behavior that has to be developed in a student and the content in which this behavior is to operate" [35]. *Improvement of the Student Skills*, meaning that the students are able to solve the problems that the curriculum addresses better than before, is also considered a measure of curriculum success by some authors [36-38]. Another mentioned factor is the students' overall interest in the course, measured by the *Enrollment Numbers* [22, 39]. A curriculum can be considered successful, if the enrollment numbers in the subject where the curriculum is applied are rising, e.g., from year to year. All these mentioned factors can be measured directly and expressed with numbers.

This is, however, not always the case. Some of the success criteria can be only determined by collecting the opinions from the relevant stakeholders. For example, if the course involves working with external partners, such as companies, feedback should be gathered from those as well. Roseman and Maurizio mention the contacts and support from the industry among the success criteria [22]. Khmelevsky explains this idea by mentioning that in order to satisfy the industry partners that actually provide the students with the project work, it has to be assured that their requirements have to be fulfilled [40]. Feedback should also be gathered from the administration or a faculty, responsible for the curriculum [22, 41, 42]. It has to be assured that they have fulfilled their own goals that they have set before the curriculum rollout. This provides two more success criteria: *External Feedback*, and *Administrative Feedback*.

Table 1. Success Criteria for IS Curriculum

Success Criterion	*Explanation*
Student Performance	The students have achieved the grades with a higher mean than a given threshold.
Mastering of the Learning Objectives	The students have achieved the learning objectives, defined before rolling out the curriculum.
Improvement of the Student Skills	The students show the better ability to solve the addressed problems after taking the course, than they did before.
Enrollment Numbers	The enrollment numbers in the course, where the curriculum is used, are rising.
External Feedback	The external partners have fulfilled the goals that they have set for this collaboration.
Administrative Feedback	The responsible persons from the university/faculty administration have achieved the goals of teaching the subjects.
Student Engagement	Students feel themselves engaged in the learning process and find the course interesting.
Content Integrity	The contents of the single learning units fit to one another; the content is well structured in general.

Success Criterion	*Explanation*
Reasonable Workload	The content of the course can be mastered in the specified time.
Practical Application	The learned material is applicable in practice.
Pedagogical Underpinning	The course provides a deep enough view into its contents.
Learning Materials	The materials, like lecture slides, used in learning are understandable and of a good quality.
Learning Software	The software used in learning supports the content and helps in applying the gathered knowledge into practice.
Lecturer Teaching Skills	The lecturer is capable of delivering knowledge to the students.
Lecturer Competence	The lecturer masters the subject he teaches.
Lecturer Teaching Approach	The lecturer interacts with the students in a way that supports the knowledge transfer and learning process.
Hands-on Approach	The students have the ability to apply the learned skills and knowledge.
Collaborative Work	The students have the possibility to work with each other by supporting one another in projects and learning improving their social competencies.
Student Projects	The projects the students have been working on, delivered a desired outcome.

Most of the authors focus on collecting feedback from the students, since they are the actual target audience for the curriculum. Some authors evaluate the *Student Engagement* in the learning process [22, 27, 37, 39, 43, 44]. Others focus more on the *Content Integrity* of the curriculum, which means that it is well structured in general and the contents of the single learning units fit to one another [25, 45, 46]. Wong and Cheung also mention the *Reasonable Workload* [25] among the success criteria to be evaluated. It means that the content of the course can be mastered in the specified time. Another two success criteria are *Practical Application*, meaning that the learned knowledge can later be applied in praxis [22, 47, 48], and *Pedagogical Underpinning*, meaning a deep view into the curriculum content [49]. The *Learning Materials*, which are delivered to the students [37, 41], as well as the *Learning Software*, used in course to support the content [22, 37, 50, 51] are also considered as success criteria. The literature also suggests to evaluate the lecturer: his *Teaching Skills*, how well he or she is doing when transferring knowledge to students [52, 53], *Competence*, how well he or she masters the taught subject [22, 44, 54], and the *Teaching Approach*, the way he or she interacts with students [44]. Two of the reviewed authors also value the *Hands-on Approach*, the ability to apply the learned skills and knowledge during learning, e.g., by integrating an enterprise software [45, 55]. Finally, the degree of how well the curriculum inspires *Collaborative Work* [41, 44], or group work on *Student Projects* [21, 56], are also proposed as success criteria in the literature and should also be evaluated.

4.2 Development of an IS Evaluation Model

After eliciting the success criteria for an IS curriculum, we developed the evaluation model. As mentioned in the Background section, we use Kirkpatrick's model [18] as a basis. The reason for this is that this model offers flexibility and allows adaptions. We adapted the model for the purpose of the IS curriculum evaluation and used the first two levels of the model, *Reaction* and *Learning*. These categories cover all the needs and features of IS curricula and give a compact and manageable evaluation model that can be adapted for specific IS curricula and is easy to use for lecturers. The other two levels of Kirkpatrick's model, *Behavior* and *Results*, focus specifically on the skills for the job and the influence on the work environment. These factors could be measured in the scope of industry trainings and courses by evaluating the application of the learned skills in the employee's everyday work. However, it would be very hard to evaluate these in the case of university students.

We categorized the defined success criteria and assigned them to the levels of the Kirkpatrick's model. Factors such as *Student Performance, Mastering of the Learning Objectives, and Improvement of the Student Skills* can be measured and describe the effectiveness of the learning. Therefore, we categorized them under the level *"Learning"* of the Kirkpatrick's model (Fig 1).

Further factors such as: *Content Integrity, Reasonable Workload, Practical Application,* and *Pedagogical Underpinning* are connected to the curriculum content. Therefore, we grouped them together into the *"Content"* category. The factors *Learning Materials* and *Learning Software* are connected with the learning environment. Therefore, we aggregated them in the *"Environment"* category. Another three factors that describe the lecturer, *Lecturer Teaching Skills*, *Lecturer Competence*, and *Lecturer Teaching Approach* can be categorized as *"Lecturer"* category. Success criteria such as *Hands-on Approach*, *Collaborative Work*, and *Student Projects* are related to the method of learning. Therefore, we grouped them together in a category called "*Learning Method*". *Student Engagement* and *Enrollment Numbers* are two further factors that describe the students' motivation with regards to the curriculum. Therefore, we grouped them under the category *"Students' Motivation"*. Considering the feedback related criteria *External Feedback* and *Administrative Feedback*, they describe feedback received from other curriculum stakeholders. Therefore, we assigned them to the category *"Stakeholder Feedback"*.

All the elements of the categories *"Content"*, *"Environment"*, *"Lecturer"*, *"Learning Method", "Students' Motivation"* and *"Stakeholder Feedback"* describe how the students, lecturers or third parties feel about the curriculum, their overall satisfaction with the curriculum and its content. Therefore, based on the Kirkpatrick's model, they match to the level "*Results"* (Fig 1).

For every success criterion, we propose an evaluation mechanism. For the curriculum content evaluation, we suggest extending the model proposed by Martínez-Caro et al. [14], which provides survey questions to explore the *Pedagogical Underpinning* and the *Workload* of the course with the question samples from Kirkpatrick and Kirkpatrick [18], who propose questions to evaluate the other two factors, *Content Integrity* and *Practical Application*.

The model proposed by Martínez-Caro et al. [14] also can be applied in the *"Environment"* category to evaluate the student satisfaction with the *Learning Materials*. This can be extended by applying the Quality Evaluation Framework from Escudeiro and Escudeiro [16], for the evaluation of the *Learning Software*, since it allows to perform a full evaluation based on the different criteria.

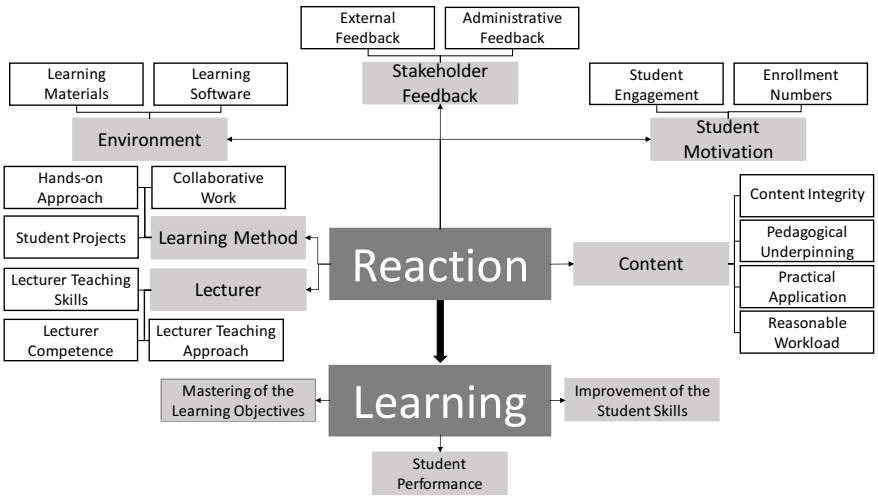


Figure 1. Evaluation Model for IS Curriculum (Source: own representation based on Kirkpatrick and Kirkpatrick [18])

For the lecturer category, we suggest a combination of the survey questions from Martínez-Caro et al. [14] to evaluate the *Lecturer Teaching Approach* and *Teaching Skills* and the survey questions from Kirkpatrick and Kirkpatrick [18] in order to evaluate the *Lecturer Competence*. For the evaluation of the *"Learning Method"* we suggest to apply the model of Martínez-Caro et al. [14] in order to evaluate the *Collaborative Work* of the students and combine it with the model from Kirkpatrick and Kirkpatrick [18] for the *Hands-on Approach* and the *Student Projects*. We also propose to measure *Student Engagement* by using the survey suggested by Martínez-Caro et al., and to use the questionnaire samples, proposed by Kirkpatrick to gather the *"External Feedback"* and the *"Administrative Feedback"*.

For evaluating the success criteria on the *"Learning"* level, the exam results can be applied: While exam results can be a measure of learning, as described in paragraph 4.1, it is suggested by Alghazzawi and Fardoun [1] to break them down with regard to single learning objectives. This way, the percentage of students that mastered a certain learning objective by checking the correct exam answers can be measured. The same approach can be applied to the students' skills improvement evaluation. This way, it is possible to evaluate, which part of the curriculum has not been mastered by the students and thus needs improvement.

5 Conclusion and Outlook

In this paper, we developed an evaluation model for IS curricula based on success criteria for IS curricula. We conducted a literature search and extracted 19 success criteria. With regards to these factors, we adapted and extended the evaluation model offered by Kirkpatrick and Kirkpatrick [18]. Furthermore, based on existing evaluation approaches, we suggest a methodology for the evaluation of each of the evaluation elements.

The proposed model can be applied by academic institutions that teach in the IS area to evaluate their curricula or by other institutions that develop academic IS curricula. Lecturers can choose which success criteria they want to evaluate and adapt the model as well as the suggested evaluation mechanism for their own purpose. E.g., if a curriculum does not include any group work or collaboration, that part of the model can be removed, and the other factors can be evaluated.

While there have been many studies on evaluation approaches over the years, there is no contribution that addresses the evaluation needs of the IS discipline, although this is an interdisciplinary area that has special requirements concerning curriculum evaluation. Therefore, with this paper, we make a first contribution in this area of study that can serve as a basis for further research. The model can be adapted for specific curricula. Furthermore, a practical application of the curriculum evaluation model in practice could deliver new results.

As every other work, this work also faces some limitations. Curriculum evaluation is a topic with a long tradition of research. Therefore, this work is based on well-known theories and evaluation models that make the results valid. However, the results in this paper are purely based on the literature search while we did not collect any empirical data in order to evaluate and extend them. Enhancing our research with empirical data could be a possible future research topic.

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Analysis and Modeling of Learning Systems and Development of a Process Model for Flexible Orchestration of Learning Environments

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Abstract. Within the fields of research and training, more and more knowledge is generated and made globally available through digital transformation. As a result of semi-structured expert interviews with the employees of an education service provider, lecturers are increasingly overstrained with the amount and the diversity of learning objects. Additionally, lecturers have insufficient knowledge about their own learning system often caused by missing formalization. This adversely affects the teaching quality.
In this paper, a concept for structuring learning systems is created. Therefore, the Learning Object Metadata (LOM) standard is extended to handle hierarchies. The approach enables lecturers to analyze and formalize their own learning system. Furthermore, a process model for the flexible orchestration of learning environments is designed. This supports the lecturer in transferring learning objects from a source to a target learning system. In a scenario-based evaluation, the applied concepts (formalization and orchestration) lead to a higher teaching quality.

Keywords: Education as a Service, Teaching as a Service, Learning System, Learning Environment

1 Introduction

Since the beginning of the 21st century, globalization and digital transformation influence not only industrial production, retail and services, but also the field of research and training [1-2]. By these "intensification border-crossing interactions" [2], broad and standardized educational areas should be formed among other things. One example is the attempted establishment of a Europe-wide higher educational area as a result of the Bologna Process [1], [3]. In contrast to standardization, the specialization in several fields of expertise increases. More and more knowledge is generated and published [4].

Through digital transformation, this wide and extensive knowledge is being made globally available and usable by means of worldwide data networks. However, nowadays, a web-based search query provides more results than usable. An additional

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problem is the missing qualitative evaluation. Thus, the retrieval of relevant content with high quality is complicated [1], [4].

These facts influence the education in general and especially the higher education. Additionally, in tertiary education, lecturers are technical well-skilled in most cases but do not encounter well-founded pedagogical concepts [3]. Another point of criticism that arised during the Bologna Process is the less practice-oriented way of teaching [3]. In this context, Kergel and Heidkamp, who investigate explorative learning, talk about the "complexity of theory-practice-transfer" [1]. The plentiful knowledge is partly not didactically prepared and Röder already mentioned that individual requirements and demand-oriented forms of knowledge transfer are often missing [4].

One possible approach to address these problems is the development of system-based curricula. Such systems might consist of learning material, an application or information system and a model organization. These systems may be provided by education service providers who are also maintaining the infrastructure and the applications for global access. This wide collection of practice-oriented learning objects is formed in the field of enterprise software. Through the years, the amount of the offered curricula increased many times over. New document types were developed, further modules or whole software solutions were added (caused by the swift progress in software technologies) and for globalization reasons new language versions were created.

Members of a special program can find this practical knowledge in terms of media and tools on a web-based platform, but the complexity problem remains. Based on the result of semi-structured expert interviews with the employees of an education service provider, lecturers are increasingly overstrained with the amount and the diversity of learning objects. A one-week train-the-trainer session is not enough to teach the lecturers in transferring learning objects to their learning environment sufficiently. As a further result of the expert interviews, the lecturers have insufficient knowledge about their own learning system often caused by the missing formalization (e.g. no formal model, many sources but partially different data, no obvious dependencies between courses) and about externally created learning content especially in new courses. This adversely affects the teaching quality, for instance because of missing course integration into higher-level context, selection of non-relevant learning objects or missing practical applications.

In order to evaluate the state of the art in this field, a well-structured and reproducible literature review following the method of Seuring and Müller [5] was conducted. The results are briefly summarized as follows. Most of the reviewed works deal with social science theories like the spatial theory, for example, in conjunction with the future campus [6] or media-virtual learning rooms [7]. Other publications do have an engineering background, but the primary focus lies either on the learner [8] or the technical learning system itself [4]. As a conclusion, the state of the art does not sufficiently support lecturers in solving the aforementioned problems.

This paper is oriented towards the Design Science Paradigm following Hevner et al. [9-10]. The problem is already identified and its relevance is investigated by means of a structured literature review. To solve the problem, different artefacts are constructed and their value is evaluated descriptively. The goal of this paper is to create a concept

for the structuring respectively formalizing of learning systems and to develop a process model for the flexible orchestration of learning environments. This so-called education/teaching as a service should lead to a higher teaching quality. The scope of these concepts is limited to system-based education, as they cannot be transferred trivially to other educational fields because of their technical difference.

2 Learning System and Learning Environment

In common usage, learning system and learning environment are often used synonymously [4], whereas in the context of this work, these two essential terms were separately defined in the following.

2.1 Learning System

A learning system is conducive "to impart, practice, examine and evaluate knowledge acquirements and skills" [11]. According to Röder, it comprises a collection of media and tools [4]. In this case, media could be single- or multi-media and they encourage the learning process. As tools, he mentions for example experimental arrangements, personnel computers or institutions.

Adapted from the Systems Theory following Masak [12], a learning system is a set of learning components and their relationships to each other. It is a system whose components have learning-theoretical references and different properties. Between these single components, there could be a hierarchical structure.

Taking additional references, a learning system can be visualized [13] and it supports the lecturer choosing the main factors of an educational system (learning goals, learning contents and teaching methods) [14] and as a consequence it encourages the learning and teaching process. Furthermore, a learning system is a model to purposefully describe and optimize learning surroundings.

Learning systems can be differentiated into source learning systems and target learning systems. So-called curriculum designers create the source learning systems with the aim of an absolute standard having reference character for the usage by many lecturers. As opposed to this, the target learning system is defined by the lecturers themselves. If both learning systems have similar components with the same properties, this enables mappings from source to target systems.

Adapted from Chiticariu and Tan [15], system mappings are ambitious and describe the specifications of relations between two systems. It describes how components and their structure can be transferred from a source system to a (partly) different-structured target system.

2.2 Learning Objects

A learning system comprises several learning components. Within computer science, examples for those components are learning objects or ‑ synonymously used - teaching materials like documents or videos and tools like (model) organizations or application or information systems. In this work, learning objects are in the main scope.

Learning objects do have an amount of properties [16]. They can be described with the help of metadata [4]. To guarantee interoperability between (learning) systems, standards have to be followed.

In terms of learning objects, the Learning Technology Standards Committee (LTSC) of IEEE recommends the usage of LOM [17]. These metadata are required for relating learning objects and structuring the learning system. Table 1 shows the extendable blueprint of the LTSC.

Table 1. Excerpt of categories within the LOM standard [4]

Category	*Generic Metadata*
General	Title, description, language
History	Status, author, version
Technical requirements	Platform, file size, media format
Pedagogical requirement	Document type, difficulty level
Rights	Originator, conditions
Relations	Type of relation, description
Classification	Source, tags, purpose

2.3 Learning Environment

According to Röder, a learning system can be structured into two different variants [4]. If the tree structure is used, a hierarchy is generated, whereas applying the main reason of using the net structure is fast navigation. In this work, trees are used because these structure leads to clearer overviews and it is especially adapted for content segmentation.

Considering a determined part of a structured learning system, this part is defined as so-called learning environment. Consequently, in the context of this work, a learning environment is a selection of learning objects (independent of the aggregation level) and their relations to each other with the help of the above-mentioned metadata categories. The complete build-up of a generic learning system is depicted in figure 1.

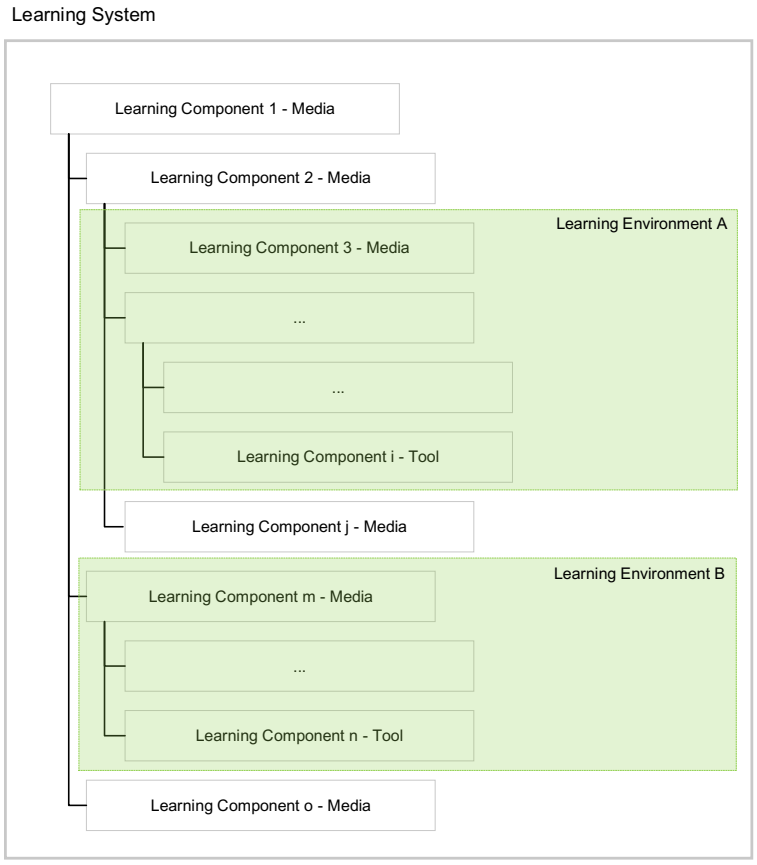


Figure 1. Build-up of a generic learning system

3 Analysis and Modeling of Learning Systems

The following section comprises the systematic derivation of learning systems. The first step is to analyze a source learning system. After that, the way of structuring a target learning system is described.

3.1 Analysis of a Source Learning System

For the mapping process, a given source learning system (e.g. of an education service provider) is assumed. To reach a satisfying mapping result, this system has to be analyzed and described. Generally, since such a system is created for several use cases, the content-related focus and thereby the pursued intentions have to be known to check the applicability for different target learning systems.

As a next step, all components of the source learning system and their relations to each other have to be examined. On this basis, it is necessary to analyze the structure

of the learning system. The use of hierarchical levels enables the identification of whole learning object bundles as well as the selection of single learning objects.

As already mentioned, metadata are a requirement to relate learning components, to structure the learning system and to identify target-relevant learning objects. Those metadata can be described, analyzed and categorized with the help of the LOM standard. To handle not only single learning objects but also learning object bundles over different hierarchical levels, the LOM standard is extended in this work, for example, using one property like 'language' as bundle metadata to group together several learning objects by this property.

Moreover, it is necessary to take care of the following or content-similar metadata: 'Content-related tags', 'language' and 'difficulty level'. As a result of the first prototypical case study done within this paper (see chapter 5), these extendable set of metadata is ranked as essential for the mapping process. The more metadata exist, the more precise the selection of learning objects is.

3.2 Structuring of a Target Learning System

After analyzing the source learning system, the next step is to structure a target learning system (e.g. a course or an entire professorial chair of a university). The following guidance is a useful approach to formalize generic learning systems.
As with the source learning system, the content-related focus and its field of application have to be determined. This is a rough orientation and it enables application analysis among others.

With the help of different instruments like (module) manuals, catalogues, organizational and operating plans as well as integrated (information) systems, structuring criteria of the target learning system can be identified. For the following structuring, an unambiguous hierarchy is absolutely essential. To make this structure decision, the information content of the used instruments is crucial because potentially one of them specifies the structure (e.g. 'faculty – study path – module' or 'faculty – institute – module') implicitly.

After structuring the target learning system for the elements of all hierarchy levels, metadata have to be identified to realize the following mapping process. Again, as with the source learning system, the more relevant metadata exist and the more precise the specifications gathering these metadata are, the more precisely the need of learning objects can be defined.

Subsequently, the object under investigation has to be demarcated clearly. Examples could be single learning objects of a course, entire courses or successions of courses.

As a result of the case study done within this paper, for the demarcated object, the following or at least similar metadata are also absolutely essential for the mapping process: 'Content-related tags', 'language' and 'difficulty level'.

For the object under optimization, the following process model can be used to flexibly orchestrate learning environments.

4 Process Model for flexible Orchestration of Learning Environments

After analyzing a source learning system and structuring a target learning system, the following three-step mapping process model has to be applied. At first, both systems are adjusted to each other (adjustment) to increase the mapping result quality. Secondly, based on the selection criteria, a sample space of learning objects from the source is orchestrated (selection). This quasi-generated learning environment is adjusted within the third step (refinement). All three steps will be described in the following.

4.1 Adjustment

If both systems have similar metadata, they can be matched and afterwards mapped to each other. As already mentioned, this will increase the quality of identifying learning objects because with the help of the adjusted metadata the source learning system can be browsed effectively and efficiently. These cutbacks of the entire source learning system simplify the identification of only course-relevant learning objects for the lecturers.

To enable a productive mapping, the transformation of the three metadata 'Content-related tags', 'language' and 'difficulty level' is absolutely essential because these are the as a result of the case study identified main selection criteria. Generally, there has to be paid attention since such optimizations include some risks because of incorrectly adjusted metadata making it difficult to identify relevant learning objects.

4.2 Selection

After adjusting metadata of both systems, all necessary metadata have to be collected in the so-called metadata base. This base consisting of assembled and adjusted metadata is used to reduce the entire source learning system and filter/select relevant learning objects from all hierarchy levels step by step and transfer them into the sample space. In doing so, the following problems can occur:

1. Too many learning objects were identified.
2. Not enough or just partly relevant learning objects were identified.
3. No (relevant) learning objects were identified.

4.3 Refinement

These problems could be solved independently of each other during the refinement phase. Using content-related and structural tags, the created sample space (learning environment) could be browsed again and thus being reduced effectively and efficiently. This way, surplus learning objects can be easily removed. Additionally, a prioritization performed by the lecturer also refines the result.

Hierarchization, combination and orchestration can solve the problem of insufficient learning objects. The hierarchization uses structural attributes to identify not-selected

or just (incorrectly) removed learning objects at the same hierarchy level. Because of the unambiguous reference to the original object, the selection is added to the learning environment.

Combinations make sure that necessary relations and dependencies between learning objects are included in the process of refining the learning environment. Learning objects identified this way are requirements or extensions of the present learning environment. Via orchestration, optional recommendations from the curriculum designer on the side of the source learning system can be included in the learning environment.

If there were no relevant learning objects identified, the target learning system has to be more specified in further iterations or the source learning system has to be checked for the presence of relevant learning objects.

4.4 Evaluation of the Learning Environment

As a last step, the lecturer has to apply the learning environment created for himself to evaluate the result. This includes the appraisal of the composition grade, especially with reference to usage, quality and utility of the learning objects for the purposes of the course under investigation.

As part of continuous improvements, the evaluation results can be used to enhance the source learning system with the help of the identified potentials. By way of example, a restructuring of the source learning system could lead to higher quality learning object composition grades or an addition of further metadata to existing learning objects could lead to better selections.

5 Case Study

In order to proof the concept, a scenario-based evaluation was chosen. At first, an exemplary source learning system was analyzed. Afterwards, a target learning system was restructured. Finally, the mapping process was executed to select and orchestrate course-relevant learning objects from the source and transfer them to the target learning system. The whole process model is depicted in figure 2.

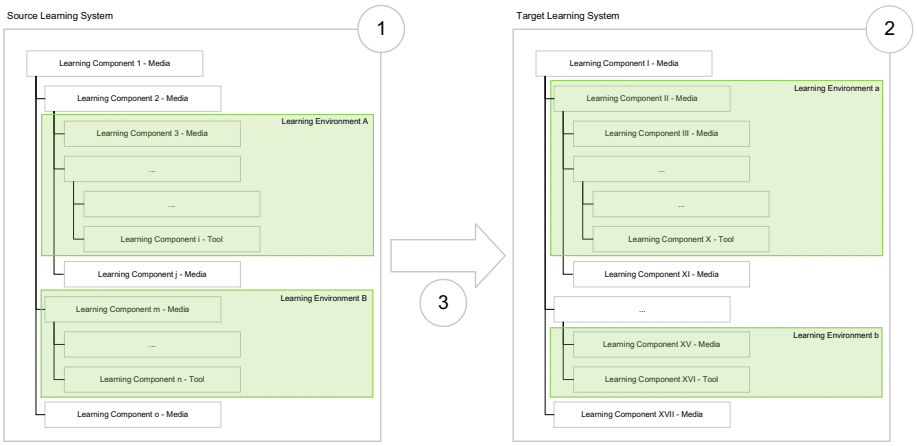


Figure 2. Generalized evaluation process model

The learning system constructed by the education service provider was taken as a source. This composition consisting of learning materials (media), a model organization and an application system (both tools) was created with the main goal of practical use. Considering media only, learning objects are on the bottom-level of the system's hierarchy. These objects were combined to so-called modules and these then were combined again to so-called curricula on the top hierarchy level. To handle those hierarchy structures, the LOM standard was extended, so that not only learning objects can have metadata, other level also could have. In figure 3 the exemplary source learning system including those metadata is depicted.

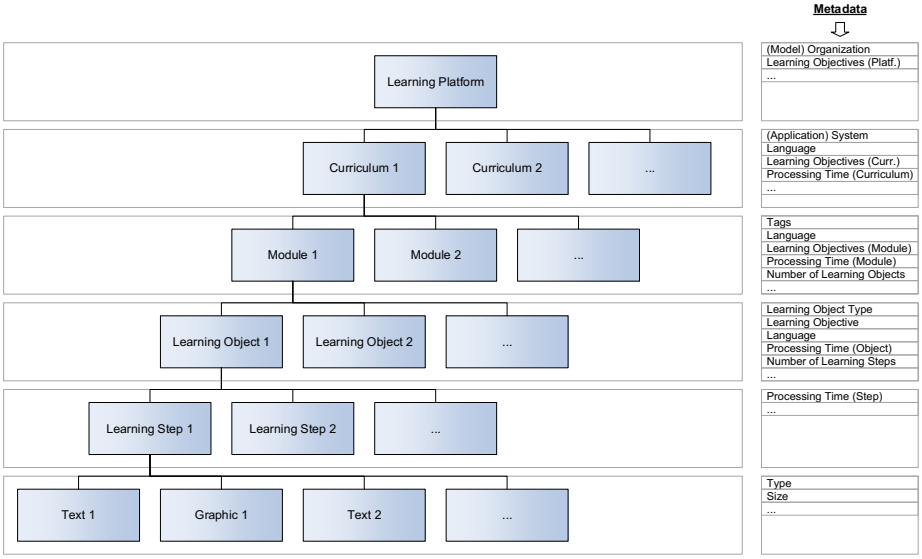


Figure 3. Structure and exemplary metadata of the source learning system

On the other side, an informatics faculty of a German university was chosen as exemplary target learning system. In a semi-structured interview with the teaching coordinator the status quo was qualitatively gathered in detail. All learning modules including some metadata were collected in a module catalogue, but there was no formal model to reveal structural dependencies between these modules. The reasons were too many artifacts trying to structure the system, redundantly data storage, uncertain responsibilities and the absence of formal rules to enter all module metadata consistently.

