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Preface

Welcome to the third Digital Enterprise Computing Conference DEC17 at the Herman Hollerith Center in Böblingen. It is a pleasure for us to organize the DEC17 as an annual conference. The conference provides a platform for researchers, students and executives from corporate practice to discuss experiences, solutions and future developments around the digital transformation. This requires close cooperation between different partners from science, business and society. The DEC17 provides an ideal platform to promote this partnership.

We live in an increasingly interdependent, dynamic and fragile world. The potential of information technology for the further development of business models is immense. These must be examined in integrated projects between research and practice and linked to real business processes. At the same time, new business models are emerging on the basis of new technological developments, which significantly expand the existing business for many industries and companies.

Therefore, strategic innovations in products, services and processes are necessary to fully exploit the opportunities of digital transformation. Through the application of scientific concepts in research and teaching, we support the transformation of society, economy and science together with our partners at the Herman Hollerith Center in Böblingen. Data, information and knowledge are fundamental concepts of our everyday life. The digital economy requires new concepts for value-added processes based on data. This requires interdisciplinary linking of approaches from informatics, business administration, social sciences and other relevant disciplines.

The diversity of technological innovation is immense and can be delineated along new architectures and methods for both business and IT, collaborative business models and enterprise social networks, digital services, cloud infrastructures, mobility systems, Internet of Things, Decision Systems, Big Data, and other relevant concepts. Such concepts inspire business strategy and create new opportunities for the next generation of digital products and services. The digital transformation refers both to the continuous development of business models as well as to the dynamic development of IT itself.

The DEC17 conference addresses this change and structures the conference program along three tracks. The track "Digital Models and Architecture" covers fundamental and practical aspects supporting the digital transformation for digital products, services, business processes and related information systems with digital architecture. The papers within this track discuss both technological and business aspects of the digital transformation and support insights on digital processes and architectures. The track "Digital Marketing" refers to the use of digital technologies as an interface between firms and customers. This covers the global rise of eCommerce, social media, search engine and display marketing, virtual and augmented reality, as well as the evolution of new marketing services empowered by customer co-creation, customer data, and other relevant issues. Finally, in the "Agility & Innovation" track, we address relevant core issues related to innovation in companies and the creation of agility. Companies today have to create new structures and processes for agile innovation processes, especially in regulated

environments. For this reason, more extensive insights are needed to shape the corresponding innovation processes in firms.

First of all, we would like to thank Roland Bernhard, District Administrator of Böblingen, for the support of all activities around the Herman Hollerith Center as a home for science, research and practice, and especially for supporting this conference. We would like to thank all sponsors for their continuous support. We thank the Track Chairs and the members of the program committee for their contribution to the selection of the scientific papers of the conference. We would also like to thank the authors of the conference, who again submitted a lot of interesting papers to the conference in 2017. We received 35 submissions to the relevant deadline of DEC17. All submissions were reviewed according to scientific standards by several members of the program committee. In the end, 17 submissions were accepted for the conference.

We hope that you will enjoy the DEC17 conference at the Herman Hollerith Center in Böblingen as well as take productive and inspiring insights from the conference. We wish you an interesting program, helpful contacts and best conversations.

Alexander Rossmann, Alfred Zimmermann

Chairs of DEC17, Herman Hollerith Center Böblingen, Germany

Böblingen, July 2017

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Applying the Minimal Cost of Change Approach to inductive Reference Enterprise Architecture Development

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Abstract: Enterprise architectures (EA) help organizations to analyze interrelations among their strategy, business processes, responsibilities, application landscape and information structures. Such ambitious endeavors can be supported by using reference models for EAM. Although research thoroughly addresses the development of reference models, the characteristics of EA models are not investigated in this context. Our work therefore applies one approach for inductively constructing reference process models to the EA domain. We thus contribute to the reference modeling research field in general and its application to development of reference enterprise architectures in detail.

Keywords: Reference Enterprise Architecture, Reference Modeling, Inductive Development, Enterprise Architecture, Enterprise Modeling

1 Introduction

Enterprises need to be aware of the relations among their strategy, business processes, applications, information infrastructures and roles to be able to rapidly react on changing demands in the market and within their organization. Enterprise Architecture Management (EAM) contributes to this purpose by providing methods and tools to establish a more holistic perspective on enterprises [ASM12, Lan17], which includes to systematically capture and develop the different architectural layers of an enterprise (e.g. business, application and technology architecture). Since EAM projects are highly time- and resource-consuming organization would benefit from reference models for EAM that are related to a problem of a certain group of organizations, e.g. to a certain industry. Reference models are information models that are reusable, of exemplary practice and universal applicability [Fet07]. In the context of EAM, van der Beek et al. define a reference enterprise architecture as *"... a generic EA for a class of enterprises, that is a coherent whole of EA design principles, methods and models which are used as foundation in the design and realization of the concrete EA that consists of three coherent partial architectures..."* [Bee12]. Although there exist many methods for the development of reference models [FL04], these approaches lack an investigation regarding their applicability towards EAM [TSF17] and mainly focus on business process model structures [RFL13].

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In order to contribute to the gap of reference enterprise architecture developement, our work applies the "Minimal Cost of Change" (MCC) approach for inductive reference model development [Ard13] to EAM. Therefore, we adjust the MCC, which was develop for reference process model construction, and apply it to sixteen EA models of different financial institutions in order to derive a first reference enterprise architecture using the ArchiMate language for EA modeling. In chapter 2 we therefore set the theoretical fundament for reference modeling and EAM in general and have a close look on the MCC approach as it is defined in [Ard13]. Afterwards, chapter 3 applies the approach to our EAM endeavor. Finally, chapter 4 concludes our findings and addresses further research work in this field.

2 Theoretical Background

2.1 Reference Modeling

From a user-oriented perspective, Thomas understands a reference model as a model used to support the construction of another model [Tho06b]. From the perspective of reusability, other authors such as vom Brocke argue that reference models are characterized by the concepts of universality and recommendation [Bro03]. In general, reference models are information models developed for a certain problem in a certain application domain. The purpose of their development is to be reused in a concrete application case in this domain. The reuse of a reference model is intended to increase both efficiency and effectivity of an enterprise's information systems and their change management [Bro03].

Regarding the overall approach of reference modeling, the life cycle of reference models can be distinguished between the phase of construction and the phase of application [FL04, Tho06a]. By presenting insights in reference enterprise architecture development we contribute to the first phase, i.e. the construction of reference models. Research discusses two generic strategies for reference model construction. While the deductive reference modeling derives reference models from generally accepted knowledge, the inductive approach abstracts from individual models to agree on a common understanding within the reference model [BS97]. Regarding Ardalani et al. most of the established reference models have been developed based on deductive approaches since only a few inductive approaches exist [Ard13]. Still, inductive reference modeling provides potential because more and more relevant data in terms of logs and concrete information models of organizations are available. Further, Rehse et al. point out that inductively developed reference models tend to have a higher degree of detail, are more mature and seem to be more accepted when it comes to reference model application [Reh16].

One available method for inductive reference model construction is proposed by Fettke [Fet14]. In seven steps the method (i) defines the reference model's requirements, (ii)

collects the individual models and (iii) pre-processes them before (iv) deriving an initial reference model. After (v) post-processing the resulting reference model it has to be (vi) evaluated from different perspective and (vii) maintained since the integration of new individual models may enhance the reference model. In the fourth step a reference model is abstracted from the set of presorted individual models. In the literature no general approaches exist how to perform this abstraction. Rehse et al. suggest to apply abstraction techniques from business process mining since the majority of reference models are based on business process model structures [RFL13]. Especially developed for inductive reference process model development, Ardalani et al. propose the *minimal cost of change (MCC)* approach, which is based on the idea of minimized graph edit distance [Ard13].

Based on the former findings, it can be derived that most contributions in inductive reference modeling research are focused on reference models that follow the structure of business process models. Our work tries to enhance this circumstance by applying existing abstraction techniques to other reference model structures, i.e. reference models based on the structure of enterprise architectures. In concrete, we apply the MCC approach to individual gathered enterprise architectures in a certain domain. We chose the MCC approach since it is the best documented approach. Hence, the following sections explain the MCC approach in more detail and reveal the characteristics of enterprise architectures before documenting the MCC's application in the main part of our work.

2.2 The Minimal Costs of Change Approach

In their work Ardalani et al. present an approach for the inductive development of business process reference models [Ard13]. The approach is called "minimal cost of change" (MCC) and is based on a minimized graph edit distance in order to derive a reference model from a given set of individual process models that address the same process. These individual process models represent real-world models from, e.g., a certain enterprises of an industry domain. The MCC approach can be used to develop a reference process model from these models. According to Fettke and Loos, reference models can provide common, good, or even best practice [Fet07]. Ardalani et al. say that reference models, which were developed inductively, mainly serve for developing reference models of common practice nature, since their basis lies in existing individual models, whose quality cannot always be assured but their practical usage. Hence, they claim that the MCC approach serves for inductively developing common practice reference process models [Ard13]. The approach is thoroughly presented by explicit definitions, calculation formulas, algorithms, an abstract example and a software prototype for its realization. All mentioned aspects relate to event-driven process chains (EPC) as a representation language for process models [KNS92].

In this work we apply the MCC approach to the enterprise architecture domain. In order to increase comprehensibility for this endeavor, this section presents the MCC approach

by means of used concepts and its procedure. Still, we encourage the reader to get acquainted with the work in [Ard13] for a deeper understanding.

An EPC model consists of events and functions, which are related to each other by means of connectors. Connectors can be of different type, like “and”, “or” or “xor”. EPCs are digraphs and represent control flows. Thus, each event or function has at least one predecessor and successor (except start and end points). By definition, a function only can follow an event and vice versa [KNS92]. The MCC approach defines the *EPCsSet* as the pool of all individual process models used for the reference model development. The general idea behind MCC is to decide whether the integration costs of a certain model element from the EPCsSet into the reference model justifies its inclusion. This decision is made by comparing this *cost value* with a pre-defined *threshold value*. Since a model element can occur in several individual models having different predecessors, successors or connection types, the cost values are not calculated for a single model element, but for a relation consisting of a model element and its predecessor. Summarizing the approach, the cost value is calculated by a formula which depends on four factors:

i. the element frequency *f(element)*, i.e. how often a function or event occurs in the pool of individual models. E.g. gets 0,4 when occurring in 40% of the models

ii. the relation frequency *f(relation)*, i.e. how often a function or event has the same predecessor in the pool of individual models.

iii. the cost functions *cost(ins)*, *cost(del)*, *cost(mov)*. Ardalani et al. assume costs occur when inserting, deleting or moving a function or event in the reference process model. They define cost(ins)=10, cost(del)=1 and cost(mov)=5.

iv. the existence of elements’ *preelement* in the reference model. If a function’s or event’s predecessor is already integrated in the reference model, its integration costs will decrease. In this case the function *exist(preelement)* returns 1, otherwise 0 is returned.

Ardalani et al. define the formula, which is used in order to calculate the integration costs of a relation from the individual models, as follows [Ard13, p. 5]:

$$costValue(relation) = f(element)*cost(ins) - (\, f(element) - f(relation) \,)*cost(mov) - (\, 1-f(relation) \,)*cost(del) - (\, 1-exist(preelement) \,)*f(relation)*cost(mov) \quad (1)$$

At this point we want to stress, that according to Ardalani et al. the value of *costValue* represents the costs, that can be saved when adding an element to the reference model [Ard13, p.5]. The higher this value, the more relevant is the element for the reference model. Thus, an element is integrated into the reference model when it exceeds the threshold value. Further, the MCC approach makes several assumptions for its usage. First, they define the same costs for inserting, deleting and moving for different elements. Second, the costs of inserting, deleting and moving can be predefined. Third,

the approach requires a stable namespace, i.e. the same EPC event has the exact same label in each individual model.

Based on these definition and formula (1) the MCC approach provides an algorithm how the reference model is developed. The algorithm comprises three main steps, in which the individual models are processed and assigned to different kind of sets (e.g. the EPCsSet) during the algorithm's iteration. In *Step 1* the *ElementsSet* and *RelationsSet* are initialized. While the former parses the individual models for events and functions together with their frequency of occurrence in the EPCsSet, the latter stores the element (i.e. event or function), its preelement and the type of connection. Since each EPC starts with one event, this start event's preelement is defined as "*null"*. Afterwards the costValue is calculated for each entrance of the RelationsSet using formula (1). At this point, no element exists in the reference model, thus, exist(preelement) returns 0 for each calculation.

In *Step 2* the MCC approach iteratively picks a relation from the RelationsSet and integrates it into the reference model. Each iteration works as follows: First, the relation with the highest costValue is selected. Second, it will be decided, whether the relation is inserted into the *ReferenceModelRelationsSet* (i.e. the set defining the reference model) or into the *ReservedRelationsSet*. The latter stores all relevant relations, where the preelement is not part of the reference model yet. If the preelement of the relation at hand is in the ReferenceModelRelationSet, the relation will be added there as well. Otherwise, the relation is added to the ReservedRelationsSet. Although [Ard13] do not specify it explicitly we can assume, that a relevant with a "null" preelement is added to the ReferenceModelRelationsSet. Third, after the relation is added to the reference model the ReservedRelationsSet is checked for successors of the reference model elements, which will then be integrated. Fourth, the RelationsSet is updated, since changes in the ReferenceModelRelationsSet cause changes of the costValues. This loop is traversed until the threshold value is reached or all relations of the RelationsSet are integrated.

In *Step 3* the reference model is created by the entries of the ReferenceModelRelationsSet. Some problems may occur when deriving the reference model from this set. For example, the right connectors have to be used when multiple elements have the predecessor. Therefore, the MCC approach defines several rules that intend to avoid such conflicts [Ard13].

2.3 Enterprise Architecture Management

Architecture is defined as a fundamental organization of a system embodied in its components, their relationships to each other, and to the environment, and the principle guiding the organizations design and evolution. An Enterprise Architecture (EA) is the formal declaration of the basic structures of an organization, its components and relations, as well as the processes used for development [Lan17]. Through EA models the complex interrelations between an enterprise's organizational and operational

structure with used information systems, processed data and realizing technologies are made explicit. Such models consist of layers and elements, which define different perspectives on the enterprise. Therefore, [WF08] define essential layers, of which an enterprise architecture consist: business architecture, process architecture, integration architecture, software architecture and infrastructure architecture.

In this context, Enterprise Architecture Management (EAM) can be seen as a management discipline, which is integrated in IT management, business management or even can be seen as a separate discipline within an enterprise [ASM12]. It aims to provide a powerful approach for a systematic development of the enterprise in accordance with its strategic visions, yet its value depends on the organizational ability to perform EAM effectively. As a management philosophy, it is a holistic way to understand, plan, develop control and adjust organizations architecture. As an organizational function it enables and improves existing strategic planning and implementation processes. As a methodology and culture it represents an open approach among the managers and proposes a set of management practices in order to reach a global optimum for the firm, free of egoism and opportunism [ASM12].

In order to develop an EAM endeavor, enterprise can draw on a variety of EA frameworks, which are thoroughly analyzed in [Mat11]. In our work we use the TOGAF framework [The10] as it is widely accepted among practitioners and comes with an detailed modeling language specification ArchiMate [The15] as well as an open source modeling tool Archi[3]. ArchiMate is a well-documented modeling notation and currently accessible in version 3.0 [The16]. For this work we utilized the former version 2.1, which was the latest version when we started our endeavor. For modeling the ArchiMate Core Meta-Model was used, which constitutes of the business layer, application layer and technology layer. For each layer, ArchiMate provides meta models for each of these layers and further specifies relations among them. Each meta model consists of architecture elements, e.g. the business process and business role element on the business layer or the application component element on the application layer. Further, the language introduces the concept of architecture viewpoints, which are projections of the EA model, each considering a certain purpose by addressing different stakeholders' interests. For example, the business function viewpoint reveals defined responsibilities between business roles and business functions for process architects [The15].

3 Application in Reference Enterprise Architecture Development

This chapter gives an introduction into the application of the MCC approach described above to EA models. Instead of calculating formula (1) on individual EPC models, we applied them to a pool of EA models, which came from enterprises of the same domain and focus on the same phenomenon. As depicted earlier, EA models can be represented by different viewpoints, which are projections of the EA model with a certain intention

[3] See http://www.archimatetool.com.

[Lan17]. The Open Group defines a set of standard viewpoints that summarize common utilization of the viewpoint concept [The15]. Before demonstrating our results, we shortly explain the individual EA models at hand. They were acquainted during a project, which is located in the financial domain. The project aims to develop a reference model that guides financial institutes how to effectively and efficiently implement a compliance organization into their organizational structures. Therefore, the reference model is based on the structure of enterprise architectures. The individual models we used for applying the MCC approach consider how financial institutes identify new industrial customers in order to comply with the German Money Laundering Act [Ger08]. The models were gathered by dint of 16 structured interviews with responsible persons from the particular institutes. Afterwards, all interviews were transferred to EA models using the same modeling structure and guidelines, which was done according to Lankhorst [Lan17]. Each individual EA model was structured by six different ArchiMate viewpoints, that displayed different aspects of the EA models. In the following we concentrate on one specific viewpoint of these resulting 16 individual EA models – the "Oboarding Procedure". All activities described in section 3.1 were performed for each viewpoint, which resulted in the final reference model for industrial customer identification.

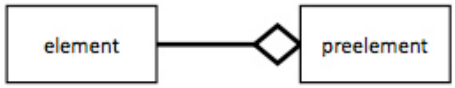
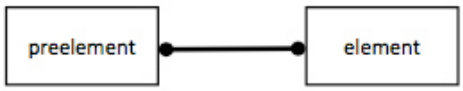
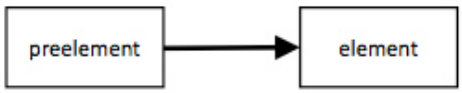
3.1 Applying MCC for inductive R-EA development

Before describe the MCC application we first want to explain the viewpoint of the individual models we use for it. Therefore, we use the ArchiMate standard viewpoint *business process viewpoints*, which intends to reveal main activities, its flow and related responsibilities in a financial institute when new industrial customers are identified. We call this viewpoint "*Onboarding Procedure"*. We therefore adjusted the standard viewpoint to our purposes and used the following model elements: *business function* (grouping behavior), *business event* (something that happens and influences behavior) and *business role* (the responsibility for performing a behavior). These ArchiMate elements can be related to each other by dint of different relationship types: *assignment relation* (a role is assigned to a function), *triggering relation* (an event or function triggers another function) and *aggregation relation* (a function groups other functions).