As main problem the numerous and diffuse structuring opportunities concomitant with missing formalization were identified. The learning system was described decentrally with different artifacts but there was no unambiguous and complete definition. With the help of these artifacts and the expert interview, the system was restructured as depicted in figure 4.

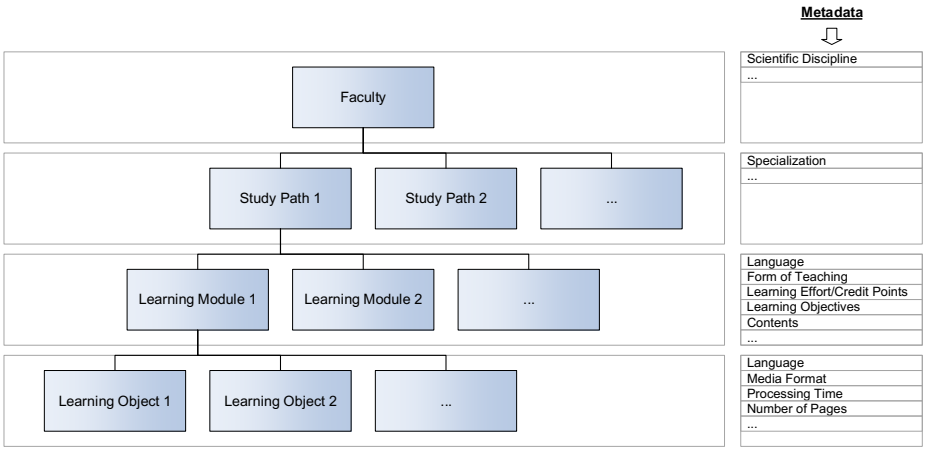


Figure 4. Structure and exemplary metadata of the target learning system

It could be seen that both systems had similar hierarchical structures. Similar metadata were identified and, if needed, adjusted to reach a higher quality mapping result. To create a learning environment for a specific course, the metadata base was determined. Based on this, learning objects were selected and the thus created learning environment was refined after a weakness analysis.

All content-related (i.e. intended learning goals, course content) and structural (i.e. language, duration, learning objectives) requirements were objectively fulfilled. For example, the temporal frame of 1,260 minutes to be available was exceeded by just 2% while using all proposed learning objects. However, the process of composition could counteract exceedance as well as shortfalls (see refinement).

A second expert interview showed that the orchestrated learning environment also subjectively fits. Despite this one specific case, important tendencies were figured out. The usage of the process model resulted in effort minimization, especially the temporal effort of the learning coordinator (approximately reduced by half), regarding learning objects selection and course creation.

By using the process model, the intricacy of the mapping process from source to target learning system is reduced and the complexity of learning systems in general is more manageable.

Of course, the mapping process, the resulting learning environments and the learning effort of the learner have to be further evaluated by means of variance analysis for at least two terms.

6 Conclusion

As stated before, the missing formalization of learning systems is a big issue. Furthermore, it was pointed out that lecturers are increasingly overstrained with the amount and the diversity of existing learning objects. As consequence, the problem is how to figure out the requirements (metadata) of a non-formalized learning system and to select and transfer relevant learning objects into a specific learning environment.

In this paper, a concept for the structuring of learning systems was created. It enables lecturers to analyze and formalize their own learning system. That is the prerequisite to fill parts of the system with high quality learning objects from a learning system with similar metadata.

Furthermore, a process model for the flexible orchestration of learning environments was designed. This supports the lecturer to transfer learning objects from a source learning system to the lecturer's target learning system (e.g. courses, research groups, trainings).

The advantages of using the learning objects from the source learning system are the large amount and variety of high quality teaching topics and their high topicality. Additionally, the lecturers have central access to the learning objects with a high availability. Finally, the lecturer can choose flexibly the learning objects and change its learning environment by means of the three-step mapping process.

All in all, if the target learning system is formalized, it enables the application of the mapping process. As a result, high quality learning environments can be transferred to the target learning system. Regarding to the introduction, this leads to a higher teaching quality as the evaluation with real lecturer staff showed in the described case study. Additionally, the lecturer has to spend less time creating learning materials. He only has to get familiar with the externally created learning objects and benefits from the external expert knowledge.

For future research, comprehensive evaluations have to be done. Therefore, the process model can be applied gradually to further test cases, for example starting from other lecturers in the same learning system up to different lecturers in further learning systems. Additionally, the transferability of the process model to other educational fields has to be investigated. Thus, the quality of the generalized process model in different domains can be examined.

Another aspect is the correlation of changes in orchestrated learning environments over at least two terms and the accompanying changes in the learner's learning success. By means of evaluations of the lecturers, conclusions about the quality of the learning systems as well as of the process model can be drawn.

For future research with engineering reference, the implementation of the selection process for the automatic orchestration of learning environments could be possible. This leads to an effort minimization for the lecturers.

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Steuerung einer industriellen Produktionsanlage mit SAP ERP: Konzeption einer Lehreinheit für Industrie 4.0

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Abstract. Aktuelle Studien zeigen, dass in Deutschland dringender Bedarf an einer Erhöhung des Schulungsangebots im Themengebiet Industrie 4.0 besteht. Dieser Beitrag beschreibt eine Lehreinheit für einen Workshop zum Thema Industrie 4.0, der die Steuerung einer industriellen Produktionsanlage mit SAP ERP beinhaltet. Aufbauend auf einem Modellunternehmen wurden mehrere Szenarien zur Integration der Produktionsanlage in die Geschäftsprozesse entworfen und bewertet, das gewählte Zielszenario im Rahmen einer Softwareentwicklung technisch umgesetzt sowie ein Ablaufplan anhand fachdidaktischer Theorien und durch Auswertung bestehender Curricula konzipiert. Der Workshop wurde zudem mit einer Testgruppe von Schülern einer Fachoberschule mit Fachrichtung Wirtschaft durchgeführt und mittels Fragebogen evaluiert.

Keywords: Lehreinheit, Industrie 4.0, IoT, SAP ERP, Festo Didactic

1 Einleitung

Produktionsunternehmen sehen sich mit gestiegenen Anforderungen hinsichtlich ihrer Flexibilität, Produktvielfalt, Termintreue und Entwicklungszyklen konfrontiert, welche sowohl durch die gestiegenen Kundenanforderungen, als auch durch den Preisdruck auf den Käufermärkten verursacht werden [1]. Dieser Entwicklung kann durch intelligente Fabriken begegnet werden, welche durch eine umfassende Vernetzung und unter Berücksichtigung verschiedener Umweltfaktoren selbstständig Entscheidungen über anstehende Produktionsprozesse treffen können [1,2]. In Anlehnung an die vergangenen drei industriellen Revolutionen und zur Verdeutlichung der zu erwartenden disruptiven Umwälzungen wird dieser Wandel als *Industrie 4.0* bezeichnet [3].

Bei der Realisierung kommen cyber-physische Systeme zum Einsatz, bei welchen Objekte wie beispielsweise Produktionsanlagen, Maschinen, Geräte und Logistikkomponenten mit Sensorik ausgestattet und über eine Kommunikationsinfrastruktur miteinander vernetzt werden, wodurch die systematische Auswertung von Echtzeitdaten und die Erstellung virtueller Abbilder der Realität ermöglicht werden [2]. Diese Objekte werden auch als Dinge bezeichnet und da zur Vernetzung oftmals Internettechnologien

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zum Einsatz kommen, ist der Begriff *Internet der Dinge* beziehungsweise *Internet of Things* (IoT) entstanden [4].

Die Umsetzung von Industrie 4.0 ist jedoch nicht nur eine technologische Herausforderung; zur Sicherung der Zukunftsfähigkeit müssen auch bisherige Geschäftsmodelle kritisch hinterfragt sowie äußere Einflussfaktoren berücksichtigt werden [5]. So wurde in diversen Studien [5,6] festgestellt, dass zur Sicherung der Wettbewerbsfähigkeit in Deutschland eine Erhöhung des Schulungsangebots für Schülerinnen und Schüler zum Thema Industrie 4.0 erforderlich ist.

In diesem Beitrag wird die Entwicklung und Evaluation einer Lerneinheit für Industrie 4.0 vorgestellt. Dabei wird eine Festo Didactic Fertigungsanlage mittels der Software LabVIEW mit einem SAP ERP-System gekoppelt. Im Vordergrund steht dabei die Forschungsfrage: „*Wie sollte eine Lehreinheit für einen Industrie 4.0 Workshop für Schüler der Oberstufe unter Verwendung des Modellunternehmens Global Bike Inc. aussehen und wie kann dieses technisch umgesetzt werden?*".

Methodisch wird die Konzeption der Lehreinheit mit argumentativ-deduktiver Analyse sowie Referenzmodellierung [7] durchgeführt, die technische Umsetzung als Softwareentwicklung mit einer Abwandlung des von Krcmar [8] vorgestellten Prototypen-Modells umgesetzt sowie die Evaluation der Ergebnisse mit Hilfe eines Fragebogens [9] quantitativ ausgewertet.

2 Industrie 4.0 in der Aus- und Weiterbildung in Deutschland

Die Zukunftsfähigkeit deutscher Unternehmen ist einer Studie von Jeschke et al. [5] zufolge nicht nur aufgrund des späten Erkennens der Einsatzmöglichkeiten von Industrie 4.0, dem großen Anteil von kleinen und mittleren Unternehmen mit einer zu geringen Größe für den rentablen Einsatz von Industrie 4.0, sondern auch aufgrund der Konkurrenz durch Internetkonzerne sowie Wettbewerbern aus dem asiatischen Raum und der Risikoaversion deutscher Unternehmen gefährdet. Um die internationale Wettbewerbsfähigkeit deutscher Unternehmen nachhaltig zu sichern, werden in dieser Studie umfangreiche und ineinandergreifende Maßnahmen genannt. Kurzfristig umsetzbare operative Maßnahmen umfassen dabei den Ausbau der IT-Kompetenzen, geänderte Personalentwicklungs- und Ausbildungskonzepte sowie Kostensenkungen und Effizienzsteigerungen. Zu den langfristig angelegten Maßnahmen gehört die internationale Ausrichtung der Unternehmenskultur und Unternehmensstrategie. Durch gleichzeitige Investitionsprogramme und regulatorische Maßnahmen muss dieser Prozess durch die öffentliche Hand und den Gesetzgeber unterstützt werden [5]. Als eine konkrete Handlungsempfehlung im operativen Bereich wird in derselben Studie der Begriff *Ausbildung 4.0* eingeführt. Demnach sei es notwendig, die Inhalte und Lehrpläne anzupassen und insbesondere die Vermittlung von Informatik-Kenntnissen auszubauen, um die neue Generation auf die Herausforderungen der kommenden Jahre vorzubereiten [5].

In einer Studie der bayerischen Metall- und Elektroarbeitgeber, welche von der Universität Bremen durchgeführt wurde, sind die Auswirkungen von Industrie 4.0 auf die Aus- und Weiterbildung untersucht worden [6]. Dort wird konkret beschrieben, dass

- eine gewerblich-technische Ausbildung weiterhin gute Beschäftigungschancen bietet, wenn eine Weiterbildung in Industrie 4.0 verfolgt wird,
- für die Arbeitsplatzsicherheit in Zukunft Kenntnisse im Umgang mit dezentralen, intelligenten Systemen sowie mit Daten und deren Analyse notwendig sind,
- die Anzahl der Arbeitsplätze für Un- und Angelernte abnehmen wird,
- zwar keine neuen Berufsbilder erforderlich sind, die momentan vorhandenen aber mit Industrie 4.0-Inhalten angereichert werden müssen und
- Bildungsanbieter das Angebot über Industrie 4.0, cyber-physische Systeme, Datenanalyse und IT-Sicherheit erheblich erweitern müssen.

Beide Studien zeigen, dass es von dringender Notwendigkeit ist, das Schulungsangebot für Schülerinnen, Schüler, Studierende und Auszubildende, aber auch für Fachkräfte mit langjähriger Berufserfahrung, zu erhöhen, um die vierte industrielle Revolution erfolgreich bewältigen zu können. Zugleich zeigt eine weitere Studie, dass das ERP-System der Firma SAP SE im Jahre 2013 in Deutschland mit mehr als 54% den höchsten Marktanteil besaß [10]. Es ist damit sehr wahrscheinlich, dass Schülerinnen und Schüler in ihrer zukünftigen Arbeit mit SAP-Systemen konfrontiert werden und es erscheint sinnvoll, für ein praxisnahes Schulungsangebot die marktführende Unternehmenssoftware in eine entsprechende Lehreinheit zu integrieren. Zur realitätsnahen Gestaltung kann zusätzlich z.B. eine Festo Didactic Fertigungsanlage verwendet werden.

3 Der Industrie 4.0 Workshop

Um das Schulungsangebot im Bereich Industrie 4.0 zu erweitern, wurde eine Lehreinheit für einen Workshop „Industrie 4.0“ entworfen. Als Zielgruppe wurden vorerst Schülerinnen und Schüler ab 16 Jahren definiert, da diese einerseits die für die Komplexität des Themas benötigten Vorerfahrungen besitzen und andererseits kurz vor dem Schulabschluss eine Entscheidung für die eigene berufliche Zukunft zu treffen haben. Der entworfene Workshop kann aber auch Basis für die Arbeit mit anderen Zielgruppen sein. So erscheint es sinnvoll, dass sich beispielsweise Informatikstudierende mit Hilfe dieses Workshops mit den Auswirkungen der Digitalisierung auseinandersetzen.

3.1 Randbedingungen des Workshops

Modellunternehmen Global Bike. U.a. um auf die Notwendigkeit von Schulungen zu reagieren, wurde von der SAP SE das SAP University Alliances Program (UA) ins Leben gerufen, welchem mittlerweile mehr als 2.300 Bildungseinrichtungen in 90 Ländern weltweit angehören. Ziel des Programms ist es, Schülerinnen, Schülern und Studierenden Zugriff auf SAP-Software zu ermöglichen. Zur Schulung an einem SAP ERP-System sind plausible Stamm- und Bewegungsdaten notwendig. Der Industrie 4.0 Workshop wurde daher aufbauend auf dem Modellunternehmen *Global Bike Inc.* (GBI) entworfen, welches im Rahmen des SAP UA Programms für Schulungszwecke bereitgestellt wird [11]. Hierbei handelt es sich um einen fiktiven Fahrradkonzern mit zwei Produktionsstandorten, der Marktführer im Privatkundenbereich und Spitzensport ist.

TUMlab im Deutschen Museum. Das TUMlab ist ein von der Technischen Universität München (TUM) betriebenes Experimentierlabor für Schülerinnen und Schüler und befindet sich im Ausstellungsbereich des Deutschen Museums in München. Durch das Angebot an Kursen aus verschiedenen Fachbereichen soll das Interesse an Naturwissenschaft und Technik nachhaltig gefördert werden.

Festo Didactic Fertigungsanlagen. Das TUMlab besitzt für einen Automatisierungskurs zwei didaktische Fertigungsanlagen der Firma Festo. Jede dieser Anlagen besteht aus vier Stationen, die mit Sensoren und Aktuatoren ausgestattet sind.

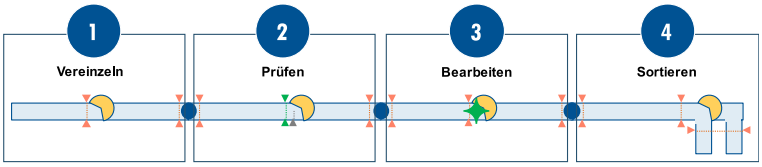


Abbildung 1. Festo Didactic Fertigungsanlage (eigene Darstellung)

Station 1 dient dem *Vereinzeln* der Werkstücke: durch eine mechanische Schranke, welche konstruktionsbedingt immer nur ein Werkstück weiterleiten kann, ist sichergestellt, dass ausschließlich ein Werkstück die weiteren Stationen passiert. Station 2 dient zum *Prüfen* der Farbe des Werkstücks: die Signale eines Reflex- sowie Induktivsensors werden logisch miteinander verknüpft, sodass eine eindeutige Zuordnung zu den drei Farben Silber, Rot und Schwarz möglich ist. Station 3 dient zum *Bearbeiten* des Werkstücks: ein an einer Linearachse montierter Bohrer kann zur Bearbeitung gehoben und gesenkt werden. Station 4 dient zum *Sortieren* der Werkstücke: über eine mechanische Weiche kann das Werkstück gezielt auf eine der beiden Rutschen geleitet werden und durch die verbaute Sensorik kann zugleich eine Rückmeldung erfolgen.

3.2 Ziele des Workshops

Einer der wichtigsten Vorgänge der Unterrichtsplanung ist Hubwieser [12] zufolge die Definition von Lernzielen, mit denen beschrieben wird, was mit einer Unterrichtseinheit erreicht werden soll. Dies lässt sich auch auf einen außerschulischen Kontext übertragen, beispielsweise einen Industrie 4.0 Workshop im TUMlab. Die Taxonomie von Lernzielen nach Krathwohl [13] sieht vor, dass die Beschreibung eines Lernziels sowohl eine *Wissensdimension* als auch eine *Kognitive Prozessdimension* umfasst.

Neben diesen Ausführungen wurden bei der Formulierung der folgenden zehn Lernziele die Studienergebnisse zum Thema *Industrie 4.0 in der Aus- und Weiterbildung*, bestehende Curricula des SAP UA Programms sowie Diskussionen mit Mitarbeitern des TUMlabs berücksichtigt:

LZ01 Die Teilnehmenden können die Bedeutung des Begriffes Industrie 4.0 einordnen und dessen geschichtlichen Hintergrund erklären.

LZ02 Die Teilnehmenden können die Notwendigkeit und Vorteile von ERP-Systemen in Industriebetrieben sowie deren grundlegenden Begrifflichkeiten anhand eines Modellunternehmens unterscheiden.

LZ03 Die Teilnehmenden können mit Hilfe der SAP GUI und geeigneten Transaktionen die Stammdaten in einem SAP ERP-System erkunden.
LZ04 Die Teilnehmenden können mit Hilfe der SAP GUI und geeigneten Transaktionen die Materialstücklisten sowie Bestände im SAP ERP-System überprüfen.
LZ05 Die Teilnehmenden können mit Hilfe der SAP GUI und geeigneten Transaktionen die Stücklisten von verschiedenen Fertigerzeugnissen im SAP ERP-System analysieren und die Unterschiede bewerten.
LZ06 Die Teilnehmenden können mit Hilfe der SAP GUI und geeigneten Transaktionen Fertigungsaufträge im SAP ERP-System erzeugen sowie die verschiedenen Fertigungsauftragsstatus sowie die Kostenkalkulation analysieren.
LZ07 Die Teilnehmenden können mit Hilfe der Rollenbeschreibungen die Produktionsschritte den einzelnen Stationen zuordnen.
LZ08 Die Teilnehmenden können mit Hilfe eines papierbasierten Fertigungsauftrags und der SIM-Box (manuelle Steuerung der Festo-Anlage) die Produktion an der Fertigungsstraße selbstständig durchführen und eigene Fertigprodukte erzeugen.
LZ09 Die Teilnehmenden können anhand der durch die LabVIEW-SAP-Schnittstelle automatisiert ablaufende Produktion die Verbesserungspotentiale für betriebswirtschaftliche Prozesse durch eine automatisierte Fertigung identifizieren.
LZ10 Die Teilnehmenden können im Rahmen einer Diskussion die Auswirkungen einer vollständigen Automatisierung im Industrie 4.0 Kontext auf Wirtschaft und Gesellschaft erkennen und kritisch bewerten.

Zur Begrenzung der Lerninhalte wurden als Nicht-Ziele festgelegt, dass weder die technische Ansteuerung einer Fertigungsanlage, noch die zu deren Vernetzung mit einem SAP ERP-System verwendeten Technologien und Methoden im Fokus stehen sollen. Stattdessen soll ein Überblick der Chancen und Risiken von Industrie 4.0 an einem praktischen Beispiel vermittelt werden sowie auf die Verwendung von Unternehmenssoftware wie SAP ERP zur Produktionsprozesssteuerung eingegangen werden.

Zur Überprüfung der Reihenfolge der Lernziele und deren Eignung für die geplante Zielgruppe wurden diese in der Taxonomischen Tabelle (Tabelle 1) klassifiziert [14].

Tabelle 1. Klassifikation der Lernziele in der Taxonomischen Tabelle in Anlehnung an Anderson et al. [14], Übersetzung ins Deutsche nach Baumgartner [15]

	Kognitive Prozessdimension					
Wissensdimension	**1. Erinnern**	**2. Verstehen**	**3. Anwenden**	**4. Analysieren**	**5. Bewerten**	**6. Erzeugen**
A. Faktenwissen		LZ01 LZ02				
B. Konzeptionelles Wissen			LZ03			
C. Prozedurales Wissen		LZ09		LZ04 LZ07	LZ05	LZ06 LZ08
D. Metakognitives Wissen					LZ10	

3.3 Szenario des Workshops

Das fallbasierte Lernen hat bei Lernformaten wie diesem Workshop eine große Bedeutung für das Verständnis sowie den Transfer des Gelernten in die Praxis [16]. Aus diesem Grund wurde für die Integration der Festo Fertigungsanlagen in die Prozesse des Modellunternehmens *GBI* ein eigenes Szenario entworfen:

Zur Steigerung des Umsatzes und zur Erhöhung der Kundenzufriedenheit beschließt die GBI ihre Touringbikes zukünftig nicht nur einzeln, sondern auch in einem Bundle mit Zubehör anzubieten. Das mitgelieferte Zubehör umfasst eine Wasserflasche zusammen mit einem Wasserflaschenhalter. Um diese am Fahrrad befestigen zu können, sind jedoch weitere Bohrungen am Rahmen notwendig. Diese werden während des Fertigungsprozesses nur an den Fahrrädern vorgenommen, welche als Bundle ausgeliefert werden sollen. Somit müssen alle Fertigungsaufträge zukünftig mit Losgröße 1 als kundenindividuelle Auftragsfertigung durchgeführt werden. Dieses Szenario wurde durch die Einführung neuer Fertigerzeugnisse sowie der Anpassung von Stücklisten und Arbeitsplänen in das SAP ERP-System des Modellunternehmens eingepflegt.

3.4 Technische Umsetzung

Zur Realisierung des Workshops war eine verteilte und mit verschiedenen Technologien umgesetzte Softwareentwicklung notwendig. Der globale Systementwurf ist in Abbildung 2 dargestellt und die einzelnen Artefakte werden in den folgenden drei Abschnitten zusammengefasst.

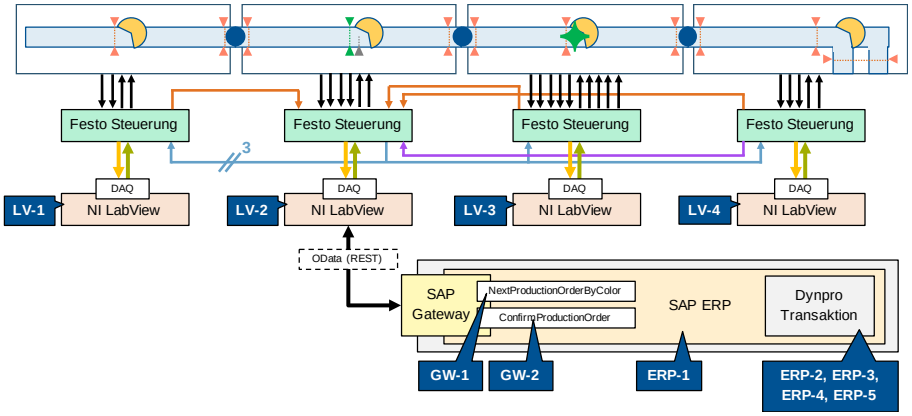


Abbildung 2. Globaler Systementwurf (eigene Darstellung)

Fertigungsanlagensteuerung. Die Steuerung der Fertigungsanlage selbst wurde mit LabVIEW realisiert, welches digitale Signale an die Steuereinheit der Festo-Anlage sendet. Hierzu wurde für jede Station der Fertigungsanlage ein eigenes Programm geschrieben, welche über eine hartverdrahtete 3-Bit Leitung einen Statuswert überträgt. Über LabVIEW wurden die ermittelten Sensordaten an die SAP-Gateway Schnittstellen übertragen (Artefakte LV-1, LV-2, LV-3 und LV-4; siehe Abbildung 2).

SAP-Schnittstellen. Zur Anbindung der Fertigungsanlage an das SAP ERP-System wurden in SAP-Gateway zwei Artefakte implementiert, welche als REST-Schnittstelle über Open Data Protocol Informationen bereitstellen. Die erste Schnittstelle dient zur Ermittlung des nächstdurchzuführenden Fertigungsauftrages, inklusive der Information, ob eine Bearbeitung des Fahrradrahmens durchgeführt werden soll, in Abhängigkeit von Werk und Farbe. Die zweite Schnittstelle dient zur Rückmeldung eines Fertigungsauftrages, wobei automatisch die Warenausgänge der Rohmaterialien sowie der Wareneingang des Fertigerzeugnisses systemseitig verbucht werden (Artefakte GW-1 und GW-2; siehe Abbildung 2).

Administrationsoberfläche. Zur Vorbereitung des Szenarios wurde in ABAP eine Administrationsoberfläche als SAP-Transaktion entwickelt, welche es dem Kursleiter ermöglicht, Fertigungsaufträge für die zu produzierenden Fahrräder als Massenbuchungen im System anzulegen sowie den Wareneingang der für die Produktion dieser Aufträge notwendigen Rohmaterialien im System zu verbuchen. Hierdurch ist sichergestellt, dass während des Workshops keine systemseitigen Materialverfügbarkeitsfehler auftreten. Darüber hinaus bietet die Administrationsoberfläche eine Statusübersicht, welche die in den beiden Werken geplanten Fertigungsaufträge und Lagerbestände veranschaulicht (Artefakte ERP-1, ERP-2, ERP-3, ERP-4 und ERP-5; siehe Abbildung 2).

3.5 Ablauf des Workshops

Vor der Ausarbeitung des Ablaufplanes wurden existierende und erprobte Curricula aus dem SAP UA Programm ausgewertet, wobei deren Unterlagen zur Inspiration und Orientierung im Aufbau der Übungen und Gestaltung der Medien dienten. Der Ablaufplan orientiert sich strikt an der Reihenfolge der Lernziele, welche mit Hilfe der Taxonomischen Tabelle überprüft wurden. Die Durchführung des Workshops erfolgt im TUMlab, welches sich als außerschulisches Schülerlabor versteht, weshalb rezeptive Lehrformen vermieden und stattdessen geleitet-produktive und selbstständig-produktive Lehrformen verwendet werden sollen [12,17]. Da die Teilnehmenden im Mittelpunkt stehen, soll auf lehrerzentrierte Sozialformen verzichtet werden [12]. Die Dauer eines Durchlaufs wurde auf drei Stunden für 16 Teilnehmende festgelegt, womit Schulklassen mit bis zu 32 Schülerinnen und Schülern den Workshop an einem Tag besuchen können.

Einleitung und Übung. Zu Beginn des Workshops werden die grundlegenden Begriffe zu Industrie 4.0, Unternehmenssoftware und SAP ERP erläutert sowie das Modellunternehmen vorgestellt. Danach führen die Teilnehmenden selbstständig mit dem *SAP Graphical User Interface* (SAP GUI) aufeinander aufbauende Übungen durch: einerseits wird durch die Analyse von Produkten, Stücklisten und Lagerbeständen das Modellunternehmen besser kennengelernt, andererseits durch die Erläuterung von Arbeitsplänen und Fertigungsaufträgen ein Verständnis für Produktionsprozesse gefördert.

Manuelle Produktionssteuerung. Im Anschluss soll der Produktionsablauf an den Festo Fertigungsanlagen von den Teilnehmenden manuell und selbstständig durchgeführt werden, wozu eine Einteilung in zwei Gruppen erfolgt: die eine Gruppe produziert

Deluxe Touringbikes in Heidelberg (Deutschland), die andere Gruppe produziert Profi Touringbikes in Miami (USA). Zentraler Bestandteil ist der papierbasierte Fertigungsauftrag, welcher die Arbeitsschritte dokumentiert und von Station zu Station weitergereicht wird. Die vier Stationen der Fertigungsanlage (siehe Abbildung 1) werden von jeweils zwei Teilnehmenden besetzt und repräsentieren die folgenden Rollen:

- An Station 1 befinden sich Fertigungsplaner, die im SAP ERP-System den als nächstes zu bearbeitenden Auftrag zur anstehenden Farbe heraussuchen und auf dem papierbasierten Fertigungsauftrag vermerken.
- Der Auftrag wird an die Qualitätsbeauftragten an Station 2 weitergeleitet. Dort wird mit Hilfe der Sensorik der Station die auf dem papierbasierten Fertigungsauftrag angegebene Farbe überprüft und bestätigt.
- Nach erfolgreicher Prüfung wird das Material an die dritte Station zu den Produktionsmitarbeitern weitergeleitet. Je nachdem, welcher Auftrag von den Fertigungsplanern vermerkt wurde, nehmen diese die Bohrungen am Rahmen des Fahrrads vor.
- Anschließend wird das Werkstück an Station 4 zu den Lagermitarbeitern weitergeleitet. Diese sortieren das Material in Abhängigkeit des Auftrags und melden die erfolgreiche Produktion im SAP ERP-System zurück.

Durch diese manuelle Produktionsübung werden nicht nur die Abhängigkeiten zwischen den Prozessschritten, sondern insbesondere auch die Fehleranfälligkeit aufgezeigt.

Automatische Produktionssteuerung. Um nun die Vorteile und Veränderungen durch den Einsatz von Industrie 4.0 innerhalb der Produktion zu zeigen, werden die Produktionsanlagen vom Kursleiter auf die automatisierte Produktionssteuerung umgeschaltet. Hierdurch kommuniziert die Festo Fertigungsanlage über eine SAP-Gateway Schnittstelle selbstständig mit dem SAP ERP-System und ermittelt zur erkannten Farbe den nächsten zu produzierenden Fertigungsauftrag und führt diesen vollautomatisch durch. Parallel dazu werden die Fertigungsstraße und Lagerbestände überwacht. Dabei werden sowohl die bereits kennengelernten SAP-Transaktionen, als auch die für diesen Workshop implementierte Administrationsoberfläche genutzt.