In order to enable the applicability of the MCC to the EA model viewpoint, we made the following adjustments:

- In contrast to EPCs, EA models have a variety of relation types, from which not all clearly define that one element is a preelement of another. Since [Ard13] require this from a relation, we define a preelement for each ArchiMate relation type. Tab. 1. provides an extraction of these consideration due to space limitations. We further differentiated between the elements that take part in the relationship, e.g. a business role is the preelement when being assigned to a business process or function.

- EA models do not follow such a strict control flow like EPC models. Thus, we changed *cost(mov)* from 5 to 2. While EPC models require a strict order of elements, EA models only do partially.
- In line with [Ard13] we assume, that identical model elements of the individual EA models have the identical label. This was ensured, since we firstly compiled a model element library when identifying new elements and developed each EA model from this library.

Connector Type	*Visualization*
Aggregation Relation (preelement aggregates element)	
Assignment Relation (preelement is assigned to element)	
Triggering Relation (preelement triggers element)	

Tab. 1: Assigning preelements to used ArchiMate relations

After these pre-adjustments the three steps of the MCC's algorithm were performed. This happened completely manually, since no tool was accessible or implemented for this endeavor. In Step (1) of the MCC the *RelationsSet* was initialized by traversing all 16 individual viewpoints and identifying all existing relationships in the EA models. For each relationship identified its frequency of occurrence (*f(relation)*) and its elements' frequency of occurrence (*f(element)*) was calculated. On this basis, the *costValue* for each relation was initially calculated. This was done using Excel sheets. In Step (2) the MCC loop for integrating relevant model elements into the *ReferenceModelRelationsSet* was traversed. Initially, we defined the threshold value with 50%, i.e. 0,5. We decided so in order to only included model elements, that were mentioned by at least every second financial institute. After interpreting the final *RelationsSet* we then decided to drop the threshold value to 30%, since no business role would have been included into the reference model. This is due to the high diversification of organizational structure in the different institutes. The resulting *RelationsSet* is shown in Tab. 2 . The entries above the bold line indicate all relations, that were integrated into the *ReferenceModelRelationsSet*, which resulted in the reference model. The table shows the round of MCC iteration, the element name, its preelement and the respective relation type as well as *f(element), f(relation)* and *costValue*.

Round	element	preelement	relation	f(element)	f(relation)	costValue
1	New Industrial Customer	(null)	---	0,93	0,93	9,27
2	Customer Identification	New Industrial Customer	triggering	1	0,93	9,8
3	Due Diligence	Customer Identification	triggering	1	0,93	9,8
4	Assessment of Customer Relation	Due Diligence	triggering	1	1	10
5	Customer Due Diligence (CDD)	Due Diligence	aggregation	1	1	10
6	Rejection of Customer	Assessment of Customer Relation	triggering	1	0,93	9,8
7	Acceptance of Customer	Assessment of Customer Relation	triggering	1	0,93	9,8
8	Conduction of Identification (Legal Person)	Customer Identification	aggregation	0,93	0,93	9,27
9	PEP-Screening	Assessment of Customer Relation	aggregation	0,93	0,93	9,27
10	Sanctions Screening	Assessment of Customer Relation	aggregation	0,93	0,93	9,27
11	Conduction of Identification (Natural Person)	Customer Identification	aggregation	0,87	0,87	8,53
12	Verification of Customer Data	Customer Identification	aggregation	0,8	0,8	7,8
13	Enhanced Due Diligence (EDD)	Due Diligence	aggregation	0,8	0,8	7,8
14	Simplified Due Diligence (SDD)	Due Diligence	aggregation	0,8	0,8	7,8
15	Risk Assessment of Customer	Assessment of Customer Relation	aggregation	0,8	0,73	7,6
16	Due Diligence	Risk Assessment of Customer	triggering	1	0,07	7,2
17	New Deputy of Existing Customer	(null)	---	0,6	0,6	5,6
18	Customer Identification	New Deputy of Existing Customer	triggering	1	0,53	8,6
19	Interest of Customer in Product	(null)	---	0,6	0,6	5,6
20	Customer Identifiaction	Interest of Customer in Product	triggering	1	0,53	8,6
21	Risk Assessment of Customer	Customer Identification	triggering	0,73	0,07	5,07
22	Regular Customer Monitoring	(null)	---	0,53	0,53	4,87
23	Customer Identification	Regular Customer Monitoring	triggering	1	0,4	8,2
24	Due Diligence	Regular Customer Monitoring	triggering	1	0,07	7,2
25	Product Specific Identification	Customer Identification	aggregation	0,47	0,47	4,13
26	Employee Compliance	Assessment of Customer Relation	assignment	0,4	0,33	3,2
27	Customer Risk assessed	Assessment of Customer Relation	aggregation	0,4	0,33	3,2
28	Employee Compliance	Due Diligence	assignment	0,4	0,27	3
29	Anti Money Laundering Officer	Due Diligence	assignment	0,33	0,2	2,27
30	Anti Money Laundering Officer	Assessment of Customer Relation	assignment	0,33	0,2	2,27
31	Customer Account Manager	Due Diligence	assignment	0,27	0,27	1,93
32	Anti Money Laundering Officer	PEP-Screening	assignment	0,33	0,07	1,87
33	Anti Money Laundering Officer	Sanctions Screening	assignment	0,33	0,07	1,87
34	Customer Account Manager	Customer Identification	assignment	0,27	0,13	1,53
35	Customer Account Manager	Assessment of Customer Relation	assignment	0,27	0,07	1,33
36	Customer Account Manager	Risk Assessment of Customer	assignment	0,27	0,07	1,33
37	Corporate Account Officer	Customer Identification	assignment	0,2	0,2	1,2
38	Employee Back Office	Customer Identification	assignment	0,2	0,2	1,2
39	Chief Compliance Officer	Due Diligence	assignment	0,2	0,13	1
40	Chief Compliance Officer	Assessment of Customer Relation	assignment	0,2	0,13	1
41	Decision over Customer Relation	Assessment of Customer Relation	aggregation	0,2	0,13	1
42	Rejection of Customer	Decision over Customer Relation	triggering	1	0,13	7,4
43	Rejection of Customer	Decision over Customer Relation	triggering	1	0,13	7,4
44	Customer Risk assessed	Decision over Customer Relation	triggering	0,4	0,07	2,4

Tab. 2: The final RelationsSet for the viewpoint "Onboarding Procedure"

In the application of Step (3) we modeled the resulting EA model viewpoint based on the resulting *ReferenceModelRelationsSet* from the previous step. The resulting ArchiMate model was then further analyzes, since the MCC approach may exclude relevant model elements. This was the case for several business roles like the anti-money laundering officer. These model elements were found by further investigating the interviews' transcripts as well as other literature like the German law from [Ger08]. The resulting reference model is shown in Fig. 1. To shortly explain the resulting reference model, one can see several functions the onboarding procedure consists of, namely the customer identification, due diligence and the assessment of the customer relation. Each function

aggregates sub-functions, which are not explained here in more detail. Customer Account Manager, Anti-Money Laundering Officer and Compliance Employee as well as the Chief Compliance Officer are assigned to the main functions. The customer identification is triggered by different events and the assessment of the customer relation triggers three different events.

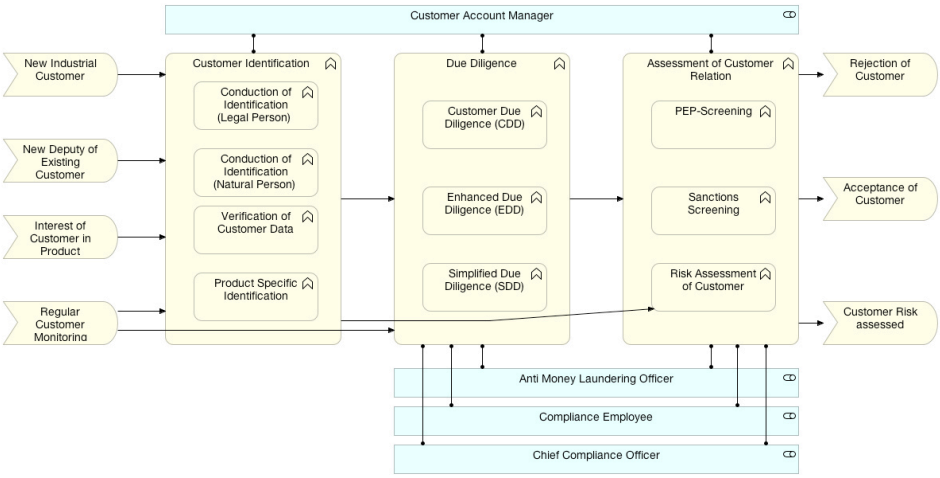


Fig. 1: Resulting Reference Model for Viewpoint "Onboarding Procedure"

4 Conclusion

In order to facilitate the inductive development of reference enterprise architectures, our work applies the “Minimal Cost of Change” approach by Ardalani et al., which abstracts from individual process models to a reference process model based on the idea of a minimized graph edit distance [Ard13]. Although initially developed for the business process domain, our work shows, that it can be applied to EA models by dint of several adjustments of the approach itself and the definition of EA models (without change EA model structure itself). The main findings are as follows: EA models do not share the strict control flow order like process models and define much more types of interrelations among the EA model elements. Thus, each type has to be investigated how to be processed during the MCC application. Further, EA models are represented by a set of viewpoints. Consequently, the development of a reference enterprise architecture requires several MCC iterations, each for one viewpoint. Another aspect is, that the costs for inserting, moving and deleting have a different influence when developing reference models in the EA domain. All in all, we assess the MMC approach applicable to the inductive development of a reference enterprise architecture. Still, there are many aspects to be considered in future research. EA model relations should thoroughly be investigated - the role of preelements as well as whether the costs of change differ

among the relation types. Further, the definition of thresholds currently is very vague and it needs to be discussed whether its value should change between different EA viewpoints. Like for business process models, a tool that implements the MCC approach for EAM would support the development process. Likewise to the limitations mentioned in [Ard13] the integration of semantic measurement methods when calculating the frequency of occurrence of a model element in the pool would enhance the method. From a more general perspective on this topic other abstraction techniques, e.g. the ones mentioned in [RFL13], should be investigated regarding their applicability to EAM, too.

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Comparison of Business Model Development Frameworks with regard to IoT

Martin Kinitzki[1], Dieter Hertweck[2]

Abstract: With the Internet of Things being one of the most discussed trends in the computer world lately, many organizations find themselves struggling with the great paradigm shift and thus the implementation of IoT on a strategic level. The Ignite methodology as a part of the Enterprise-IoT project promises to support organizations with these strategic issues as it combines best practices with expert knowledge from diverse industries helping to create a better understanding of how to transform into an IoT driven business. A framework that is introduced within the context of IoT business model development is the Bosch IoT Business Model Builder. In this study the provided framework is compared to the Osterwalder Business Model Canvas and the St. Gallen Business Model Navigator, the most commonly used and referenced frameworks according to a quantitative literature analysis.

Keywords: Internet of things, IoT, business model, value proposition

1 Introduction

The Internet of Things (IoT) trend is sprouting up just as the amount of use cases arising from it. As the probably most discussed trend in the computer world lately, most consider the Internet of Things the next web revolution. With all the new chances promised to companies, ignoring it might put organizations at risk of falling behind the competition [GaFC13]. When it comes to the implementation of IoT into business strategy, many companies struggle as it entails a great paradigm shift. The Ignite methodology promises to help with these strategic issues as it unites best practices from diverse industries with expert knowledge and derives recommendations for the top level.

The objective of this study is to introduce the strategy execution part of Ignite and answer the research question on how the framework for IoT business model development compares to established frameworks with a matrix of criteria as the result. For this purpose, it refers to the most recent literature as well as the most commonly used and referenced frameworks. Due to the fact of the project being a work in progress, there will only be a short overview given of the methodology and the discussed frameworks. The focus is put on the areas of IoT Strategy, IoT Opportunity Identification and Management and the IoT Business Model Development.

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2 Methodology

In order to focus on answering the research question, a systematic literature analysis was conducted. The underlying method was adapted from Webster und Watson [2002]. Relevant literature was captured from (a) ACM; (b) IEEE and (c) SpringerLink. The search strings used in combinations are presented in Table 1.

In order to set the focus on the latest findings, we only considered literature published since 2012. Whenever possible, a filter criteria restricting results to scientific papers and disciplines related to management or computer science was applied.

Search keyword
'internet' ∧ 'things'
'ubiquitous' ∧ 'computing'
'business' ∧ 'model' ∧ ('canvas' ∨ 'development' ∨ 'framework')
'idea' ∧ 'generation'
'business' ∧ 'opportunity' ∧ identification

Tab. 3: Search strings for the database research

After removing duplicates and narrowing down the results, the contents were pre-examined in a first content-related evaluation based on titles and abstracts. As a last step in the process the cross references were checked and appropriate results were added to the reference library. Finally, the remaining literature was analyzed in full detail in order to answer the raised research question. For individual results on each search execution and keyword combination per database there is a table to be found in the appendix of this paper.

3 Theoretical Foundation

3.1 Ignite project

Although the term of the Internet of Things is broadly used, there is no common definition [WoFl15]. It mostly depends on the perspective from which it is viewed – whether the connected things themselves, the protocols or the semantic challenges are put into focus [WoFl15]. The definition of the Internet of Things used in this term paper is more abstract and describes the vision of the physical and digital worlds becoming one as a result of smart objects being connected through the Internet [CoEk11, FlWW15]. The idea goes back to the early 90s with Weiser visioning the Ubiquitous Computing [Weis93] and has been developed further over the years with the term of Pervasive Computing [ECPS02, Saty01] as the precursor to the Internet of Things.

Ignite represents a methodology based on best practices from the Enterprise IoT project driven by Robert Bosch GmbH. Enterprise IoT holds a set of analyzed use cases from

various industries in cooperation with certain branch-specific experts with the goal to develop IoT best practices and make them available as an open framework. It is supposed to support the management of the transition towards IoT-based business models. Hereby the strategy definition and management at enterprise level as well as the solution delivery and implementation at project level are covered. Ignite consists of two areas dealing with the following aspects [Ente15a]: a) Strategy Execution: Definition and management of an IoT strategy and portfolio as well as the preparation for IoT adoption and b) Solution Delivery: Planning and execution of IoT projects.

3.2 Examined Ignite modules

Entering the Internet of Things, every company is forced to ask itself how far to go when the entailed paradigm shift is concerned. The Ignite Strategy Execution is supposed to help answering this question by creating a better understanding of how the transformation into an IoT driven business should look like and how a portfolio of IoT opportunities has to be managed before finally being executed with the result of new business models [Ente15b]. The strategy execution part of Ignite is divided into six areas, shortly described in the following.

IoT Strategy: The IoT strategy, just like any business strategy, contains a vision as well as goals and guiding principles. Is also describes strategic alliances and partner ecosystems that should be developed. The portfolio management of IoT opportunities and projects just as budget management are part of the IoT strategy, too.

IoT Opportunity Identification and Management: The IoT Opportunity Identification covers the generation of innovative ideas within the organization from which new business models are derived later in the process. Idea refinement as well as the development of the final business model is covered in IoT Opportunity Management. Detailed business models based on the most promising ideas are created and their feasibility is analyzed.

Initiation: The initiation stage describes the phase of chosen opportunities becoming initiatives, ran as internal projects, spin-offs or even merger and acquisition projects. Internal projects interface with the IoT-Ignite Solution Delivery methodology.

IoT Center of Excellence: The goal of an IoT Center of Excellence is to accelerate new projects by providing consulting and support with the knowledge based on projects from the past.

IoT Platform: The IoT Platform represents a platform on which IoT projects are developed. It usually is shared and includes connectivity solutions as well as technical and functional standards.

The development of these elements to full extent should not be regarded an obligation for every organization. It rather depends on several factors like whether it is executed by

a start-up company at early stage or how well established the strategy and portfolio management already are. In any case it will be necessary to examine the current state of structures and processes in order to identify the need for adaptation [Ente15b].

3.3 IoT Strategy

When defining an IoT Strategy, an organization has to decide how far it wants to move towards the Internet of Things trend. The answer to this question will most likely vary depending on factors like industry, grade of diversification or the force of competition [Ente15c]. According to the best practices the methodology is derived from, it is inevitable to explicitly articulate vision, goals and guiding principles based on these questions and their answers before developing IoT business models [Ente15c]. The following examples are based on the IoT Strategy Execution as described in Ignite.

Vision: Company X will transform itself from a pure product business into a market leading provider of connected industrial services.

Goals: In the product areas P, Q, and R, we will reduce maintenance costs by X % based on connected services.

Guiding principles: Company X will establish an internal, IoT-focused, open innovation program in combination with a strategic value chain analysis to identify key opportunities.

3.4 IoT Opportunity Identification and Management

After defining the overall strategy, the concrete opportunities have to be determined. In order to achieve that, the types of opportunities in the context of IoT have to be assessed in the first place. IoT-Ignite differentiates between new business opportunities and internal improvement opportunities [Ente15d, Ente15e].

When it comes to the generation of innovative ideas, there are two different ways mentioned in the methodology: the open idea generation as a green field approach and a structured idea generation with the evolvement of ideas within a given context. The influence of the idea generation method on the creativity of solutions has been researched by Chulvi et al [CGMA13]. According to Ignite it is highly recommended to set up incentive programs in order to encourage employees to involve themselves in the improvement of existing processes as well as the creation of new solutions. Every idea that seems promising requires further refinement to finally evolve into a business opportunity or, later on, a concrete business model.

As there is no common definition on what exactly a business model contains, this study refers to the concept of Gassmann et al. [GaFC13] in which a business model is reduced to four dimensions as depicted in Figure 3. In short: ***Who*** *is the customer*, ***What*** *is the offer*, ***How*** *is the value proposition distributed* and *what is the* ***value*** *for the business?*

The concept is clearly centered on the business model's customer value proposition (CVP) [JoCK08, Oste04, Teec10]. The value proposition is utterly important when examining the suitability of a business model within the Internet of Things as it describes bundles of products and services that are valuable to the customer (e.g. data obtained from connected devices) [Oste04]. For that reason, the systemic frameworks are considered less appropriate as they tend to be too generic and abstract [CaSW14] compared to the value based ones discussed in this term paper.

When the idea refinement has been passed and the opportunity is finally defined, the next step can be performed – the development of an IoT business model. A framework for the development provided in Ignite is the Bosch IoT Business Model Builder. Hereinafter this framework as well as the established St. Gallen Business Model Navigator and the Osterwalder Business Model Canvas will be set against each other.