Diskussion. Abschließend erfolgt eine ausführliche, geleitete Diskussion, in der die Unterschiede zwischen manueller und automatischer Produktionssteuerung sowie die Auswirkungen auf diese eine Produktionssituation, aber auch auf die Wirtschaft im Allgemeinen und langfristig auf die Gesellschaft insgesamt, besprochen werden. Hierbei sollen auch mögliche Auswirkungen auf die Berufs- und Studienwahl der Teilnehmenden zur Sprache kommen, ohne dabei jedoch Entscheidungen vorzugeben.

4 Ergebnisse des Industrie 4.0 Workshops

Zur Überprüfung der Lernziele und der Eignung für die Zielgruppe wurde der Workshop mit interessierten Schülerinnen und Schülern einer Fachoberschule mit Fachrichtung Wirtschaft aus München durchgeführt und mittels eines Fragbogens überprüft.

4.1 Evaluationsmethodik

Die verwendete Evaluationsmethodik orientiert sich am Vorgehen von Utesch, Hauer, Heininger und Krcmar [9], welche einen Fragebogen zur Studierfähigkeit auf Basis von Lernzielen entwickelt haben und dabei die Beantwortung nach der Likert-Skala vorsehen. Diese umfassen (++) *trifft auf mich zu*, (+) *trifft öfters auf mich zu*, (0) *trifft mittelmäßig auf mich zu*, (-) *trifft eher selten auf mich zu* und (--) *trifft nicht auf mich zu*. Aus den Lernzielen wurden insgesamt 15 inhaltliche Fragen zu den Themenbereichen *Industrie 4.0*, *Unternehmenssoftware / ERP-Systeme*, *SAP ERP*, *Produktionssteuerung und Automatisierung* sowie drei Fragen zum allgemeinen *Interesse* am Themengebiet abgeleitet. Der Fragebogen wurde von den Teilnehmenden einmal vor und einmal nach dem Workshop ausgefüllt, sodass ein direkter Zusammenhang zwischen den beiden Einschätzungen, aber auch zu den Inhalten des Workshops, hergestellt werden kann.

4.2 Auswertung der Fragebögen

Im Anschluss an den Workshop wurden die Fragebögen ausgewertet und für jede Frage die prozentualen Anteile der einzelnen Antwortmöglichkeiten berechnet. Bei allen Ergebnissen handelt es sich um eine Selbsteinschätzung der Teilnehmenden. Insgesamt umfasst die Auswertung 11 Fragebögen. Im folgenden Abschnitt werden von den 18 Fragen die 9 interessantesten Ergebnisse vorgestellt.

Industrie 4.0. Im Themenblock Industrie 4.0 (siehe Abbildung 3) wurde aufgezeigt, dass sich vor dem Workshop lediglich 27% der Teilnehmenden etwas unter dem Begriff Industrie 4.0 vorstellen konnten. Keiner von ihnen sah sich in der Lage, die Hintergründe erklären zu können. Nach dem Workshop änderte sich diese Einschätzung: 91% konnten sich unter dem Begriff etwas vorstellen und die Hintergründe erklären. Bei den Vor- und Nachteilen von Industrie 4.0 sowie dessen Auswirkungen auf Wirtschaft und Gesellschaft war das Bild vor dem Workshop durchmischt, lediglich 9% bzw. 18% waren der Meinung, diese benennen zu können. Nach dem Workshop änderte sich dies: 82% konnten die Vor- und Nachteile wiedergeben und 91% die Auswirkungen auf Wirtschaft und Gesellschaft beschreiben.

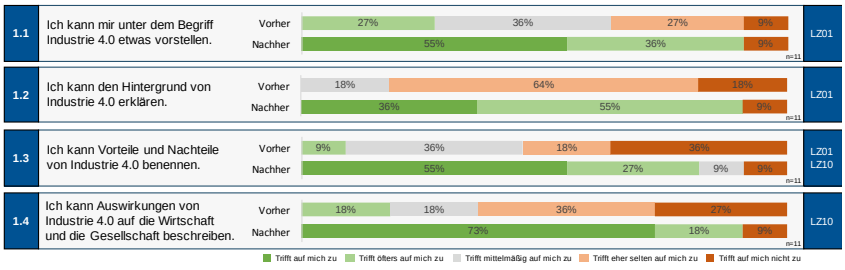


Abbildung 3. Auswertung Fragen zu Industrie 4.0 (eigene Darstellung)

Unternehmenssoftware / ERP-Systeme. Die Auswertung dieses Fragenblocks (siehe Abbildung 4) ergab, dass sich vor dem Workshop lediglich 9% unter den beiden Begriffen etwas vorstellen konnten, was danach auf 73% anstieg. Zu erklären, wofür ERP-Systeme eingesetzt werden, traute sich vorher kein Teilnehmender zu, danach waren es fast zwei Drittel (63%). Dieses Ergebnis muss unter dem Hintergrund betrachtet werden, dass keiner der Teilnehmenden, obwohl es sich um Schülerinnen und Schüler einer Wirtschaftsoberschule handelte, zuvor mit einem ERP-System gearbeitet hatte.

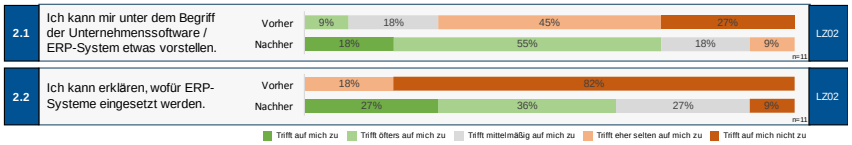


Abbildung 4. Auswertung Fragen zu Unternehmenssoftware / ERP (eigene Darstellung)

Produktionssteuerung und Automatisierung. In diesem Fragenblock (siehe Abbildung 5) gaben vorher nur 9% an, dass Sie die Zusammenhänge eines Produktionsablaufes erklären können. Nachher waren es fast alle Teilnehmenden (91%). Die Beschreibung der Tätigkeiten in einem Produktionsablauf sowie die Erklärung der Vorteile einer automatischen Steuerung trauten sich vorher nur ein Teil (27% bzw. 45%) zu. Nach dem Workshop sahen sich jedoch alle dazu mehr oder weniger in der Lage.

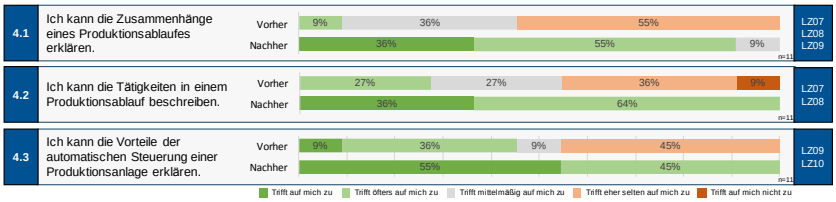


Abbildung 5. Fragen zu Produktionssteuerung / Automatisierung (eigene Darstellung)

5 Fazit und Ausblick

In diesem Beitrag wurde die Konzeption einer Lehreinheit für einen Industrie 4.0 Workshop für Schülerinnen und Schüler der Oberstufe vorgestellt, in welchem die manuelle und automatische Steuerung einer industriellen Produktionsanlage mit SAP ERP veranschaulicht wird sowie die Auswirkungen auf Wirtschaft und Gesellschaft kritisch beleuchtet werden. Hierfür wurden in einem ersten Schritt 10 Lernziele beschrieben und anhand der Taxonomie nach Krathwohl [13] überprüft. Darauf aufbauend wurde ein fünfschrittiger, insgesamt 3 Stunden umspannender Workshop entwickelt, welcher es Teilnehmenden zuerst ermöglicht den Produktionsprozess an einer didaktischen Fertigungsanlage und die Integration einer Unternehmenssoftware wie SAP ERP zu erleben. Anschließend wird demonstriert, welche Effekte durch Industrie 4.0 – insbesondere durch eine konsequente Automatisierung, hier durch Kopplung des SAP ERP-Systems mit der Fertigungsanlage – auftreten können. Mit der beschriebenen Konzeption

wurde eine realitätsnahe Industrie 4.0 Lehreinheit mit Bezug zum Berufsweg der angesprochenen Zielgruppe erstellt. Die Teilnehmenden übernehmen zunächst verschiedene Rollen, wie Fertigungsplaner, Qualitätsbeauftragter, Produktions- und Lagermitarbeiter, womit sie einen manuellen Produktionsablauf widerspiegeln. Anhand einer funktionsfähigen und extra für diesen Zweck mit SAP ERP verknüpften Fertigungsstraße wird der Wechsel von manueller Produktionssteuerung zur vollautomatisierten Industrie 4.0 nicht nur theoretisch-abstrakt eingeführt; vielmehr wird die Fertigungsstraße didaktisch in ein Anschauungsobjekt für den Wechsel der industriellen Prozesse umgewandelt. Mit der Umstellung der Fertigungsstraße auf das Industrie 4.0-Szenario geht für die Teilnehmenden ein fundamentaler Wechsel ihrer bisher im Kurs eingenommenen Arbeitsrolle einher und der gesamte Ablauf der Produktion wird deutlich einfacher und effizienter. Die Konzeption greift somit die Ambivalenz der Industrie 4.0 auf und macht die weit reichenden Chancen ebenso wie mögliche Nachteile, etwa den Verlust von Arbeitsplätzen, unmittelbar erfahrbar. Statt konfliktreichen Punkten aus dem Weg zu gehen, werden diese mit den Teilnehmenden gemeinsam diskutiert. Die für sie persönlich wesentlichen Aspekte – zum Beispiel was die anstehenden Veränderungen für ihren eigenen Berufsweg bedeuten – werden mit ihnen zusammen eingeordnet, insbesondere mit Blick auf die Relevanz der Industrie 4.0-Inhalte für ihre berufliche Aus- und Weiterbildung sowie ihre beruflichen Perspektiven und Möglichkeiten. Diese abschließende Diskussion ist ein immanent wichtiger Bestandteil der Konzeption und Durchführung des Kurses und sollte von einer Begleitperson übernommen werden, die kompetent mögliche Ängste und Sorgen der Schülerinnen und Schüler adressieren und ihnen geeignete Entwicklungsperspektiven aufzeigen kann.

Diese Form der Konzeption des Workshops gibt auf Grundlage aktueller didaktischer Methoden Antwort auf die eingangs gestellte Forschungsfrage. So wurde der Workshop mit Fachoberschülern der Fachrichtung Wirtschaft durchgeführt und die Erreichung der Lernziele mittels Fragebogen evaluiert. Da der Workshop bisher nur mit einer Gruppe von 12 Schülerinnen und Schülern durchgeführt wurde, sollte zur besseren Bewertung der Eignung des Workshops für diese und weitere Zielgruppen die Stichprobe vergrößert werden. Durch den Einsatz des entwickelten Fragebogens ist eine einfache Evaluation möglich, welche aber ggf. durch weitere Evaluationsinstrumente ergänzt werden kann. Bei einem weiterhin positiven Feedback könnte der Industrie 4.0 Workshop in das reguläre Angebot des TUMlabs aufgenommen und auch von anderen Bildungseinrichtungen, welchen ähnliche Fertigungsstraßen zur Verfügung stehen, adaptiert werden. Durch die bereitgestellte Administrationsoberfläche sind zur Durchführung des Workshops bei potentiellen Kursleitern keine tiefergehenden Kenntnisse des PP-Moduls von SAP ERP notwendig, was eine Adaption der Lehreinheit begünstigt.

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E-Learning und Educational Service Engineering

Teilkonferenzleitung

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Development of an Evaluation for Flipped Classroom Courses

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Abstract. Digital learning has become more than just a trend in the modern world. Blended learning concepts have proven their usability. A further development is the so called flipped classroom. This approach repurposes class time to focus on application and discussion. The acquisition of knowledge will happen at home, enabled by virtual lectures. In the past, many researchers and lecturers demonstrated the advantages of flipped classroom concepts within case studies and self-developed assessment. Still a standardized evaluation of flipped classroom concepts is missing. However, it is necessary to learn from the past and improve future education. This paper presents a generic evaluation of flipped classroom concepts. On the example of a case, we will demonstrate which elements of a flipped classroom concept can be assessed and which measures may serve to improve the acceptance, the learning outcomes and applicability for students and teachers.

Keywords: Evaluation, Assessment, Flipped Classroom, Online Tutorials, Technology Acceptance, Learning Success

1 Introduction

The rising digitalization of economy, society and everyday life also affects educational institutions [1]. Teachers and students are no longer bound to traditional ex-cathedra lectures. They may also attend pure virtual lectures or blends [2]. One possible blended learning approach is the so called flipped or inverted classroom. A flipped classroom (FC) is defined as a concept where interactive, group based learning activities occur inside the classroom, while the individual learning of basic knowledge occurs outside the classroom [3]. Many studies prove the success of FC constructs [4, 5]. Although the construction of flipped classrooms is quite popular, there is still a lack of substantial empirical evidence on learning outcomes [6]. Researchers worry about the deficiency of rigor [3, 7]. Furthermore, scientists identify an absence of comprehension regarding the impact on students' approaches on learning [4]. The quality of lectures has been a point of controversial discussions in the past [8]. Evaluations help to ensure a constant and transparent quality of lectures and learning outcomes [9]. Still, there is no standardized method for the evaluation of flipped classroom classes available [3]. We

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contribute to this research area by introducing a generalizable multi-method approach to evaluate flipped classroom concepts. Two types of evaluation can be distinguished: formative, which aims at the improvement and learning quality and summative, which assess the learning effects [9]. Learning quality is strongly related to learning time, learning success and acceptance [10]. Today the learning time is covered by the workload of the students and given by the so called Bologna-Declaration [11]. Thus, we will concentrate on the learning success and the acceptance. The measurement of learning success and the system acceptance are built on applicable and proven metrics such as technology acceptance model (TAM) [12] and the learning taxonomy of Krathwohl [13, 14]. Based on the existing theory, we will develop a model of a formative, multi-method evaluation of flipped classroom concepts.

In the following, we will give a brief update on shortcomings in flipped classroom assessment research. Afterwards we will introduce the underlying theories and align them to the research topic. We present a model for the evaluation of flipped classroom and use the model on the hand of a case study. Afterwards we will discuss the results. Furthermore, we give a brief summery on limitations and further research.

2 Definitions

2.1 Shortcomings in Flipped Classroom Assessment Research

A flipped classroom is an inversion of traditional classroom and at-home activities [7, 15]. This educational technique consists of two parts: a computer-based individual knowledge acquisition at home and an interactive group based learning environment inside the classroom [3, 16, 17]. The learners receive the basic contents via online tutorials. For the part of training and applying the knowledge, ideally in problem solving situations, they meet vis-à-vis in small groups guided by the lecturer [3]. The individual time of knowledge acquisition is transferred from the group session in classroom to the individual learning environment. The guided knowledge acquisition time can be used to work with the knowledge, to gain and to deepen the skills [16].

The majority of articles about flipped classroom deals with the conceptualization of FC-courses [e.g. 18, 19] for a specific context (e.g. education in health management [20]). Some also include assessments of the presented approaches [21–23]. Findings from existing meta-analysis [3, 24–26] show that the evaluation of FC-concepts includes two major fields: FC-acceptance and the measurement of the learning success. Regarding the acceptance of FC there is a focus on learner acceptance rather than on teacher acceptance of the concepts. Student's acceptance is often stated as students' perception or opinion and based on the students' subjective responses. The items for the measurement often show a lack of the scientific basis [3, 27]. In most studies, acceptance is used as a measure to compare the approval of a FC in comparison to traditional lectures [28–30]. Some studies consider the use frequency of the video tutorials and the use habits as well [31]. The FC acceptance of the teacher is rarer. In this area studies on cost and effort estimations are prevailing [31, 32].

We found less articles dealing with the learning success in FC rather than those dealing with acceptance. Most studies are based on individual statements and test-results [19, 22, 28]. Some researcher conducted tests in order to compare the learning level of a FC-group with those from a group following traditional lectures. Critique came up about comparing test results as a measure for the learning success [3].

Many studies on FC show a lack of rigor [3, 7]. The evaluations were often built as a response to the situation [7]. Most researchers used self-developed scales (e.g. [33, 34]) without a systematic derivation. The findings show a research gap. There is a need for a standardized evaluation of FC classes. Uniform classroom evaluations enable the systematic analysis in order to improve the future learning quality [35, 36]. We will contribute to the discussion and present a multi-method instrument to evaluate FC-courses. The instrument is based on proven theories. The metrics will aim at the basic parameters of learning quality.

2.2 Measuring Learning Success

Knowledge acquisition and the capability to perform on the basis of this knowledge describe the learning process. However, both are not directly observable. The measurement of the learning success can be enabled only by workarounds [27]. "The learning outcomes represent the goal assessment or measures for determining the success of a learning program" [37]. Learning outcomes are collected and categorized in learning taxonomies [27]. The cognitive objectives of the taxonomy of Anderson and Krathwohl [38] can be used to assess the reached level of the learning outcomes. This taxonomy is based on the taxonomy of Bloom [39]. The cited model consists of two dimensions: a cognitive dimension and a knowledge dimension. The first dimension implies the knowledge adoption and the corresponding cognitive processes: remember, understand, apply, analyze and create. The complexity of knowledge adoption increases. This means that the basic learning objectives can be ranked in a hierarchical manner. Basic targets have to be attained before higher levels like apply, analyze and create can be reached. The second dimension distinguishes certain kinds of knowledge like factual, conceptual, procedural and metacognitive knowledge. The taxonomy enables the development of learning objectives. They include the cognitive processes as well as a topic of interest. Thus, the taxonomy helps to compare different teaching approaches. The achievement of higher levels enables higher learning success.

A flipped classroom model is more an expansion of the curriculum, rather than a mere re-arrangement of activities [3]. As shown above, the complex structure of learning success makes it difficult to measure. In the past taxonomies were mainly used to prove the summative effects of FC concepts [21, 26]. A detailed derivation of the learning success is rare. The assessment of learning-success should consider the range of learning outcomes. Well-developed learning objectives are the basis for the comparison of the outcomes. They could be ranked objectively by the attainment of higher learning levels. This makes the taxonomy of Krathwohl an impartial instrument to measure learning-success.

2.3 Acceptance Research

The use of a certain technology often depends on the acceptance of the systems. This relation was proven and established by Davis [12] in the technology acceptance model (TAM) and is still recognized until nowadays. This clear and easy to understand relation, made the TAM one of the most frequently cited models in Information Systems research. The model and its key components are still explored [40]. The basic idea of the TAM is that the intention to use impacts the real use of a technology. The intention is influenced by different factors like the perceived usefulness (PU) of the respective technology and their perceived ease of use (PEU) as well as factors from the fields of social environment, attitude or work-related factors. TAM was strongly influenced by the theory of reasoned action [41]. Usually the core components of TAM are operationalized by different items. The item relations are measured with the help of questionnaires including 7-point-likert-scales. The standardized measures allow to predict the acceptance and to measure the strongest impacts on acceptance. Furthermore, the uniform use enables the comparison of different TAM-studies [42].

By using TAM, we concentrate on the technology level. The behavior of the lecturer and students' perceptions about the FC-course will be evaluated in a further sequence. The standardized items and the independency from the technology used make the TAM an applicable instrument. In the context of our study the TAM is used to discover the influence factors that impact the decision to use the online tutorials. The examination of the weights of the impact factors can be used to improve the tutorials for future courses. Using the TAM to evaluate learning concepts is not new, though not common. Different studies can be identified, which use TAM for the evaluation of blended learning [43]. In FC-research acceptance is often measured by similar but not standardized constructs [44].

3 Development of the Flipped Classroom Assessment

The assessment model presented aims at the formative assessment of the learning quality. Learning quality can be described by learning time, learning success and the acceptance of teaching tools [10]. These aspects are very different and can hardly be evaluated at once. The content related evaluation takes place a priori and aims at the capabilities of the lecturer. The assessment of the acceptance will happen during the class and focusses on the perception of the students. This means the evaluation has to be proceeded at different times (Table 1).

Table 1. Evaluation time table

t	*What*	*Measure*	*Interpretation*
pre-classroom	Learning level	Learning objectives and levels	Learning goals must be defined and ranked in accordance with the learning levels. Higher learning levels should be enabled.
classroom	Acceptance	TAM	High value for UI and PU are favourable.
	Perception	Binominal scale	Positive values for individual speed, teacher contact and knowledge acquisition are favourable.

The interplay from analysis and formative interference of the concept using independent measures, enables the long-time improvement of the course. In the run-up of the class the lecturer has to ensure adequate levels of learning objectives. During the term the objective criterion of the evaluation shifts from the concept of the lecture to the students. Using the TAM, the acceptance of the technical components can be assessed. Although TAM is known as a standard instrument in order to predict future use, the use situation differs. In order to face cohort effects and reduce factors that have a considerable external influence on the results, we built the model with the help of well-considered and limited key variables. This means the model was built to make it easy to use and to understand. Furthermore, we considered major basic conditions aiming at reliability and validity [45] (Table 2).

Table 2. Conditions for acceptance measurement

Condition	*Application*
Use proven and accepted measures [40, 46]	Using measures from original TAM or proven operationalisations of variables
Limit the number of factors to guarantee the statistical proof even by small group sizes [47]	Reduction to few, well proven measures
Independency of measures [45]	Checking the reliability
Independency of measures from the lecture objectives [48]	Exclusion of variables used for special technologies (e.g. perceived playfulness for game based learning)

Table 3. Items and measurement of the acceptance

Construct	*Definition*	*Item*
PEU	the degree to which a person believes, that using a system would be free of effort	Interacting with the system does not require a lot of my mental effort. I find the system to be easy to use. … easy to get the system to do what I want it to do.
PU	the degree to which a person believes that using a particular system would enhance his or her job performance	Using the system improves my performance in my course. … in my course increases my productivity. … enhances my effectiveness in my course. I find the system to be useful in my course.
SN	the persons perception that most people who are important to him think he should or should not perform the behavior in question	People who influence my behaviour think that I should use the system. People who are important to me think that I should use the system.
PEn	the extent to which the computer is perceived to be enjoyable […]	7 Point Likert scales between the opposites: Fun/Frustrating; negative/positive; pleasant/unpleasant; pleasurable/painful; exciting/dull; foolish/wise; enjoyable/unenjoyable

We used the key constructs of TAM: PU and PEU [49] and the explanatory constructs subjective norm (SN) [41] and perceived enjoyment (PEn) [12, 50]. These factors aim at the social implications of the tutorial use like social influences and attitude towards

the tutorials. The construct of PEn is expected to play an important role to explain the IU. Hedonistic aspects on software usage become more and more important, especially in learning oriented usage situations. Table 3 shows the operationalization of the constructs. The assessment can be proceeded during the semester.

Furthermore, we evaluated the students' perception on the influence of the concept and the learning habits and the perception of the lecturer. We developed the scale on the basis of former research in the field of FC and deduced measures for the evaluation. three fields were mainly evaluated to assess the attitude of the students towards the FC concept: individual organization, knowledge acquisition and lecturer contact. The research field is dominated by the assessment of the knowledge acquisition. The evaluation of the influence of the lecturer is a rare. For the development of our evaluation model, we concentrate on FC-courses. Table 4 shows the measures, the focus and the related work.

Table 4. Measuring the Students' Perception

Question	*Focus*	*Related Work*
I can determine my own speed of learning. I can work self-contained. I work continuously over the whole semester.	individual speed and learning time	Evaluation of self-regulated learning and perception about the self-paced time [21, 51]
I receive a good overview on the topic. I can manage the learning matter. I feel well prepared for the tests.	knowledge acquisition	Attitude towards FC in regard to pass the exams and to emphasize learning success [18, 19, 28, 29, 52, 53]
The lecturer is dedicated. The lecturer takes notice of me.	lecturer contact	Assessment of the awareness of the lecturer [20, 29, 34, 54]

In order to present the applicability of the evaluation concept, we will demonstrate a use case of the evaluation in the next chapter. The case will show, how the evaluation can be proceeded and how the results can influence the conceptualization of further classes.

4 Application Example of the Evaluation

The case presented is a master class with about 100 participants. The subject of the course is "Project Management". The FC-concept is built of three different bricks: the basic learning content taught via online video tutorials, face to face reading seminars and guest lectures from practitioners. The video tutorials enable the gain of fundamental knowledge during the individual learning time [2]. The tutorials are based on sets of slides, that contain the basic content. The slides were verbally described and complemented by examples and comprehensive case descriptions. The sets of slides all include the fundamental knowledge in accordance with the taxonomy used like definitions, rules and concepts of the field. 25 videos with an individual length between 10 and 40 minutes are provided. The division into sections enables an individual learning style [25, 26, 55, 56]. All videos have a total length of 307 minutes. The second

brick is presented by guest lectures. The third brick is the so-called "reading seminar". The seminar is made up for a maximum of 20 learners each. The attendance of this seminar is voluntary. Though the students receive a reward for the participation in form of bonus points for the final exams. Students are confronted with articles from specific journals, that correspond with the topics of the video-tutorials. The students are asked to prepare the texts at home using a questionnaire as guideline. During the reading seminar they have to present their results, discuss them with their peers and align them to the basic contents of the class. Table 5 shows the achievable learning levels for the online tutorial (Lecture 8 "Project Execution) and the corresponding reading class (Lindner, F.; Wald, A.: Success factors of knowledge management in temporary organizations, in: International Journal of Project Management, 29 (2011).

Table 5. Comparison of the learning levels

Level	*Online tutorial*	*Reading*
create	-	-
assess	-	You are able to assess the knowledge management methods presented. You can assess the results in regard of the context.
analyze	-	You understand which methods can be used and choose the right one regarding the context.
apply	You are able to use methods of quality control	You are able to use the methods demonstrated.
understand	You are able to define the term „product quality"	You may understand the hypotheses set up in the text and the results of the hypothesis testing.
remember	You receive an overview about the topic of project quality	You are able to describe the key concepts of the text.

Table 5 gives an overview of learning levels on the example of the case. We realize a gap at the level of "create", which has to be patched.

During the term, we asked the students to fill out a questionnaire in order to evaluate the acceptance and the perception of the students. We received 68 completed questionnaires from the students. Cronbach's alpha is for all constructs higher than 0.8, which is regarded as a significant value for the reliability of the items [47].

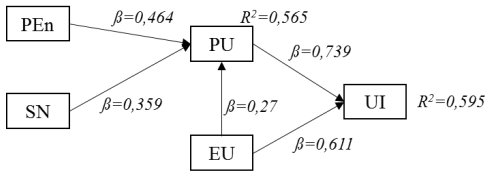


Figure 1. Technology Acceptance Model for the Flipped Classroom

We proceeded a linear regression analysis to measure the impact of the constructs on the use intention (UI). Figure 1 shows that the model is able to explain about 60% of the Use Intention (adjusted R2=0,595). This can be regarded as a comparatively high

value in order to explain the intention of the students to use the system [40]. The main predictors of the UI are PU and Perceived Ease of Use. PU can be explained to more than 50% (adjusted R2=0,565). It is mainly influenced by PEn, rather than by SN and EU. This means the intrinsic motivation to perform is higher than the influence by the peer group. It is important to mention that the software-use situation can be described as voluntarily. Although highly recommended by the teacher in order to pass the class, PEn and Subjective Norm have no significant direct impact on UI. This can be explained by the utilitarian use situation. Hedonistic and social aspects become less important, when the use-situation is work-related [50]. EU impacts the UI directly as well as indirectly via PU. The students regard the access to the system as easy and uncomplicated.

Table 6. Results regarding the Students' Perception.

Question	*FC- Concept*	*n*
I can determine my own speed of learning.	62	67
I can work self- contained.	60	66
I receive a good overview on the topic.	56	68
I can manage the learning matter.	56	65
I feel well prepared for the tests.	54	61
The lecturer is dedicated.	30	65
The lecturer takes notice of me.	24	57
I work continuously over the whole semester.	30	62

Table 6 shows, a great majority thinks that the FC enables to work with an individual speed and self-paced. Most students think they can manage the knowledge acquisition [43, 57]. However, less than 50% of the students sense the dedication of the lecturer and the interplay positive. And the permanent learning during the semester is not guaranteed by the concept. Three fields force the lecturer to act. In future the contact time hast to be upgraded in quality and social turns towards the students and the continuously working has to be improved.

The evaluation of the case with the help of the FC evaluation leads to the following insights: The learning levels which can be achieved reach up to "assess". This learning level is only enabled by the additional contact time during the reading seminar. The online tutorials are regarded as easy to use and usable. Sadly, the students do not emphasize fun while working with the tutorials. The students experience the FC-model positive regarding their individual learning time and the knowledge acquisition. The contact time and the role of the lecturer could be revised as well as cooperative learning facilities [58].

5 Conclusions and Limitations

Recent research shows some deficiencies regarding rigor and validity in measuring the effects of flipped classroom [3, 4, 7]. Our research contributes to this discussion, as this paper presents an evaluation instrument to assess the learning quality of flipped classroom courses. The model was developed with the help of proven measures from

the taxonomy of Krathwohl and TAM. Furthermore, the students' perceptions towards of the knowledge acquisition can be measured. For the development of this scale we used existing flipped classroom evaluations. We emphasis the FC-evaluation presented as easy to use and to understand. Still, the future quality of the evaluation depends on more feedback from more cases in order to improve the model. Only standardized use will lead to comparable and better results.

Future research and use may enhance the model. As the model presented is appropriate to detect fields for further improvement, a well-defined action plan has to be developed and deduced from more cases. It would be of great value to increase the number of respondents for the development of the structure model. Furthermore, the relation between the learning objectives and the assessment of the knowledge effectively gained has to be clarified in future [25].

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Innovation management in schools: Barriers and enablers to making as educative practice

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Abstract. This paper explores the use of maker technologies as activities embedded in a wider educational ecosystem. Innovations are generally described as the exploitation of new ideas; hence novel technologies and processes need to be adopted by the relevant user groups. The paper starts with a conceptual overview of maker technologies, innovation types and highlights the special situation of educational quasi-markets, where innovation management is different to fully competitive markets, such as the hardware and software industry. At the core of the paper are teachers' perceptions of barriers and enablers to using novel technologies. Assuming a systemic perspective on innovations, the paper also discusses topics such as appropriate funding, national regulations, curricular flexibility, technologies ready to use and adequate training opportunities for teachers. Hence, first findings of a research project on making and innovation management in schools are presented on the basis of 25 interviews from nine European countries.

Keywords: innovation management, making, schools, education, 3d-printing

1 Introduction

Making, as a fundamental human activity, has long been acclaimed to be a critical ingredient to experiential, problem-based learning, following the writings of John Dewey and Seymour Papert [1]. Making in education presents a shift from learning abstract concepts to discovering concepts through active experimentation, inventing and actually playing with technologies in pursuit of a personal goal, i.e. what Dewey refers to as 'authentic inquiry'. Even though the maker movement itself goes back as far as 2001, when the Massachusetts Institute of Technology's 'Bits to Atoms' program started [2], the use of maker technology for teaching purposes in schools and universities has only recently received researchers attention, as shown in a literature review [3] identifying first empirical studies in 2011. Since then, maker technologies have vastly improved, in terms of performance, affordability as well as user friendliness – reaching users beyond the usual suspects of tinkerers and hackers [4].

Additionally, Carstensen argues that 'making' is also a means to address aspects such as a lack of interest in STEM subjects (science, technology, engineering and

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maths) in general as well as attracting female students to STEM in particular [5]. Mainly because students can experience the relevance of what they learn in terms of observable changes in the physical world they attempt to control, be it through printing 3D-objects or by controlling the watering of a plant [6]. The result of these experiences is a sense of empowerment, so that young people develop confidence in their abilities to make things themselves and appreciate technologies as means to achieve things they are interested in, so that the ultimate objective of learning might not be programming or electronics but gardening, a game or art. Still, even though making is lauded in German speaking countries, Europe and overseas [7], innovative teaching practices including maker technologies seem to be far from mainstream – given the limited numbers of studies in the previously mentioned literature review [3].

Hence, the objective of this paper is to analyse pedagogical innovations considered as embedded actions in an existing ecosystem with inherent barriers and enablers. More concretely, we wanted to know whether innovation management could be a viable approach to support making as an educative practice in a more systematic fashion. But for that we needed to explore the general innovation culture in schools and their existing approach to manage innovations first. Critical conditions for innovations to be discussed include funding, regulations, curricular flexibility, availability of technologies ready to use and adequate professional development opportunities for teachers. The paper is structured into the following main sections: (1) a brief introduction of maker technologies in education, ways of categorizing innovations and the particularities of innovating within the educational sector; (2) a description of the study design as well as research participants; (3) the presentation of research results concerning teachers' descriptions of innovations, the barriers they experience, and which innovation management practices are currently at their disposal.

2 Related concepts

2.1 Maker Technologies in Education

There is no established canon of technologies that define the maker movement per se, even though 3D printing, single board computers (e.g. raspberrypi.org) and microcontrollers (e.g. Arduino.cc) have received considerable attention in reviews including the educational use of making [4, 8, 9]. What technologies are used is also influenced by costs of equipment and software. Fortunately, in most cases open source and freeware versions are available, such as FreeCAD (freecadweb.org), a parametric 3D modeller, or Arduino's IDE, which also exist as cloud-based web editor (https://create.arduino.cc/editor). Compared with other approaches of technology-enhanced learning such as the 1:1 desktop setting in computer classes, maker tools are relatively inexpensive [10].

However, one of the main benefits of making is the actual fabrication of a physical object (e.g. including sensors, laser-cut shapes, 3D-printed elements or computable e-textiles) in order to obtain a prototype of a solution which can then be evaluated more comprehensively, including usability, tactile experience or aesthetics [8]. A second,

frequently cited, benefit of building and tinkering for learning is the creative process, which enables concepts to be discovered rather than to be acquired passively [11]. The specific outcomes of using maker technologies in education are then reported as [9]: cross-topic integration of knowledge, development of self-confidence and resourcefulness, out-of-the-box thinking, fascination with STEM and problem-solving and the ability to critically distinguish making and consumption.

2.2 Types of Innovation

Innovations are generally described as the exploitation of new ideas; hence innovations imply novelty and use (i.e. the acceptance of the solution by a relevant user group) [12]. A working definition adopted for the research presented is "An innovation can be a new product or service, a new production process technology, a new structure or administrative system, or a new plan or program pertaining to organizational members. … Innovation is a means of changing an organization, whether as a response to changes in its internal or external environment or as a pre-emptive action taken to influence an environment" [13]. An important feature of innovation, considering the possible size of educational systems, is 'degree of innovation', referring to the amount of change required. Tidd suggests the following categorization in order to distinguish between different aspects such as 'What is changing?' and also 'How fast is it changing?' [14]:

- *Disruptive Innovations*: re-writing the rules, reframing the problem;
- *Radical Innovations*: novel, unique service / product;
- *Incremental Innovations:* day-to-day innovations, sustaining existing services.

We found that in the context of formal and informal education, an initial discussion of what teachers saw as innovations was paramount to create a shared, common ground. Some teachers saw themselves as reflective practitioners, rather than innovators. However, most teachers would reference at some stage the rules and norms of their workplaces as limiting or enabling conditions for any type of innovation (technical, organisational, pedagogical etc.). When asking teachers, disruptive innovations were generally seen more critical, due to difficulties around estimating the benefits they would bring to learning (implying that an effect would need to appear on standard evaluation instruments) as well as the effort the innovation would require from the teacher [15]. We are aware, that there is an ongoing discussion about the inflationary use of the term 'disruptive innovations', see [16]. Still, we think that unlike innovations in a business environment, which are readily defined and acknowledged, innovations in educational settings, need some domain-specific adaptations. Not the least because the next section looks at quasi-markets, to which Christensen's notions of low-end or new-market footholds [ibid.] are not easily transferable.

2.3 Innovations in educational quasi-markets

Calling for innovation management in schools is often related to a perceived inability of the educational sector to innovate effectively. Lubienski [17] shows that simply offering students and parents the choice of which schools they want to join, does not yet

create a market where innovation is a differentiator and wherefore innovations become desirable per se. Lubienski makes the argument that educational systems are quasi-markets: "schools are in an ambiguous position for sensing and responding to market-style signals. Particularly when bound by obligations such as open access, equity, etc., schools often do a poor job of acting like private providers" (ibid).

The term quasi-market was introduced by Le Grand in his analysis of public service reforms in the late 1980s [18]. Le Grand described a market where on the one hand providers competed for purchasers, but on the other hand providers were not necessarily profit-maximising firms. Put differently, schools do not show the business-like approach to innovation where profitable innovations are extended and less profitable practices are abandoned; and given their mission to provide a service to a wider society that is desirable. Hence, quasi- markets are different in that [19]: (a) providers may be state-owned or charitable organisations, hence not entirely profit-driven; (b) choice may be exercised on behalf of the user and (c) users 'spending power' is determined by the value of a voucher or earmarked budget, rather than their wealth.

3 Qualitative study design

The research follows a qualitative approach, based on semi-structured interviews. This allows for more flexibility in contrast to fully standardised interview methods [20]. During the selection of teachers to be interviewed, we aimed to include teachers with different experiences concerning maker technologies as well as teachers coming from different school types. With the remaining interviews engaging professions such as strategy advisors, university lecturers or company directors, we wanted to reflect the diversity of stakeholders in the educational sector. Two different interview guidelines were developed: one set of questions for educational organisations and a slightly adapted set for commercial organisations. While all questions were mandatory, the sequence of the questions could be changed. Also, ad-hoc questions were possible in case it seemed reasonable to explore an issue in more details. Interviews were organized and implemented in nine countries (Figure 1). Interviews were done through video conferencing or face to face. All interviews took place in the months between June and August 2017. In some instances, interviewees decided to fill in answers in writing, so that there was an individual reflection phases prior to the interview.

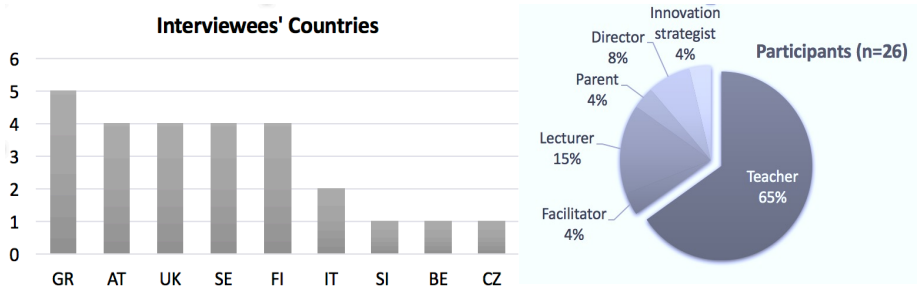


Figure 1. Interviewees' countries of residence and their professional backgrounds

44% of interviewees were between 31 and 40 years. Concerning interviewees gender, we achieved a fair balance between male and female respondents (Figure 2).

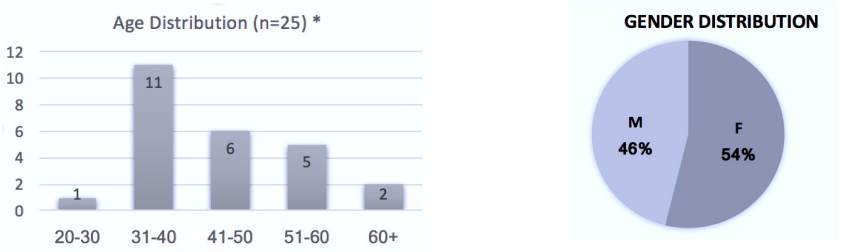


Figure 2. Interviewees' age and gender distribution

4 Research results

The interviews addressed 5 areas: (1) defining innovations; (2) elaboration of innovation barriers; (3) elaboration of innovation enablers; (4) capturing existing innovation management practices and (5) measuring innovation – an aspect not included in this paper. Throughout the paper, the source of interview responses is indicated in brackets with a country acronym and a number, e.g. SI4 stands for interview number 4 with a Slovenian teacher.

4.1 Different perceptions of innovation

A first question when researching the innovation capacity of the educational sector is 'how do we define innovation?'. Lubienski [19] suggests that practices are innovative if they are new within their local context. This interpretation goes counter to the idea that innovation has to be 'new' in general. This is an important distinction, since, as previously discussed, a defining characteristic of innovation is acceptance and uptake of 'new practices' by relevant groups [21]. In our interviews, we asked teachers how they define innovations as well as what they would expect as outcomes. In general, we found responses varying in their degree of specification, ranging from a focus on educational methods and tools to broader notions of innovations being expressions of mindsets or value systems. More specific definitions included the following statements:

- Innovations can be project-driven classes, using new media, based on related professional development There is a need to be on top of current developments. This is also an expectation society and ministry have towards schools. However, the latter also presents a dilemma in that we need to experiment with innovative products and simultaneously demonstrate evidence for improved learning, which leaves little room for experimentation (AT1).

- Innovation is mainly teacher driven, though there is little time for innovation since many topics need to be covered. For teachers, outcomes of innovation shouldn't imply major disruptions but there should be a way to connect with existing practices (AT2).
- Usually, innovations have a strong technology focus (e.g. Smartboards, document cameras). Innovations are an important factor to be different than other schools, especially since there are schools competing for the same students in the area. Once you have too few students there is a risk to be combined with another school in which case you lose sovereignty about the way you structure your teaching. All in all, innovation should make things easier (AT3)
- Innovations include good information technology as well as courses that teach programming and robotics, not yet connected with other science subjects. However, schools should concentrate on applying 'innovative methods'. Schools are not the place to invent innovations (AT5).
- Innovations involve a mandate to focus activities, new technologies and new didactic methods. Since we are a technical school, innovation is inherent to teachers' individual preparation. For example, recently we started teaching about Industry 4.0 (IT15)

Statements defining innovations in schools as mindsets, motivational strategies or openness towards increasingly heterogeneous groups of students included:

- Innovations should inspire students to be creative and to create new things. Innovation, as one of the outcomes, should raise students' interests in STEM and make them more open minded about the potential uses of computers and smartphones (GR6).
- Innovations are expressions of open-minded teachers and students. Innovations imply change, which in turn can lead to stress. So, whatever the innovation, it's important to include teachers and students early on (GR7).
- Innovations should help to get the best out of students and teachers. Innovations are a necessity to spark students interest in the subject. Innovations should lead to questions and the urge to experiment, make mistakes and therefore learn (UK11)
- Innovative teaching helps to attract more students. Innovation should be defined by its objectives and not by tools. So, the Internet would be only a tool, but the overall objective must be to learn how to use a variety of information sources (CZ18).
- Innovations are to reform the idea of teaching and learning. We need innovations as motivators for students. The expected outcome is still 'learning'. What did the student achieve (FI23)
- Innovation is about openness and diversity. Innovation is already triggered by the new curriculum we are implementing. Innovation should establish a certain state-of-mind: seeing how things are connected (FI24).

However, there were also voices of concern: "The term innovation is scary for many teachers because it is the term that is constantly being talked about and teachers in the Czech Republic are often pushed into it, whatever it means. It is often understood neg-

atively. For many teachers, innovations mean only watching movies or visiting exhibitions, using computers and a projector. … I would not define 'innovation' in teaching as a necessity to change the way of teaching or the necessity to use new aids or play games, but as an opportunity to include cooperation with specialized workplaces or using the Internet as a search tool." (SI4)

4.2 Barriers to innovative teaching practices

There is rarely an organisation that would say innovation is not important to them, still, many organisations do not consider themselves effective innovators [22]. The barriers brought forward frequently include 'perceived riskiness' or 'short term objectives such as saving costs'; which stop organisations following through with their innovations strategies. One of the key enablers of effective innovations according to Loewe and Dominiquini [22] is visionary leadership behaviour, which in turn requires a common definition or a shared understanding of what innovation is or why it matters to the organisation. One of the reasons we included this point in the interview guide and discussed it in the previous section.

Besides having a shared vision on innovation, the interviews included three possible areas where barriers could be present:

- *Knowledge / Skills:* Knowing about latest innovations in the field, having the skills to preselect potentially applicable technologies [23];
- *Markets*: Knowing which products / markets are relevant, dependencies on market conditions (offerings, educational focus) [24];
- *Funding*: An organisation's ability to make the necessary investments, including financial and man power resources.

Knowledge gaps. In this section of the interview, we asked teachers about their ways to keep up with the growing amount of information related to innovative technologies relevant to their respective subjects. We also asked them what they found particularly important to boost innovations in their schools.

Teachers attempt to be on top of their subjects as well as related educational technologies by: accessing the Internet (SI4, GR6); reading relevant journal and magazines (AT1,GR7); attending open days, fairs and exhibitions (AT2, GR6, CZ18); having local interest groups for exchanging experiences (AT2, GR6, Fi23), using information channels provided by the education ministries, e.g. 'IT at school in Austria'(AT3); exploiting personal contact to the computer department of the local university (SI4, UK11); following e-learning classes (GR7); organizing professional development sessions at the school (UK11); joining Facebook groups (FI23, FI25).

Markets. The 'markets section' of the interview aimed to explore the relationship between teachers and schools' processes regarding the planning and approving of innovations, given that there is a 'market of opportunities'. Firstly, we wanted to know,

whether teachers felt like they were up to date with what the market had to offer. However, with hindsight we can say that these questions seemed too removed from teachers' daily experience. Concerning their knowledge about what the market was offering, teachers stated:

- We don't have a lot of contact in that area. Some of the technologies really need to be presented, so that we can get a better impression of what the innovation is all about (AT1). Similarly, another teacher commented, that yes, the information is there, but once a product is purchased, it's quite cumbersome to get it running. The latter involves a lot of Google searches (AT2).

There were more comments on how schools decided about the adoption of innovations:

- On one side, we have some quite rigid structures and on the other side there are no 'extra' financial resources. So, schools need to collect money from parents, donors or do things like 'Sponsor Runs' – basically running for money (AT2).
- If innovative technologies are used in the classroom, it is important to have a sufficient quantity of those. After all, most groups are heterogeneous and if all students need to participate in the activity I need enough devices to allow for groups that advance at different speeds (AT3). We only have one lab for 1,300 students where we can use 3D printer, Lego robotics or Arduinos (AT5).
- Our decision making is constrained by the Ministry of Education. If they are not interested in a particular innovation, it cannot become part of the formal curriculum. Also on one occasion we got a national product, even if this was far removed from the current state of art (SI4). The kind of innovations that a teacher is allowed to introduce is limited to what the government proposes, since that's the reason why the funds were assigned to the school in the first place. If a teacher has a good idea, he's not allowed to put it into practice because he does not have enough funds. (IT15)

Funding. Funding explored how teachers perceived the level of investment the schools put into learning, professional development and technological infrastructures. There were two main arguments driving the discussion about funding:

(a) *Type of school:* private or public, or in Finland we had a research-oriented school, or in Austria we had the 'new middle schools' which had a somewhat better funding than other school types.
(b) *Source of funding:* there will be national differences, but some parts of the school's cost are covered by a national budget, other costs are covered by the local community (municipality) and then there is some extra money coming in from parents or donors. Although the latter depends on the network the school has as well as the general socio-economic situation of the region where the school is located.

But even if different sources can be combined, it seems like the teacher needs to develop quite some fund-raising qualities if he or she wants to get a project of the ground: "*Funding is absolutely a big problem, the school budged sounds quite big, but there are lots of big costs. The primary cost is the teachers, the building and then very*

little is left. About 30.000 is like nothing for a school of around 1300 studying. The whole budget has been frozen for 3 years now and no inflation adjustments were made. You always have to pay the teachers and the building first, and it always get less and less left. It's is really hard to get even 100 € for something, you have to ask for 10-20 € things, and don't get any money. In our school, parents have a strong organisation and they continuously contribute, but not all teachers want to go to ask parents. You need to have a budget from the school." (AT5)

Then there is the economic situation of a country, which determines how much budget is made available for education: "*Funding is very low. Our Ministry of Education is not funding neither schools nor researchers in the academia. And this is the major obstacle. Almost all we do is through external contributions.*" (SI4) Or similarly Greece: "*Finally, innovation is traditionally related with paying extra for acquiring the necessary new equipment and that is a real barrier in a country under financial crisis like Greece. But, judging by my experience, innovation is not an expensive thing and people in charge should know about it.*"(GR6) Interesting about the last comment is the statement that innovation doesn't have to cost much. Of course, there is a difference in wanting to use Arduinos and stepper motors of about 50 € or a Lego Mindstorm Robot that can cost anything between 200 € and 500 €. In contrast to these statements, we also have schools which are facing no difficulties in getting the necessary resources – at least as far as the technology is concerned: "*We have a pretty good situation with the technology. Our high school is a pilot school in technology area and in our secondary school we get quite good support for investing in new technology (for example Drones and the equipment for programming*)." (FI23)

4.3 Existing innovation management practices in schools

Lessig [25] highlighted the importance of managing innovation by quoting Machiavelli, an Italian philosopher, known for his acute analysis of politics: "Old versus new. That battle is nothing new. … Innovation makes enemies of all those who prospered under the old regime, and only lukewarm support is forthcoming from those who would prosper under the new. Their support is indifferent partly from fear and partly because they are generally incredulous, never really trusting new things unless they have tested them by experience" [25]. Hence, innovation management needs to reduce the risks for those innovating, present firm support from management and provide the required resources in terms of finance and expertise.

Typical innovation management methods include establishing a personal responsibility for knowledge, knowledge management as business strategy, assessing external knowledge, knowledge management trainings, reward systems for knowledge sharing and establishing best practices [23]. Most important is a process or network perspective on innovation management. Current innovation management applications [14] emphasizes the importance of networks for (a) sharing information, (b) sharing infrastructures and (c) co-specialization. Additionally, the networking aspect of innovation management has led to the increased use of social media such as Facebook Groups or WhatsApp Groups. The figure below lists tools and organisational arrangement interviewees mentioned in the context of their schools.

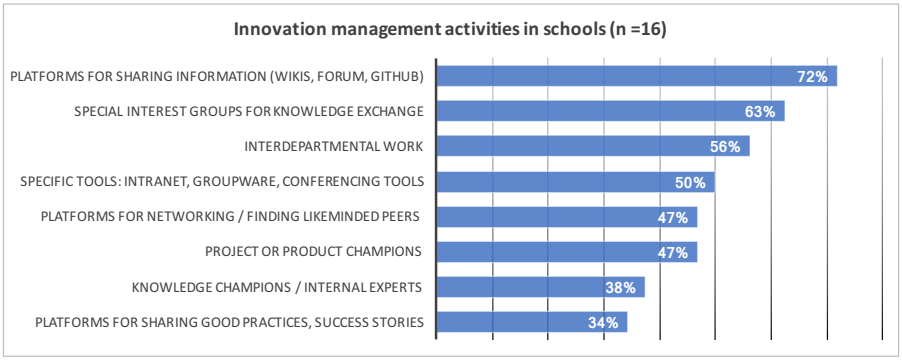


Figure 3. Interviewees perceptions of innovation management tools in their schools

In some instance networking platforms were not confined to the limits of the school and also connected teachers at a regional or national level, like the use of peda.net in Finland or bildung.at in Austria. Peda.net is a social networking platform with personal profiles and discussion forums. There are different ways of using it and teachers, students and parents can sign in and check or comment what has been done at the school or at the day-care. However, it is primarily the schools and teachers, who decide how they are using it. Bildungt.at is a sharing platform for services, content and initiatives, including online materials supplementing school books or specifications of and recommendations for learning management systems (LMS).

Expertise-based innovation management differentiates two types of tools [26]:

a) *technical tools* related to the acquisition and use of new information and
b) *relational tools* related to the exchange of knowledge, internally as well as externally.

Although this differentiation is not always clear cut and depends on how a technology is used, we can see that the top five tools include strong networking capability and the last three tools mainly enable knowledge-push strategies (Figure 3). However, there is no technological determinism in innovation management, which leads Tidd [14] to remark that several decades of research on innovation management have failed to create a comprehensive framework to guide innovation management. The author's main argument is related to researchers' neglect of environmental contingencies: speed of change of technologies, changing demands for services and innovations in general or access to relevant research communities (since not all changes can be covered in-house). In some instance some very fine-grained factors might also play a role, e.g. when the same technology (Moodle in this case) was used with great enthusiasm for a variety of innovation management tasks (SI4) whereas another organisation made less positive experiences, so that the tool was soon replaced (AT5).

5 Discussion and outlook

Enriching the educational landscape by new technologies has a long tradition and discussions about technological features frequently dominate the debate. Even today,

when technology and the use of software is commonplace in many areas of life, the embedded nature of educational technology is still neglected. As the reflected in the diverse interview responses, changes in educational systems are ‘changes of running systems', hence the management of innovations is a much-needed ingredient to ensure the efficient usage of the already scarce time resources of teachers and learners alike.

On top, a strategic approach to ‘making’ in the schools of the interviewees is missing. ‘Strategic’ in the sense that ‘maker technologies’ enable different ways of learning which also needs to be taken into account in teacher preparation programs and curricula. As put forward by Resnick and Rosenbaum [27]: “The tinkering approach is characterized by a playful, experimental, iterative style of engagement, in which makers are continually reassessing their goals, exploring new paths, and imagining new possibilities. Tinkering is undervalued (and even discouraged) in many educational settings today, but it is well aligned with the goals and spirit of the progressive-constructionist tradition—and, in our view, it is exactly what is needed to help young people prepare for life in today’s society”.

The quote shows how existing preferences in the educational system, e.g. emphasizing content delivery and quantitative assessment, run counter to a pluralism of learning paths including the bottom up experiences of creating tangible objects, the notion of adapting solutions to changing conditions and an essentially different way of accessing STEM problems. Hence, making and tinkering requires not only a rethinking of students’ interactions with specific topics but also the rethinking of STEM curricula (e.g. project rather than subject-driven organisation of knowledge) and assessment methods (e.g. collaboration and scientific inquiry skills rather than concept recall).

6 Acknowledgements

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A Cultural Perspective on Personalized eLearning – Designing Corporate Trainings for Chinese Learners

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Abstract. In a globalized world, as we live in today, corporate training oftentimes takes place online. These online learning environments can be personalized for cultural groups to reach better learning outcomes. This paper examines dimensions for cultural personalization evaluating corporate trainings with Chinese learners. It thus relies on Design-Based Research to develop a toolbox along cultural dimensions and aspects of personalization. The aim is to help trainers to adapt trainings to the Chinese target group with the focus lying on the didactic aspect of how to transfer content to achieve optimal learning outcomes.

Keywords: eLearning, personalization, culture, China.

1 Introduction

In today's globalized world, companies operate as multinational corporations relying on an equally multinational workforce. This implies international teams as well as teams working geographically dispersed all over the world. The indicated circumstance entails the need for an effective functioning of those teams and their work-related activities [1]. Employees in multinational companies often have different levels of education, training needs, learning objectives and motivation to participate. For trainings accompanying software rollouts in locations away from headquarters, reaching the same level of knowledge is generally difficult. It seems as if there is not a single cause, but rather a mixture of aspects causing this problem. For example, people not working in the headquarters might not share the company's understanding of processes, might interpret central directives differently or have divergent previous levels of knowledge [2]. These distinct training needs can be addressed by personalizing learning environments. Ways of personalizing online trainings apart from personalization done by the IT system is oftentimes a more feasible approach due to company regulations and costs. In multicultural and geographically dispersed working environment, a cultural personalization seems promising as cultural differences between nations prevail. Therefore, this paper aims at developing a concept for a cultural personalization, in which trainers consider the cultural background of the learners. Hence, the research question is: **How should eLearning be personalized**

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from a cultural perspective for a Chinese target group to achieve optimal learning outcomes?

In order to examine the challenges described above from an academic point of view, the THP@BBM project (Tooling Harmonization Project @ Bosch Business Sector Mobility) at the Robert Bosch GmbH is used as an exemplary case. Within the project, the tooling ordering process in Bosch's automotive central purchasing division is harmonized. The harmonization takes place mainly in the SAP ERP-systems, making training 4.000 end-users located world-wide inevitable. So far, no personalization has been made for the online trainings of the project. This will now change, as the rollout moves to the Asian region, concentrating on China. Improvements are expected from a cultural personalization, focusing on the didactical aspect of how to tailor the way in which trainings are delivered to the Chinese learners.

2 Methodology and Research Approach

Design-based research (DBR) is defined as "[…] a research methodology aimed to improve educational practices through systematic, flexible, and iterative review, analysis, design, development, and implementation, based upon collaboration among researchers and practitioners in real-world settings, and leading to design principles or theories."[3, p. 2]. Main arguments in favor of this approach include establishing a strong connection between real-world problems and educational research [4], improving IT artifacts and implementing an iterative and interactive research process, engaging in integrative research methods and presenting contextual research results [3]. Despite the focus lying on DBR, the set of structures provided by Gupta and Bostrom is also considered to provide a frame for the practical work elaborated within DBR. This frame includes the social setup of the team, the variety of technology to be possibly used and the learning process to achieve learning objectives [5]. A more detailed picture is provided by classifying the research approach into the three epistemological perspectives behaviorism, cognitivism and constructivism. Behaviorism refers to learning taking place when the behavior of the learner himself changes as a reaction to an external stimulus, such as a different learning method. Cognitivism is influenced by the learner's mental setup and his perception of the learning process. Lastly, constructivism encourages learners to develop new ideas based on their previous knowledge. This process is supported by allowing the learner to absorb the information relevant to him in the way, which is most practical for him and eventually drawing his own conclusions [5].

Coming back to the research approach, DBR consists of the following four phases depicted in Figure 1. Phase one outlines the general problem, which is the base for establishing design guidelines. Therefore, a literature review of the state-of-the-art of cultural personalization and eLearning is performed and its results are presented. In phase two, draft principles are derived from the literature to describe the intervention. The DBR-process then continues with iterating, testing and evaluating the proposed solutions by putting them into practice in phase three. As a basis for this evaluation, current trainings in the THP@BBM are analyzed conducting open-questioned interviews. To conclude, the fourth phase reflects the process of deriving design principles, which are elaborated within the toolbox in section 5.

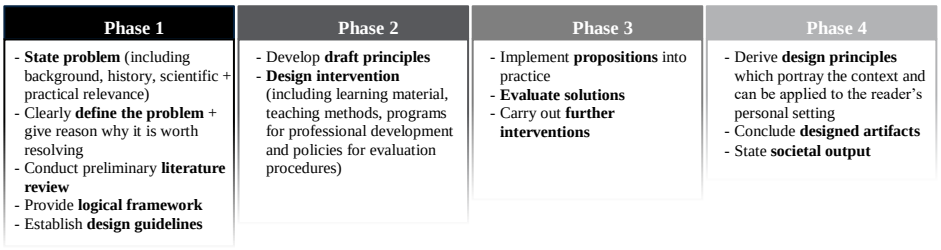


Figure 1: The four phases of DBR (adapted from Herrington et al., pp. 4092–4095)

3 Application of Theoretical Concepts

This paper focuses on corporate trainings taking place in an online learning environment, making use of media such as telephone conferences, social media and video clips. According to Shen et. al, online learning, commonly referred to as "eLearning" „[...] aims to provide the tools to create a personalized learning path and to be able to dynamically readapt learning paths according to user feedbacks and environment changes in order to optimize the acquisition of needed competencies"[6, p. 304]. ELearning draws on the use of different media sources – synchronous and asynchronous, so that learners are able to decide for themselves when, how and where to learn. Traditional eLearning was designed for a homogeneous group of learners or for single anonymous learners without special learning needs and preferences for learning methods. In literature, this concept is commonly referred to as "one-size-fits-all approach" (see also [12]; [7]. Personalization of end-user trainings aims at addressing these challenges and offers the possibility to meet the specific needs of learners [8].

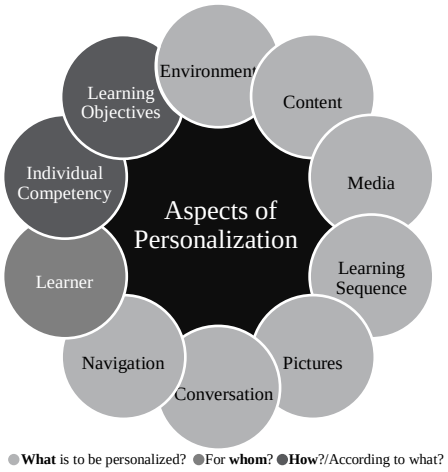


Figure 2: Aspects of Personalization Mapped to Guiding Questions (Adapted from [7] and [10])

As can be seen in Figure 2, the task – or the "what" of personalization – is mapped to several aspects of personalization [9]. First, the **environment** in which learning takes place. A motivating learning atmosphere should be created so that learners are satisfied with the knowledge transfer [8]. Second, the **content** needs to be well incorporated in the personalized learning environment to reflect the preferences and habits of the targeted learners. Third, the **media** used for transferring knowledge. Using the right media is essential for successfully delivering the key message of trainings [10]. The fourth aspect is **learning sequences**. A flexible sequence allows learners to choose how and what they want to learn in which order. Also, the learning environment should be personal through **pictures** of the trainers. Moreover, **conversation** needs to be personalized by e.g. adjusting the language used to the audience. Sixth, the learner has to be able to explore the content provided by personalizing **navigation**. Trainers should concentrate on the **learner** himself and make trainings personally relevant for each member of the target group [9]. Especially relevant for the didactic approach is the "how" of personalization [7]. **Individual competency** of the learner makes it possible to skip parts of the training material already known**. Learning objectives** [9] address the goal of enabling each learner to reach the given objectives [8]. This does not imply lowering the objectives until the whole group reaches them, but in turn focusses on the individual and his strengths and weaknesses.