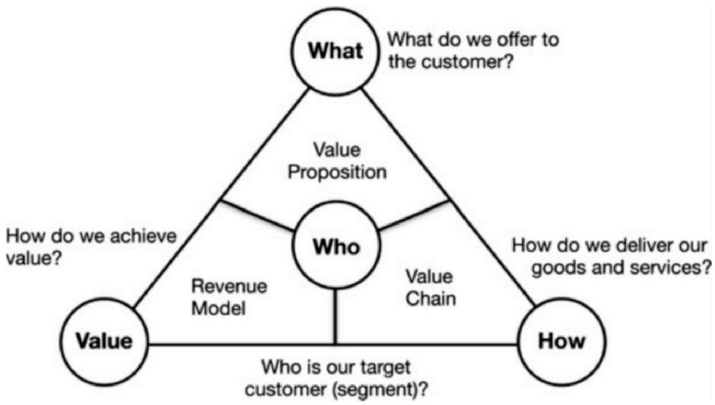

Fig. 2: Customer Value Proposition [GaFC13]

4 Comparison of business model development frameworks

The presentation of the Bosch IoT Business Model Builder in Ignite inevitably raises the question whether already established frameworks could not also fulfill the intended purpose and where the differences and benefits are.

In the following the surveyed frameworks will be introduced and an explanation on the selection will be given.

4.1 Surveyed frameworks

After the scientific appropriateness was ensured, the frameworks mentioned in the examined literature were used for a quantitative analysis in order to determine the most referenced frameworks. The analysis was carried out using the Google Scholar search engine as it performs searches on multiple databases. As a result, the Osterwalder Business Model Canvas and the St. Gallen Business Model Navigator appear to be the most referenced frameworks and therefore are used for the comparison (see Tab. 7).

Bosch IoT Business Model Builder: The Bosch IoT Business Model Builder is a framework for the development of IoT based business models. It especially emphasizes on the peculiarities of the Internet of Things like a clearly articulated partner value proposition (PVP) or the significance of data derived from connected things and the services built on top [Robe15].

St. Gallen Business Model Navigator: The St. Gallen Business Model Navigator is the result of more than five years of extensive research by the University of St. Gallen in which 250 business models from different industries within the last 25 years have been analyzed and 55 recurring business models have been identified [GaFC13]. Based on this knowledge, the developed framework utilizes the power of recombination of these patterns for business model generation [GaFC13].

Osterwalder Business Model Canvas: The Osterwalder Business Model Canvas serves as a tool used to assemble and discuss business models composed of building blocks [OPSM10]. These building blocks cover the four main business areas: customers, offer, infrastructure and financial viability [OPSM10]. According to Osterwalder, Pigneur et al. these building blocks are the best way to properly describe a business model [OPSM10].

4.2 Definition of comparison criteria

The criteria for comparison are derived from the process of business model development as it is explained in the stated literature and complemented with the peculiarities deduced from the Ignite process. The literature that was selected for the definition of criteria represents the most recent and often cited literature in the area of business model development and covers the frameworks that are used for comparison.

The process steps can be concentrated in the three major phases: Initiation, Understanding and Design. Within the initiation phase all steps from the analysis of the current situation over the first idea to the detailed objectives are covered. In the understanding phase the value proposition as well as value-added elements are defined. The last phase of the development process includes the financial perspective as well as the final selection itself. With the conclusion of the final phase, the implementation of the business model is ready to begin, which is covered by the ‘Initiation’ phase of Ignite Strategy Execution.

Phase	Process Step	Criterion	[GaFC13]	[JoCK08]	[OPSM10]	[Robe15]	[TBGF14]
Initiation	Current Business Model Analysis	Situation analysis	X		X		X
		Interaction analysis	X	X	X		
		Risk analysis	X	X	X		X
	Mobilization	Motivation		X	X		
		Involvement of employees from different functions	X	X	X		
		Involvement of industry outsiders	X		X		
		Knowledge allocation		X	X		X
	Ideation	Creative methods (eg. set cards)	X	X	X		
		Recombination of existing concepts and model patterns	X				
		Expert interviews		X	X		X
	Strategic embedding	IoT-Strategy alignment				X	
		Goal definition (short-term/mid-term)			X	X	X
		Differentiator definition		X	X	X	
Understanding	Dimensional analysis (CVP / PVP)	Customer definition (Who)	X	X	X	X	X
		CVP definition (What)	X	X	X	X	X
		CVP distribution (How)	X	X	X	X	X
		Company value definition (Value)	X	X	X		X
		PVP definition	X		X	X	
		PVP distribution	X	X	X	X	
	Value-added analysis	Data from connected things				X	X
		Information				X	
		Services			X	X	
		Technology				X	
		Know-How				X	
Design	Monetary consideration	Cost structure definition	X	X	X		
		Revenue mechanism definition	X		X		X
	Non-monetary consideration	Market entering				X	
		Technology access				X	
	Selection	Prototyping	X		X		X
		Testing			X		X
		Selection	X		X		X

Tab. 4: List of criteria derived from literature

4.3 Framework comparison

The criteria matrix introduced before is now used as the base for the comparison of business model development frameworks. As the matrix represents a comparison and not an evaluation, a rather simple scale is introduced, providing information on how the criteria are covered by the frameworks. '+': covered by framework; '(+)': partially covered by framework and '-': not covered by framework.

Phase	Process Step	Criterion	Bosch	BMC	SGU
Initiation	Current Business Model Analysis	Situation analysis	-	+	+
		Interaction analysis	-	+	+
		Risk analysis	-	+	+
	Mobilization	Motivation	-	+	(+)
		Involvement of employees from different functions	(+)	+	+
		Involvement of industry outsiders	-	+	+
		Knowledge allocation	-	+	(+)
	Ideation	Creative methods (e.g. set cards)	-	+	+
		Recombination of existing concepts and model patterns	-	-	+
		Expert interviews	-	+	(+)
	Strategic embedding	IoT-Strategy alignment	+	(+)	-
		Goal definition (short-term/mid-term)	+	+	-
		Differentiator definition	+	+	(+)
Understanding	Dimensional analysis (CVP / PVP)	Customer definition (Who)	+	+	+
		CVP definition (What)	+	+	+
		CVP distribution (How)	+	+	+
		Company value definition (Value)	-	+	+
		PVP definition	+	+	+
		PVP distribution	+	+	+
	Value-added analysis	Data from connected things	+	-	-
		Information	+	-	-
		Services	+	+	(+)
		Technology	+	-	-
		Know-How	+	(+)	-
Design	Monetary consideration	Cost structure definition	(+)	+	+
		Revenue mechanism definition	-	+	+
	Non-monetary consideration	Market entering	+	-	-
		Technology access	+	-	-
	Selection	Prototyping	-	+	+
		Testing	-	+	-
		Selection	-	+	+

Tab. 5: Comparison of frameworks

5 Conclusion and future work

The comparison of business model development frameworks as the main result of this term paper shows that the Bosch IoT Business Model Builder as it is described in the Ignite methodology should not be considered a stand-alone framework for the development of IoT-specific business models as it lacks significant aspects of the development process, especially in the initiation and design phases. It should rather be regarded as an extension to the established frameworks. When comparing the frameworks, it is apparent that with the combination of the frameworks by Bosch and Osterwalder nearly every criterion is covered. Only the 'recombination of existing concepts and model patterns' is a unique feature of the St. Gallen Business Model Navigator as it more or less describes the core of the framework itself.

From the examination of the Ignite Strategy Execution methodology and the comparison of frameworks several questions emanate that seem worth further research and discussion: a) How can frameworks that are already being used in organizations subsequently be adjusted to support the development of IoT business models?; b) How exactly has an organization's architecture to be changed in order to successfully implement IoT business models?

Appendix

SpringerLink				
Keywords	**Time**	**Attributes**	**Results**	**Selected**
Internet + of + things	2012 - 2015	articles-only / title-only / free-only	72	12
business + model + development	-	title-only / free-only	4	3
business + model + canvas	2012 - 2015	articles-only / discipline-filter / free-only	58	13
idea + generation	-	title-only / free-only	42	7
business + opportunity + identification	2014 - 2015	articles-only / discipline-filter / free-only	177	5

ACM				
Keywords	**Time**	**Attributes**	**Results**	**Selected**
Internet + of + things	2012 - 2015	articles-only / title-only / free-only	131	3
business + model + development	2012 - 2015	articles-only / abstract-only / free-only	156	2

IEEE				
Keywords	**Time**	**Attributes**	**Results**	**Selected**
Internet + of + things	2012 - 2015	articles-only / title-only / free-only	53	5
business + model + development	2012 - 2015	articles-only / title-only / free-only	72	4
business + model + canvas	2012 - 2015	articles-only / title-only / free-only	5	0
idea + generation	2012 - 2015	articles-only / title-only / free-only	66	2
business + opportunity + identification	2012 - 2015	abstracts-only / title-only / free-only	64	5

Tab. 6: Results of literature search

Google Scholar		
Keywords	**Founder**	**References**
Osterwalder Business Model Canvas	Osterwalder	3430
St. Gallen Business Model Navigator	University of St. Gallen	833
Component Business Model	IBM	663
V4 Business Model Framework	Al-Debei & Avison	109

Tab. 7: Quantitative analysis of business model development frameworks

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Open Integration of Digital Architecture Models for Micro-granular Systems and Services

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Abstract: The digital transformation of our society changes the way we live, work, learn, communicate, and collaborate. This disruptive change drive current and next information processes and systems that are important business enablers for the context of digitization since years. Our aim is to support flexibility and agile transformations for both business domains and related information technology with more flexible enterprise information systems through adaptation and evolution of digital architectures. The present research paper investigates the continuous bottom-up integration of micro-granular architectures for a huge amount of dynamically growing systems and services, like Microservices and the Internet of Things, as part of a new composed digital architecture. To integrate micro-granular architecture models into living architectural model versions we are extending enterprise architecture reference models by state of art elements for agile architectural engineering to support digital products, services, and processes.

Keywords: Digital Transformation, Digital Enterprise Architecture, Internet of Things, Microservices, Architecture Metamodel Integration Method, Adaptable Services and Systems

1 Introduction

Information, data and knowledge are fundamental concepts of our everyday activities and are driving the digital transformation of our global society. Smart connected products and services expand physical components from their traditional core by adding information and connectivity services using the Internet. Digitized products and services amplify the basic value and capabilities and offer exponentially expanding opportunities [PH14]. Digitization enables human beings and autonomous objects to collaborate beyond their local context using digital technologies [Sc15]. Information, data, and knowledge become more important as fundamental concepts of our everyday activities. The exchange of information enables more far-reaching and better decisions of human beings, and intelligent objects. Social networks, smart devices, and intelligent cars are part of a wave of digital economy with digital products, services, and processes driving an information-driven vision.

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The Internet of Things (IoT) [PC15], [Uc11], and [AIM10] connects a large number of physical devices to each other using wireless data communication and interaction based on the Internet as a global communication environment. Additionally, we have to consider some challenging aspects of the overall architecture [Zi15] from base technologies: cyber-physical systems, social networks, big data with analytics, services, and cloud computing. Typical examples for the next wave of digitization are smart enterprise networks, smart cars, smart industries, and smart portable devices.

The fast moving process of digitization [Sc15] demands flexibility to adapt to rapidly changing business requirements and newly emerging business opportunities. To be able to handle the increased velocity and pressure, a lot of software developing companies have switched to integrate Microservice Architectures [BZ16]. Applications built this way consist of several fine-grained services that are independently scalable and deployable.

Digitization [Sc15] requires the appropriate alignment of business models and digital technologies for new digital strategies and solutions, as same as for their digital transformation. Unfortunately, the current state of art and practice of enterprise architecture lacks an integral understanding and decision management when integrating a huge amount of micro-granular systems and services, like Microservices and Internet of Things, in the context of digital transformation and evolution of architectures. Our goal is to extend previous approaches of quite static enterprise architecture to fit for flexible and adaptive digitization of new products and services. This goal shall be achieved by introducing suitable mechanisms for collaborative architectural engineering and integration of micro-granular architectures.

Our research paper investigates specific research questions, which are answered by following main sections:

RQ1: *How should a digital architecture be holistically tailored to openly integrate a huge amount of micro-granular systems and services, like Internet of Things and Microservices architectures?*

RQ2: *What are fundamental elements of architectural models for Internet of Things and Microservices architectures?*

RQ3: *How can we integrate micro-granular architectural models and what are architectural implications for a decision-controlled composition of micro-granular elements, like Internet of Things and Microservices?*

The following Section 2 explains the setting of a digital enterprise architecture and links it with a specific architectural decision environment. Section 3 focusses on architecting the Internet of Things, while Section 4 presents an architectural approach to integrate Microservices. In Section 5 we are extending architectural integration mechanisms for an open world to be able to a-posteriori integrate a huge amount of partial metamodels for micro-granular systems and services. Finally, we summarize in Section 6 our research findings and limitations, and sketching our next steps.

2 Digital Enterprise Architecture

The discipline of Enterprise Architecture Management (EAM) [La13], [Be12] defines today with frameworks, standards [To11] and [Ar16], tools and practical expertise a quite large set of different views and perspectives. This abundance of ingredients for EAM leads in practice often to a "heavy EA" approach, which is not always feasible enough to support practical initiatives of software development and maintenance within a living and changing business and system environment.

We argue in this paper that a new refocused service-oriented EA approach should be both holistic [Zi11] and [Zi13] and easily adaptable [Zi14] for practical support of software evolution and transformation of information systems in growing business and IT environments, which are based on new technologies like social software, big data, services & cloud computing, mobility platforms and systems, security systems, and semantics support. A Digital Architecture should support the digital transformation with new business models and technologies that are based on a large number of micro-structured digitization systems with their own micro-granular architectures like Internet of Things (IoT) [WSO15], mobility devices, or with Microservices [BZ16].

In this paper, we are extending our previous service-oriented enterprise architecture reference model for the context of digital transformations with Microservices and Internet of Things with decision making [JSZ15], which are supported by interactive functions of an EA cockpit [JS14]. Enterprise Services Architecture Reference Cube (ESARC) [Zi14] is our fundamental architectural reference model for an extended view on evolved micro-granular enterprise architectures (Fig. 1).

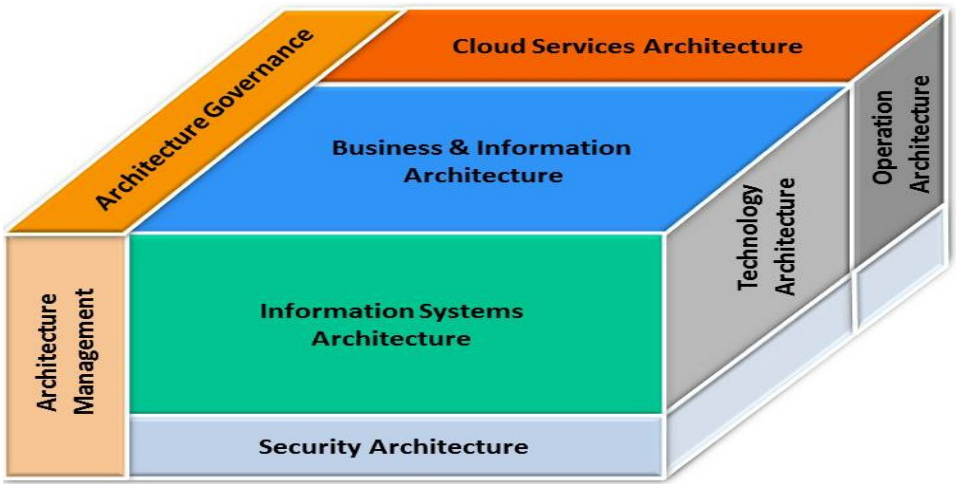

Fig. 1: Enterprise Services Architecture Reference Cube [Zi14][Zi15]

The new ESARC for digital products and services is more specific than existing architectural standards of EAM [To11], [Ar16] and uses eight integral architectural domains to provide a holistic classification model. While it is applicable for concrete architectural instantiations to support digital transformations, it still abstracts from a concrete business scenario or technologies. The Open Group Architecture Framework [12] provides the basic blueprint and structure for our extended service-oriented enterprise architecture domains.

In our current research, which extends the more fundamentally approach of a decision dashboard for Enterprise Architecture [Be12] and [La13], we are exploring how an Architecture Management Cockpit [JS14], [JSZ15] can be leveraged and extended to a Decision Support System (DSS) for digital architecture management. Our architecture cockpit in Fig. 2 implements a facility, which enables analytics and optimizations using multi-perspective interrelated viewpoints on the system under consideration. Each stakeholder taking part in a cockpit meeting can utilize a viewpoint that displays the relevant information. Viewpoints, which are applied simultaneously, are linked to each other in a such manner that the impact of a change performed in one view can be visualized in other views as well.

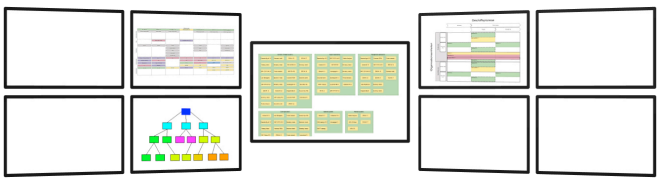

Fig. 2: Architecture Management Cockpit [JS14], [JSZ15]

Jugel et al. [JSZ15] present a collaborative approach for decision-making for architecture management. They identify decision making in such complex environment as a knowledge-intensive process reflecting the balance between decentral and central architectural decisions. Therefore, the collaborative approach presented is built based on methods and techniques of adaptive case management (ACM), as defined in [Sw10].

The ISO Standard 42010 [EH09] describes how the architecture of a system can be documented using architecture descriptions. The standard defines views, which are governed by viewpoints to address stakeholders' concerns and their information demands. Jugel et al. [JSZ15] introduce an annotation mechanism to add additional knowledge to an architecture description represented by an architectural model. In addition, [JSZ15] refines the viewpoint concept of [EH09] by dividing it into Atomic Viewpoint and Viewpoint Composition to model coherent viewpoints that can be applied simultaneously in an architecture cockpit with central and mobile. Architectural Issues and Decisions, were already introduced in the inspiring model of Plataniotis [Pl14]. Architectural decisions can be linked with architectural artifacts, decomposed, translated, and substituted into other decisions.