Following this outline, we can now turn to culture. Culture can be understood as "collective programming of the mind", by which members of one community are distinguished from the members of another [11, p. 6]. Nowadays, everyone is not only cultural but rather multicultural, incorporating patterns from ethnicity, lifestyle and profession [12]. Despite an increasing multiculturalism, cultural issues arise when people are confronted with behavior, which is not compatible with their own cultural background [7]. Hofstede's model of national culture is consulted to gain an insight into cultural differences by outlining the relevant dimensions. The **Power Distance Index (PDI)** measures the degree of inequality within a society. China ranking at 80 is a country with a large PDI. Concerning trainings, the trainer possesses absolute authority [13] with trainings being teacher-centered and passive learners [14]. It is not common for learners to freely express themselves [13]. Germans (35), ranking rather low on PDI, emphasize decentralized organizations with equal distribution of power where it is acceptable to contradict the trainer. The second dimension, **Individualism vs. Collectivism (IDV),** is about a person's perspective on the self-image, defining it as "I" or "we". At 20, China is very collectivistic. In trainings, Chinese learners tend to

perform best in group work. Germans (67) are significantly individualistic. For **Masculinity vs. Femininity (MAS)**, masculine societies strive for achievements, are competitive and status is important, while feminine societies aim for cooperation, take care of the weak and pursue a high quality of life. In China (66), low-skilled employees work many hours and often leave their families to earn a living. For students, it is crucial to which school and university they go [15]. Chinese learners feel comfortable with little-structured learning environments and situations. The **Uncertainty Avoidance Index (UAI)** represents the degree, to which members of a culture feel (un-) comfortable with ambiguity and unknown situations. In China (30), truth is relative, making it acceptable to bend the truth to keep face, no matter whether online or offline [13]. In trainings, the aspect of keeping face is most important for Chinese learners. Also, conflicts should be avoided and harmony be preserved. At 65 in Germany, the UAI implies that people favor clear structures and it is important to live by the rules. "**High Context vs. Low Context**" is introduced as well [16]. High context (HC) cultures such as China require a high level of context and pre-programmed information when communicating. The message itself contains minimal information and the receiver is expected to interpret. Chinese learners heavily rely on non-verbal communication channels [13]. Oftentimes, those channels are unavailable in online learning environments, hindering Chinese learners from extracting cues needed to decode the meaning of the message [13]. Low context (LC) cultures such as Germany transmit most information in the explicit message itself, requiring little body language. Germans often rely on direct communication.

Bringing together eLearning, personalization and culture, what learners perceive to be a good training is mainly influenced by the fit of their cultural norms to those of the training [17]. ELearning often lacks cultural sensitivity, which impedes the learning process and keeps eLearning from unfolding to its full potential when learners are expected to leave behind their culture and follow the trainer's culture ([7], [12], [18]). Cultural personalization does not solve all problems arising within eLearning, but neither does a „one-size-fits-all" approach [12]. Table 1 summarizes the presented literature, formulating draft principles along phase two of DBR.

Table 1: Draft Principles

Draft Principle	*Description*
Draft principle 1: Culturally personalize the eLearning environment to benefit the learner ([19])	Move away from the "one-size-fits-all" approach by meeting learning needs of heterogeneous groups of learners. Increases learning outcomes and motivation to participate.
Draft principle 2: Make use of social media to support the learning process in eLearning ([20], [21])	Reaches more participants more quickly. Hands over responsibility of learning to the learner himself. Allows for independently navigating through learning content.
Draft principle 3: Adopt a clearly pronounced and simple language to increase understanding ([9], [7], [13])	Addresses the differences in general educational approaches between Chinese and German learners.
Draft principle 4: Include non-verbal cues in eLearning ([17], [13])	Facilitates learning for Chinese learners as more context is provided.

4 Qualitative Analysis of Current Trainings

Along DBR, the draft principles are proved and implemented in practice. Therefore, the description of the intervention is necessary. As proposed by Schultze, research by observation is conducted in the first step [2]. For this reason, four online trainings with international participants are observed by joining Skype sessions, listening and making notes. The trainings are all end-user trainings for different IT-tools within BBM. The researcher concludes, that trainings are typically not personalized and thus conducted by a trainer who seems to train in the same way no matter where learners come from. Asian learners did not ask questions or requested further explanations during the trainings. In meetings taking place on a regular basis, a more familiar atmosphere prevailed. Asian learners freely participated in discussions and did not hesitate to state their opinion and engage in discussions. These first impressions are later revisited and set in context with experiences of users who participated in THP@BBM trainings.

Following the cycle of DBR, the intervention is designed to gain a more complete understanding of learner's needs. It thus relies on the qualitative method of conducting open-questioned interviews to better understand whether current trainings are perceived differently from Chinese and German learners. This course of action is also followed by Schultze who relies on informal conversations and unstructured interviews to collect data from participants. For this reason, a sample of eleven employees is drawn. Whenever possible, interviews are conducted in person to establish a personal connection, otherwise telephone interviews are conducted. This is especially relevant for the interaction with the Chinese participants and possible through the researcher being located in Shanghai. The interviews are not recorded to encourage participants to talk freely [2]. During the interviews, key points are documented and afterwards transcribed. Typically, two trainers conduct the trainings. All training material is available online for the users in the wiki of a BoschConnect community, which is an

internal social media platform. Additionally, questions are gathered and answered in a forum, which is intended to encourage end-users themselves to answer questions, which they see and can answer with their personal background.

Most Chinese participants received the training invitation via e-mail, not via BoschConnect. For them, the tooling-topic was new. The Chinese employees participated because the concerned process is relevant for their daily job, whereas the Germans do not regularly work with it and were generally interested in the topic. When discussing missing aspects of the trainings, Chinese participants did not provide feedback. In contrast, German participants requested to be trained in German. Evaluating the structure and content, Chinese participants commented that everything is clear and understandable. Concerning the layout of the slides, they provided positive feedback only, such as liking the simple slides with not too much information and the colors used. Germans were more indifferent, noting that they did not clearly remember the slides as they are designed according to the current Bosch style guide. Feedback about the teaching style can be categorized according to time, content and use of media. Regarding time, both Chinese and German learners commented that sticking to the time planned is highly important. Chinese participants pointed out that the training was planned longer than it actually lasted. They valued sticking to the timeframe planned for a training as more important than answering all open questions. Relating to the content itself, a Chinese participant stated: “providing more details is desirable”. Germans found the amount of information included appropriate. When discussing the use of media, for Chinese participants asking questions during the training in the chat was alright. They would, however, prefer receiving an answer directly during the training. Some German participants had the same opinion. Contrarily, others preferred providing answers via BoschConnect. Comments about Skype as the tool for delivering the content were positive and Skype was regarded as an appropriate medium by all participants. Chinese participants did not express additional wishes concerning the channels of instruction. The same held true for the framework of the training. Only one Chinese participant articulated that the “structure is clear and good”, whereas the German participants suggested again to offer German training sessions and offering trainings in the morning and in the afternoon. Moving to the BoschConnect community, the majority of Chinese participants claimed to have used the community before as well as after the trainings. The design and layout of the community was perceived well and described as “understandable”, very good” and “often updated”. German participants affirmed to not use the community because they do not find the content personally relevant and are confronted with an information overload, trying to block it by not joining communities. The content was generally liked and described as “great”, “clear and easy to use” and “nicely designed”, but also criticized as “difficult to find”. Again, constructive feedback such as adding tags to each post was provided.

5 Discussion & Conclusion

The first iteration with its implementation now leads to the outputs of DBR. The scientific output considers the insights gained from field research to refine the initially proposed draft principles and retrieve design principles. Therefore, the interview results are discussed and interpreted. The environment is strongly influenced by the high **PDI**. Learners have a passive role in trainings [14] and memorize what is presented to them [22], [13]. The trainer should thus encourage the learners to ask questions and engage in discussions. Concerning **IDV**, personal opinions are often held back and the trainer is not criticized as he would lose face [12]. Thus, an active and open learning environment should be adopted by assigning practical tasks to small groups [12]. Next, the impact of **MAS** on the eLearning environment suggests to create certificates for successfully completing trainings. Second, the training content is personalized through a glossary to create a common understanding of frequently used terms. The low **UAI** indicates that it is preferable to first gather as much information as possible to then choose what is most relevant. All training documents should thus be available online. Next, media is considered. **IDV** implies that Chinese learners heavily rely on social media, especially on WeChat, so that the use of an official WeChat account to reach the target group fast and easily is recommended. For communicating with **HC** cultures, merely relying on the audio function of Skype is not enough and should be enriched by e.g. giving video-conferenced lectures. The Chinese preference for vivid colors, complicated-looking designs and games can be addressed by not only relying on PowerPoint slides, but also on e.g. Prezi to engage in story-telling based on flash technology or PowToon for simple animated explanation videos. This adequately addresses the behavioral perspective previously presented by engaging in different learning methods. Regarding the low Chinese **UAI**, one should keep in mind that Asian learners perceive a response time of more than one day as inadequate for answering e-mails as they expect others to check their messages as often as they do [13]. In order to avoid this pressure, forums should be checked regularly, a shared team inbox can be used to process e-mails quickly and creating FAQ pages guarantees reading access at all times. The learning sequence is personalized by making content freely available to learners. Personalizing roles using photographs and pictures is highly relevant in the Chinese **HC** culture. Additional non-verbal cues should be incorporated in trainings as project members uploading their picture to the platforms frequently used. Regarding conversational personalization, a mixture of written, spoken and visual media is recommended for the Chinese **HC** culture. Considering **PDI**, it is advised to use a globalized English and abstain from the use of colloquial language. Trainers have to be aware of the gestures they are using, as some might be perceived to be offensive for Chinese learners. Within the navigational aspect, the low **UAI** indicates that Chinese learners are comfortable with navigating through trainings and training material provided. Examining the learner himself, motivation is crucial for training success. Motivation is higher for voluntary than for mandatory trainings. In this way, the cognitive perspective is addressed. Relating to **MAS**, it is proposed to engage learners in process improvements and officially award the best idea. With this recommendation, also the constructivist perspective is satisfied as learners are encouraged to develop new

ideas. The learner's individual competence is addressed by offering basic and advanced trainings. **PDI** for the last aspect, learning objectives, implies to precisely address the learning objectives. Including a poll at the beginning of the trainings, inquiring the expectations and previous knowledge of the learners encourages a more interactive and learner-centered approach.

These results lead to the reevaluation of the draft principles, which are now adapted and enhanced within Table 2:

Table 2: Design Principles

Draft Principles	*Refinement*	*Design Principles*
1: Culturally personalize the eLearning environment to benefit the learner	The learner benefits when he recognizes personal relevance (which is then intrinsically motivating and establishes a clear understanding of what he is expected to learn) and thus reaches the learning objectives.	Culturally personalize the eLearning environment to benefit the learner by increasing personal relevance to reach the learning objectives.
2: Make use of social media to support the learning process in eLearning	The advantages of social media in eLearning is confirmed. Principle is extended to tools offering synchronous modes of communication (e.g. Skype) for a complete learning framework.	Make use of collaborative tools such as social media to support the learning process in corporate eLearning.
3: Adopt a clearly pronounced and simple language to increase understanding	Need for easily understandable words and slow speed of language is confirmed. The wording is improved.	Deliver eLearning in a well-understandable common language to increase understanding.
4: Include non-verbal cues in eLearning	Need for non-verbal cues is confirmed. Reason is provided.	Include non-verbal cues to address learners from high context cultures.
	A low threshold for contacting trainers and communicating during trainings should prevail. Create a learning environment where learners actively participate throughout the learning process.	Create an active learning environment where learners feel comfortable to communicate with peers and trainers.

Based on the design principles, the design artifacts, which represent the practical output, are composed. Within the frame of this paper, a toolbox is put together, aiming at providing a range of proposals, which can be drawn from when personalizing corporate eLearning for Chinese learners and thus answers the research question. Chinese learners should be addressed according to their previous level of knowledge, be provided with a broad scope of information available whenever they need it and build-up knowledge in small teams where no participant fears to lose face. They feel more comfortable gathering information from different types of media, not displaying a strong need to be guided through each step of the learning process. The feeling of a personal connection eases the barrier to address questions, which can be reached by introducing trainers with a picture and by relying on video conferences. Furthermore, learning objectives should be formulated and communicated clearly. Addressing MAS, learners can often be motivated through awards and certificates. A lot of potential for personalization is seen in the content, where the provision of additional information and the consideration of culturally tinted meaning of e.g. colors, numbers, etc. are considered. The aspect of conversation is personalized regarding an adoption of language to satisfy the needs of power-distant Chinese learners. Moreover, the HC aspect is addressed by relying more heavily on videos and video conferences than only audio tools. The environment can also have a positive affect when being personalized. It includes the cultural elements of the PDI for a clear positioning of the trainer and the use of polls during trainings. The MAS suggests to hand out certificates to the learners and the prevailing collectivism is addressed by engaging in group work. Furthermore, the UAI is satisfied by providing an overview of the agenda throughout the complete training. Lastly, most proposals are made for the media aspect. It is mainly concerned with the PDI for the use of language, allowing basic questions during trainings and the UAI regarding the use of a support concept, FAQ-pages and a shared inbox. The high context aspect indicates to make a strong use of tools, which allow transferring non-verbal cues also and to rely on a WeChat account to reach the collectivistic Chinese learners quickly. Concluding the design artefacts, it is highlighted that recommendations are made based on generalizations, which are not true for all Chinese and can only aim at providing useful suggestions for a broad range of Chinese learners.

Despite the output of the DBR, this paper faced several limitations. First, not the entire design circle is completed but instead relies on initial suggestions. Second, the time span of longer than one week between participating in trainings and interview is perceived as being too long to remember many details. Third, more personal interviews are believed to have led to more detailed results due to the high context of Chinese culture. Lastly, a personal relationship to the researcher is considered to lead to more detailed answers, entitling him to be entrusted with the outright opinion and critique.

In Table 3, the findings are now mapped according to the cultural dimensions of the design principles they address, providing a short summary of the most important aspects.

Table 3: Relevance of Cultural Dimensions on Design Principles

Cultural Dimension	*Design Principle(s) Addressed*	*Relevant for*
PDI	1 (increase personal relevance), 3 (language)	English language, positioning of trainer, handling of questions, reaching learning objectives
UAI	2 (collaborative tools)	Use social media, provide side-information and agenda
HC	4 (non-verbal cues)	Include non-verbal cues
IDV, MAS	5 (active learning environment)	Use WeChat, take care of colors used, provide certificates

The anticipated changes exploiting further benefits for corporate eLearning among Chinese learners are thought to be reached when social media is used in a more refined way. It can thus be additionally studied how far Chinese learners benefit from its use as supporting tool compared to it being relied on as solely used tool when dealing with new theoretical topics. Moreover, further research should be conducted if in the described learning environment, a blended learning approach would better suit Chinese learners.

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Knowing what Learners Like – Developing a Cultural Sensitive Peer Assessment Process in MOOCs

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Abstract. MOOCs attract learners from various cultural backgrounds with differing educational beliefs and learning preferences. Research has long acknowledged that culture has an impact on the adoption and use of information technology. Cultural differences can cause conflicts, especially when learners provide each other with feedback during the peer assessment process. With this paper, we use a design science approach to create a cultural sensitive peer assessment process in MOOCs. Based on Hofstede's cultural dimension theory we derive design elements and evaluate them in a qualitative and comparative study with Swiss and Chinese students. Our results show that different cultures prefer different designs. Consequently, our key contribution is the practical elaboration of design elements, which can be integrated in MOOCs to provide a better learning experience. Further, we contribute to cross-cultural theory by using an existing framework and adapting it to a new and relevant phenomenon: MOOCs.

Keywords: Massive Open Online Courses, design science research, culture sensitive peer assessment procedure, Hofstede's cultural dimension theory

1 Introduction

The number of university enrollments is growing worldwide. This development results from two main reasons: First, the globalization leads to an opening of the formal education system and an increasing participation of people from all over the world, including developing countries. Second, as technology is changing in unpredictable ways, people are forced to constantly pick up new skills to meet the changing demands of the global job markets [1]. Many routine-job specific tasks can already be substituted by machines, leading to an increasing demand for higher education and "foundational skills", which computers find harder to learn, like creativity, problem solving and empathy. The increasing demand for higher education as well as the changing demands of the global job markets present severe challenges for universities. Curriculums are rigid, non-modular and changes are expensive and associated with institutional obstacles. Due to the changing needs and requirements of the educational system, a promising alternative and a game changer how we perceive

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and experience education has evolved: the so-called Massive Open Online Courses (MOOCs). MOOCs provide mostly free educational opportunities in terms of open access online courses to a massive number of learners [2]. In contrast to formal education, learners can choose courses based on their specific needs and create a modular and flexible learning experience. The additional benefits of accessibility and low costs lead to massive participation rates, in some cases over 250,000 learners per course. This leads to immense scalability challenges, especially as MOOCs do not only impart factual knowledge but also encourage learners to apply higher order thinking skills. For this purpose, peer assessments are widely used. This procedure is promising as it not only overcomes the scalability challenges in a MOOC but also improves the learning experience for MOOC participants due to the dual role responsibility of learner and assessor [3]. However, research has long acknowledged that cultural differences can inhibit the successful use of information technology and its acceptance [4]. Especially the case of peer assessment in MOOCs, which directly connects learners from various cultural backgrounds, is challenging as learners have different culturally embedded learning preferences and educational beliefs, which might affect the acceptance of peer feedback. For example, in China it is common to only receive feedback, and in particular criticism, from higher ranking people. In Switzerland there is more interdependence between less and more powerful people.

To provide a better quality learning experience for all learners, instructional designers of MOOCs are required to cautious study the learning and design preferences of different cultures to deliver culturally sensitive instructions for the peer assessment process. Accordingly, in our research, we try to answer the following research question:

How should peer assessment in MOOCs be designed to enhance the learning experience by considering cultural differences among learners?

To do so, this study follows a design science research (DSR) methodology [6]. After reviewing existing theory and research about MOOCs, web-based peer assessments and the cultural dimension theory of Hofstede [5] we build a problem formulation. We then use the requirements from scientific literature to derive objectives for our solution. Based on the objectives, we develop design elements for a cultural adapted peer assessment. In a next step, we empirically evaluate these design elements through a qualitative and comparative study in the form of semi-structures interviews with Swiss and Chinese students. Accordingly, this study has practical as well as theoretical contributions. First, our key contribution is the practical elaboration of cultural sensitive design elements, which can be used by instructional designers of MOOCs to enhance the peer assessment procedure. Second, we contribute to the existing theory of cross-cultural research by adapting an existing framework to the specific case of peer assessments in MOOCs.

2 Theoretical Background

2.1 Massive Open Online Courses (MOOCs)

In order to operate with a concrete idea of what MOOCs are, it is helpful to discuss the concerned term in advance. Since the occurrence of MOOCs is a relatively new phenomenon there is no commonly accepted definition. However as stated already in the term MOOC, most definitions share four main characteristics:

MASSIV(LY): the capacity of a MOOC expands to large number of learners. While most courses have some hundred enrolled participants some courses reached over 150,000 registrations. [7]

OPEN: MOOCs can be accessed by anyone with an Internet connection. They provide a learning experience to a vast number of learners around the globe regardless of their location, age, income, ideology and level of education, without any requirements, or courses fees to access high quality education [2].

ONLINE: Courses are readily accessible via Internet connection. However, in some variations of MOOCs, so called blended MOOCs, learners have the possibility to face-to-face meetings, on top of the online interaction [7].

COURSES: MOOCs provide a coherent learning sequence with integrated learning material and formative assessment [8]. They are provided by international institutes of informal as well as formal education [9].

The current literature categorized MOOCs based on their underlying learning theories. Two main types are existent: "cMOOCs" and "xMOOCs". Connectivist MOOCs (cMOOCs) put a strong emphasis on communication between the participants. They promote self-organized learning trough networked learning environments and social learning processes. The teacher's role is limited and knowledge is created through interaction between learners. In Extension MOOCs (xMOOCs) learning objectives are pre-defined and courses resemble traditional courses whereas teachers share their knowledge through lectures [10][11].

2.2 Peer Assessments in MOOCs

In general, peer assessment is defined as an arrangement in which individuals consider the amount, level, value, worth, quality or success of the products or outcomes of learning of peers of similar status [12]. The case of peer assessments in MOOCs involves some unique challenges. First, the issue of scale. The peer assessment procedures need to be scalable to class sizes of tens or hundreds of thousands learners, allocate a balanced workload across the participants and provide reliable and accurate assessment. For every submitted assignment there is a pool of thousands of potential assessors. The logistics of linking reviewers and assignments involves technical as well as instructional challenges. To increase the reliability of ratings different probabilistic models of peer assessment are currently tested. Involving statistical models in the allocation process of peer assessments provide a certain compensation for grader idiosyncrasies [13]. Second, there is no instructor mediation, supervision or guidance. Peer assessments can be a learning process in

itself as seeing a learner's work from the perspective of an assessor can be an effective instructive experience. However, the dual role responsibility of being a learner and assessor might bring up multiple challenges for the MOOC participants. Further, without supervision, MOOC participants might feel a lack of obligation to assess their peers effectively. Effective assessment involves reliability – giving accurate and error-free feedback to a learner's work – and has to be clearly articulated [14]. Third, the audience of learners in MOOCs is international. Peer assessors have different native languages, cultures and worldviews [15]. Depending on their culture, learners have differing educational beliefs, which affect their preferences regarding giving as well as receiving feedback.

2.3 Hofstede's Cultural Dimension Theory

Although other researchers have made substantial contributions to the understanding of the concept of culture, Hofstede's framework is the most influential of cultural classifications. Hofestede [5] was able to identify 'majority preferences' which result of the way children are brought up in a society and condensed them in five dimensions: (1) Power Distance, (2) Individualism vs. Collectivism, (3) Masculinity vs. Femininity, (4) Uncertainty Avoidance and (5) Long Term Orientation.

Power Distance describes the extent to which members of a society accept that power is distributed unequally. Societies with large power distance accept hierarchical orders in which every person has a place. In countries with low power distance people demand justifications for inequalities and strive to equalize the distribution of power within the society. In Individualistic cultures only loosely knit social frameworks are existent and people are expected to take care only of themselves and their immediate families. In contrast, in collectivistic cultures tightly knit frameworks in society are existent and people can not only rely on their relatives but also expect members of a particular in-group to look after them. Masculine cultures value achievement and success. Society in general is more competitive. The dominant values for feminine cultures are cooperation, caring for others and quality of life. Society in general is more consensus-oriented. Uncertainty avoidance describes the extent to which people of a society feel threatened by ambiguity and uncertainty. Countries with strong uncertainty avoidance tend to rigid codes of belief and behavior and are intolerant of unorthodox behavior. Countries with weak uncertainty avoidance, maintain a more relaxed attitude in which practice counts more than principles. Countries with long-term orientation hold a future-orientated perspective. They encourage thrift and efforts in modern education as a way to prepare for the future. For countries with short-term orientation the near term point of view is the prominent perspective. They prefer to maintain time-honored traditions and norms while viewing societal change with suspicion [5].

3 Research Method

The main goal of this study is to develop and define design elements that support cultural sensitivity of the peer assessment process in MOOCs. To do so, we followed a DSR approach [6]. After the problem identification, we identified challenges in the current design by analyzing the MOOC platform Coursera and derived objectives of a solution. We completed three MOOCs: Modern Art & Ideas (The Museum of Modern Art), Leading Innovations in Arts and Culture (Vanderbilt University) and Coursera Mentor Community and Training Course (Coursera Community Team). We chose Coursera, based on its high popularity, amount of courses and amount of students. We defined five areas of the peer assessment eligible for cultural adaptivity and created different design solutions for all those areas that are subject to cultural preferences. These solutions are inferred in close reference to the literature, in particular Hofstede's cultural dimension theory [5]. For evaluating our design elements, we conducted 16 semi-structured interviews with 8 randomly selected participants from Switzerland and 8 randomly selected participants from China to evaluate whether the developed design elements correspond to the learners' preferences in practice. All participants had prior experiences with peer assessments. However, only 4 of the Chinese and 3 of the Swiss participants completed a peer assessment process in a MOOC. Therefore, prior the interviews, we elucidated the procedure of the peer assessment in Coursera to ensure a consistent level of knowledge about the process. The age ranged from 19 to 27 (mean 24.19; mean Swiss 23.50; mean Chinese 24.88). We chose this approach for our inquiry as qualitative research designs have been shown to be particularly well suited to analyze dynamic, interactive processes [16]. Further, we decided to interview Chinese and Swiss students as the coherent cultures inhibit major differences and therefore offer a firm base for a comparative study. Prior the interviews, we asked the participants to fill out the Value Survey Model [17] to evaluate if the participants of both sample groups correlate with the official scores of their relating country, published by Hofstede. The Value Survey Model is a 30-item questionnaire for comparing culturally influenced values and sentiments of similar respondents from two or more countries. The following table gives an overview of the VSM data of the participants of this study and the official scores published by Hofstede in brackets.

Table 1. VSM Data

VSM Data	Chinese	Swiss
Power Distance	48,50 (80)	16,88 (34)
Individualism vs. Collectivism	21,88 (20)	43,75 (68)
Masculinity vs. Femininity	52,50 (66)	30,63 (70)
Uncertainty Avoidance	61,88 (30)	65,00 (58)
Long Term Orientation	82,50 (87)	70,00 (74)

The scores do not perfectly match with the official country scores published by Hofstede. This has several reasons: First our sample groups represent a specific population group of these countries as we interviews students. Further, our sample groups are relatively small and answers also reflect other characteristics than culture,

e.g. gender and age. However, the tendencies are recognizable. In particular, and of most importance for this study, the differences of cultural values between the Swiss and Chinese are visible. Afterwards, all participants received the interview guidance with explanations of the aim of this study, the aim of the interview, background information about MOOCs and the peer assessment process in MOOCs and the following 25 open-ended interview questions. The interview questions are divided into six categories. The first set of questions target to get a deeper understanding of the participant's general perception of peer assessments. The following five categories question on the participants' preferences regarding the prior defined design elements. During the interviews, we asked for both roles, reviewer and reviewee. The interview ended with collecting information about the participant's current country of residence, age, gender, educational background and current nationality as well as nationality at birth. On average, the interviews took 30 minutes. For the analysis we prepared written transcripts of all interviews and looked at the text data, seeking correlations in descriptions of the participants' preferences regarding the peer assessment process in MOOCs.

4 Towards Designing and Evaluating Peer Assessment Design Elements

Following the DSR process, the first activity emphasizes the problem identification. The second activity contains the definition of objectives for a solution. Activity 3 contains the design and development of artifacts. Activity 4, demonstration, and 5, evaluation, are implemented in the empirical part of this study.

4.1 Problem Identification

MOOCs attract learners from all over the world. However, so far MOOC providers do not consider cultural differences of their customers. Research has long acknowledged that cultural differences can inhibit the successful use of information technology [4]. To prevent learner rejection and fluctuation, MOOC provider should consider cultural differences. This is especially important during the peer assessment, as this process directly connects learners from various cultural backgrounds.

4.2 Definition of Objectives

During a typical peer assessment in Coursera learners are requested to complete an assignment and submit it online. Each assignment is then distributed to three randomly selected fellow learners. Each fellow learner then rates the assignment based on pre-specified scoring rubrics and is requested to provide further feedback in the form of written comments. The mean score of all ratings as well as the written comments are then made available to the learner who submitted the assignment [15]. The multicultural nature of MOOCs leads to individual and collective enrichment. However, cultural differences among the learners also provide challenges for

instructional designers. First, the acceptance of feedback: Referring to the dimension of power distance, it is questionable to what extent learners accept the received feedback from their peers, especially if the feedback involves criticism. In cultures with high power distance, students expect the teacher to outline paths. Status in important and hierarchies are well accepted [5]. At the moment, Coursera does not offer any information to learners about their peer reviewers. However, especially learners from cultures with high power distance might prefer to have more information. Second, group dynamics: Group dynamics appear very different in collectivistic and individualistic cultures. Whereas collectivistic cultures put a strong emphasis on social networks, harmony and the preference of small group belongings, individualistic cultures tend to focus on individuals [5]. During the peer assessment process in Coursera the learner's assignment is randomly distributed to three different reviewers. If the learner has to complete multiple assignments involving peer assessments, the reviewers will change during the course. The current allocation process neglects collectivistic values like the preference of small group belongings. Third, competition and comparison between learners: Whereas feminine cultures tend to avoid situations, which distinguish clear winner and losers, masculine cultures put emphasis on achievement and success [5]. The results of the peer assessment in Coursera are shown as percentage. However there is no information about the performance scale of the course. Competitive learners have no opportunity to set their performance in relation to the performance of the other MOOC participants. Fourth, Instruction: In cultures with weak uncertainty avoidance learners feel comfortable in unstructured learning situation whereas learners from cultures with strong uncertainty avoidance tend to prefer structured learning situations [5]. Learners from cultures with high uncertainty avoidance might prefer strict instructions how to assess their peers' assignments, whereas learners from cultures with low uncertainty avoidance might feel more comfortable with more freedom regarding the assessment process. At the moment Coursera offers rubrics for assessment to ensure uniform and consistent reviewing and ask the reviewer to provide additional qualitative feedback. Fifth, interaction between learners: The need for interaction might vary between learners from different cultures. Cultures with long-term orientation believe that truth depends on context and situations [5]. Thus, learners from those cultures might prefer the opportunity to discuss an assignment and the peer feedback to gain a deeper understanding of the context. At the moment, Coursera does not offer the opportunity for interaction between learners during or after the peer assessment process. Discussion does solely take place in the discussion forums, open and visible for everyone.