3 Architecting Internet of Things

The Internet of Things (IoT) fundamentally revolutionizes today's digital strategies with disruptive business operating models [WSO15], and holistic governance models [WR04] for both business and IT. With the huge diversity of Internet of Things technologies and products organizations have to leverage and extend previous enterprise architecture efforts to enable business value by integrating the Internet of Things into existing business and computational environments.

The Internet of Things [WSO15] connects a large number of physical devices to each other using wireless data communication and interaction, based on the Internet as a global communication environment. Real world objects are mapped into the virtual world. The interaction with mobile systems, collaboration support systems, and systems and services for big data and cloud environments is extended. Furthermore, the Internet of Things is an important foundation of Industry 4.0 [Sc15b] and adaptable digital enterprise architectures [PH14]. The Internet of Things, supports smart products as well as their production enables enterprises to create customer-oriented products in a flexible manner. Devices, as well as human and software agents, interact and transmit data to perform specific tasks part of sophisticated business or technical processes [Uc11], [PC15].

The Internet of Things embraces not only a things-oriented vision [AIM10] but also an Internet-oriented and a Semantic-oriented one. A cloud-centric vision for architectural thinking of a ubiquitous sensing environment is provided by [Gu13]. The typical setting includes a cloud-based server architecture, which enables interaction and supports remote data management and calculations. By these means, the Internet of Things integrates software and services into digitized value chains.

A layered Reference Architecture for the Internet of Things is described in [WSO15] and (Fig. 3), where layers can be implemented using suitable technologies.

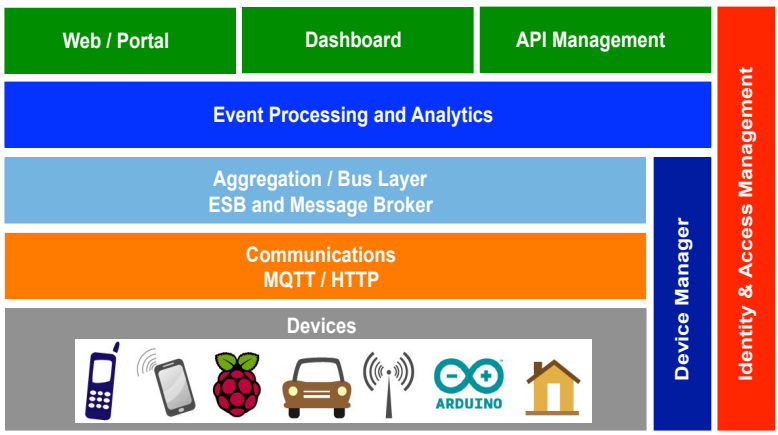

Fig. 3. Internet of Things Reference Architecture [WSO15]

From the inherent connection of a magnitude of devices, which are crossing the Internet over firewalls and other obstacles, are resulting a set of generic requirements [Ga12]. Because of so many and dynamically growing numbers of devices we need an architecture for scalability. Typically, we additionally need a high-availability approach in a 24x7 timeframe, with deployment and auto-switching across cooperating datacenters in the case of disasters and high scalable processing demands. The Internet of Thing architecture has to support automatically managed updates and remotely managed devices. Typically, often connected devices collect and analyze personal or security relevant data. Therefore, it should be mandatory to support identity management, access control and security management on different levels: from the connected devices through the holistic controlled environment.

The contribution from [PC15] considers a role-specific development methodology and a development framework for the Internet of Things. The development framework specifies a set of modeling languages for a vocabulary language to be able to describe domain-specific features of an IoT-application, besides an architecture language for describing application-specific functionality and a deployment language for deployment features. Associated with programming language aspects are suitable automation techniques for code generation, and linking, to reduce the effort for developing and operating device-specific code. The metamodel for Internet of Things applications from [PC15] specifies elements of an Internet of Things architectural reference model like IoT resources of type: sensor, actuator, storage, and user interface. Base functionalities of IoT resources are handled by components in a service-oriented way by using computational services. Further Internet of Thing resources and their associated physical devices are differentiated in the context of locations and regions.

4 Architecting Microservices

The term Microservices became popular in the last years and refers to a fine-grained style of service-oriented architecture (SOA) applications combined with several DevOps elements. James Lewis and Martin Fowler define a Microservice Architecture [BZ16] as an approach for developing a single application from a suite of small services, each running in its own process and communicating with lightweight mechanisms, like HTTP. Microservices may additionally access NoSQL databases from on premise and optional Cloud environments.

These services are built around business capabilities and are independently deployable by an automated deployment pipeline. Typically, there is a bare minimum of centralized management of these services. Microservices may be written in different programming languages and can use different data storage technologies. As opposed to big monolithic applications, a single Microservice tries to represent a unit of functionality that is as small and coherent as possible. This unit of functionality or business capability is often referred to as a *bounded context*, a term that originates from Domain-Driven Design [Ev04].

However, Microservices also come with the need for a strong DevOps culture [Ne15] to handle the increased distribution level and deployment frequency. Moreover, while each single Microservice may be of reasonably low complexity compared to a monolithic application, the overall complexity of the system has not been reduced at all. Gary Olliffe [Ol15] distinguishes between the inner architecture and the outer architecture of Microservices (Fig. 4).

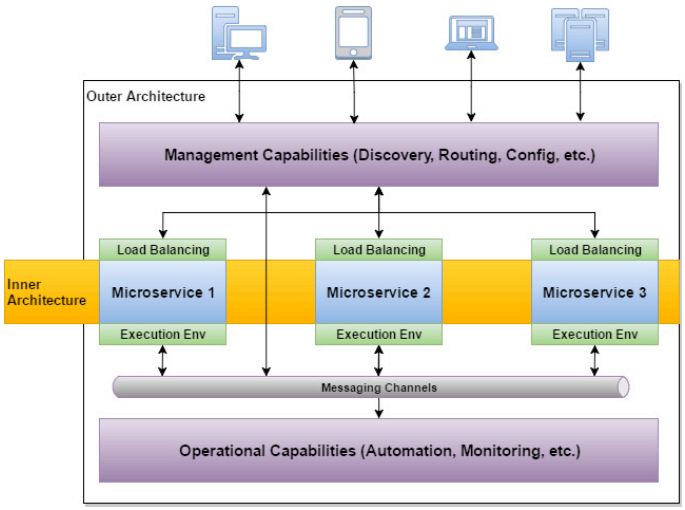

Fig. 4: Microservices Inner and Outer Architecture, based on [Ol15]

By splitting up a big monolith into more fine-grained independent services, you shift most of the hindering complexity from the inner architecture to the outer architecture, where inter-service communication, service discovery, or operational capabilities have to be handled. The greatest benefits that come with Microservices are the possibility to use the best-fitting technology for each *bounded context*. Typical examples are: increased application resilience (if one Microservice fails, the others may not be affected, at least if there is no chaining), independent and efficient scalability instead of replicating the complete monolith, and faster and easier deployment [Ne15]. Especially the last advantage is an important step towards agility of business and IT systems.

Enabling technological heterogeneity is usually considered an advantage of Microservices [BZ16] that allows the selection of the best tool for the job, reduces the possibility of lock-ins for outdated technology, and supports a culture of innovation and experimentation. However, Microservices also come with some risks for the organization. An explosion of technological diversity can quickly become overwhelming and unmanageable. Moreover, you are dependent on employees with the corresponding skills to handle these technologies and programming languages. This is why most organizations that use Microservice Architecture either provide some very basic standardization without limiting their teams' choices too much or encourage the use of only a certain technology subset by offering suitable tooling and infrastructure.

5 Architecture Metamodel Integration Method

Our current work extends our basic service-oriented enterprise architecture model from ESARC by integrating a huge amount of open architectural models of micro-granular systems and services, like IoT and Microservices. To be able to integrate a large amount of architectural resources efficiently we have developed ESAMI – Enterprise Services Architecture Metamodel Integration [Zi13], [Zi15], which is a correlation-based model integration approach for service-oriented enterprise architectures. It is a big challenge to continuously integrate numerous dynamically growing architectural descriptions from different microstructures with micro-granular architecture into a consistent digital architecture. To address this problem, we are currently formalizing small-decentralized mini-metamodels, models, and data of architectural microstructures, like Microservices and IoT into DEA-Mini-Models (Digital Enterprise Architecture Mini Model).

DEA-Mini-Models consists of partial DEA-Data, partial DEA-Models, and partial EA-Metamodel. They are associated with Microservices and/or objects from the Internet of Things. These structures are based on the Meta Object Facility (MOF) standard [MOF11] of the Object Management Group (OMG). The highest layer M3 represents abstract language concepts used in the lower M2 layer and is, therefore, the meta-metamodel layer. The next layer M2 is the metamodel integration layer and defines the language entities for M1 (e.g. models from UML, ArchiMate [Ar16], or OWL [OWL09]). These models are a structured representation of the lowest layer M0 that is formed by collected concrete data from real-world use cases.

By integrating DEA-Mini-Models micro-granular architectural cells (Fig. 5) for each relevant IoT object or Microservice, the integrated overall architectural metamodel becomes adaptable and can mostly be automatically synthesized by considering the integration context from a growing number of previous similar integrations. In the case of new integration patterns, we have to consider additional manual support.

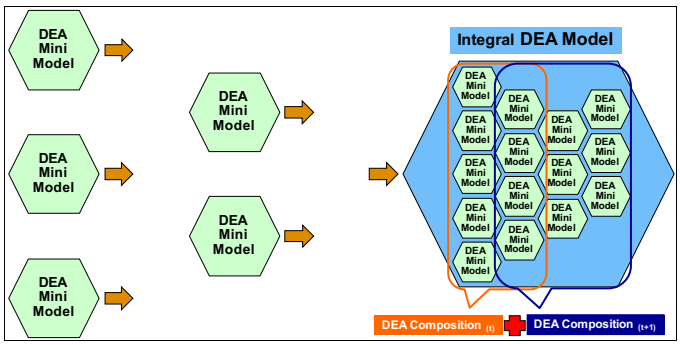

Fig. 5: Federation by Composition of DEA-Mini-Models [BZ16]

A DEA-Mini-Model covers partial EA-IoT-Data, partial EA-IoT-Models, and partial EA-IoT-Metamodels associated with main IoT objects like IoT-Resource, IoT-Device,

and IoT-Software-Component [PC15], and [WSO15]. The challenge of our current research is to federate these DEA-Mini-Models to an integral and dynamically growing DEA model and information base by promoting a mixed automatic and collaborative decision process [JSZ15] and [JS14]. We are currently extending model federation and transformation approaches [Tr15], [Fa12] by introducing semantic-supported architectural representations, from partial and federated ontologies [An13], [OWL09] and associate mapping rules with special inference mechanisms.

Fast changing technologies and markets usually drive the evolution of ecosystems. Therefore, we have extracted the idea of digital ecosystems from [Ti13] and linked this with main strategic drivers for system development and their evolution. Adaptation drives the survival of digital architectures, platforms and application ecosystems.

6 Conclusion

In this paper, we have identified the need for a bottom-up integration of a huge amount of dynamically growing micro-granular systems and services, like Microservices and the Internet of Things, as part of a new suited digital enterprise architecture. In order to support the digitization of products, services, and processes by integrating micro-granular architecture models for a living and holistic digital enterprise architecture model we have extended traditional enterprise architecture reference models by state of art elements for agile architectural engineering.

According to our research questions we have leveraged a new enterprise architecture approach to model a living digital enterprise architecture, which is in line with adaptive models and digital transformation mechanisms. We have extended in our work the new architectural integration context from the Internet of Things architecture and suppored Microservices for the digital transformation of products and services. Finally, we have extended our previous quite static enterprise architecture reference model to be able to integrate micro-granular systems and services, like Microservices and Internet of Things. This is a fundamental extension of our previous work on the ESARC reference model to be able to integrate through a continuously bottom-up approach a huge amount of micro-granular systems with own and heterogeneous local architectures.

We have additionally considered alternative approaches for the integration of large sets of divergent systems by introducing an open world modeling approach. Our approach has some limitations, which result from our original focus with manually working integration models for existing architectural metamodels assuming a closed word of a classical enterprise.

We are currently working on extended decision support mechanisms for an architectural cockpit for digital enterprise architectures and related engineering processes. Future work will extend both mechanisms for adaptation and flexible integration of digital enterprise architectures as well as decisional processes with rationales and explanations.

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Digital Transformation in Higher Education – The Role of Enterprise Architectures and Portals

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Abstract: Digital transformation is considered as one of the mega-trends in industry and the public sector. One of the sectors with potential for digital transformation is higher education in universities and university colleges. Many universities and schools developed digitization strategies and new kinds of offerings for their traditional target groups and for new, non-traditional target groups. However, digitization and digital strategies often are limited to digitizing the content of lectures and to opening access to education modules by offering them online. We argue that digitization strategies should include a wider focus and propose that enterprise architecture management could provide an important contribution in structuring digitization efforts and that enterprise or knowledge portals could play a role for implementing the strategies.

Keywords: Digital transformation, higher education, enterprise architecture, portal.

1 Introduction

Digital transformation is considered as one of the mega-trends in industry and the public sector. In general, digital transformation describes the shift from traditional (often physical) creation and delivery of customer value, including the operational procedures related to this, into the massive use of digital technologies which enhance or replace the traditional product or services with digitized ones. According to a white paper of the World Economic Forum [WEF16] digital transformation offers a huge potential of innovation in the magnitude of several trillion US$ and addresses industries (e.g. logistics, healthcare, automotive) and public sector applications (e.g. healthcare, government). One of the sectors with potential for digital transformation is higher education in university and university colleges. Many universities and schools developed digitization strategies and new kinds of offerings for their traditional target groups and for new, non-traditional target groups. However, digitization and digital strategies often are limited to digitizing the content of lectures and to opening access to education modules by offering them online. We argue that digitization strategies should include a wider focus and propose that enterprise architecture management could provide an important contribution in structuring digitization efforts and that enterprise or knowledge portals could play a role for implementing the strategies concerning educational services.

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The paper follows an explorative research approach by combining theories and findings from various sectors of research and applying them in higher education. Most of the work presented is based on an argumentative-deductive research approach. A case study from Rostock University serves as basis for illustrating the proposals and validating ideas.

The remainder of the paper is structured as follows: Section 2 presents the background for the research work from enterprise architecture management and portals. Section 3 discusses digital transformation in higher education and presents possible transformation strategies. Section 4 shows examples for using these strategies from a real world example using enter prise architectures as guiding means. Section 5 discusses the use of enterprise portals for strategy implementation. Section 6 summarizes findings and discusses future work.

2 Background

This section summarizes relevant background for our work from enterprise architecture management (section 2.1) and enterprise and knowledge portals (section 2.2).

2.1 Enterprise Architecture Management

In general, an EA captures and structures all relevant components for describing an enterprise, including the processes used for development of the EA as such [Ah12]. Research activities in EAM are manifold. The literature analysis included in [WK15] shows that elements of EAM [Bu10], process and principles [Jo04], and implementation drivers and strategies [Sa15] are among the frequently researched subjects. Furthermore there is work on architecture analysis [Jo07], decision making based on architectures [Jo04 and IT governance [Si10]. However, there is no specific focus on the integration of product-IT and EAM.

Of specific relevance for digital transformation are EAM frameworks identifying structures and dependencies in EA. In this context, TOGAF [TOG11] is considered by many researchers as industry standard and defines three different architectural levels which are visible in many other frameworks: The Business Architecture defines the business strategy, governance, organization and key business processes. The Information Architecture is divided into two sub-layers: Data Architecture and Application Architecture. The Data Architecture describes the structure of an organization's logical and physical data assets and data management resources. Its objective is to define the major types of data, necessary to support the business. Data Architecture is also called Information Architecture. The Application Architecture provides a blueprint for the individual application systems to be deployed, for their interactions and their relationships to the core business processes of an organization. The Technology Architecture describes the physical realization of an architectural solution. The logical

software and hardware capabilities, which are required to support the deployment of business, data, and application services, are also defined in this dimension [TOG11]. ArchiMate [TOG12] is a notation for modelling TOGAF.

2.2 Portals

A *portal* allows access to consistently integrate heterogeneous applications or data sources [DG02] and generally describes a Web application in which contents, services and functions are integrated [CC02]. *Enterprise portals* provide the user with personalized internal and external corporate information as the basis for business decisions [ST98]. In addition to the employees of the enterprise the customers and business partners are increasingly explicitly included in the portal. *Community Portals* address the need to structure and further develop contents that are available on the Internet for specific areas of interest. These interest communities are not based on any formal membership and are largely self-organizing. Examples are *Community Web Portals* [Sta00] and portals for *Communities of Practice* [Tur99].

A further group of portal terms results from using the portal contents and their structuring. *Information portals* provide the access to high quality information for particular target groups [Ag03]. The term *Semantic Portal* is usually used when formalized conceptual models, such as ontologies and related technologies of the Semantic Web are applied to support, for example, restructuring, presentation and navigation in portal contents. *Organisational Memory Systems* are IT systems that implement the knowledge base of an organisation while simultaneously supporting the use of the knowledge base [Leh98]. Knowledge portals [Sa05] are therefore to be regarded as Organisational Memory Systems provided individualization and process support are focused on organizational matters.

3 Digital Transformation in Higher Education

Our approach to analyse possible digital transformation paths in higher education is based on a general digital transformation model which is presented in section 3.1. Section 3.2 applies this general model and elaborates selected general digital transformation paths in higher education. Section 3.3 investigates which enterprise architecture layers are affected by the different approaches in order to identify tasks to be tackled in enterprise architecture management.

3.1 Digital Transformation

In many industrial domains, products and services traditionally are delivered based on physical infrastructures (e.g. shops, bank offices, service centres) or persons (e.g. sales agent, broker). Often, also the products are physical ones and the operational processes

are using physical support. Customers in many of these domains increasingly expect that apps, mobile services or services accompanying the products offer additional value for them, i.e. the providers of products or services have to decide how to improve the overall customer experience or their products. In this context, digital transformation describes the shift from traditional (often physical) creation and delivery of customer value, including the operational procedures related to this, into the use of digital technologies with the aim to enhance or replace the traditional product or services with digitized ones. In order to further investigate the digital transformation, we used a structural approach for analyzing digitization paths proposed in [BB11]. This approach considers two dimensions of potential digitization, the digitization of the product offered by a company and the digitization of the operational procedures for offering these products. In both dimensions, three steps are distinguished (see figure 1 a).

In the product dimension, these steps are to *enhance* (add complementary services to a product), *extend* (new product features by using digital components) or *redefine* products (newly designed products replacing the earlier generations). In the procedure dimension, the steps are *create* (new and IT-based operating capabilities), *leverage* (the new capabilities for more efficient procedures) and *integrate* (more efficient and traditional procedures).

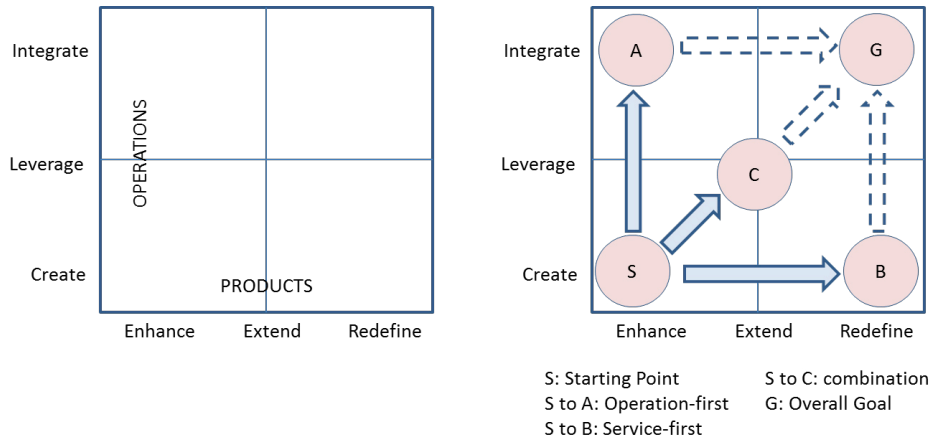

Fig. 1: Dimensions of the Digital Transformation approach [BB11]

3.2 Digital Transformation Paths in Higher Education

Assuming that the overall objective of digital transformation in higher education is to achieve a redefinition of education services and accompanying re-development of operational processes, there are at least three different possible paths which have to be considered:

- Service-first transformation focusing on a change and redefinition of services before addressing major improvements and changes in operations.
- Operation-first transformation aiming at new and improved digital internal processes as a basis for later redefinition of services.
- Service – operation combination attempting an integrated transformation of both aspects.

Operation-first would basically require a digitization of all value creation and most supporting services. Value creation in higher education is everything related to the education process of students from admission, registration for programs and courses, examination in courses, the development of programs and their quality assurance, etc. Supporting services include facility management, study planning, scheduling, teacher allocation and much more. All in all this basically requires an integrated campus management functionality including support for mobile workers and for knowledge management.

Service-first would have to focus on creating new education products and transforming existing products into digital ones. One aspect of this activity is opening established education programmes for access from outside the higher education institution on national and international level. This is usually connected to making the content of the education digital and to also providing digital means for student – teacher and student – student interaction and collaboration. Internationalization also requires adaptations regarding the applied language. Furthermore, most traditional education programmes need to be decomposed into a smaller level of granularity, e.g. instead of three year study programmes into shorter certificate courses and instead of 6 ECTS teaching modules into smaller but combinable modules. Such decomposition would support to offer them for a wider target group and increase flexibility.

Service and operation combination would be a systematic inter-relation of both approaches presented before. This could, for example, be a new study format for a new target group of the university in combination with digitization of the operational processes related to the new study format and target group. Many of such combination paths result from pilot project for implementing digitization of higher education.

4 Enterprise Architecture and Portals supporting Digital Transformation in Higher Education

This section focuses on a discussion about the role of enterprise architectures and portals in implementing digital transformation. For this purpose, section 4.1 uses an excerpt from the enterprise architecture of Rostock University, which serves as an illustrative case for this paper, and section 4.2 presents experiences regarding required changes in this enterprise architecture and the role of portals.

4.1 Enterprise Architecture – An example from Rostock University

The concept of enterprise architectures in general and the TOGAF as a standard in the field were briefly introduced in section 2.1. In this section, we structure our discussion about the effects of different digital transformation paths (as presented in section 3) on the organization by considering the different enterprise architecture layers according to TOGAF. As a means to illustrate our view, we use an excerpt of the enterprise architecture of Rostock University. This excerpt originates from earlier work in published in a capability management project [Pi13], campus management and an e-learning project [Sa15].

The current situation of the enterprise architecture at Rostock University can be summarized as follows:

- Business architecture: established catalogue of administrative services for internal research and teaching, human resource management, facility and other supporting services. Coverage of all student lifecycle phases in business processes (from application to issuing exit certificates). Bachelor, Master, and PhD program development and delivery at the facilities of Rostock University.
- Application architecture: various information systems providing support for certain functionalities in administrative and supporting services. Partly integrated systems for managing student lifecycle and for planning and operating study programmes. Learning management and training software modules. Multitude of specialized application for specific faculties of the university. Various literature databases and library systems.
- Data architecture: no enterprise-wide data model but functionally integrated data models and exchange possibilities (e.g. for student lifecycle management, for administrative purposes, for facility planning, etc.). Teaching content captured digitally but often not integrated with administrative data.
- Technology architecture: central IT-infrastructure for the university with additional decentral environments for some faculties and research units.

4.2 Digital Transformation Paths in Higher Education

In the service-first strategy the most severe changes have to be performed in the application architecture as new platforms for delivery of innovative education products or services have to be implemented. This could, for example, be MOOC platforms or support for collaborative learning and peer learning in distributed student groups who cannot attend on-campus teaching modules but are geographically distributed. The business architecture also will be affected of service-first transformation paths as online examination procedures and modified workflows for issuing certificates or arranging on-site modules might be needed. However, most of the traditional campus management functionality should stay stable. In the data architecture, one of the important changes is the more intense use of digital content and the integration of different media types with administrative course and student data.

In the process-first transformation path, digitization of all value creation and supporting processes is in focus, which from an enterprise architecture perspective affects the business architecture most and – for alignment of business and IT – also the application architecture. In the business architecture, the implementation of digital processes and their optimization usually is only one aspect to be tackled. Equally important is the adaptation or organisational structures to changed processes and the creation of new organisational functions, e.g. an organisation unit for online education programmes or certificates. In the data layer, a better integration of data models of the information systems supporting operative processes is required.

For the combined service / process transformation paths, the above changes and adaptations in service-first and process-first transformation paths also have to be performed but this usually is performed with focus on single departments or a clearly defined organizational scope. An example would be to start with digital transformation in all education programmes outside the traditional Bachelor/Master system and continue with internationally oriented programmes. It can be noted that in all three transformation paths all architecture layers are affected.

5 Portals as a Support for Strategy Implementation

The focus of Rostock University's digital transformation strategy currently is on the education programmes and services offered, i.e. the strategy can be as "service-first". In 2015, the university decided to create online courses based on MOOCs and new certificate programmes for non-traditional target groups. The project KOSMOS supports the implementation of these new services. KOSMOS aims at attracting new target groups to university education and to develop and explore new study formats. New target groups are, for example, experienced job professionals who completed their higher education long ago, or practitioners without a sufficient level of formal qualification but much experience from practice. New study formats are, for example, short study programmes (6 months or one year) for mixed target groups and a combination of on-

campus and online teaching.

In KOSMOS it became clear that a portal for teaching and learning could serve as an integration point to implement the strategy. New target groups and formats need an adjusted or different kind of support by learning management systems compared to the traditional target groups, since didactic and pedagogical concepts also differ. In order to facilitate this adaptivity requirement, the approach is that learning management systems (LMS) should be flexibly adaptable to the learner's individual demands when it comes to contents and applications supporting the learning process. In KOSMOS, this LMS is a portal integrating existing and future learning objects and tools supporting the different learning phases. This portal is called "MyKosmos".

The MyKosmos portal integrates different functionalities and applications into a single user interface. Examples are:

- Meta-search engine: one element of the integration is to provide a single user interface to searching several literature database and research information systems. Based on the student profile (i.e. the study format, current integration into working groups and personal background), the meta.search is configured to search with priority in those database assumed to be the most important ones for the task at hand.

- Integration of learning management systems: Rostock University has a learning management system for supporting teaching in different courses (Stud.IP[3]), for interactive content and learning objects (ILIAS[4]) and for scheduling education and providing individual information (LSF[5]). These systems are integrated into the MyKosmos portal provided a joint view on relevant data.

- Collaborative work of distributed student groups is supported by integrating synchronous (Skype[6]) and asynchronous communication, document sharing, joint editing of documents and awareness functions for group work.

- Program managers and course responsible persons (teachers) may integrate additional functionality into the portal by using the "portlet" concept of the Liferay platform which forms the basis for MyKosmos.

The above summary shows that MyKosmos is contributing to the integration of various applications which in turn is part of the digital transformation activity. Furthermore, the portal also contributed to ´development of more synchronized work flows as the portal development was prepared by business process integration activities. More concrete, we modelled all future usage scenarios for the portal and derived integration needs on process and application level from the scenario models. For this purpose we used an

[3] http://www.studip.de/
[4] http://www.ilias.de
[5] https://www.his.de/produkte/sva-fsv-gx-campus/lehre-studium-forschung.html
[6] https://www.skype.com

approach from enterprise modelling based on Troux Architect as a tool and Troux Semantics as notation. We modelled the different planned ways how MyKosmos would be used by the future users. This resulted in process model-like scenarios, as depicted in Figure 2 showing the example “distributed study formats: assignment work”.

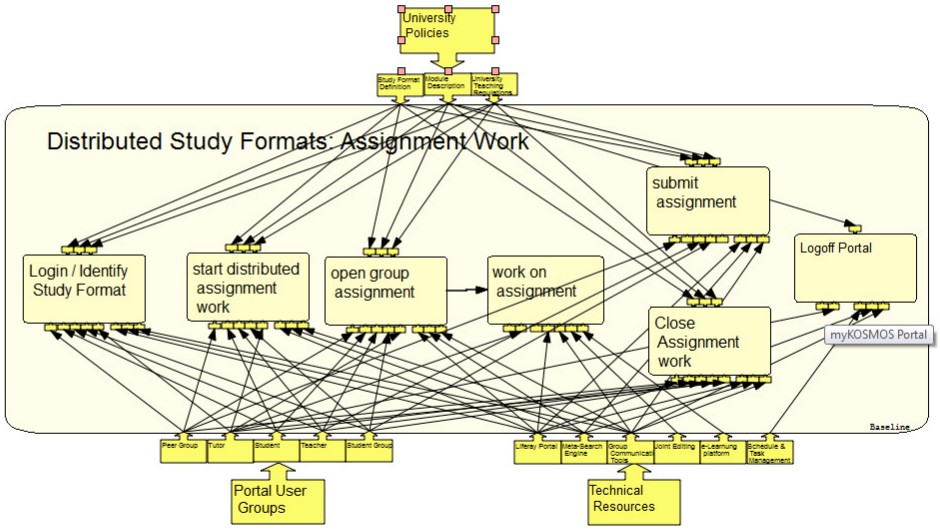

Fig. 2: Process model (excerpt) for new study format

The scenario starts with the student logging in. According to his profile he is provided with an individually configured entry page, making offers for his learning process. Following his course of study, completing different modules within the study format, the student choses to open or proceed with his assignment work for a certain module, which is loaded presenting the recent state of his work in progress. Once having caught up with his recent results, the student is confronted with different tasks to be fulfilled in order to fulfil the assignment, however is free to choose which task to pick. A regular assignment the designed study formats includes information research the portal supports providing the appropriate sources for the study format. In addition many assignments also involve the communication with fellow students since they are assigned group work. In the process the work should be documented to be handed in, where the kind of documentation being determined in the assignment description.

During the work process coordination issues between the team members should be resolved as well, which might be due to the individual time tables and working hours, as well as the specific interests or responsibilities within the task assignment. At the end of each session the user has the choice between submitting his work for the correction process and simply closing it to proceed in another sessions.

6 Summary

The paper investigated digital transformation from the perspective of higher education organizations and investigated general transformations paths and their implementation. We argue that enterprise architectures form an excellent support for planning the transformation and that portals are a suitable support for implementing the transformation. This statement is supported by experiences from Rostock University and the development and use of the MyKosmos portal.

The limitation of this work is that the digital transformation paths should be described in much more detail and investigated in many more case. A description in much more detail should include the objectives and steps of transformation activities and an analysis of all enterprise architecture layers including visualisation of effects of these digital transformation steps across all layers. The dependency on only a single case of transformation should be remedied by involving other higher education organizations also. This is at the same time the most important future work in the field.

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The potential of Artificial Intelligence in academic research at a Digital University

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Abstract: Steady growing research material in a variety of databases, repositories and clouds make academic content more than ever hard to discover. Finding adequate material for the own research however is essential for every researcher. Based on recent developments in the field of Artificial Intelligence and the identified digital capabilities of future universities a change in the basic work of academic research is predicted. This study defines the idea of how Artificial Intelligence could simplify academic research at a Digital University. Today's studies in the field of AI spectacle the true potential and its commanding impact on academic research.

Keywords: Artificial Intelligence, Academic Research, Digital Strategy, Digital Capabilities, Digital University

1 Introduction

Research material in general is available from many different sources, including databases and repositories. Although living in a highly-digitalized world, the growing amount of digitally available academic content is still stored decentralized in an unstructured way and therefore more, hard to find. Studies estimate that more than half of all scientific papers are only read by their authors, editors and peer reviewers [Rm16] and as much as 90% have never even been cited [Rd16]. The described characteristics of academic data perfectly match the IBM definition of big data [Zp13]. It is now state of the art to use Artificial Intelligence (AI) for the evaluation of big data [Od13]. If you imagine an entirely digital university providing simple access to academic material, there won't be any way to avoid AI. This hypothesis leads to our research question: How can AI simplify academic research?

This discussion paper is based on a literary review with focus on Artificial Intelligence (Sec. 4) and Academic Research. Focusing on Academic Research the multiple offers of online university courses such as Cousera [CO17] or Stanford Online [SU17] are not in scope of this paper because they focus on providing a new way to present processed

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academic information rather than helping academics to find resources. We presume that a digital university is essentially in favor of potential support of AI in academic research. Therefore, in Section 2 it is explained what digital capabilities are needed to transform a university into a digital university. Section 4 outlines the potential starting points for AI in academic research. The results will be finally summarized in conclusions (Sec. 5).

2 Herman Hollerith Center Böblingen as Digital University

The Herman Hollerith teaching and research center (abbr. HHZ) is integrated into the structure of Reutlingen University, the Reutlingen Research Institute and the computing faculty. Entrepreneurial questions are focused on strategic research topics and explored in a closed dialogue between research and practice [HH17]. Universities are competing globally for students, academic staff and funding, and only those that manage to remain relevant and leverage new digital capabilities will benefit in the digital age [PC17]. Digital technology as driving force in digitization is used to transform the customer experience, operational processes and business models [Wg14]. Therefore, it is essential for the HHZ to develop own digital capabilities by identifying the activities that would most benefit from rapid digitization.

As a result of our research we identified five top capabilities the HHZ should focus on next:

1. Boosting the customer (student) experience by using new technologies,
2. Establishing students as influencers and brand ambassadors by establishing a successful alumni-network,
3. Building a solid IT governance to enhance collaboration, innovation in learning & research environments and education,
4. Re-designing exams in an environment of blended learning and
5. Simplifying academic research through Artificial Intelligence.

Latter will be discussed more detailed.

3 Artificial Intelligence

There is not the one standard definition for Artificial Intelligence. A simple catchy definition is provided by Chuck Williams [Wc83]: ‘Artificial Intelligence is a multi-disciplinary field whose goal is to automate activities that presently require human intelligence’. Rather more comprehensive Stuart J. Russell and Peter Norvig [RN95] believe Artificial Intelligence could be clustered into four categories: Systems that think like humans, systems that act like humans, systems that think rationally and systems that act rationally.

Behaving like humans is primarily relevant for AI when interacting with people. This kind of expert systems need to know the rules of conversation in order to substantiate their decisions or interact with humans. The underlying principles therefore might also be based on human conversational behaviors. Historically AI in the category of thinking like humans is often similarly designed to the thinking patterns of the human brain. Whereas nowadays AI is also used to evaluate human decisions for example in traffic situation. The categories of thinking or acting rationally are mainly based on making logical decision. Accordingly, problems must be simplified and described in a logical notation. In a complex environment, the solution provided by AI might not be perfect but at least reasonable. In addition, AI provides the solution before the human mind has even taken the decision into consideration [RN95].

AI also can be distinguished in strong AI and weak AI. While strong AI is defined as general intelligence in the sense of the creation of human-like intelligence of machines, whereas weak AI aims to provide intelligent algorithms somewhere stored inside the software [HT17]. Machine-learning, deep-learning, natural language processing and neural networks are often summarized under the term of AI.

Correctly it should be differentiated between Artificial Intelligence and Computational Intelligence (CI) as a sub-area of AI. CI includes concepts, paradigms, algorithms and implementation of developing systems that enable intelligent behavior in complex environments to be automated [KR11]. Neural networks and machine learning are falling under CI, while the others are related to AI.

To enable systems to think or act like humans or simply rationally the system generally must be supplied with a good knowledge about the areas of application. The AI can either learn about the relevant topics by itself, when it is implemented as neural network, or it can be trained on sample data. Once enabled, AI can solve problems based on special search algorithms, combining existing knowledge and reasoning with a novel perspective and making decisions where knowledge is uncertain.

One state of the art example is IBMs Watson. Back in 2011 a machine using Watson AI won against a human player in Jeopardy©. The same technology is now able to perform visual recognition [GI17]. IBM however, is not the only company in the field of Artificial Intelligence: In 2016 Google attracted attention with its AI AlphaGo, which defeated Go star Lee Sedol. Special interest created some unorthodox movements by AI, which are not common standard in the game [TG17]. AI as a not common standard is able to support represented and inferred knowledge about a specific topic. Amassing knowledge about every user relevant topic is the goal of Facebook. Therefore, they are utilizing the user data to train their own AI to analyze, cluster and rate the content of every single post [SO17]. As already mentioned another relevant field of usage of AI is communication. Latest trends in communication based on AI are chatbots, systems for voice recognition in cars or products for home automation – those meanwhile are even provided as software-as-a-service [AW17].

4 Unleashing the power of AI

The basis of each academic research is to collect all relevant information on the current situation and the level of the research. Could these two aspects be the starting point for the development of new use cases for existing AI systems? Moreover, can experienced AI systems be used to simplify academic research?

AI could support researchers in various situations such as helping with qualitative surveys with experts. Creating, executing and evaluating those surveys takes researches a lot of time, because the questions of course need to be based on facts, the spoken word must be transcribed and finally the insights must be analyzed. By using AI speech recognition and language skills time can be saved when creating and evaluating questionnaires. With an advanced understanding of human communication, it would also be possible for AI to carry out interviews on its own. Chatbots and virtual assistant technology can be used to build that kind of academic support.