4.3 Design and Development

Addressing the discussed areas of the peer assessment process eligible for adaption, the following section deduces design elements for a cultural sensitive peer assessment process. It should be noted that the deduced design elements refer to the process of the peer assessment and are not design elements of the user interface. First, to address the acceptance of feedback, the peer assessment process needs to include information

about the reviewers. The information might include basic information such as name, age as well as the educational background and relevant work experience (DE1). Second, to address differences in group-dynamics, learners should have the option to keep the same reviewer during a course to meet the preferences of small group belongings of collectivistic cultures (DE2). Third, to give competitive learners the opportunity to set their performance in relation to the performance of other MOOC participants, the results of the peer assessments should be made comparable, for example on a grade-scale (DE3). Fourth, to meet the need for instructions, especially in high uncertainty avoidant cultures, MOOC providers should consider the inclusion of a more extensive support in the form of more information and instructions on how to give feedback during the peer assessment process (DE4). Finally, learners should be offered the opportunity to discuss their assignments and received grades. It should be considered to include the opportunity of private messages with reviewers after the assessment is done (DE5).

Table 2. Design Elements and their inherent cultural dimension

Design Element	Dimension
DE1: Profile Information *Learners from cultures with high power distance prefer to have information about their reviewer whereas learners from cultures with low power distance prefer anonymity.*	Power Distance
DE2: Group Dynamics *Learners from collectivistic cultures prefer to keep the same reviewers during the duration of a MOOC whereas learners from individualistic cultures prefer to change reviewers.*	Individualism vs. Collectivism
DE3: Competition and Comparison between Learners *Learners from masculine cultures prefer to receive grades instead of "passed/failed" and see a scale of their performance in relation to the performance of their fellow learners.*	Masculinity vs. Femininity
DE4: Instructions *Learners from cultures with high Uncertainty Avoidance prefer to have detailed instructions for the peer assessment process in a MOOC, whereas learners from cultures with low Uncertainty Avoidance prefer to have more freedom how to review their peers.*	Uncertainty Avoidance
DE5: Interaction between Learners *Learners from cultures with Long Term Orientation prefer to interact with their reviewers and rate their received feedback.*	Long Term Orientation

5 Results

To evaluate our theory derived design elements for a cultural sensitive peer assessment we asked the 16 participants of this study about their preferences. The following table summarizes our findings.

Table 3. Comparison of Swiss and Chinese Preferences

DE	*China*	*Switzerland*
1	Preference for Information: 7 (87,50%) Preference for Anonymity: 1 (12,50%)	Preference for Information: 1 (12,50%) Preference for Anonymity: 7 (87,50%)
2	Keep the same Reviewers: 3 (37,50%) Change Reviewers: 5 (62,50%)	Keep the same Reviewers: 0 (0%) Change Reviewers: 8 (100%)
3	Preference for Grades: 7 (87,50%) Preference for Scale: 8 (100%) Preference Passed/Failed: 1 (12,50%) Preference for No Scale: 0 (0%)	Preference for Grades: 6 (75%) Preference for Scale: 7 (87,50%) Preference Passed/Failed: 1 (12,50%) Preference for No Scale: 0 (0%)
4	Preference for Instructions: 3 (37,50%) Preference for Freedom: 5 (62,50%)	Preference for Instructions: 4 (62,50%) Preference for Freedom: 4 (37,50%)
5	Preference for Interaction: 6 (85,71%) Rate the received Feedback: 8 (100%) Preference no Interaction: 1 (14,29%) No Rating of received Feedback 0 (0%)	Preference for Interaction: 3 (37,50%) Rate the received Feedback: 7 (87,5%) Preference no Interaction: 1 (14,29%) No Rating of received Feedback 0 (0%)

6 Evaluation

The aim of this study is to investigate how to design a cultural sensitive peer assessment process in MOOCs to enhance the learning experience for all learners. For this purpose, we used Hofstede's cultural dimension theory [5] to deduce theoretically driven design elements and evaluated these design elements on their validity in practice through a qualitative study with Swiss and Chinese students. We claimed that culture has an impact on design preferences of the peer assessment procedure in MOOCs. On the one hand, our results confirm that learners from different cultures have varying design preferences. However, some design elements did not confirm with the requirements derived from scientific literature.

Considering DE1, profile information, the results show clear differences in design preferences. Whereas Swiss students stated they prefer anonymity, Chinese students prefer to have more information about their reviewers in a MOOC. As one Chinese participant states: *"Yeah, I prefer to get more information about the peers. I don't care about the name but I really care about his background and his major, or experience, because I want to know what kind of person... Because I want to know if I can get some connection between he or she and me. If he can make a judgment."* Based on the cultural dimension theory these differences can be explained through the strong power distance in Chinese culture, as less powerful people should be dependent and therefore not entitled to criticize and in this case even assess the performance of more powerful people. DE2, group dynamics, does not confirm in our study. We hypothesized that, because of collectivistic values like the importance of group belongings, Chinese MOOC participants prefer to keep the same reviewers during the duration of a course. However, only 37,5% of the participants stated they prefer to keep the same reviewers whereas 62,5% stated they prefer change. Most of

the participants indicated that they value diversity of opinions over the development of relationships. As one Chinese participant quoted: "*I think this is a way to have me learn more how people evaluate my work. Different people's opinion might be different from each other. I think it's earning things from experience from the evaluation from different people."* Although the majority of Chinese students stated to prefer differing reviewers during a MOOC, there are still noticeable differences to Swiss students. Whereas all of the Swiss students (100%) claimed to prefer to change reviewers frequently, some Chinese students also considered the advantages of keeping the same reviewers. As one participant claimed: "*Oh yeah, I think it's a question of consistency. So I think to have the same reviewers all through the course is better."* Future research will need to execute a deeper analysis of this design element to evaluate its significance. Considering DE3, competition and comparison between learners, we hypothesized that the participants from both countries prefer to have distinct grades and the opportunity to compare their performance. Based on our results, this holds true in practice. Both countries have similar scores on Hofstede's cultural dimension "masculinity vs. femininity" which conduce as explanation for the similarity in preferences. Participants from both countries predominantly valued the opportunity to set their performance in relation to the performance of their peers as one Swiss participant stated: "*I think that would be really helpful. Sometimes just having a number doesn't really tell you what this number means. So if you have something to compare you with that can be very useful."* Considering DE4, instructions, we hypothesized that learners from countries with high uncertainty avoidance prefer to have stricter instructions on how to give feedback during the peer assessment in a MOOC. Our data confirms this assumption. The majority of Swiss participants stated they prefer to have strict instructions how to review their peers in a MOOC as this quote demonstrates: "*I think strict instructions are useful because they imply consistent evaluations which are not subjective."* In contrast, the majority of Chinese participants valued freedom during the peer assessment process. The preferences are congruent with the cultural dimension theory [5]. Strong uncertainty avoidance implies an emotional need for rules expressed by the desire for more instructional support on how to do the peer assessment process in MOOCs. Weak uncertainty avoidance manifests in dislike of rules and the Chinese participants are more comfortable with weak instructional support. When having a closer look at what instructions the participants perceived as valuable, it is noticeable that the Swiss participants predominantly value support how to assess the content of the peer's assignment leading to a consistent and fair evaluation process. The Chinese participants emphasized that there might not be one best answer and that, for example a single best-case solution is not enough. They prefer support which aspects they should consider in their evaluation for example through multiple cases and multiple sample answers for comparison. One Chinese participant said: "*Maybe just a best practice. Oh, or maybe, yeah I know that. So maybe a best practice from like different point of views. So not just one, maybe we can have couple of it."* From a theoretical point of view, these differences can be explicated by the tolerance of deviant ideas and ambiguity, resulting from weak uncertainty avoidance in the Chinese culture. Finally, our results show that DE5, interaction between learners, holds partially true in

practice. We hypothesized that learners from long-term orientation cultures prefer the opportunity to rate the received peer feedback in MOOCs. Our data confirms this assumption. Most participants stated they believe this opportunity will lead to more efficient peer assessments. As one Chinese participant stated: "*Yeah I think this can help, like to make the evaluator to evaluate others more fairly.*" This belief can be explained by the desire for accountability, honesty and self-discipline in cultures with long-term orientation [5]. However, the majority of Swiss participants stated that they don't value the opportunity to further interact with their reviewers. Despite main work values like learning and perseverance in long-term orientation cultures the Swiss participants predominantly emphasized the increased workload and the risk of manipulation through the opportunity of direct and anonymous interaction between peers after and in particular during the assessment. As one Swiss participant said: *"I think anonymity is good because otherwise it is an immense effort to personally discuss with the peers and as I said I strictly prefer anonymity during the whole thing and to discuss personally would be contradictory."*

7 Limitations and Future Research

The conducted analysis exposes a high research potential in various further areas. First, the participants only represent two countries, China and Switzerland. Future research needs to compare more countries to gain a better understanding how design preferences evolve and consequently develop general solution concepts for different cultures. Further, future research needs to quantitatively examine the impact of the developed design elements on the learning experience of MOOC participants. This study offers valuable contributions for theory and practice. However, we should note possible limitations. Nations might not be the best units for studying cultural differences, as they do not produce groups of people with uniform codes of behavior. For example, a Swiss person who spent couple of years in Australia might inhibit a mixture of both cultures.

8 Conclusion

With this study, we developed design elements to create a cultural sensitive peer assessment process in MOOCs. First, we used the Hofstede's cultural dimension theory [5] to identify areas of the peer assessment process eligible for adaption. Second, we derived theory driven design elements for a cultural sensitive assessment. Finally, we conducted a qualitative and comparative study with Swiss and Chinese students to evaluate the validity of the design elements in practice. The results show that differences in design preferences exist and the data we derived from practice appeared to be similar to those derived from theory. We contribute to the existing theory of cross-cultural research by adapting an existing framework to the specific case of peer assessments in MOOCs. Further, our key contribution is the practical illustration of how to adapt the peer assessment process in MOOCs for a cultural sensitive assessment process. Referring to the system MOCCA [18], which presents

the first system that is able to automatically adapt its interface to the preferences of users of any national culture [18], instructional designers could develop different versions of the peer assessment process according to different combinations of cultural dimension scores. This approach would lead to a peer assessment process that adapts itself to the learners' cultural preferences rather than having the user to adapt to a more or less standardized interface.

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Academic Media Architecture for Digital Learning Environments in Higher Education

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Abstract. Digitalization and emerging technologies influence higher education and especially students and lecturers in many ways. The following paper develops two artefacts: First of all, a meta-model for student profiles as a basis for understanding their requirements and secondly, an academic media architecture bridging the gap between the changing requirements of students, institutions, companies and the government. The requirements evolve with the ongoing digitalization and the different possibilities of effective media use in higher education. The academic media architecture allows for universities to analyze their current media use but also to support the target-oriented implementation of a redesigned architecture in order to remain competitive with competitors entering the higher education market, such as Udacity and eVersity.

Keywords: academic media architecture (AMA), requirements for e-learning, digital learning environments

1 Introduction

Khan Academy, Udacity, Coursera, eVersity and quite a few other names could be mentioned to mark a fundamental turn in higher education representing two things: On the one hand, they are a mirror of today´s society being more mobile and more online. On the other hand, they address the need of people gaining knowledge in specific topics rather than taking a full study program [1]. At first sight they currently do not seem to be a direct competition for traditional universities, but they might very well be in the future. Therefore, a rethinking of the goals, roles and positions of universities in the future has to take place. This can only be done systematically if the students and the requirements of the institutions, companies and political actors are well known and addressed within the transformation process.

The goals of the paper are first the modelling of student profiles as a decision basis for the provision with educational products and services and secondly, based on step

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one, the design of an academic media architecture (AMA), which is a conceptual framework of media for higher education. The student profile illustrates the demand side of the market and the AMA the supply side catering for higher education students. To reach these goals the following research questions have to be answered:

(1) What are the requirements of institutions, companies and politics with respect to skills and competencies of future employees? (2) What are the emerging characteristics of students with respect to university education in a digital environment? (3) How can – based on these parameters – the AMA for higher education be modelled? In the following section we conceptualize the topic before we take a closer look at the current knowledge on modelling student profiles and the design of AMA in scientific literature. Therefore, we discuss the requirements for digital learning environments set by institutional, corporate and political stakeholders. The analysis of the student profile is based on metadata of surveys whose elements are verified in literature (section 3). The resulting student profile is the basis for designing an AMA presented in section 4.

2 Background and Conceptual Foundation

We focus on students of higher education which includes regular on-campus students at universities but also part-time and remote-learning students with full-time jobs or a background which makes it impossible to attend lectures personally (e.g. family responsibilities and physical impediment) [**2**]. Due to their educational, family and ethnic backgrounds students show a high level of diversity which has never seen before at universities [3] and thus makes it also interesting for research because existing concepts are not fitting to the emerging requirements brought up by digitalization. In higher education the traditional top-down ways of disseminating knowledge through face-to-face tutorials and in-class lectures are in need of reform.

2.1 Institutional, Corporate and Political Requirements

Digital technology assists universities in meeting the academic needs of an increasingly heterogeneous student body. In addition digital teaching poses a new challenge for universities to face the current changes and to reform and internationalize university curricula and exam regulations [**2**] in order to enable the graduates to meet the demands of the digital working life. While digitalization has produced a new student target group and clientele due to easier access to higher education as described above [**3**], it also forces the institution in charge to come up with a different qualification profile for professors and a willingness to integrate digital media in teaching. The professors' role is no longer that of mere communicators or imparters of knowledge but they themselves need to have the digital skills and technical expertise for digital teaching [**2**]. Implementing digital technology at universities does not merely mean digitizing academic knowledge [**3**] but involves establishing the appropriate digital infrastructure while at the same time teaching students how to utilize this infrastructure. Apart from providing the

necessary digital infrastructure, institutions should encourage and support the teaching staff to use digital technology efficiently for teaching by providing incentives to integrate digital media into the curricula [**2**].

One of the universities' main goals today must be to bridge the digital literacy skills gap between graduate students and the expectations of the corporate world.. The pervasive use of digital technology leads employers to expect a different, i.e. higher, level of digital literacy from their employees. In the digital age, universities – apart from providing students with the necessary specialist knowledge required in the student's course of study – must enable students to develop the interdisciplinary digital literacy skills required by a globalized professional world [**4**]. In order to improve employability graduates should know how to search databases and how to use digital technology for a better work result. Furthermore, they should be able to analyze digital information, to respond to digital developments quickly, to utilize and benefit from digital media such as social and professional online networks and platforms, apps, cloud storage, etc.

The changing institutional and corporate requirements also influence the political discussion and underline the necessary adjustments of the political surroundings allowing for the transformation of the educational sector to be supported. This is especially important as the higher education is mainly governed by political decisions, regulation and laws. Initiatives like [**2**,**5**] outline the political actions to enable this transformation. Furthermore the legal implications going hand in hand with the digital development, such as the (changing) provisions relating to copyright in particular, intellectual property law in general and data protection laws have to be addressed by political decisions. To sum up and answer the first research question, the AMA has to fulfil the following requirements: to address the needs of a heterogeneous student body, to support the qualification of students for digital working life, to assist the professors in their teaching, to provide the necessary infrastructure for the higher education facilities, to support the digital literacy of the students and has to relate to the political and legal framework conditions.

2.2 Conceptualization

Digitalization influences students' behavior and needs with respect to their learning processes. Universities recognize this change and try to meet the emerging needs and resulting requirements. Some of these requirements have already been analyzed and are briefly presented in the following, being important for the concepts addressed by the AMA (Figure 1). Most students possess digital literacy skills, which means they are able to use laptops, mobile technologies like smart phones, iPods, and tablets for research, information capturing or communication [6]. Flexibility is another important factor for students. Flexible learning is defined as "a movement away from a situation in which key decisions about learning dimensions are made in advance by the instructor or institution, toward a situation where the learner has a range of options from which to choose with respect to these key dimensions" [7]. Key flexibility dimensions are related to time, to content, to entry requirements, to institutional approach and resources, to delivery and logistics [7]. Flexible learning in this sense

enables the students to learn anywhere, anytime and to decide on the amount of learning content they like to study at a given point in time. A recent study states that students are getting "easily bored in the absence of diversity" [8]. In order to reach the students not only flexibility is an important factor, but involvement and collaboration as well as sharing have to be addressed [9]. A way to involve students into the learning process is by working with case studies [10], allowing the group members to collaboratively develop own solution. Working in groups also implements the *sharing of knowledge*, the exchange of knowledge between students.

Besides the mentioned requirements of students, different learning methods need to be considered by universities. *Blended learning*, for example, combines online and offline learning modalities [**11**]. The concept of *authentic learning*, a practical and specific design concept, refers to the idea of embeddedness of learning in the student's endeavors. The main goal of an authentic task is to encourage students to find ways of solving problems [**12**]. In *case- and scenario-based learning*, students receive a problem set in an everyday context [**13**].

The different learning methods and the students' requirements influence the learning environment. A *learning environment* can be defined as a "social system, focusing on the continuous development and validation of human knowledge and skills in a particular domain" [**14**]. Learning environments for the students can be regarded as mainly *digital learning environments* [**15**].

Following these concepts, we develop an AMA, describing the relationships between different media used in the learning process. These are used to address the preferred learning method of the students and their requirements. The resulting AMA considers these media elements – such as social media and learning applications – interfaces, functionalities, and communication relationships [**16**]. The challenge for universities is that they cannot control and influence the constituents that a learning environment depends on. As a consequence, students gain more control over their learning processes and the design of "their" AMA [**16**]. This is a typical characteristic of social media, where control over relationships and communication processes switches from the supply to the demand side. Figure 1 summarizes the relevant concepts for the AMA.

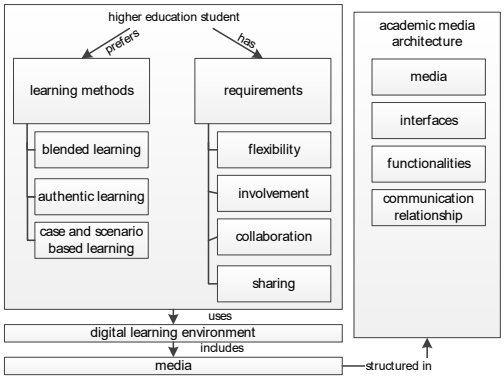


Figure 1. Concepts addressed by the AMA

Nonetheless, universities as the supply side for higher education have to understand future needs of the students. To arrange the needs and resulting requirements, student profiles are derived supporting the design of an AMA which is regarded as a conceptual framework for analyzing and adapting the current design of higher education courses. In the following, the state of the art for deriving student profiles and respective modelling approaches is briefly presented.

2.3 State of the Art

Student profiles are already an object of research and are discussed in different areas of research with various main focuses of interests and goals. A profile in this context is defined as a cluster of properties describing a certain and coherent group of entities, [**17**]. One example is the profile of students with full-time jobs in Germany [**18**]. The profile both influences and supports decisions concerning the offered study programs for this group of students and allows for the systematic testing of a successful mapping [**19**]. Other researchers use profiles to define the requirements of students with different social backgrounds concerning the learning environment [**20**]. The research on and use of student profiles is internationally accepted. The focuses are reaching from technological backgrounds of students [**10**], technology usage [**21**], learning processes [**22**], demographic details [**23**], and competences of students [**24**] to pedagogic and psychological characteristics [**25**]. However, most profiles are specialized and restricted to certain topics. For a broader use in higher education a more comprehensive profile is needed, which bases on a meta-model of properties and allows for the instantiation of various different profiles for an individualized offer. In this paper we therefore aim at designing a meta-model for a holistic student profile taking into account demographic aspects, personal careers and career plans, learning habits and preferences, further training and the students´ state of health. This is important for describing the students as some students may have physical impediments which influence the requirements for learning material or media.

In order to meet the special requirements in the educational context past research has shown that it is important to choose the media with respect to the specific requirements and goals of the teaching field [**26**]. The selection process for the media has also to consider the profile of the "target" students and the subject of interest.

We design an AMA which considers the elements of the architecture: media, interfaces, functionalities and communication relationships. Architectures in the context of media are discussed in research, e. g. [**27**], but AMAs are not discussed in literature so far. The AMA focuses on the conceptual design and not on the technical implementation as various technical solutions are already available.

3 Student Profile

Based on the first and second research question answered in section 2, the following section models the student profile by taking the emerging characteristics of students

with respect to university education in a digital environment into account, which is necessary to develop the AMA in a next step.

3.1 Modelling Approach

The design process of the meta-model for the student profiles is based on conceptual modelling. This is an eligible approach to develop and modify information systems [**28**]. In order to derive a suitable basis for the AMA we looked for a modelling approach which allowed for a comprehensive overview of the relevant properties for the architecture. For the student data model we thus decided on the s*tar schema* approach. The approach's main advantages are the ease to use, that it can be interpreted intuitively, and that it can be updated and accommodates flexibly [**29**]. For this paper we focus on a higher degree of abstraction concentrating on *metadata* in a first step. The classes of the holistic meta-model can be used for instantiating profiles, matching specific scenarios and goals.

Our metadata is structured in three components as classes, properties, and the encoding scheme [**30**]. A star schema consists of a fact table and numerous dimension tables. The fact table represents facts about the situation which should be viewed and modelled. When combining the star schema with the elements of metadata, the facts correspond to the classes. Facts can be characterized by properties [**31**]. Dimension tables consist of nonnumeric attributes whereas fact tables can have numeric as well as nonnumeric data [**29**]. The encoding scheme includes the different characteristics of a dimension, e.g. male or female for the dimension gender.

With this, the basis for developing the meta-model for student profiles and deriving an AMA is built.

3.2 Meta-model of Student Profiles for Digital Learning Environments

The design of the meta-model for the student profile is based on metadata of five surveys for different student target groups: university entrants, students in higher semesters, new graduates, graduates, who have finished university several semesters ago and student drop-outs. The surveys were designed on the one hand using generally accepted questionnaires recommended by following institutes. Firstly, KOAB which is a project coordinated by the International Centre for Higher Education Research (INCHER-Kassel). For that project university alumni participate in surveys. The surveys are run 1.5 years after the students' degree and are repeated four to five years after the degree, secondly, HIS which is a publication series of survey results conducted by the German Centre for Higher Education Research and Science Studies (DZHW) and as third source the Hagener Online Panel (HOP) which is a virtual lab for online surveys of the institute of psychology of the FernUniversity in Hagen. Students can participate in different surveys of the institute but also in surveys developed by students for their bachelor or master theses. Secondly, the surveys were based on scientific standards by survey literature [**32**,**33**,**34**]. In a first step we identified nine classes by the evaluation of the literature listed above and assigned the metadata to the thematic related classes (see Figure 2).

The questions of the survey are mainly derived from the literature mentioned above, but were adapted to the specific situation of universities. For example, metadata representing the compatibility of study and profession are added to surveys. The class *health* was derived from the Social Survey and the German Federal Statistical Office [**32**].

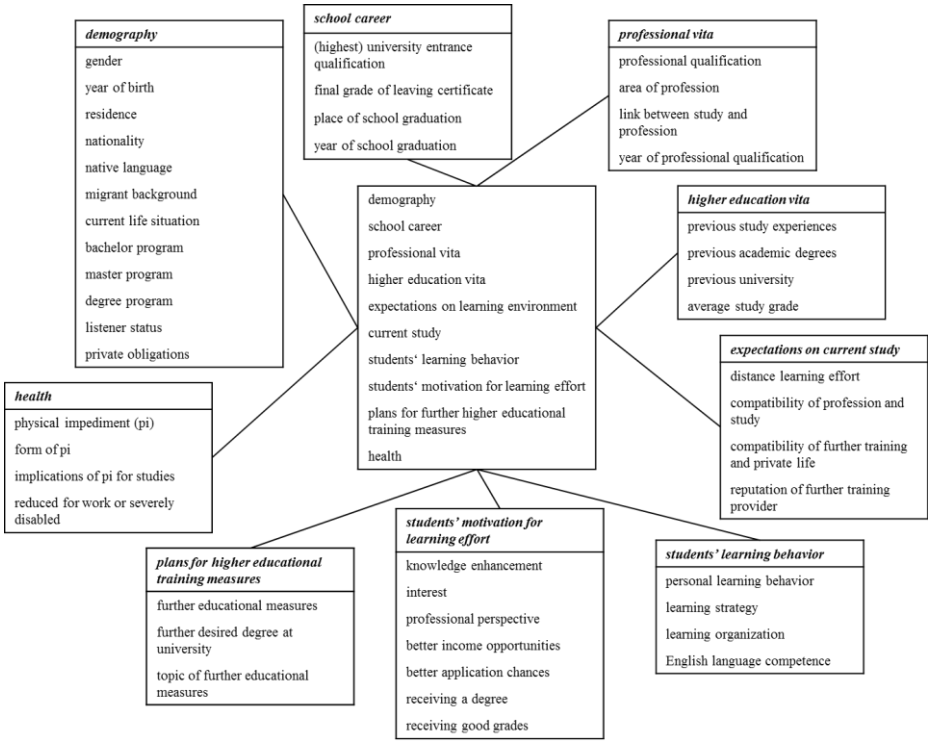


Figure 2. Star schema of student profiles

As explained above it is necessary to use a comprehensive student definition as digital learning environments are designed for a broader public than only the "typical" university students directly graduating from school. Therefore, the profile was complemented by characteristics which are relevant in addition to the student metadata profile. For example the class *plans for further educational training measures* and the appropriate properties. The resulting profile (Figure 2) is describing the metadata characteristics of the student of digital learning environments.

In the center of Figure 2 the fact table presents the classes of the metadata profile for students of digital learning environments. We identified nine classes for the profile from the surveys. In the star schema each class is supplemented by one corresponding dimension table, demonstrating the properties of each class. The star schema in Figure 2 only presents the classes and the corresponding properties, but behind each property there is another table showing the associated encoding scheme which could not be shown in the figure. As explained above the encoding scheme represents all

possible assorted manifestations of the property. After the analysis and illustration of the meta-model for student profiles which depicts the requirements of the demand side, in the following section the AMA is derived as part of the supply side of higher education.

4 Architecture for Academic Media Use

In order to derive a first idea for the design of an architecture for the use of media in an academic context three dimension tables from Figure 2 are exemplarily analyzed: "students' motivation for learning effort", "students' learning behavior" and "expectations on learning environment." These dimension tables are selected as they are not merely demographic but present classes that can be addressed and to a certain extend be controlled by adapting the academic media architecture. Implications for the architecture and thereby structure and use of technology in academic teaching will be derived from these classes. As illustrated in Figure 1, the AMA consists of four components, whose bases are described in the following.

The first component is the *media* itself. Therefore, [**11**] points out that digital technologies offer prospects for modifying education so that students learn in various ways and explore through different electronic and dynamic media. Students are motivated by autonomously choosing different learning media from different educational providers to suit their own learning requirements [**35**]. Students can use the public presentation of their arguments supported by media to defend their position and to learn to express their way of thinking [**36**,**37**]. The use of media in a learning environment enables students to combine their work and daily endeavors with their studying (see Figure 2). The expectations concerning the autonomy should be balanced with supporting students with regards to collaboration, media literacy and assessment. A high degree of structure provided and a low degree of dialogue lead to a high transactional distance (TD). The autonomy of a learner increases with growing transactional distance [**38**]. [**38**] recommends a low TD for students with low self-management skills, while high TD supports the self-regulated learning for learners with better self-control or motivation. Since digital literacy is seen as a core competence (see section 2.1), students need to be enabled to work with digital technologies. Furthermore, media supports the lecturers to concentrate on their unique contribution for learning processes by providing context, acting as mentors, fostering reflection, and creative thinking.

Interfaces to different media which enable the communication between students and lecturers are the second component of an AMA. In an authentic context different learning tasks have to reflect the way knowledge is used in real life. In order to deepen the understanding, access to expert thinking needs to be provided. By using social media tools, students are able to directly interact with experts [**36**]. The sharing of knowledge is connected to the institutional knowledge sharing culture [**40**,**41**].

The third component covers *functionalities* which fulfil the requirements of students and lecturers concerning media in the digital learning environment. It encourages authentic learning tasks supporting transfer of knowledge. These are

authentic "macrocontexts" for learning discussion and problem solving and were proven useful as instructional strategies [**13**]. According to [**26**] students use the competence, or a combination of knowledge, skills and behaviors that should be applied in their professional life situations. Students are using simulations and game-based learning for information skills training [**42**]. With digital technologies students can inquire and research topics for themselves [**43**]. To address flexibility in thinking as well as transfer of skills, a learning environment should offer multiple roles and perspectives to the students and work with tasks that allow competing solutions and a diversity of outcomes. It should also offer articulation and collaboration, as these deepen the understanding and reasoning and identifies the gaps in lines of thought [**35**]. By supporting students to collaborate within their learning processes, they get prepared for the digital working life. The use of digital technology allows flexibility and efficient delivery of learning. One solution is blended learning with a "dynamic digital scaffold" for media use in learning environments [**11**] for emphasizing the facilitation for the lecturers to address the student's learning behavior (see Figure 2) and their need for flexibility. This hybridization enables lecturers to "improve instruction at scale by personalizing the students' learning experiences" [**11**]. Technical devices may influence this structure via automatic feedback, given in, e.g., learning tasks, opposed and/or contributed to interpersonal dialogue [**44**].

The last component focuses on *communication relationships*. [**45**] note that digital technologies offer ways to help students develop and maintain various types of communication. Technological advances have the potential to strengthen and restructure teaching and learning in higher education. Digital technologies promote a learner-centered environment, "when implemented through active inquiry-based learning pedagogies, online learning can stimulate students to use higher order skills such as problem solving, collaboration, and stimulation" [**45**].

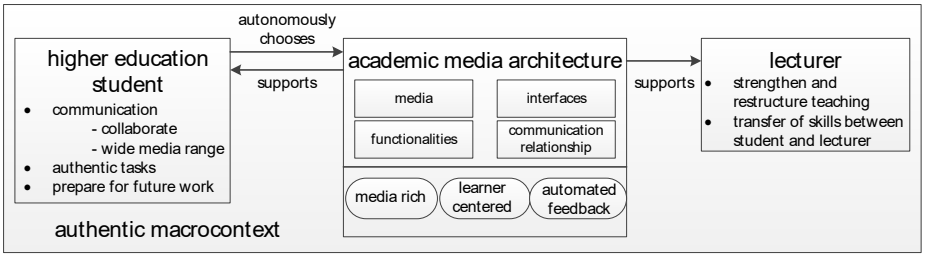


Figure 3: Context and design principles of an AMA

The concept of and relations within the proposed AMA are shown in Figure 3. The authentic macrocontext is the framework for the AMA. Furthermore, the figure is divided into three parts: On the left the higher education students with their characteristics and requirements on the AMA is presented. The lecturers are positioned on the right. The AMA supports both. It is on the one hand illustrated with its four components, and on the other hand the important design measures below.