The effort spent searching through literature to ascertain the current state of the research is incredibly high. Finding information about current developments, which are often press released from specific institutions, seem in some cases even impossible. It also includes a certain degree of uncertainty because one can never be sure of finding all important and relevant information. Many academic search engines helping researches already exist, among them Google Scholar, Microsoft Academic Search, PubMed and JSTOR. Yet these only searches through papers using clearly categorized information such as the publication date and keywords. If AI could be taught to find meaning in the thousands of books and research papers published each year, it could automatically highlight important new trends or discoveries, and draw conclusions from them. A tool named Semantic Scholar developed by the Allen Institute for Artificial Intelligence seems to be an interesting step towards high quality academic search results [Kw15]. Advanced search algorithms, which combine search in a specific themed field with auto-detection of related themed fields, clustering results e.g. based on self-created tags and or relevance of authors, will be a beneficial usage of AI in academic research.

AI could be a kind of scientific assistant offering researchers new perspectives for their topics, assisting them in the everyday research work and could thus enable real scientific progress.

5 Conclusion

Artificial intelligence can support academics like professors and researchers with contextual information, connections between topics and further assistant tasks during their research. If we think of a digital university, where all structured and unstructured data is stored in a digitally way and is thus available for Artificial Intelligence transferring existing AI algorithms and concepts have a lot of potential in academic research.

Furthermore, the exponential growth of digitally available data worldwide and advances in cloud computing combined with the use of AI can help to unleash the real potential of new scientific knowledge and accelerate scientific progress.

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Implementation Strategies for Enterprise Social Networks

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Abstract: In recent times, enterprises have been increasingly dealing with the use of social media in internal communication and collaboration. In particular, so-called Enterprise Social Networks (ESN), promise meaningful benefits for the nature of work in corporations. However, these platforms often suffer from poor degrees of use. This raises the question of what initiatives enterprise can launch in order to stimulate the vitality of ESN. Since the use of ESN is often voluntary, individual adoption by employees need to be examined to find an answer. Therefore, the Unified Theory of Acceptance and Use of Technology (UTAUT) model was selected for the theoretical foundation of this paper. Following a qualitative research approach, the available research provides an analysis of expert interviews on specific ESN implementation strategies and included factors. In order to extensively conceptualize and generalize these strategic considerations, we conducted an inductive coding process. The results reveal that ESN implementation strategies can be understood as a multi-level construct (individual vs. group vs. organizational level) containing different factors dependent on the degree of documentation and intensity. This research in progress describes a qualitative evaluation as a preliminary study for further quantitative analysis of an ESN adoption model.

Keywords: Enterprise Social Networks, implementation strategy, technology acceptance, UTAUT

1 Introduction

Communication and collaboration in enterprises is undergoing rapid change. The latest information technology has fundamentally transformed the manner in which corporate collaboration operates ([CA08]; [MMJ05]; [SNB13]). A substantial step in this development has been the rise of Enterprise Social Networks (ESN): "Web-based platforms that allow workers to (1) communicate messages with specific coworkers or broadcast messages to everyone in the organization; (2) explicitly indicate or implicitly reveal particular coworkers as communication partners; (3) post, edit, and sort text and files linked to themselves or others; and (4) view the messages, connections, text, and files communicated, posted, edited and sorted by anyone else in the organization at any time of their choosing" [LHS13].

Typical solutions have been implemented, for example, on the basis of software solutions such as IBM Connections, Jive, Microsoft SharePoint, or Slack. Forecasts

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emphasize the increasing relevance of these platforms. Market researchers anticipate a global revenue volume of 3.5 billion USD for investments in ESN by 2019 [Th15]. This indicates a doubling of revenues between 2014 and 2019 and a yearly growth rate of close to 20%.

The existing body of research has found that ESN exerts a positive influence on a variety of personal and organizational aspects, e.g. communication ([vSB15]; [TL12]), collaboration ([Be14]; [Br09]), knowledge-sharing and dissemination ([An16]; [EAF15]), innovativeness ([Le14]; [PRB15]), work performance, and job security [Wu12].

However, a look into corporate practice shows that enterprises struggle to realize the potentials that are associated with ESN: enterprises often do not achieve the benefits they desire [WS11] and the expectations reposed in ESN are mostly not met [DPF11]. The cause of these failures is twofold: overemphasis of technological aspects and underestimation of social factors in the introduction phase ([vR13]). As long as the introductory processes for ESN only focus on software functions, sustainable success is improbable.

This raises the question of how enterprises can stimulate the adoption of ESN in order to achieve levels of vitality that allow the realization of the above mentioned potentials. Previous studies have linked disappointing adoption rates to the following exemplary factors: resource constraints, lack of guidance, training and support, as well as extensive time and effort requirements to learn how to use ESN [DPF11]. In light of these findings, it seems reasonable to claim that enterprises need to support the introduction of ESN.

One key success factor that has been reported is the formulation and implementation of specific strategies for the purpose of influencing ESN adoption. A lack of implementation strategy has been found to delay the adoption of ESN, while relying on passive rollout strategies has often proved unsuccessful [KSR13]. In turn, an appropriate strategy would encourage and facilitate the smooth adoption of the communication platforms. These strategies typically include such elements as planning the implementation, securing resources, and guiding the adoption [AA15]. Prior studies suggest that, in order to tailor the strategic considerations specifically to the organizational context, a necessary first step is to gain an extensive understanding of the impact on ESN on the organization. This may refer to potential changes in the existing corporate culture as well as in the established communication structure [RRv11]. As the use of ESN is often voluntary, in which case the adoption decision is made by employees, it is vital to make sure that strategy reaches out to and addresses even the bottom level of employees [MR14].

A literature review shows that traditionally ESN implementation strategies follow one of two different approaches: bottom-up vs. top-down. The first approach is characterized by the fact that the introduction of ESN is driven by the employees, that the latter pro-actively ask for the implementation of the platforms. Contrarily, in the top-down approach, we have a scenario where top management serves as the driving force behind

platform introduction [MR14]. The practical application of this categorization was confirmed by Williams and Schubert [WS11]. In an analysis of seven in-depth case studies, the authors found that both approaches were applied in enterprises. These findings were later extended in a literature review by Louw and Mtsweni, who write that the adoption process works best when the implementation approach is hybrid, meaning that both approaches are applied simultaneously [LM13].

In contrast to these findings, Richter et al. have observed that the bottom-up/top-down labeling dichotomy is not used in practice and so is of dubious relevance [Ri13]. Examining 21 case studies, the authors describe that enterprises rather follow one of two strategies: exploration ("a continuous investigation of possible use cases for new (open) tools, through a participative approach") or promotion ("the intentional business-aligned and skilled use of the new tools focusing on well-defined usage potential") [Ri13]. Both strategies are of a complementary nature and may be used simultaneously.

In light of these mixed findings, it is important to define tangible strategies for the improvement of ESN vitality. This is a matter of high practical as well as theoretical relevance. It has been reported that well-defined implementation strategies for ESN adoption are missing in practice [LPB14]. Additionally, an analysis of related scientific work regarding ESN implementation unearthed only very few tangible indications of relevant factors in implementation strategies [VL15]. Therefore, it remains unclear which particular factors in implementation strategies need to be considered in order to stimulate ESN use [AA15].

The purpose of this paper is to explore the nature of ESN implementation strategies by answering the following research questions:

(1) Which factors are considered in ESN implementation strategies in order to foster ESN use?

(2) How are relevant factors for ESN implementation strategies structured in a conceptual model?

The remainder of this paper is organized as follows. Chapter 2 illustrates Technology Acceptance research and characterizes the UTAUT model as a theoretical foundation. Then, in chapter 3, the qualitative research approach that was used to gather expert opinions on tangible strategies is described. The conceptual model for ESN implementation strategies is elaborated in chapter 4, and its implementations are presented in chapter 5. Limitations and further research issues are subject of chapter 6.

2 Theoretical foundation

Central to the degree of vitality of ESN is the user himself. As platform use is often voluntary, the decision for use or non-use is made on the individual level by employees. This leads to the following question: why do people adopt information technology? The problem of user adoption has featured Information Systems research for a considerable

period of time. A traditional framework for Information Technology Adoption is provided by the Technology Acceptance Model (TAM) as developed by Davis et al. [DBW89]. It yields a causal model for describing the predictors and relevant constructs specifying the degree of utilization of technological systems. TAM has been applied to different technologies and has proven its predictive capacity for individual technology adoption [BDV10]. The model's success is due to its comprehensibility and ready applicability, but also the high degree of reliability of the initial variables, as a meta-analysis by King and He [KH06] demonstrated. Along with the further development of Technology Acceptance theory, the original TAM model was later extended by other constructs and relationships.

This led to the development of advanced models like Unified Theory of Acceptance and Use of Technology (UTAUT) ([Ve03]). This theory was developed through a review and consolidation of the constructs of eight models that earlier research had employed to explain information systems use behavior (Theory of Reasoned Action, Technology Acceptance Model, Motivational Model, Theory of Planned Behavior, a combined Theory of Planned Behavior/Technology Acceptance Model, Model of Personal Computer Use, Diffusion of Innovations Theory, and Social Cognitive Theory). Finally, UTAUT led to four key constructs supporting technology acceptance: 1) performance expectancy, 2) effort expectancy, 3) social influence, and 4) facilitating conditions. The first three constructs are direct determinants of use intention and behavior, and the fourth is a direct determinant of use behavior. Additionally, four moderators are included that have an effect on different relationships in the model: gender, age, experience, and voluntariness of use. The UTAUT causal model is shown in figure 1.

As Venkatesh et al. state, the model explains as much as 70% of the variance in behavioral intention [Ve03], proving its robustness and comprehensibility. However, the question of what specific actions enterprises can take to stimulate adoption remains. A common criticism of UTAUT refers to its limited usefulness when it comes to explaining what single interventions drive user acceptance: "Little is known about the key antecedents that influence the UTAUT constructs" [BDV10]. One way of raising the explanatory power of Technology Acceptance research might be to elaborate the model in specific contexts ([VB08]; [KSR12]). Given the initial question of what implementation strategies are used in enterprises to foster adoption, extension of the UTAUT model specifically to ESN adoption seems reasonable.

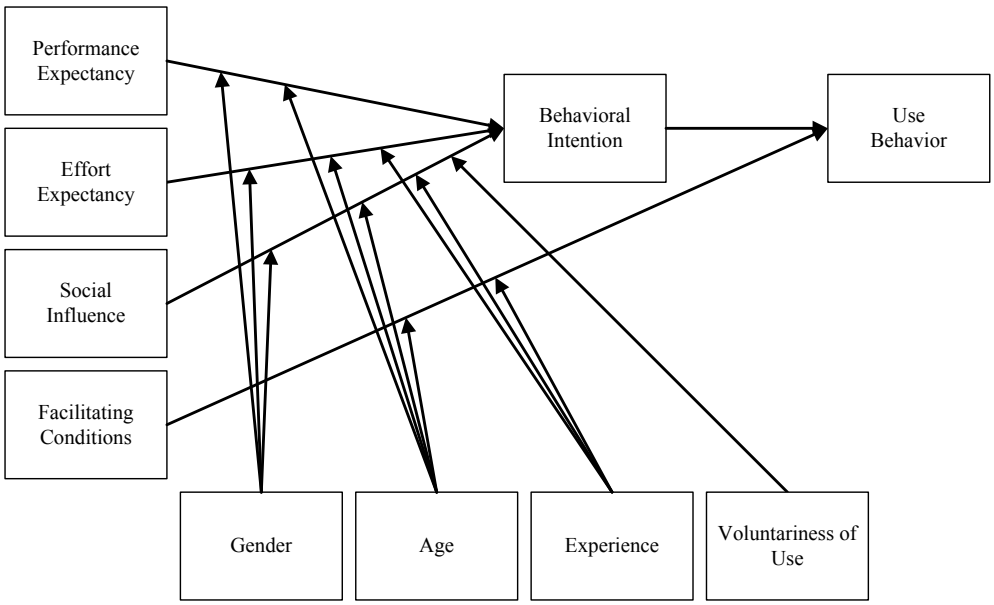

Figure 1: The UTAUT model ([Ve03])

3 Method

Since the literature on ESN adoption provided no hints as to which concrete factors need to be included in an ESN implementation strategy, we chose a qualitative research approach to identify what ESN implementation strategies are used in practice. Furthermore, we sought to identify the factors behind these strategies and how they impact on the adoption rate.

For purposes of this explorative study of ESN implementation strategies in corporations, a methodical study approach based on qualitative evaluation as presented by Silverman ([Si13]) was implemented. The sample chosen for qualitative evaluation covers companies with proven experience in using ESN. For this reason, only those companies were invited to participate that had already implemented ESN within their organization and therefore had obtained relevant experience.

All in all, ten major German enterprises were selected for participation in this study. Consequently, we conducted explorative interviews with corporate executives responsible for the implementation of ESN. The interviews took place in autumn 2014 and data were collected by way of telephone interviews. We developed a semi-structured questionnaire and used it as a guideline; the interviews took, on average, 35 minutes.

In order to provide intersubjective confirmability, all telephone interviews were digitally recorded and subsequently transcribed [OK09]. Initially, we analyzed the results of the transcription case by case. On this basis, we developed a category system to evaluate the written material in a structured manner [Si13]. It was then possible to gather and interpret the data based on the categories identified.

4 Results

The results of the qualitative evaluation are presented below. As control variables, we used the time since ESN was introduced and the technological solutions applied. For the ten companies interviewed, the introduction of ESN took place between April 2012 and October 2014. Concerning the technological solutions used, the main focus was on Jive (n=5), followed by IBM Connections (n=2), Microsoft SharePoint (n=2) and Yammer (n=1).

4.1 Conceptual model for ESN implementation strategies

Analysis of the ESN implementation strategies revealed, for the interviewed sample, a heterogeneous pattern. Hence, it can be generally distinguished between (1) whether an implementation strategy is established explicitly or implicitly, (2) what degree of implementation intensity the enterprise strives for in general, and (3) which organizational levels (individuals, group, organization) are addressed by the implementation strategy concept. An overview of the evaluated factors for implementation strategies is shown in figure 2.

With regard to the first dimension, it should be noted that eight of the ten enterprises analyzed had not documented an explicit strategy for ESN implementation. This applies in particular to corporations in the early stage of introducing ESN. The data also indicate that only in a minority of enterprises were extensive strategic considerations invoked in the phase of platform introduction preparation. The initiatives for implementation were rather weakly described and not generally communicated in many corporations. An elaborated strategy for ESN implementation only existed in two of the ten corporations.

The second dimension refers to the degree of intensity of the ESN implementation strategy. When analyzing the implementation efforts in different enterprises, it became clear that the strategies differed widely in depth. Some enterprises supported the introductory process with a rather low amount of internal resources and concentrated on single and often isolated activities (low intensity). This often involves provision of technical support, standardized learning offers, and single contact persons. At higher levels of intensity, the implementation strategy contains a variety of coordinated and related activities that are more resource-demanding but also promise to anchor ESN use at a deeper level in the enterprise. This usually means the establishment of distributed responsibilities, extensive community management, individual support, substantial training, and several specialized contact persons.

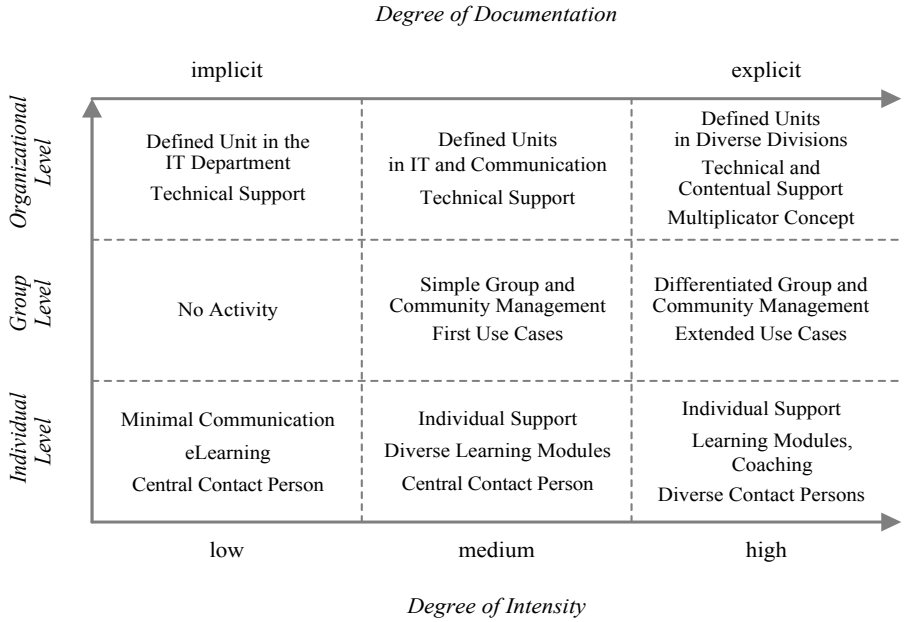

Figure 2: Factors of ESN implementation strategies

Regarding the third dimension, this showed that ESN implementation initiatives mainly relate to three levels. The reported factors for ESN implementation relate to the individual, group, and organizational levels. This result means that the implementation strategy needs to address not only individual employees (e.g. project managers, community leaders, helpdesk employees) but rather the whole organization as well (e.g. units with explicit responsibilities such as support or communication). Thus, different levels of intensity regarding ESN implementation strategy are associated with differentiated activities on the individual, group and organizational levels. The single identified initiatives are documented in figure 2.

Moreover, based on the findings of qualitative evaluation, it can be assumed that the degree of documentation of an ESN implementation strategy increases with the general intensity of ESN implementation.

4.2 Impact of implementation strategies on ESN system use

The influence of implementation strategies on ESN system use can only be described subjectively on the basis of the qualitative evaluation. As the expert interviews indicate, a greater intensity of implementation strategy positively affects ESN adoption and use. Therefore, the results of our qualitative research can serve as a basis for the setup and evaluation of corresponding quantitative explorations in future steps of the research project.

From among the companies interviewed in this sample, no holistic measurement scale could be derived for determining ESN use. Rather, questions in this regard are frequently answered purely subjectively or based on different internal surveys. Differentiated measurements of system use are generally developed as the maturity of corporate ESN increases. In this process, the introduction and use of appropriate control models can well be regarded as a partial task of implementation strategy.