5 Conclusion and Further Research

The paper has shown that universities face changes in students' behavior and their requirements, as well as new requirements by companies, institutions and politics. It is important to follow a structured procedure when introducing changes in order to fulfil these needs. In a first step, it was crucial to design a meta-model for student profiles to understand the demand side and based on that to derive design principles for an AMA as shown above. Our paper elucidates how an efficient design of an AMA can be derived based on requirements of different interest groups of society. To validate these findings different methodical approaches should also be applied and tested to identify additional aspects for the application of the architecture in higher education. As the developed AMA can be used for higher education in general, it is important to analyze and validate the specific needs that manifest in the respective instantiation of the meta-model for each university.

Further research should dive into the systematic process of creating suitable instantiations of student profiles and deriving respective manifestations of the AMA to provide an individualized learning environment. An interdisciplinary approach could be pursued by looking into adaptive learning environments coming from the field of educational media research and secondly, by integrating the knowledge on learner profiles from psychology. Moreover, it would be necessary to create an approach for measuring the "success" of the mapping process of student profiles and their learning environment, including metrics to measure learning progress and the success of interventions by lecturers. In order to support the validity of the AMA an exemplary case study could be performed by instantiating the model. Finally, questions of data ownership and security arise which need to be addressed regarding legal implications. Therefore, our paper provides a basis for different research ideas.

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Einfluss der Lernstrategien beim Game-based Learning auf den objektiven und subjektiven Wissensgewinn

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Abstract. Das Lernen hat sich mit fortschreitender Digitalisierung verändert und nur noch wenige Universitäten greifen auf reine Präsenzlehre zurück. Eine Möglichkeit Lerninhalte online zu vermitteln sind Game-based Learning Anwendungen. Diese erzielten bereits positive Ergebnisse, z.B. in Hinblick auf Wissensgewinn. Auch Analogien zwischen Spielenden und Lernstrategien wurden hergestellt. Der Einfluss der Lernstrategien auf den Wissensgewinn wurde bislang jedoch nicht hinreichend untersucht. Deshalb wird in diesem Beitrag eine Studie dazu durchgeführt, wobei das subjektive und objektive Wissen zu drei Messzeitpunkten erhoben wird. Im Rahmen der Studie konnten signifikante Wissensgewinne festgestellt und Strategien identifiziert werden, die Wissensveränderungen erklären.

Keywords: Game-based Learning, Lernstrategien, Wissensgewinn, Lernerfolg

1 Einleitung und Motivation

Game-based Learning ist mittlerweile weit verbreitet, auch in der Universitätslehre. Es gibt zwei Designformen von Game-based Learning Anwendungen: Gamification und Serious Games. Während unter Gamification die Einbindung einzelner Spielelemente in einen spielfremden Kontext verstanden wird, bezeichnet ein Serious Game die Entstehung eines vollwertigen Spiels mit festen Regeln und Zielen [1]. Eine Zuordnung zu einer dieser beiden Designformen ist oftmals nicht eindeutig möglich, allerdings haben beide Formen des Game-based Learning eines gemeinsam: Sie setzen Spielelemente ein, so dass die Lernenden motivierter sind, mit mehr Spaß an die Themengebiete herangehen und sogar Wissensgewinne erzielen, die mit traditionellen Lernmethoden nicht erreicht werden [2]. In einem Spiel sind höhere Punktzahlen erreichbar, wenn die richtige Strategie für das Lösen des Problems herangezogen wird. Analog dazu erzielen Studierende im Studium auch bessere Ergebnisse bei richtiger Wahl der Lernstrategie [3]. Im Spielbereich eignen sich metakognitive Strategien zur Problemlösung. Dementsprechend können Studierende unter Anwendung dieser Leistungsverbesserungen beim Game-based Learning erzielen [3]. Allerdings fehlt bislang eine Untersuchung der Beziehung zwischen Lernstrategien und Wissensveränderungen beim Game-based Learning. Boerner et al. (2005) erhoben Lernstrategien nach Wild und Schiefele (1994) und korrelierten sie mit dem Lernerfolg

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der Studierenden, wobei sie Noten und Selbsteinschätzungen berücksichtigt haben. Mit bestimmten Strategien konnten Aussagen über den Erfolg im Studium vorhergesagt werden [4]. Die Messung des Lernerfolgs über Noten ist jedoch kritisch, da bei der Notengebung eine komplexe kognitive Leistung auf nur eine Zahl reduziert wird und das Erreichen von Lernzielen nicht berücksichtigt wird [5]. Aus diesem Grund sollen im Rahmen dieses Beitrags Veränderungen im Wissen über drei Messzeitpunkte im Zusammenhang mit Lernstrategien beim Game-based Learning betrachtet werden.

2 Lernstrategien und Wissensgewinn im universitären Kontext

Lernstrategien. Während des Studiums müssen die Studierenden auf verschiedene Lernstrategien zurückgreifen, um das jeweilige Lernziel zu erreichen und die Prüfungsleistung zu absolvieren. Dabei spielen verschiedene Faktoren, wie beispielsweise Studienrichtung oder Studienfortschritt, bei der Wahl der Lernstrategie eine Rolle [6].

Die Definition von Lernstrategien ist nicht einfach, da in der Literatur keine Einigkeit über den Begriff besteht. Generell identifizieren Streblow und Schiefele (2006) folgende Merkmale von Lernstrategien in den verschiedenen Definitionen. Lernstrategien sind ein *„Ablauf von effizienten Lerntechniken, die zielführend und auch flexibel eingesetzt werden, immer mehr automatisiert ablaufen, aber bewusstseinsfähig bleiben“* [7: pp. 353].

Neben verschiedenen Definitionen von Lernstrategien existieren unterschiedliche Einteilungen dieser. Die Kategorie der kognitiven Lernstrategien behandelt Prozesse, bei denen Informationen aufgenommen, verarbeitet und gespeichert werden. Dazu gehören die drei Substrategien Wiederholung, Elaboration und Organisation [8; 9]. Neben den kognitiven Strategien sind metakognitive Lernstrategien zu finden. Sie dienen der Kontrolle des Lernprozesses und beinhalten unmittelbare Kontrollmechanismen, die während des Lernens zum Einsatz kommen [10]. Aufgrund der Tatsache, dass der Begriff Metakognition nicht nur für die Bezeichnung der Fähigkeit zur Kontrolle und Steuerung kognitiver Prozesse verwendet wird, sondern er ebenfalls das individuelle Wissen über eigene Kontrollstrategien und schon gelernte Informationen kennzeichnet [11], unterscheidet Weinstein (1988) zwischen Planung von Lernschritten, adaptiver Regulation des eigenen Lernverhaltens sowie Überprüfung der Lernfortschritte durch Selbstüberwachung [12]. Die letzte Rubrik der Lernstrategien umfasst die ressourcenbezogenen Strategien, deren Ziel die Bereitstellung von Ressourcen ist, mit deren Hilfe das Lernen unterstützt sowie vor äußeren Einflüssen abgeschirmt wird. Diese Selbstmanagementaktivitäten organisieren die Lernaktivitäten. Beispielsweise gehört hierzu die Suche nach einer geeigneten Lernumgebung oder das effiziente sowie effektive Planen der Arbeitszeit [11].

Wissensgewinn. Der Begriff Wissen besitzt keine eindeutige Definition in der Literatur. Generell wird Wissen als *„Gesamtheit von Kenntnissen und Fähigkeiten beschrieben, die Individuen zur Lösung von Problemen einsetzen.“* [13: pp. 23]. Ein

anderer Ansatz behandelt die Sichtweise der Entstehung von Wissen. Hiernach entsteht Wissen *„durch den Einbau von Informationen in Erfahrungskontexte“* [14: pp. 82].

Die bisherige Betrachtung von Wissen zeigt, dass dieses Gebiet sehr komplex ist. Des Weiteren ist zu erkennen, dass Wissensgewinn auf vielerlei Arten und Weisen erfolgen kann und somit eine generelle Erfassung schwierig ist. In diesem Beitrag soll unter Wissensgewinn der Wissensgewinn im Lernfeld verstanden werden. Eine ähnliche Bezeichnung verwenden Boerner et al. (2005), wobei sie „Lernerfolg im Lernfeld“ nutzen. Lernerfolg soll dabei das Resultat didaktischer Aktivitäten sein, was verkürzt heißt: Lernerfolg ist *„das Behalten von Fakten, Ereignissen oder Vorgängen“* [15: pp. 111]. Kerres (2001) kritisiert jedoch, dass hierbei nicht berücksichtigt wird, dass Lernerfolg auch der Aufbau von kognitiven Schemata oder der Erwerb von Fähigkeiten bedeutet. Des Weiteren wird diskutiert, ob Lernen mehr als nur Wissen ist und auch das *„Verstehen, Anwenden und Handeln“* mit einschließt [15: pp. 112].

Im vorliegenden Beitrag soll lediglich das Verstehen bzw. das Behalten von Fakten zu bestimmten Themen in Bezug auf das Erreichen einzelner Lernziele abgefragt werden und somit nur ein Teil von Lernerfolg. Deswegen wird nicht derselbe Begriff verwendet, sondern Wissensgewinn, was genau diesen Teil beschreibt. Das Lernfeld ist hierbei das Feld, in dem die Studierenden neues spezifisches Wissen lernen. Das Erlernen von Informationskompetenz, welches die Fähigkeit beschreibt *„Informationsbedarf zu erkennen, Informationen zu ermitteln, zu beschaffen, zu bewerten und effektiv zu nutzen“,* ist das Lernfeld dieses Beitrags [16: pp. 215].

3 Serious Game “Lost in Antarctica”

Zum Erlernen der Informationskompetenz wird in dem Beitrag das Serious Game „Lost in Antarctica“ eingesetzt. In zwölf Leveln setzen sich die Studierenden in dem Browser-Spiel mit Themen der Informationskompetenz wie z.B. Recherche, wissenschaftliches Schreiben und Urheberrecht auseinander. Dazu nehmen die Studierenden an einer Forschungsexpedition in der Antarktis teil. Da ihr Flugzeug abstürzt, müssen sie dieses neben ihrer Forschung reparieren. Für das Lösen von Aufgaben erhalten sie Punkte. Das Erreichen einer gewissen Punktzahl kennzeichnet den erfolgreichen Abschluss eines Levels und wird durch den Erhalt eines Bauteils für die Flugzeugreparatur belohnt. Zusätzliche Punkte können gegen Minispiele, die einen reinen Unterhaltungszweck haben, eingetauscht werden. Die zu lösenden Aufgaben sind vielfältig (siehe Abbildung 1). Es sind allein zu lösende Aufgaben (z.B. Multiple Choice, Lückentext, Drag & Dop, Kreuzworträtsel, interaktive Systemscreenshots (Screen 1)) und im Team zu lösende Aufgaben (z.B. Abstimmungen oder Fallbearbeitungen (Screen 2)) integriert. Diese spielerische Form des Lernens soll die Motivation der Studierenden zur aktiven Auseinandersetzung mit Themen des wissenschaftlichen Arbeitens fördern [17].

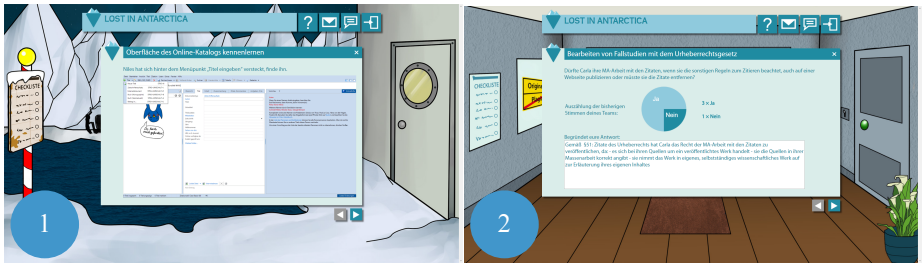


Figure 1. Screenshots aus dem Serious Game

4 Empirische Studie zu Lernstrategien und Wissensgewinn

4.1 Hypothesenherleitung

Deterding et al. (2011) hat bereits festgestellt, dass Lernspiele motivierend auf den Nutzenden wirken, so dass dieser Aktivitäten ausdauernder verfolgt. Außerdem konnte bereits gezeigt werden, dass Studierende durch Spielelemente im Lernkontext effizienter lernen und eine positive Beeinflussung des Lernerfolgs auftritt [18]. Da bei der Messung über Noten die Leistung auf nur eine Zahl reduziert wird und das Erreichen der Lernziele aber auch bedeutend ist [5], erfolgt die objektive Messung in dieser Studie durch die Beantwortung von Fragen, die jeweils ein Lernziel darstellen. Darüber hinaus erfolgt eine subjektive Messung durch Selbsteinschätzung des Wissens seitens der Studierenden. Aufgrund der positiven Ergebnisse bei ähnlicher Messung aus der Literatur (z.B. [2]) ergibt sich folgende Hypothese:

H1: Durch das Lernen mit einem Serious Game wird der subjektive und objektive Wissensgewinn der Studierenden positiv beeinflusst.

Boerner et al. (2005) und Blickle (1996) untersuchten bereits, ob ein Zusammenhang zwischen den Lernstrategien der Studierenden und ihrem erfahrenen Wissensgewinn besteht. Allerdings wurden die Lernstrategien nicht mit dem Wissensgewinn der Studierenden korreliert, sondern anhand des Studienerfolgs bzw. der Vordiplomsnote [4; 19]. Dabei bezogen Boerner et al. (2005) nicht nur die Noten mit ein, sondern auch Selbsteinschätzungen des Lernerfolgs. Es gelang ihnen die erreichten Noten und Abschlussnoten anhand der Lernstrategien vorauszusagen, allerdings mit einem relativ geringen Vorhersagewert [4]. Bezüglich des selbst eingeschätzten Lernerfolgs konnten sie jedoch eine höhere Varianzaufklärung erreichen [4]. Da der objektive Lernerfolg über die erreichte Note noch nicht aussagekräftig genug für das vorhandene Wissen der Lernenden ist, untersucht das vorliegende Paper nachfolgende Hypothese:

H2: Die Lernstrategien der Studierenden beim Lernen mit einem Serious Game beeinflussen den objektiven und subjektiven Wissensgewinn positiv.

4.2 Studiendesign

In der Studie werden zum einen das subjektive und objektive Wissen und zum anderen die Lernstrategien erhoben. Die Studie wird semesterbegleitend im Rahmen einer Wahlpflichtveranstaltung des Studiengangs Wirtschaftsingenieurwesens in Vertiefung Maschinenbau durchgeführt, in der die Studierenden wissenschaftliches Arbeiten mit dem Serious Game erlernen. Bevor die Studierenden mit dem Serious Game starten, wird das Vorwissen zu allen im Serious Game behandelten Inhalten geprüft und die Lernstrategien erhoben. In der Mitte und nach erfolgreicher Beendigung des Serious Games wird das Wissen der Studierenden jeweils erneut erhoben, um den Wissensgewinn über den gesamten Spielverlauf feststellen zu können. Dabei werden in der Mitte des Serious Games nur die bereits behandelten Inhalte und am Ende erneut alle Inhalte abgefragt.

Zur Erhebung der Lernstrategien wird der LIST-Fragebogen in Anlehnung an Boerner et al. (2005) mit einer 6-stufigen Likert-Skala (1=trifft überhaupt nicht zu, …, 6=trifft völlig zu) eingesetzt. Lediglich die Fragen zur Orientierung an Instruktionen, Fragen zur Erfolgsmessung und zum Zeitaufwand finden keine Berücksichtigung. Die metakognitive Skala wird ebenfalls nicht explizit alleine dargestellt, sondern über ihre Subfragen. Die Nichtberücksichtigung der Fragen zur Orientierung geht darauf zurück, dass keine Studierenden im Fernstudium befragt werden und somit an diesen Studierendentyp gerichtete Fragen nicht notwendig sind. Die Fragen zur Erfolgsmessung werden ausgeschlossen, da innerhalb des Serious Games keine Notenvergabe erfolgt und generell diskutabel ist, inwiefern sich der Lernerfolg auf einen Messwert reduzieren lässt [20]. Anstelle dessen ist der Wissensgewinn im Lernfeld hier durch objektive und subjektive Wissensfragen erfasst. Der Zeitaufwand wird ebenfalls nicht ermittelt, da bereits gezeigt wurde, dass der Lernerfolg nicht mit der eingesetzten Zeit zum Lernen zusammenhängt [4].

In der Studie wird der subjektive und objektive Wissensgewinn geprüft, da die Diskrepanz zwischen dem tatsächlichen Wissen und dem, was eine Person glaubt zu wissen sehr groß sein kann [21]. Das subjektive Wissen wird nach Flynn und Goldsmith (1999) anhand einer 6-stufigen Likert-Skala erhoben [22]. Zur Erhebung des objektiven Wissens müssen die Studierenden Fragen zu jedem im Serious Game behandelten Thema der Informationskompetenz beantworten. Zu jedem Themengebiet wird den Studierenden eine Frage entsprechend eines Lernziels innerhalb des Serious Games gestellt, wobei die Fragentypen variieren (z.B. Multiple Choice, Freitext, Wahr/Falsch, Drag & Drop).

4.3 Auswertung der Ergebnisse

Insgesamt haben 114 Bachelorstudierende im Rahmen der Wahlpflichtveranstaltung an der Studie teilgenommen, wovon 107 die Umfrage zu allen drei Messzeitpunkten vollständig ausgefüllt haben. Mit 87 männlichen und 20 weiblichen Teilnehmenden haben überwiegend männliche Studierende an der Umfrage teilgenommen. Die Spannweite des Alters der befragten Studierenden reicht von 18 bis 32 Jahren bei einem Mittelwert von 22,15 Jahren.

Lernstrategien. Beim deutschen Ausgangsmodell für die Erfassung der Lernstrategien im Studium von Wild und Schiefele (1994) wird von mehreren Ebenen ausgegangen, die zum Teil von Boerner et al. (2005) validiert und erweitert wurden. Auf der obersten Modellebene stehen die kognitiven, metakognitiven und ressourcenbezogenen Lernstrategien, die sich wiederum in Substrategien aufteilen. Daher wurde jeweils eine Faktoren- und Reliabilitätsanalyse innerhalb der Lernstrategiegruppen durchgeführt. Tabelle 1 zeigt die Ergebnisse nach der Eliminierung von acht Items.

Lernstrategie	Cronbachs Alpha	Eliminierte Item Nr.	Faktorladung der Items	Erklärte Varianz
Wiederholung	.803	5	_1/.759, _2/.772, _3/.720, _4/.559, _6/.693, 7/.606, _8/.664	47.018 %
Kritisches Prüfen	.803	-	_1/.699, _2/.742, _3/.814, _4/.768, _5/.741, 6/.754, _7/.636, _8/.761	54.939 %
Zusammenhänge	.803	8	_1/.698, _2/.829, _3/.767, _4/.711, _5/.770, _6/.754, _7/.734	56.707 %
Organisation	.825	-	_1/.525, _2/.736, _3/.811, _4/.693, _5/.700, _6/.643, _7/.603, _8/.663, _9/.491	43.361 %
Planung von Lernschritten	.848	-	_1/.796, _2/.740, _3/.683, 4/.731, _5/.783, _6/.794	57.109 %
Selbstüberwachung	.817	1 und 6	_2/.799, _3/.782, _4/.823, _5/.829	65.328 %
Regulation der Lernaktivitäten	.858	5	_1/.716, _2/.773, _3/.849, _4/.672, _6/.848, 7/.666, _8/.650	55.244 %
Anstrengungsma-nagement	.878	5	_1/.812, _2/.834, _3/.664, _4/.729, _6/.806, 7/.663, _8/.821	58.420 %
Aufmerksamkeits- und Konzentrationsma-nagement	.937	-	_1/.811, _2/.906, _3/.867, _4/.911, _5/.857 _6/.884	76.252 %
Zeitmanagement	.825	4	_1/.829, _2/.859, _3/.893	74.108 %
Lernen mit anderen	.732	-	_1/.762, _2/.686, _3/.846, _4/.688	55.989 %
Gestaltung der Studienumgebung	.894	4	_1/.782, _2/.908, _3/.759, _5/.875, _6/.878	70.970 %
Verwendung von Literatur	.831	-	_1/.843, _2/.755, _3/.802, _4/.872	67.125 %

Tabelle 1. Reliabilitäts- und Faktorenanalyse der Lernstrategien

Die verbliebenen Items weisen jeweils eine korrigierte Item-Skala Korrelation >.300 auf und das Cronbachs Alpha liegt durchgängig über .700. Insgesamt sind die KMO-Werte (.622 bis .881) in einem ziemlich guten bis verdienstvollen Bereich. Auch die Faktorladungen sind relativ hoch, so dass davon ausgegangen werden kann, dass die Lernstrategien der Literatur auch im Datensatz der Studie wiederzufinden sind. Der Boxplot in Abbildung 2 verdeutlicht nochmal die genaue Verteilung der Antworten der Studierenden.

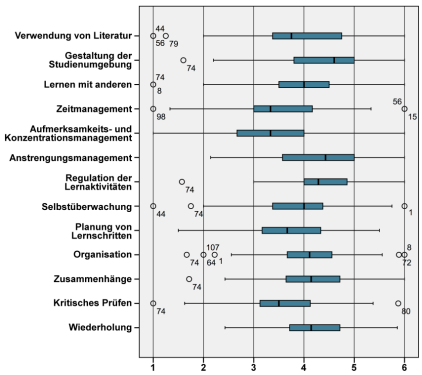


Figure 2. Boxplot der Lernstrategien

Subjektiver Wissensgewinn. Mittels Reliabilitäts- und Faktorenanalyse konnte zu jedem Messzeitpunkt ein Faktor identifiziert werden, so dass insgesamt drei Komponenten, bestehend aus jeweils vier Items, gebildet wurden (Cronbachs Alpha = .904; erklärte Varianz = 81,203 %). Um Unterschiede im subjektiven Wissen zwischen den verschiedenen Messzeitpunkten festzustellen, erfolgte eine Varianzanalyse mit Messwiederholung (Sphärizität verletzt, Korrektur nach Huynh-Feldt: Mauchly-W_2 = .805, p = .000). Ein signifikanter Unterschied konnte zum subjektiven Wissensgewinn über die drei Messzeitpunkte festgestellt werden ($F_{2,212}$ = 12.499, p = .000, partielles η2 = .105). Auf einem Signifikanzniveau von α = .05 unterscheidet sich das subjektive Wissen signifikant zwischen dem ersten (M_1 = 3.05, SD_1 = .958) und zweiten (M_2 = 3.51, SD_2 = .981) Messzeitpunkt in Höhe von .460 Einheiten. Ein weiterer Wissensgewinn ist zwischen dem ersten und dritten (M_3 = 3.47, SD_3 = .956) Messzeitpunkt erkennbar (p = .002, Δ_{I-J} = .416). Da die Studierenden zwischen den Messzeitpunkten nur Lernphasen unter Verwendung des Serious Games erfuhren, ist der identifizierte Unterschied auf diese Ursache zurückzuführen. Zwischen dem zweiten und dritten Messzeitpunkt ist kein signifikanter Unterschied feststellbar. Hier wird vermutet, dass dies auf eine zweimalige fehlerhafte Selbsteinschätzung zurückzuführen ist. Kim et al. (2016) erklären dieses Phänomen mit dem Kompetenzlevel einer Person. Danach führt Inkompetenz eher zu einer Überschätzung und mit zunehmender Kompetenz wird der eigene Wissensstand unterschätzt [23]. Falls nicht anders angegeben, wird durchgehend von einem Signifikanzniveau von α = .05 ausgegangen.

Objektiver Wissensgewinn. Studierende mussten die Fragen zum objektiven Wissen unterschiedlich beantworten, da kein einheitliches Antwortmuster, wie z.B. bei der Likert-Skala, vorlag. Zur Thematik *Internetrecherche* sollten drei Nachteile dieser genannt werden. Eine Varianzanalyse mit Messwiederholung (Sphärizität verletzt, Korrektur nach Huynh-Feldt: Mauchly-W_2 = .887, p = .002) ergab keine signifikanten Werte ($F_{2,212}$ = 2.342, p = .104, partielles η^2 = .022) und somit zeigten sich keine signifikanten Unterschiede der Mittelwerte (M_1 = .464, SD_1 = .303; M_2 = .539, SD_2 = .309; M_3 = .533, SD_3 = .345). Zur *Katalogrecherche* mussten die Studierenden angeben, was die Abkürzung OPAC (Online Public Access Catalogue) bedeutet. Die Häufigkeiten der richtigen Antworten unterschieden sich zu den Messzeitpunkten ($M_{1richtig}$ = 25; $M_{2richtig}$= 72; $M_{3richtig}$ = 74). Die Unterschiede in den Antworten wurden durch die Signifikanz des Cochran-Q-Tests bestätigt (T = 67.853, p = .000). Der McNemar-Test ergab keinen signifikanten Unterschied zwischen dem zweiten und dritten Messzeitpunkt ($\hat{x}'^2_{unkorrigiert}$ = .250, p = .6171). Folglich liegt ein objektiver Wissensgewinn vor und eine Speicherung des Wissens im Langzeitgedächtnis, da ohne direkte Lernphase zwischen dem zweiten und dritten Messzeitpunkt keine signifikanten Unterschiede in den Antworten vorhanden sind. Die Studierenden mussten zu *Recherchestrategien* diejenigen Ergebnisse auswählen, die eine bestimmte Suchanfrage ergibt. Eine Varianzanalyse mit Messwiederholung (Sphärizität verletzt, Korrektur nach Huynh-Feldt: Mauchly-W_2 = .715, p = .000) ergab keine signifikanten Werte ($F_{2,212}$ = 2.373, p = .109, partielles η^2 = .022), wodurch keine signifikanten Unterschiede der Mittelwerte (M_1 = .457, SD_1 = .255; M_2 = .514, SD_2 = .194; M_3 =

.490, SD_3 = .178) erkennbar wurden. Der Cochran-Q-Test zur *Datenbankrecherche* zeigte, dass sich die Antworten ($M_{1richtig}$ = 70; $M_{2richtig}$= 89; $M_{3richtig}$ = 91) signifikant unterscheiden (Q = 18.318, p = .000), d.h. mehr Studierende wussten zu den späteren Messzeitpunkten, wofür die Abkürzung WTI (Wissenschaftlich-technische Information) steht. Das Wissen ist auch hier im Langzeitgedächtnis gespeichert, was der McNemar-Test zwischen dem zweiten und dritten Messzeitpunkt zeigte, da kein signifikanter Unterschied ($\hat{x}'^2_{unkorrigiert}$ = .250, p = .6171) vorliegt. Zum Thema *wissenschaftliche Literatur erkennen* musste eine Multiple-Choice Frage beantwortet werden. Eine Varianzanalyse mit Messwiederholung (Sphärizität verletzt, Korrektur nach Huynh-Feldt: Mauchly-W_2 = .796, p = .000) ergab signifikante Werte ($F_{2,212}$ = 15.331, p = .000, partielles η^2 = .126), wodurch signifikante Unterschiede der Mittelwerte (M_1 = .576, SD_1 = .292; M_2 = .713, SD_2 = .298; M_3 = .720, SD_3 = .290) erkennbar wurden. Dabei hat zwischen dem ersten und zweiten Messzeitpunkt eine signifikante Verbesserung des objektiven Wissens um .137 Einheiten und zwischen dem ersten und dritten Messzeitpunkt um .143 Einheiten stattgefunden. Dies deutet, wie bei den vorherigen Analysen, auf eine erfolgreiche Speicherung des Wissens im Langzeitgedächtnis hin. Zur Thematik des *wissenschaftlichen Schreibens* wurde eine Frage zur Aufnahme von Quellen ins Literaturverzeichnis gestellt. Die Häufigkeiten der richtigen Antworten unterschieden sich zu den Messzeitpunkten ($M_{1richtig}$ = 55; $M_{2richtig}$= 79; $M_{3richtig}$ = 66). Die Unterschiede in den Antworten wurden durch die Signifikanz des Cochran-Q-Tests bestätigt (T = 11.103, p = .004). Demnach liegt ein objektiver Wissensgewinn nach dem Lernprozess vor. Der McNemar-Test ergab jedoch eine signifikante Verschlechterung zwischen dem zweiten und dritten Messzeitpunkt ($\hat{x}'^2_{unkorrigiert}$ = .250, p = .6171). Somit blieb eine Speicherung im Langzeitgedächtnis aus. Nun folgen die Ergebnisse der Themengebiete mit jeweils zwei Messzeitpunkten. Die Studierenden mussten ein Programm zur *Literaturverwaltung* nennen. Die Anzahl der richtigen Antworten unterscheidet sich zu den Messzeitpunkten ($M_{1richtig}$ = 19; $M_{2richtig}$= 74). Der McNemar-Test ergab einen signifikanten Unterschied ($\hat{x}'^2_{unkorrigiert}$ = 51.271, p = .0000), wodurch von einem objektiven Wissensgewinn ausgegangen werden kann. Beim *Zitieren und Bibliografieren* mussten die Studierenden die Richtigkeit eines Zitats überprüfen. Zum ersten Messzeitpunkt beantworteten 58 Studierende die Frage richtig, wohingegen zum zweiten Messzeitpunkt nur noch 36 Studierende die Antwort wussten. Der McNemar-Test bestätigte den signifikanten Wissensverlust ($\hat{x}'^2_{unkorrigiert}$ = 8.067, p = .0045). Eventuell empfanden die Studierenden die Aufgabe als zu schwierig und haben anfangs nur richtig geraten. Möglicherweise war aber auch das Lernmaterial nicht geeignet oder verwirrend, weswegen das Thema nicht richtig verstanden wurde. Zum *Urheberrecht* musste eine Aussage zu Plagiaten bewertet werden. Die Häufigkeit der richtigen Antworten unterscheiden sich zu den Messzeitpunkten ($M_{1richtig}$ = 22; $M_{2richtig}$= 64). Der McNemar-Test ergab einen signifikanten Unterschied ($\hat{x}'^2_{unkorrigiert}$ = 50.449, p = .0000). Demnach liegt ein objektiver Wissensgewinn vor. Bei *Sicherung guter wissenschaftlicher Praxis* mussten die Studierenden Aussagen zu Originalität und Überprüfbarkeit zuordnen. Da diese Aufgabe im Vergleich zu den anderen komplexer war und ggf. mehr zum Raten animierte, wurde in der Auswertung eine Bestrafung falscher Antworten mit einem Minuspunkt vorgenommen. Ein t-Test zeigte, dass die

Daten keinen signifikanten Unterschied aufweisen (t = .465, p = .643). Nach dem Lernprozess (M_3 = 3.196, SD_3 = 4.521) weisen die Studierenden eine ähnlich hohe Anzahl an richtigen Antworten auf wie zuvor (M_1 = 3.421, SD_1 = 3.571). Publikationsschritte mussten bei *Publizieren und Open Access* in die richtige Reihenfolge gebracht werden. Da auch dieser Aufgabentyp komplexer ist, wurde das Verfahren mit der Bestrafung falscher Antworten gewählt. Der durchgeführte t-Test zeigt, dass ein signifikanter Einfluss vorliegt (t = −8.958, p = .000). Die Studierenden verbesserten sich im Durchschnitt um 4,633 richtige Antworten zwischen dem ersten (M_1 = −2.785, SD_1 = 3.665) und zweiten (M_3 = 1.879, SD_3 = 5.052) Messzeitpunkt. Ob ein Ziel smart formuliert ist, mussten die Studierenden beim *Zeitmanagement* entscheiden. Der McNemar-Test ergab keinen signifikanten Unterschied in den Daten der beiden Messzeitpunkte ($\hat{x}^{2}_{\text{unkorrigiert}}$ = 1.089, p = .2967), d.h. es konnte kein objektiver Wissensgewinn festgestellt werden. Generell bedeutet kein Wissensgewinn nicht zwangsläufig, dass die Studierenden kein Wissen zu einer Thematik besitzen. Hatten sie bereits Vorwissen, konnten sie sich bei einem Vorher-Nachher-Test kaum verbessern. Da in dieser Studie allerdings der Wissensgewinn betrachtet wird, findet keine explizite Betrachtung des absolut vorhandenen Wissens statt.