In practice, the following indicators for ESN system use are frequently drawn upon: number of registered users, number of active users, number of groups/communities, number of newly established groups/communities, number of postings, comments and likes, number of shared contents, number of accesses to contents, and general activity of the users. On the basis of data protection regulations, these metrics are frequently collected on an aggregated level.

In the next research steps, however, statements on the relationship between ESN implementations strategy and system use need to be evaluated quantitatively. In this qualitative preliminary study, all interviewed executives predict a positive effect for ESN strategy on system use. This applies in particular to the early phases of introducing ESN. In the further course of use, specific cases are formed, i.e. a culture for ESN use emerges. This is frequently influenced by management and the overall company culture. Thus, the causal effect of implementation strategy on ESN use is chiefly manifested in the initial phase of system introduction. In the context of further system use, implicit ESN strategy models gain in importance.

5 Implications

Diversified implications for practice and further research on ESN can be derived from this qualitative research.

Firstly, the interviews with ESN experts provide differentiated insights into how to conceptualize the relevant constructs in the context of ESN implementation strategies. Thus, implementation strategies can be understood as a multifaceted concept described by the degree of documentation, support intensity, and focus on multiple organizational levels. The proposed model may serve as a foundation in order to derive a specific measurement model for the evaluation of ESN implementation strategies. These measurements will allow us to examine if and how single factors of practical implementation strategies impact on the key constructs of the UTAUT model.

Secondly, the insights we have gathered also possess practical relevance. The ESN implementation strategy model offers a frame of reference for the introduction of ESN. In that respect, various levels of ESN implementation strategies can be determined along with defined initiatives on the single levels. It may serve as a starting point for further development of existing strategies and, moreover, suggests initiatives to expand the implementation efforts. In addition, the reference model for the introduction of ESN can be consulted in those companies that have not yet come to terms with the new forms of communication and collaboration.

6 Limitations and further research issues

Limitations are to only be expected in any kind of research work, restricting the area of applicability of the results and, at the same time, opening up potential for further studies. In this qualitative preliminary analysis, the small sample size of the study needs to be clearly pointed out. Accordingly, the results of the qualitative evaluation will have to be quantitatively confirmed in the next steps of our research project and evaluated by a larger sample size. Further limitations derive from the nature of the qualitative research work itself. The insights gained are mainly based on the subjective opinions of experts. For this reason, the validity and reliability of the results need further examination.

The Technology Acceptance research stream served as the theoretical foundation for this paper. It suggests a positive relationship between ESN implementation strategies and the ESN adoption process [AA15]. While the Technology Acceptance literature has been widely established in Information Systems research, it has also occasioned some criticism. A common critique refers to missing actionable guidelines ([LKL03]; [VB08]). Therefore, as Venkatesh et al. suggest, future research should combine technology adoption with other research streams [Ve03]. In previous research, the UTAUT model has already been adapted to different ESN-specific contexts, e.g. to the adoption of Enterprise 2.0 applications incorporating different context-specific variables [Wa14], prediction of ESN system use with the focus on technological, social, and organizational factors [KSR12], the adoption of collaboration technologies using collaboration-related constructs [BDV10], and microblogging adoption in enterprises [Gu09].

As these Technology Acceptance models for ESN often lack suggestions for concrete action [LM13], a further extension of the UTAUT model seems promising. This could be by way of integrating the factors of the ESN implementation strategy as predictors for performance expectancy, effort expectancy, social influence, and facilitating conditions. Given that individual employees decide on the adoption of ESN, it is reasonable to focus on the question of how employees perceive the factors behind the ESN implementation strategy and how it affects their ESN adoption intentions. By asking different groups of employees, one could additionally analyze if critical aspects, seen from their perspective, are missing from the proposed model.

Another step in our research would lie in development of an appropriate measurement model for the conceptual model of ESN implementation strategy provided in this paper. By means of a literature analysis, existing measurement scales need to be identified and,

if necessary, adopted to the context in question. As far as operationalizations are missing, a scale development process will need to be implemented. The collection of data can be carried out in the ESN itself (since almost every action in ESN leaves a digital trace, see [BRT14]) or in employee interviews via online questionnaires.

It will fall to subsequent studies to show how a stronger intensity of implementation strategy affects ESN use and the associated indicators of success. Thus, this research provides a suitable basis for the development of appropriate measurement models.

Looking ahead, the quantitative evaluation of the extended UTAUT model is planned using a partial least squares structural equation modeling. Another contribution can be expected from this empirical evaluation of the model. This would also permit examination of the relative importance of the single factors in the ESN implementation strategy model vis-à-vis the behavioral intention and the actual use behavior of employees, and it would additionally shed light on the relative importance of single strategic ESN implementation efforts.

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Smart Meter based Business Models for the Electricity Sector - A Systematical Literature Research

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Abstract: The Act on the Digitization of the Energy Transition forces German industries and households to introduce smart meters in order to save energy, to gain individual based electricity tariffs and to digitize the energy data flow. Smart meter can be regarded as the advancement of the traditional meter. Utilizing this new technology enables a wide range of innovative business models that provide additional value for the electricity suppliers as well as for their customers. In this study, we followed a two-step approach. At first, we provide a state-of-the-art comparison of these business models found in the literature and identify structural differences in the way they add value to the offered products and services. Secondly, the business models are grouped into categories with respect to customer segments and the added value to the smart grid. Findings indicate that most business models focus on the end-consumer as their main customer.

Keywords: Smart Meter, Business Model, Electricity Sector, Business Model Canvas, Literature Review

1 Introduction

For a long time reliable energy provision served as a successful business model in the electricity sector. Consequently, the players in the electricity market focused on improving in this particular key activity in order to excel in competition. However, while the provisioning is and will be an important aspect in the future, findings indicate that it is already losing its significance due to the emerge of fundamental changes in the

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electricity sector [La13b, Va15]. Many of these changes are based on or linked to so-called smart meters, a game-changing-technology facilitating the potential to revolutionize the whole electricity industry [Ze14]. The major difference in contrast to traditional meters is that smart meters are equipped with communication capabilities [§ 2 Messstellenbetreibergesetz of 09.08.2016], which make them more 'intelligent' than their predecessors. This intelligence enables a whole range of new applications, for instance, remote monitoring of current power consumption [La13b]. As of today, it is still common practice to manually take readings in private households once a year and forward this information to the electricity provider. With smart meter technology this is no longer necessary, as it allows for a transmission of measurement data near real-time [La13b]. Furthermore, the frequency of readings is increased significantly such that updates in the energy consumption are available every quarter-hour [Ze14]. Since the communication is bidirectional, electricity providers can also harness the potential of smart meters in order to directly send relevant information to their customers, such as price updates [Va15]. To go even further, the technology can even be used to control consumer's household appliances via smart meter gateways [Os14]. As a potential use case, household appliances could be activated when energy prices are cheapest, thus providing its owner with cost savings. The before mentioned scenarios only represent a small fraction of potential use cases rendered possible by smart meter technology. Yet, it becomes apparent that this technology can serve as a basis for a range of innovative business models [La14].

In this study, we conducted a systematic literature review to examine the existing body of relevant research on business models based on smart meter technology. This paper focuses on the following research questions: (a) Which business models make use of smart meter technology?; (b) What are the structural differences in these business models?; and (c) How can these business models be categorized?

Due to the broad range of available literature, we restricted our research to findings dedicated to the electricity industry.

2 Methodology

In order to focus on the three presented research questions, a systematic literature analysis was conducted. The underlying method was adapted from Webster and Watson (2002). Relevant literature was captured from (a) Elsevier; (b) SpringerLink; and (c) Google Scholar since they provided the most relevant results during an initial explorative search phase. Search and analysis was conducted in November 2016 using the search criteria presented in Table 1.

As German literature was also of importance for this study, an equivalent and supplementary search with German search strings was conducted as well. Furthermore, in order to set the focus on the latest findings, we only considered literature published since 2010, the year when smart meters were initially deployed in private households.

Whenever possible, a filter criteria restricting results to scientific papers was applied. Due to the large amount of results, the search had to be narrowed down considering titles only.

Search	Search string
1	'Smart Meter' ∧ ('Electricity' ∨ 'Electric')
2	'Smart Meter' ∧ ('Utility' ∨ 'Transmission company' ∨ 'Distribution company' ∨ 'Generation company' ∨ 'Energy service company' ∨ 'Electricity generator' ∨ 'Electricity trading company' ∨ 'Electricity traders' ∨ 'Energy sector')
3	'Smart Home' ∧ ('Electricity' ∨ 'Electric' ∨ 'Smart Meter')
4	'Smart Grid' ∧ ('Electricity' ∨ 'Electric' ∨ 'Smart Meter')
5	'Smart Meter' ∧ ('Business model' ∨ 'Business Case')
6	'Smart Meter' ∧ ('Analysis' ∨ 'Analytics' ∨ 'Load profile')

Tab. 1: Search strings for the database research

After removing duplicates from the respective search results, a first content-related evaluation based on the documents' titles and abstracts was carried out. Results without any relevance to the object of this research had to be excluded from further analysis, as well as results which lacked high scientific standards. The remaining results were analyzed in full detail. Finally, the bibliographies of highly relevant results were examined to determine further literature contributing to answer the raised research questions. During this process, 105 relevant results were identified.

3 Theoretical Foundation

3.1 The traditional business model of electricity suppliers

The conventional business model of electricity suppliers can be summarized as "guaranteed power supply for end-consumers" [BG14]. It is based on the traditional value chain of the power industry, which is shaped by the central energy production of major coal-fired factories and nuclear power plants. The transportation to end-consumers is provided via transmission and distribution networks and in conjunction with the billing and customer service marks the final element of the value chain [La13b]. In order to adjust production to demand, standard load profiles are used for estimation of the power consumption [SW15]. The main customer value of this conventional business model lies in the guaranteed power supply. In the further consideration the immediate customer benefit can be regarded as the result of this guarantee and is expressed by the possibilities that derive from the given power supply – like operating devices or cooling food [Ze14]. The long-established structures of energy production in large plants and conventional distribution networks allow for stable economies of scale and low unit costs [Do14]. Revenue is generated through the direct sales of kilowatt hours to the end-consumer in a combination of the basic price and a corresponding kilowatt-hour rate [Ze14].

3.2 Market changes force business model innovations

Energy giants like EnBW, E.ON, RWE and Vattenfall including their subsidiaries used to control the electricity market in all its aspects [Ze14]. Until 1998 they held a monopoly for most parts of the value chain [Ba14]. Since then there has been fundamental changes concerning the power market as a whole driven by three significant influencing factors: Ecology, technology and politics [DH14, Va15].

Climate risks and scarcity of resources render fossil fuels increasingly unattractive and force electricity suppliers to improve their production efficiency as well as to strive for alternative energies [Ve11]. Hence, the technological progress leads to an enhancement in efficiency of these renewable energies while the costs are declining thus making them a reasonable alternative to coal power or nuclear energy. Furthermore there has been a strong improvement in power storage technology [Si14] and in information and communication technology for the electricity sector [Ve11]. Home Automation came up and Big Data concepts allowed manageability of large quantities of data produced in the power supply chain [Ve11]. These innovative technologies paved the way for a fundamental reformation of the power market [Si14]. Last but not least political change had and still has a great impact on the development of the market. In 1998 changes to Germany's Energy Industry Act (EnGW) were passed aiming for the liberalisation of the power market. The abolition of exclusive rights regarding the power generation as well as the infrastructural development in order to open up the market and increase competition were at the top of the agenda [DH14]. Secondly, activities of management and accounting of production, transmission and distribution were unbundled into vertically-integrated companies and the European Energy Exchange has been founded in order to ensure transparent accounting and discrimination-free competition [DH14]. The risk of losing customers to new competitors in the liberalized power market became a threat to the energy giants [DH14]. In conclusion, the dismantling of the existing monopoly was the highest aim [DH14].

Furthermore, with the politically induced energy turnover around the turn of the millennium reductions of CO_2 emission as well as an increase of energy efficiency were targeted. The subsidies for CO_2-neutral power sources led to an enormous rise of modern power plants providing sustainable energy [DH14]. In order to increase the efficiency, the government relies on the use of intelligent metering systems at customer-side. By means of this smart metering the customer should be enabled to independently manage the power consumption [DH14]. In a first step, households with a consumption of more than 6.000 kWh per year have been obliged by law to install a smart metering device until 2020 [§29 Gesetz zur Digitalisierung der Energiewende of 29.08.2016].

The changes in the market did not only put the providers under pressure but also had positive effects, offering new possibilities for innovative business models and services – mainly based on smart metering. For instance, new services can now be offered not only to energy consumers but also to members participating in the smart grid.

3.3 Smart Grid as an emerging market for energy services

The technological changes in the power market imply new challenges for the participating companies. Due to the integration of feature-dependent power generation like wind power or photovoltaics new aspects like weather conditions have to be taken into account rendering the forecast more difficult [DH14, Va15]. With the energy input of renewable sources exceeding the load on distribution centres many times over, the risk of instabilities arises. The result is an upcoming need for a higher degree of automation, with the aim of a market-driven load management in order to compensate the volatility of renewable energies [DH14]. A power grid with these capabilities is referred to as a Smart Grid. This is achieved by the integration of intelligent information and communication technologies into the existing grid. The smart meters provide relevant information that allow for an optimized load management within the grid as well as energy input from decentralized production plants [Va15]. In the following chapter we will discuss related business models associated with these approaches as well as other smart meter based models.

4 Results of the state-of-the-art literature review regarding smart meter based business models in the electricity sector

In order to ensure relevance of the discussed business models in this study, we focused on models which have been described in full detail. On the other hand, business model ideas that were only outlined without further discussion of the underlying value proposition or revenue generation had to be disregarded. In order to allow comparability of the models, we utilized the scheme of Business Model Canvases as introduced by Osterwalder [OP11]. Since the key activities, value proposition and revenue streams are the central elements defining a business model [Do14], we concentrate on these elements of the business model canvases in the following descriptions. In chapter 5 we will elaborate on the customer segments targeted by each business model. Obviously, all analyzed business models share smart meter technology and the respective data as the key resources.

Optimized sales of electricity: This business model is based on improving the traditional sale of electricity with the help of smart meters [Ze14]. For instance, electricity providers can optimize their internal processes in order to support automatic billing based on actual consumptions [La13b]. Furthermore, having a better understanding about the current electricity demand also leads to a more accurate sourcing on the electricity market [Ze14]. Thereby, poor planning which causes unnecessary costs is avoided. This business model also yields benefits to the electricity consumers. First of all, there is no longer a need for taking manual readings at the households. Besides that, transparency with regard to costs and consumption is enhanced through a monthly bill based on smart meter data [La13b]. And finally, some electricity providers might pass on their cost savings to their customers by offering more favorable

charges. Overall, the main activity of the electric utilities is still the provisioning of electricity to the customers [Ze14]. Furthermore, revenue streams are still generated as today via billing of the consumed energy.

Dynamic tariffs: As before, the main activity of this business model is the provisioning of electricity. However, in contrast to traditional meters, smart meters do not only capture the energy consumption, but also when it is consumed. For electricity providers this makes it possible to create offerings with dynamic electricity prices. For instance, electricity consumers can be informed about the current prices and thereupon decide if they maybe want to postpone their consumption to when energy is cheaper again [Ve11]. Modern household appliances can even be programmed such that they automatically switch on as soon as prices fall below a certain threshold [Ve11]. This is especially relevant to industrial consumers though, since their electricity demand is much larger and thus offers a greater potential for possible cost savings [La13b]. In general, one must distinguish in between time and load-variable tariffs. The former are valid for a certain timeframe only and are determined upfront. The latter instead are oriented towards a previously defined maximum load offered at a specific price, before the next jump in prices occurs [Ve11]. Again, revenue streams are generated via billing of the consumed energy [Ve11].

Energy Efficiency Services: This business model extends the existing one by offering consulting services. These services are offered to the customer in order to support with the increase of energy efficiency by providing energy reports or tips on energy saving based on the collected smart meter data [Ro13]. Beyond these automated reports, personal consultation could be provided as added-value to households as well as business customers. This individual consulting service again puts the analysed smart meter data to use in order to discover savings potential [Ro13, Ze14]. From a financial perspective, the offered services open up new revenue streams which complement the existing ones [Ze14].

Smart Homes: Smart Home involves intelligent automation systems that allow inhabitants to monitor and control functions over their building. Possible scenarios include control of energy consumption, automation of lightning or heating, ventilation and air conditioning (HVAC) appliances as well as services regarding assisted living, security and convenience. These automation applications can be linked to the energy usage in order to turn off devices if there is nobody at home, detect intruders or notify relatives about anomalies in the consumption patterns of elderly people [Ed14, KPM12, La13b]. From a business model perspective, participants of the energy sector could form strategic alliances with hardware and software providers to become solution providers. Revenue streams could increase by offering service flat rates, claiming commission fees or generating turnover through hardware sales [KPM12].

Demand Response Services: Demand Response describes interruptible loads that are made available to the electricity grid operator and can be turned off if necessary to better match demand for power with the supply and avoid throttling in the production rate of

the power plants [Ze14]. Electric utilities can buy these loads from their private and industrial customers and provide them to the grid operators so that for example appliances are turned off for a short period of time if necessary [Ei14, Ze14]. Smart meters are used for the regulation of these interruptible loads. With demand response the demand for power is adjusted instead of adjusting the supply which helps compensating the volatility of renewable energies [Ei14, SS14]. From the business perspective, revenue is generated through the sale of these interruptible loads to grid operators that are charged a fixed amount [Ze14].

Virtual Power Plants: A virtual power plant describes the combination of small and medium-sized generation plants and their control systems to one virtual unit centrally managed by one provider [DA14]. This is realized through the use of a smart metering network [Ro12]. The intelligent linkage facilitates a more efficient management as well as the possibility for small competitors to join forces regarding the power generation and marketing to gain competitive advantages [Ei14, La13b, Ro12]. The opportunity that arises from this concept is held by the providers of virtual power plants. Being the provider of a service that is regardless of the amount of energy – a regular charge can be considered a desirable revenue model [Do14]. On the other hand, small electricity producers are enabled to offer their services at the electricity wholesale market generating additional revenue [Ro12].

Data Hubs: A liberalized power market allows customers to freely choose their meter operator and electricity provider. The smart meter data collected by the meter provider not only has to be made available to the electric utility but also to the power grid operator. This situation leads to highly dynamic and volatile business relationships between a vast number of market participants requiring a high degree of flexibility regarding data distribution [SWB11]. A data hub is a multi-sided platform used to bring these participants together. It provides a reliable means of standardised bidirectional communication and automatic data exchange between the participants that furthermore poses a requirement for business models like ‘Demand Response’ [SS14]. Moreover, the data hub can be considered to be an enabler for new data-driven business models [GF12]. In contrast to the previously discussed business model, the data hub provider is given the chance to generate revenue based on usage of the platform instead of a regular charge [SWB11].