Zusammenhang Lernstrategien und Wissensgewinn. Tabelle 2 zeigt die tatsächlichen Veränderungen des subjektiven Wissens zwischen dem ersten und zweiten Messzeitpunkt. Da von einem generellen Gewinn ausgegangen wurde, ist vom späteren Messzeitpunkt der vorherige abgezogen worden. Ist die Differenz positiv, hat es einen Wissensgewinn gegeben.

Bis auf Organisation liegen alle Lernstrategien weit vom Signifikanzniveau α = .05 entfernt. Wird das Niveau etwas angepasst, ist eine signifikante negative Korrelation bei der Wissensveränderung und der Strategie zwischen dem ersten und zweiten Messzeitpunkt zu erkennen. Grund für den nicht vorhandenen Einfluss kann die Selbsteinschätzung der Studierenden sein, da sie sich lediglich daran erinnern, welche Strategie sie nutzen [4].

Lernstrategie	**Differenzen des ersten und zweiten Messzeitpunkts**		**Differenzen des ersten und dritten Messzeitpunkts**	
	r_{Sp}	**Sig. (2-seitig)**	r_{Sp}	**Sig. (2-seitig)**
Wiederholung	.032	.744	.057	.562
Kritisches Prüfen	-.029	.764	-.066	.499
Zusammenhänge	-.060	.537	-.033	.733
Organisation	-.186	.055	-.075	.446
Planung von Lernschritten	.117	.229	.085	.387
Selbstüberwachung	-.014	.884	-.058	.551
Regulation der Lernaktivitäten	.047	.629	.108	.270
Anstrengungsmanagement	.067	.496	.062	.525
Aufmerksamkeits- und Konzentrationsmanagement	-.104	.288	.021	.833
Zeitmanagement	-.116	.233	-.007	.944
Lernen mit anderen	-.062	.524	-.019	.849
Gestaltung der Studienumgebung	.027	.782	.051	.605
Verwendung von Literatur	.138	.157	.023	.811

Tabelle 2. Korrelation der Lernstrategien mit den Wissensdifferenzen mittels Spearman

Nachfolgend werden nur die Themengebiete der Informationskompetenz mit signifikanter Veränderung des objektiven Wissens betrachtet und darüber hinaus auch nur signifikante Einflüsse durch die Lernstrategien herausgestellt. Das Ergebnis zur *Katalogrecherche* zeigt, dass die Lernstrategien Wiederholung (r_{sp} = .244, p = .011), Zusammenhänge (r_{sp} = .210, p = .030), Anstrengungsmanagement (r_{sp} = .216, p = .025) und Gestaltung der Lernumgebung (r_{sp} = .254, p = .008) positiv signifikant mit dem objektiven Wissensgewinn, verbunden mit der richtigen Beantwortung der Frage, korrelieren ($diff_{richtig}$). Wurde lediglich der Zusammenhang zwischen dem Wissensgewinn und den Lernstrategien betrachtet, korrelieren die Strategien Wiederholung (r_{sp} = .284, p = .003), Selbstüberwachung (r_{sp} = .194, p = .045), Anstrengungsmanagement (r_{sp} = .205, p = .034), Gestaltung der Lernumgebung (r_{sp} = .221, p = .022) positiv signifikant. In der *Datenbankrecherche* korreliert keine Lernstrategie signifikant mit der Variable $diff_{richtig}$. Wird das Signifikanzniveau jedoch auf α = .100 verringert, korreliert die Lernstrategie Kritisches Prüfen (r_{sp} = .169, p = .043). Kritisches Prüfen korreliert mit der Wissensveränderung (r_{sp} = .169, p = .043) auf einem Signifikanzniveau von α = .050. Keine Lernstrategie korreliert signifikant mit der Variable $diff_{richtig}$ beim *wissenschaftliche Literatur erkennen*. Wurde das Niveau jedoch auf α = .100 reduziert, waren die Strategien Selbstüberwachung und Aufmerksamkeits- und Konzentrationsmanagement signifikant und Organisation und Anstrengungsmanagement lagen mit .009 Einheiten knapp darüber. Auch beim *wissenschaftlichen Schreiben* konnten nur mit einer Verringerung des Signifikanzniveaus auf α = .100 signifikante Ergebnisse erzielt werden. Die Lernstrategie Lernen mit anderen korreliert mit der Variable zur Wissensveränderung (r_{sp} = .190, p = .051) und mit der Variable $diff_{richtig}$ (r_{sp} = .173, p = .075). Auch bei *Literaturverwaltung* konnten nur mit einer Verringerung des Signifikanzniveaus auf α = .100 signifikante Ergebnisse für die Variable $diff_{richtig}$ und Lernstrategie Aufmerksamkeit- und Konzentrationsmanagement (r_{sp} = .165, p = .090) erzielt werden. Im *Urheberrecht* weist die Strategie Wiederholung (r_{sp} = .224, p = .021) eine signifikante positive Korrelation mit der Wissensveränderung auf. Demnach haben die Studierenden, die diese Strategie eingesetzt haben auch einen Wissensgewinn in der Rubrik *Urheberrecht* erfahren. Wird das Signifikanzniveau auf α = .100 reduziert, haben auch die Strategien Wiederholung (r_{sp} = .187, p = .054) und Lernen mit anderen (r_{sp} = .168, p = .084) signifikante Korrelationen, allerdings mit der Variable $diff_{richtig}$, die sowohl Informationen über die Wissensveränderung als auch das bereits zu Anfang vorhandene Wissen verfügt. Die Ergebnisse des Spearman Verfahrens zeigen beim *Publizieren und Open Access*, dass die Strategie Aufmerksamkeits- und Konzentrationsmanagement (r_{sp} = −.215, p = .026) negativ mit Wissensveränderung korreliert. Studierende, die angeben, diese Strategie häufiger zu nutzen, erfahren rechnerisch einen Wissensverlust und umgekehrt. Wird das Signifikanzniveau auf α = .100 reduziert, korrelieren auch die Strategien Gestaltung der Lernumgebung (r_{sp} = .183, p = .059) und Kritisches Prüfen (r_{sp} = −.170, p = .080) mit derselben Variable. Auffallend ist, dass negative Korrelationen auftreten, d.h. Studierende weisen Wissensverluste auf, wenn sie bestimmte Strategien präferieren.

5 Schlussbemerkungen

Zusammenfassend kann festgehalten werden, dass beide Hypothesen nur teilweise bestätigt werden können. Während die Studierenden einen signifikanten subjektiven Wissensgewinn erfahren haben, erfolgte nur bei einigen Themen der Informationskompetenz eine signifikante Steigerung des objektiven Wissens über die Messzeitpunkte. Die Beantwortung der objektiven Wissensfragen vor und nach der Lernphase könnte die Studierenden durch die verschiedenen Fragetypen (z.B. Multiple Choice, Wahr/Falsch) zum Raten verleitet haben, wodurch eine Verfälschung der identifizierten Wissensgewinne bzw. -verluste aufgetreten sein könnte. Auch bei Betrachtung des Zusammenhangs zwischen Lernstrategien und Wissensgewinn zeigten sich unterschiedliche Ergebnisse. Während nur eine geringe negative Korrelation zwischen der Lernstrategie Organisation und dem subjektiven Wissensgewinn identifiziert wurde, haben einige Lernstrategien eine Beeinflussung des objektiven Wissens hervorgebracht, wobei auch dies nur bei einzelnen Themengebieten zutrifft. Demnach ist zu vermuten, dass Lernstrategien in Abhängigkeit des Lernthemas beim Game-based Learning eine unterschiedliche Beeinflussung des subjektiven und objektiven Wissensgewinns aufweisen. Eine Studie, in der bei Lehramtstudierenden ein signifikanter Zusammenhang zwischen Strategienutzung und Selbsteinschätzung des Studienerfolgs identifiziert wurde, und bei Medizinstudierenden nicht, unterstützt diese Vermutung, da beide Studiengänge unterschiedliche Inhalte thematisieren [24]. Allerdings wurde hierbei nur die Selbsteinschätzung des Studienerfolgs betrachtet und nicht ein konkretes Lernthema untersucht oder das objektive Wissen. Demnach sollte dies in zukünftigen Studien näher betrachtet werden. Auch ist eine mehrmalige Erhebung der Lernstrategien denkbar, da die Studierenden ihre präferierten Strategien im Spielverlauf möglicherweise ändern. Grundsätzlich kann jedoch davon ausgegangen werden, dass durch den Einsatz von Lernstrategien im Game-based Learning das Wissen steigt, da sich die Lernenden gezielt mit den Lerninhalten auseinandersetzen.

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edu-hub: Eine projektorientierte Wissensplattform zur schulischen Digitalisierung

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Abstrakt. Obwohl die schulische Digitalisierung im öffentlichen Diskurs immer mehr an Bedeutung gewinnt, konzentrieren sich konkrete Digitalisierungsprojekte noch auf eine eher geringe Anzahl von Schulen und bleiben auch insgesamt deutlich hinter den Erwartungen einer sich schnell digitalisierenden Gesellschaft zurück. Ziel dieses Forschungsprojektes ist es, durch die partizipative Entwicklung einer schulübergreifenden, projektorientierten Wissensplattform zur schulischen Digitalisierung, die Durchführung von erkenntnisreichen schulischen Digitalisierungsprojekten durch gezielte IKT-Unterstützung zu vereinfachen und so letztendlich für die breite Masse an Schulen zu ermöglichen. Um die Praxistauglichkeit der Plattform sicherzustellen, erfolgt die Entwicklung partizipativ mit einer repräsentativen Partnerschule. Als wissenschaftlicher Beitrag soll neben einer Gestaltungs- und Design-Theorie für projektbasierte Wissensplattformen im Bildungskontext auch Wissen über die schulische Digitalisierung durch die Nutzung der Plattform aggregiert, formalisiert und vor allem in breiter Wirkung zugänglich gemacht werden.

Keywords: Digitale Transformation, E-Learning, Wissensmanagement, Design Science Research

1 Einleitung

Die Digitalisierung findet immer weiter Eingang in nahezu alle Gesellschaftssegmente, aber besonders an Schulen noch eher zögerlich statt (vgl. im folgenden [1]). So werden die soziotechnologischen Veränderungsdimensionen von digitalen Neuerungsprozessen oft noch nicht vollständig erkannt und diese eher als lineare Fortentwicklung bereits existierender Medien verstanden. Infolgedessen werden intelligente digitale Technologien oft nur als methodisch-instrumentelle Insellösungen in einzelnen Bereichen wie etwa der Schuldokumentation oder dem Informatikunterricht eingesetzt. Anstelle der erforderlichen Umstrukturierung auf organisationaler oder sogar Schulsystemebene vollzieht sich höchstens eine

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Umstellung von traditionellen auf digitale Lern- und Dokumentationsformate. Vielfach setzen somit Schulen die digitale Transformation mit einem Medienwechsel gleich und anstatt traditioneller (analoger) nun technologische (digitale) Lösungen ein. Damit besteht das existierende Schul- und Bildungssystem einschließlich seiner vielfach dokumentierten Limitationen unverändert weiter, inklusive eines dringenden Bedarfs an strukturellen und langfristig angelegten Änderungsprozessen [2]. Um dieser Situation entgegen zu wirken, wurden und werden die Möglichkeiten der schulischen Digitalisierung bereits in einigen Forschungs- und Pilotprojekten thematisiert (z. B. ChangeMan[1], SKOLA[2]); die hierdurch angestoßenen technologischen Neuerungsprozesse beschränken sich derzeitig jedoch meistens noch immer auf eine recht geringe Anzahl von Schulen und bleiben auch insgesamt noch deutlich hinter den Erwartungen einer sich rasch digitalisierenden Gesellschaft zurück [1]. Eine flächendeckende Unterstützung für die schulische Digitalisierung erfordert neue Wege in der Forschung und die effektive Einbeziehung der Lehrkräfte in der Entwicklung, Nutzung sowie Evaluation von innovativen und vor allem effektiven Lösungen [3-5].

Das in diesem Beitrag vorgestellte Forschungsprojekt verfolgt das Ziel, diese Situation durch die partizipative Entwicklung einer schulübergreifenden, projektorientierten Wissensplattform zur schulischen Digitalisierung deutlich zu verbessern. Die zu entwickelnde Plattform soll zum einen die projektorientierte Vernetzung aller Anspruchsgruppen der „Arbeitswelt Schule“ vereinfachen und zum anderen eine systematische und strukturierte Erfassung und Evaluation von schulischen Projekten vorantreiben. Ziel ist es die Durchführung von erkenntnisreichen schulischen Digitalisierungsprojekten durch gezielte IKT-Unterstützung zu vereinfachen und so letztendlich für die breite Masse an Schulen zu ermöglichen.

Um dies zu erreichen, soll Funktionalität für die strategische Planung, Anbahnung, Dokumentation, Diskussion und Bewertung von schulischen Projekten den Kern der Plattform bilden. Die konkrete Ausgestaltung der Funktionalität erfolgt partizipativ mit einer Gesamtschule (~1200 Schüler) mit hohem Inklusionsbedarf und moderater Digitalisierungserfahrung, die einen approximativ repräsentativen Einblick in die Bedürfnisse der verschiedenen Anspruchsgruppen in Schulen ermöglicht. Neben der Entwicklung und Evaluation eines innovativen Informationssystem (IS)-Artefaktes [6] ist die Generierung von abstraktem Gestaltungswissen [7-9] erklärtes Ziel des Projektes. So soll nicht nur eine Gestaltungs- und Design-Theorie [9, 10] für projektbasierte Wissensplattformen im Bildungskontext generiert werden, sondern auch Wissen über die schulische Digitalisierung durch die Nutzung der Plattform auf verschiedenen Ebenen aggregiert, formalisiert und vor allem breit zugänglich gemacht werden.

2 Vorarbeiten und Theoretischer Hintergrund

Dieses Forschungsvorhaben geht aus einem interdisziplinären Forschungsprojekt zur schulischen Digitalisierung hervor und im Zuge eines breiten Literaturreviews zu der

[1] http://www.bildungsserver.de/innovationsportal/blk_set.html?Id=623
[2] http://www.bildungsserver.de/innovationsportal/blk_set.html?Id=72

Gesamtthematik wurde deutlich, dass die Entwicklung und produktive Nutzung von effektiven Lehrtechnologien auf Grund der involvierten Komplexität und Diversität innovative Forschungsansätze benötigen, die der pädagogischen Realität Rechnung tragen können [3-5]. So kann design-orientierte pädagogische Forschung, die in enger Kollaboration mit Schulen, Lehrkräften, Schülern, Eltern und anderen Praxispartnern durchgeführt wird, schneller als mehrheitlich laborbasierte Forschung, zur Identifikation von kontextsensitiven Problemen, Limitationen und Herausforderungen führen [4]. Noch weitergehend, kann sogar Pädagogik an sich als eine Gestaltungswissenschaft (Design Science) konzeptualisiert werden, die von Lehrkräften in der Praxis zu entwickeln ist [3]. Abbildung 1 visualisiert diese Sichtweise mit Hilfe des so genannten *Conversational Frameworks* [3].

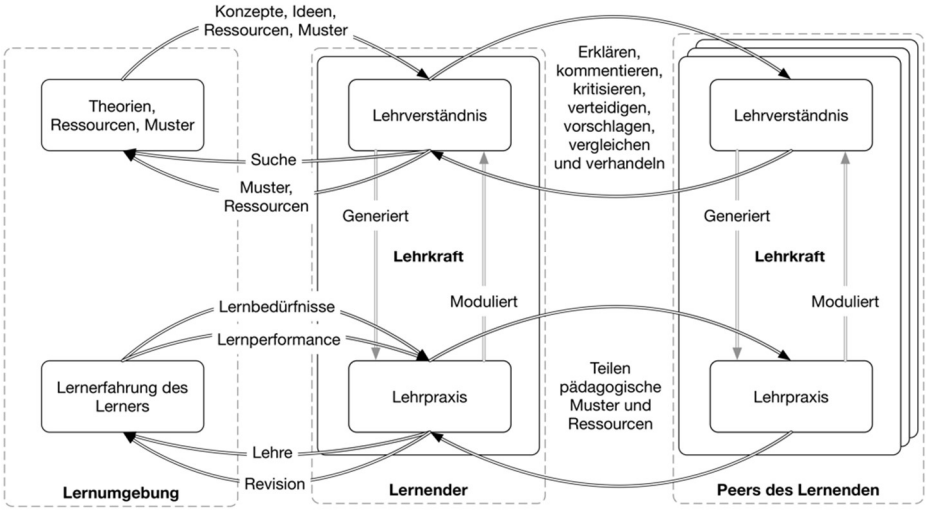


Abbildung 1. Pädagogik als Design Science, basierend auf der Abbildung 12.1 in [3, S. 225].

Das Conversational Framework ist der Versuch, ein Rahmenmodell für die Pädagogik zu schaffen und die vielen verschiedene pädagogische Ansätze und Methoden vergleichbarer zu machen (vgl. im folgenden [3]). In diesem Rahmenmodell wird zwischen konzeptioneller und praktischer Ebene unterschieden, die in einer wechselseitigen Beziehung stehen: Konzepte generieren Praxis und Praxis moduliert Konzepte. Lehre ist generell als die Vermittlung von etablierten Konzepten (Wissen) zu verstehen. Eine wichtige Aussage dieses Rahmenmodells ist, dass es verschieden Wege und Rollen bei der Vermittlung von Wissen gibt. So gibt es die Möglichkeit, sich direkt konzeptionell mit Wissen auseinanderzusetzen oder durch die eigene Praxis bestehende Konzepte zu modulieren und somit näher an die angestrebten Zielkonzepte heranzubringen.

Diese Grundmechanismen können auf unterschiedlichste Arten, mehr oder weniger effektiv kombiniert werden. Wichtige Rollen, die das Rahmenmodell heraushebt, sind neben dem im Fokus stehenden Lernenden zum einen die Lernumgebung und zum anderen die „Peers“ des Lernenden. Abbildung 1 visualisiert nun eine mögliche

Konzeptualisierung von Pädagogik als „Design Science“. In dieser Sichtweise sind Lehrkräfte ebenfalls Lernende, die Theorien, Ressourcen und pädagogische Muster einsetzen, um mit ihrer Lehrpraxis möglichst gute Lernerfahrungen für ihre Schüler zu erreichen. Eine wichtige Möglichkeit ihre Lehrpraxis zu verbessern liegt neben der generellen Interaktion mit der Lernumgebung im regen Austausch mit anderen Lehrkräften, die vor vergleichbaren Problemen stehen [3].

Aus konzeptioneller Sicht bietet diese Sichtweise ein sehr abstraktes, aber dennoch holistisches Rahmenmodell, welches nicht nur für die Formalisierung pädagogischer Muster nützlich ist [3], sondern auch ein symmetrische Betrachtung von menschlichen sowie nicht-menschlichen Akteuren (es gibt in dieser Konzeptualisierung nichts, was erfordern würde, dass Lehrkräfte menschlich sind) in einer pädagogischen „Design Science“ erlaubt. Dies ist besonders wichtig, da zu erwarten ist, dass menschliche und IT- und maschinenbasierte Akteure zusammenwirken müssen, um die seit mehreren Jahrzenten geforderte Vision des personalisierten Lernens [11] endlich flächendeckend zu realisieren.

Bevor hier ein schneller Fortschritt erwartet werden kann, müssen jedoch noch eine Reihe von infrastrukturelle Herausforderungen gelöst werden [4]. Wie Abbildung 1 darstellt, erscheint es besonders sinnvoll, das Abrufen von wissenschaftlich gesicherten Ideen, Konzepten, Ressourcen und pädagogischen Mustern sowie den zielgruppenspezifischen Austausch über diese möglichst einfach und effektiv zu gestalten.

Das Forschungsprojekt setzt an dieser Herausforderung an und möchte hier basierend auf wissenschaftlichen Erkenntnissen in partizipativer Weise eine IKT-Lösung entwickeln, welche den bestehenden Status Quo in diesem Bereich deutlich verbessert. Dazu verfolgt das Projekt im Gegensatz zu den meisten bestehenden Lösungen in diesem Bereich einen stark projekt- und anspruchsgruppenorientierten Ansatz. Ziel ist die bessere Vernetzung von relevanten Anspruchsgruppen, Anbahnung und Planung von (pädagogischen als auch nicht-pädagogischen) Projekten sowie dem Erfahrungsaustausch über die Durchführung von Projekten bzw. die Nutzung von Inhalten. Um dies möglichst erfolgreich umsetzen zu können, wurden neben dem bereits präsentierten Conversational Framework bereits weitere wichtige Kernel-Theorien, bzw. *justificatory knowledge* [9], identifiziert: (1) Das auf spieltheoretischer Ökonomie [12, 13], Multi-Level-Selektion-Evolutionstheorie [14] und kontextueller Verhaltensforschung [15] basierende Prosocial[3] (vgl. auch [16]) sowie (2) die in Schulen immer populärer werdende Problemlösungstechnik Design Thinking [17].

Beide Ansätze sollen nicht nur auf Inhaltsebene, sondern auch funktional durch die Plattform unterstützt werden, um die relevanten Anspruchsgruppen effektiv bei der Durchführung von schulischen Projekten zu unterstützen. Um darüber hinaus die Anspruchsgruppenrelevanz des Projektes sicherzustellen, wurden erste Ideen mit einer Partnerschule ausgetauscht und ein erster gemeinsamer Design-Thinking-Workshop veranstaltet.

[3] https://www.prosocial.world

3 Forschungsmethodik

Das Forschungsprojekt ist dem gestaltungsorientierten (Design-Science) Forschungsparadigma zuzuordnen [8] und verfolgt hier im speziellen einen partizipativen Ansatz des Action Design [18], bei dem die holistische Entwicklung und Einführung eines IS-Artefaktes [6], also einem soziotechnischen Ensemble das neben der IKT auch soziale und informationelle Komponenten beinhaltet, im Vordergrund steht. Dabei wird neben der Entwicklung einer Gestaltungstheorie auch die Entwicklung eines Prototyps angestrebt, was die grundsätzliche Umsetzbarkeit des Lösungsansatzes demonstrieren soll. Um die Entwicklung zu fokussieren und eine detaillierte Evaluation zu ermöglichen, soll dies in Kooperation mit einer Partnerschule erfolgen. Die Evaluation orientiert sich an dem aus der pädagogischen Forschung bekannten CIPP-Modell [19], welches eine holistische und projektbegleitende Evaluation von *Context*, *Input*, *Process* und *Product* vorsieht und damit einer auf die Faktoren Mensch und Effektivität ausgerichteten Evaluationsstrategie gleichkommt [20]. Methodisch folgt die Evaluation einem Mixed-Method-Ansatz. In weitergehenden Iterationen soll der Prototyp kontinuierlich verfeinert und den Bedürfnissen der Anspruchsgruppen entsprechend erweitert werden. Sobald ein stabiler und getesteter Stand mit überzeugender Funktionalität erreicht ist, soll die Plattform auch schrittweise für andere Schulen geöffnet werden.

4 Erstes Konzeptionelles Modell und Forschungsthesen

Ziel des Forschungsvorhabens ist die Diffusion von Wissen zum digitalen Lehren und Lernen zwischen Forschung und Praxis durch die Entwicklung einer nachhaltigen und projektorientierten Wissensplattform deutlich zu verbessern. Dazu bildet die projektorientierte Vernetzung aller Anspruchsgruppen der Arbeitswelt Schule (z. B. Rektor*innen, Lehrer*innen, Bildungstechnologie-Unternehmen und Forscher*innen) den Schwerpunkt der geplanten Plattform. Als Alleinstellungsmerkmal ist Funktionalität für das benutzerfreundliche strategische Planen, Anbahnen, Dokumentieren, Teilen, Diskutieren und Bewerten von schulischen Projekten (z. B. Unterrichtseinheiten, aber auch andere Projekte) als Kern der Plattform vorgesehen.

Die Plattform operiert damit auf einer Meta-Projektebene und zielt explizit *nicht* darauf ab, bestehende Tools und Lösungen auf operativer Projektebene abzulösen. Um diese Funktionalität etwas anschaulicher zu beschreiben, kann die Entwicklung eines neuen Unterrichtsprojektes zu einem aktuellen Thema wie dem Klimawandel als ein mögliches Szenario dienen. Die Plattform könnte hier, durch die Klassifizierung bestehender Projekte, nicht nur schnell einen Überblick über mögliche Herangehensweisen an die Thematik liefern, sondern auch einen Raum für Diskussion bieten. Beim Anlegen von neuen Projekten könnten mögliche Partner, bzw. Experten für die Durchführung des Projektes, einfacher identifiziert und direkt zur gemeinsamen Planung eingeladen werden. Zusammengefasst ist das Ziel der Plattform, als Schnittstelle zwischen Schule, Forschung, Praxispartnern sowie Schülern und Eltern

bei der strategischen Planung, Dokumentation und Evaluation von schulischen Projekten zu vermitteln (vgl. Abbildung 3).

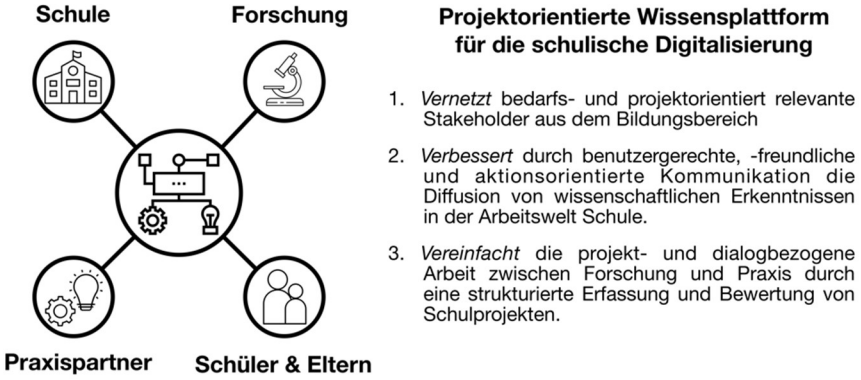


Abbildung 2. High-Level Konzeption und Thesen für zu erwartende Wertbeiträge.[4]

Im Vergleich mit generischen Sozialen Netzwerken (z. B. Twitter, Facebook), die bereits als eher informelle Kommunikations- und Wissensplattform im Bildungsbereich genutzt werden, hebt sich die geplante Plattform somit durch einen Zuschnitt auf die Bedürfnisse von Anspruchsgruppen im Bildungsbereich ab und geht mit der geplanten Funktionalität auch weit über generische Wissensplattformen wie Wikis hinaus. Die Plattform zielt darauf ab, einen effektiven aktionsorientierten Austausch innerhalb der Praxis als auch zwischen Forschung und Praxis zu ermöglichen. Das Projekt ist somit in gewisser Weise mit kommerziellen Angeboten von privaten Unternehmen vergleichbar (z. B. lehrer-online.de, digi.schule, fliptheclassroom.de), die sich auf die Unterstützung und Vernetzung von Lehrern spezialisiert haben. Im Gegensatz zu solchen Lösungen liegt der Fokus jedoch nicht auf dem Verkauf von spezifischen Inhalten, sondern auf der Vernetzung von relevanten Anspruchsgruppen, Anbahnung und Planung von Projekten sowie dem Erfahrungsaustausch über die Durchführung von Projekten bzw. die Nutzung von Inhalten. Hierzu zählt im speziellen auch die Bewertung und Evaluation von Projekten, Stakeholdern und Inhalten.

Somit fokussiert die Plattform eine offene gemeinschafts- und forschungsorientierte Betrachtung der Arbeitswelt Schule mit all ihren Teilnehmern. Diese Rolle wird zurzeit vereinzelt bereits von Blogs und themenspezifischen Internetportalen (z. B. digitaler-bildungspakt.de, digitalisierung-bildung.de, EPALE[5]) ausgefüllt, wobei hier analog zu den generischen Sozialen Netzwerken ein konkreter Zuschnitt auf die Bedürfnisse der Anspruchsgruppen im Bildungsbereich sowie Kernfunktionalitäten für den Wissensaustausch fehlen. Über solche Medien transportierte Inhalte sind generell informativ, aber unspezifisch. Die geplante Plattform hingegen unterstützt eine aktionsorientierte Auseinandersetzung mit der Digitalisierung, indem sie eine breite

[4] Darstellung basiert auf Icons des Noun Project (https://thenounproject.com/).
[5] https://ec.europa.eu/epale/de/home-page

Community um das strategische Planen, Anbahnen, Dokumentieren, Teilen, Diskutieren und Bewerten von schulischen Projekten versammelt und aufbaut.

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