Representation of discussed business models in Osterwalder’s Canvas

In order to provide an overview of the different aspects of the previously described business models, the following table summarizes them in one Business Model Canvas. This also includes the categories of Osterwalder’s model not described above.

<table>
<tr>
<td rowspan="2">Key Partners
• IT-Service providers
• Electricity producers
• Grid operators
• Electricity providers</td>
<td>Key Activities
• Data analytics
• Consulting</td>
<td rowspan="2">Value Proposition
• Cost savings
• Better usage transparency
• Improvement of environmental sustainability
• Enhanced convenience
• Stabilization of grids
• Improved load management</td>
<td>Customer Relationship
• Auto-mated service
• Personal assistance</td>
<td rowspan="2">Customer Segments
• Electricity consumers
• Electricity producers
• Electricity providers
• Grid operators
• Non-Energy businesses</td>
</tr>
<tr>
<td>Key Resources
• Access to Smart Meter Gateway
• Smart Meter Data</td>
<td>Channels
• Website
• App
• Sales</td>
</tr>
<tr>
<td colspan="3">Cost Structure
• Depending on the business model, often IT infrastructure costs</td>
<td colspan="2">Revenue Stream
• Depending on the business model, mainly usage-dependent charges</td>
</tr>
</table>

Table 1: Business Model Canvas for smart meter based business models

This overview shows that in the majority of the business models customer benefit is created through cost savings and improved load management. One of the main activities of the service providers is the analysis of the smart meter data. Important key partners are IT service providers.

5 Categorization Schema

In order to gain a better overview and a basis for further discussions, it is useful to consider the presented business models within the framework of a categorization schema. Based on the literature, several different approaches could be identified. For instance, Zeller suggests examining the business models by means of the two dimensions novelty and complexity [Ze14]. On the other hand, Lange advocates in favor of a categorization based on availability (currently and in the future) and the target market (B2B or B2C) [La13a]. Finally, a categorization along the customer level in terms of private and business customers, key customers and prosumers as recommended by Lauterborn might also serve as a viable option [La14b].

Since the formerly presented business models are very heterogeneous, a categorization based on customer level seems most suitable, but also, in particular, because this also directly depicts the associated benefit dimension of the business models. Furthermore,

we propose to expand the schema of Lauterborn to not only consider electricity user, but also cover novel customers, which have not yet been addressed in conventional business models. This allows for a more precise categorization and also enables integration of more diverse business models with uncommon customer segments.

For the second dimension of the schema, we suggest considering the added value for the Smart Grid which arises from the respective business models. Based on the literature analysis, we identified a strong variation in this facet among all inspected business models. Some of them may have a direct impact on energy provisioning as well as its usage in the future and are closely-linked to the load management of the Smart Grid. In this context, they have great potential to strengthen and stabilize the whole electricity infrastructure, and thereby benefiting all players in the electricity sector.

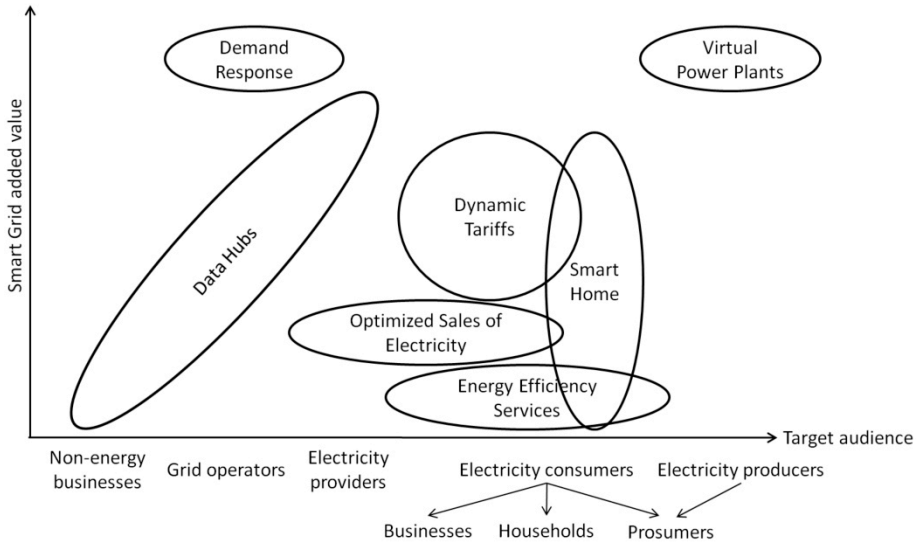

Fig. 3: Categorization of smart meter based business models

The business model 'Demand Response' provides a high added value for the smart grid, as electricity grid operators can utilize interruptible loads for load management [Ze14]. With the 'Data Hub' there is no direct value for the smart grid if smart meter data is analyzed with regard to marketing aspects [AD13]. However, if the data is used for structural planning and optimization of load management the smart grid benefits [Va15]. 'Dynamic Tariffs' on the other hand incentivize the energy consumers to postpone their energy consumption to times when energy prices are low which has positive effects on the load management. Ideally, household appliances are automatically managed by smart meters [He14, La13b, Os14]. Assisted living, security and convenience services as the other part of the smart home business model offer no benefit to the smart grid [La13b]. The 'Energy Efficiency' business model as well provides no significant added value to the smart grid. Although the required total energy demand is slightly reduced, it cannot

be specifically controlled by third parties. Due to more precise forecasting achieved by 'Optimized Electricity Sales', this business model on the other hand has a marginally higher added value. This is due to the fact that electricity providers are less reliant on expensive backup capacities required during load peaks. With 'Virtual Power Plants' the natural fluctuations of energy production can be better compensated, which results in a higher added value for the smart grid [Do14].

If one now looks at result of the categorization, it is apparent that nearly every actor of the electricity market is addressed as target customer by some new business model. Although most business models still aim at end-consumer segment that is proven to the be most profitable, it is advised to also address the other actors as potential customers as they represent new customer groups that are not yet tied to a specific provider. Furthermore, most of the discussed business models contribute to the stabilization of the smart grid so that their realization is also desirable from a macro economical perspective. With the comparison of business models, it becomes evident that new possibilities arise from the combination of models merging different customer groups and revenue streams. For example, electric utilities could provide contracts that include smart home services for the end-customer on the one hand and interruptible loads for the grid operator as demand response services on the other hand.

6 Conclusion

In this state-of-the-art review several quite heterogeneous business models have been discussed. Although most of the business models still aim at the end-customers, new potential customer groups should be taken into consideration. As the large part of the discussed models has yet to be proven in practice, a final assessment cannot be given. However, a combination of several business models appears especially promising. Furthermore, all business models employing the more and more widespread smart meters have potential for success insofar as they meet the existing customer requirements whereas the conventional business model of electricity providers will become less important. In order to remain successful, the current market actors must prepare for the changes and potential competition. Crucial factors will be the acquisition of know-how and new competencies – particularly in the IT area.

In this research paper not all categories of the Business Model Canvas could be described in detail for each business model. To obtain a more comprehensive picture about this subject, we encourage further studies on smart meter based business models relevant to the gas and heat market. In the near future a similar literature review should be conducted again in order to cover also the business models which are not described in detail in today’s literature.

Acknowledgements

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Digitization of Decentralized Corporate Energy Systems: Supportive best-practiced methods for the energy domain

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Abstract: Digitization in the energy sector is a necessity to enable energy savings and energy efficiency potentials. Managing decentralized corporate energy systems is hindered by a non-existence. The required integration of energy objectives into business strategy creates difficulties resulting in inefficient decisions. To improve this, practice-proven methods such as Balanced Scorecard, Enterprise Architecture Management and the Value Network approach are transferred to the energy domain. The methods are evaluated based on a case study. Managing multi-dimensionality, high complexity and multiple actors are the main drivers for an effective and efficient energy management system. The underlying basis to gain the positive impacts of these methods on decentralized corporate energy systems is digitization of energy data and processes.

Keywords: Decentralized Corporate Energy System, Balanced Scorecard, Enterprise Architecture Management, Value Network

1 Introduction

To balance the increasing production of renewable energy sources and their consumption, digitization of the energy sector is necessary [Reht15]. Under focus are the stabilization of grids on a macro level, energy efficiency potentials on a micro level, and energy process optimization. Enterprises discovered decentralized energy generation for different reasons such as price advantages, planning stability, declining amortization time of power facilities, flexibility of energy demand and environment /resource protection [DiVe14], [Döri15]. Therefore the number of decentralized power generating sites has increased in recent years. Decentralized power generation is defined as a production close to the point of consumption and usually focuses on renewable energy [BrAl13]. Research done in recent years shows, that corporate energy management is seldom aligned with the overall corporate strategy ending in poor energy system decisions or in business decisions contrary to energy goals [MaPi13], [Posc11]. This leads to "accidental" energy architectures [Giro09] which result in inefficient energy savings or efficiency measures. The digital transformation in the energy sector is an opportunity, as well as a thread to overcome these barriers [Dole16].

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Our paper analyzes the challenges of a digitized decentralized corporate energy system. It researches the applicability of best-practice methods to support the digital transformation to decentralized corporate energy systems. Therefore, the following research questions have been formulated:

1. *What are the main challenges for a digitized corporate energy management system?*
2. *Which best-practice-proven methods address the identified challenges, and*
3. *What has to be taken into account by an application to the energy domain?*

The feasibility and benefit of the approach is demonstrated on a case study. Clustering findings along an energy management framework enables barriers to be detected. These results are combined with three widely used modelling methods like e3Value, Balanced Scorecard or Enterprise Architecture Management to identify transformation hurdles.

2 Research Context and Methodology

The aim of this research is to analyze, design, implement and evaluate a transformation path towards a digitized decentralized energy management system. A case study approach was selected to overcome the current actual gap in empirical research. Case studies are useful to research a new domain or phenomenon, providing initial hypotheses, which may be tested later systematically on a larger number of cases [Flyv06].

Our case is a 300 employee, medium-sized enterprise in the tourist sector that offers a unique botanical garden to its visitors. It has several decentralized renewable energy systems on its property and the ecological goals are clearly stated in its corporate strategy. When the enterprise started implementing an energy management system, various obstacles were detected.

Since the authors adopt an active role in the transformation process, our research activity conforms to the tenets of action research (AR). [Bask99] defines action research as an interactive process involving researchers and practitioners acting together on a particular cycle of activities, including problem diagnosis, action intervention, and reflective learning. AR is a widely discussed collaborative research approach and a significant amount of literature on this topic is available [ALMN99]. Three data collection methods were used during the case study: participating observation, semi-structured interviews and document analysis.

Conducted research is part of a public funded research program named ENsource (www.ensource.de) which focuses on decentralized, flexible solutions for future energy production and distribution. The Ministry of Science, Research and the Arts of the State of Baden-Wuerttemberg, Germany and the European Regional Development Fund (EFRE) fund this project.

3 Case Analysis

The implementation of renewable energy generators on company´s territory is based on the corporate vision to create an economic and ecological balance. The company's founder, who felt a high environmental responsibility, set this goal in place one generation ago. The company built up several energy generation sites in the past years to achieve this corporate vision but also faces high energy demands due to green houses and several catering facilities. Since 2013, the company has started to build up an energy management system.

The scientific literature concerned with energy management systems (EnMS) is still limited and publications focus on practice-oriented books [Hubb16]. A report from Natural Resources Canada proposes a best practice framework based on results of thousands of trainings conducted with organizations in energy management [Natu15]. According to this guide, effective energy management requires a holistic approach that considers actions in eight categories: Commitment, Planning, Organization, Projects, Financing, Tracking, Communication, and Training. The performance in each category is rated on a Likert-scale of 1-5. Level 5 means the organization works in an optimal way, while level 1 means no action can be noted in this category. This framework can be used to set an energy policy or to check the state of an EnMS within an organization.

The findings of the case study are examined and rated using this framework to detect gaps in the company's decentralized corporate energy system and then to identify practice-proven methods aiming to close these gaps.

Commitment: The company's vision of economic and ecological balance is clearly formulated and published. The management board has a high commitment towards this vision and the continuous improvement of the environment is a corporate goal. Three main energy goals (energy saving, energy efficiency and decentralized renewable power generation) were set up in 2013. However, none of these goals are connected with quantifiable numbers nor with a timeline. A tracking of target achievement is not possible. Therefore, the level is set at 4.

Planning: The enterprise started to establish an EnMS according to ISO 50001 and defined detailed multiple energy targets. But an outlined roadmap connecting measures to the top energy objectives or vice versa, measures derived from the objectives, is missing. The chosen targets aren´t quantified and seem to be unsystematic. As well, no deadlines are fixed. The published energy targets are either very detailed (e.g. changing a specific catering oven) or very broad (e.g. reconstruction of the green houses). A combined energy concept is missing. This criterion is rated at level 2, aiming to 3 only.

Organization: There is one person working as an energy manager. His authority to give directions is limited and restricted to recommendations towards other business divisions. The rating of this criterion is 3.

Projects: The development of energy measures and projects are ad hoc and event-driven

and not systematically connected to the energy objectives. Several identified and published energy targets were not converted into projects due to economic reasons. Therefore, this criterion is rated at level 3.

Financing: The energy investments are based on short-term returns on investments but no business case towards monetary effects through energy savings or efficiency has been conducted. The rating is 3 again.

Tracking: At present the available data and its quality is not sufficient for implementing and tracking the aspired goals. The lack of suitable data is based upon three factors: no data is measured at relevant local spots, energy data is not digitized and finally the data is not available at the needed aggregation level. For example, it is not possible to assign the energy consumption to business models or even profit centers of the company. Therefore, this criterion is rated with 2.

Communication: On a yearly basis, the company publishes its sustainability report, which includes an overview about energy consumption, targets and projects. Via the company's intranet, energy information is supplied to the staff. The rating of this criterion is 3.

Training: Energy saving- and efficiency training for staff members takes place but results are hardly seen. A rejection of these topics even occurred due to too many ecological training measures being currently operated. The rating of this criterion is split into 4 (training takes place) and 2 (poor results).

Value Network Management: (customer-, partner-, supplier management): The category Value Network Management has not yet been part of the best practice energy management framework (Natural resources Canada, 2015). Due to the case study findings and its discussed relevance in scientific literature [KaGT04], [Hert16], [DiVo15] the category "Value Network Management" is integrated into the energy management framework.

The corporate energy system encompasses four photovoltaic sites, a gas power station, a wood distillation block heat and power station, a wood pellet power generating site and gas-fired boilers. A local energy provider supplies additionally needed electrical power and gas. The generating sites are owned and managed by several stakeholders. The traditional energy value chain (centralized power generation => transmission => distribution => retail through an energy supplier) evolves to an energy value network where power generation, distribution and retail are combined transactions. For example, building roofs are rented to a supplier that delivers the photovoltaic generation sites and gets the governmental grant for renewable energy generation in return. In this way the company consumes renewable decentralized generated electricity while accomplishing its energy goals. The value network demonstrates the complexity of relationships between the actors and diverse systems. Yet, a planned approach to use and increase the advantages of the value network is missing. The rating of this category is 3.

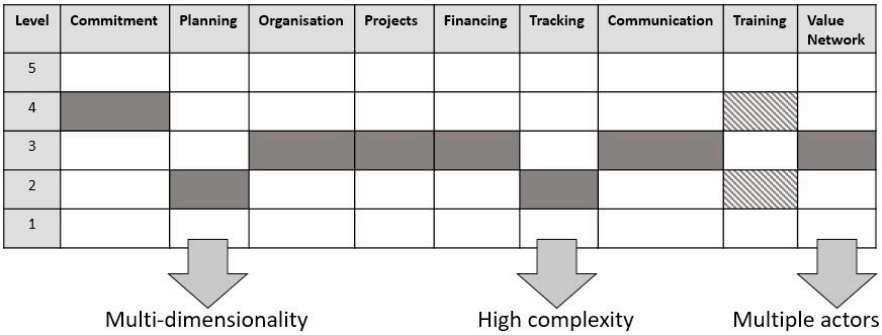

Fig. 1: Overview of the ratings and resulting resolving challenges

Figure 1 gives an overview of the final case study ratings. The results show that the company and its management board have a high commitment towards energy objectives. They have started energy transformation measures in different areas. Yet, further progress is hindered through two specific categories: planning and tracking. A third category "multiple actors" is of growing relevance since the achieving of the company´s energy goals relies on its value network.

The corporate vision of a balanced economical-ecological strategy (criteria "Commitment") requires an alignment of economic and energy-related objectives and measures (criteria "Planning"). The implemented EnMS hasn't supported such functionality so far. Therefore, the reflection of energy items to corporate decisions has not been implemented. The corporate decision making processes are mostly economically driven. To overcome this obstacle **multi-dimensional viewpoints** have to be integrated into the company's strategy.

Managing a decentralized corporate energy system is based on energy data. The category "Tracking" shows an essential gap in this area. Missing measurement spots, heterogeneous data formats and poor digitized processes are the main barriers. On top of that, the high diversity of power systems leads to **highly complexity**.

The case analysis also showed that decentralized corporate energy systems are not based on traditional supplier-buyer-value chains anymore, but encompass various actors that form an ecosystem of interdependent value-added services. This **multiple-actor-approach** is of specific means and has to be included in a management framework.

4 Identification and transfer of practice-proven methods

Based on the case analysis three main challenges in managing an efficient decentralized corporate energy system are identified: Management of multi-dimensional target systems, of system's complexity and of multiple actors in value networks.

Integrating different viewpoints into a company´s strategy can be achieved by using the Balanced Scorecard Method (BSC). The BSC approach [KaNo92] addresses a combination of four business perspectives (financial, customer, internal business processes, and learning and growth) and offers the opportunity to integrate further strategic views [KaNo96]. The BSC is a global standard, widely used in private [GrSa01], [HuHu07] and public sectors [Usde17]. Objectives are linked to measures and quantified through key performance indicators (KPI). A constant controlling of improvements is possible. Such a holistic approach enables the integration of energy objectives into corporate strategy dimensions.

The Enterprise Architecture Management (EAM) approach has been proven to be an efficient instrument to align business and IT and to control the complexity of IT landscapes [Hans12], [HRSM14]. EAM is used to model the as-is landscape and to derive from there the to-be state. The decentralized energy system reflects a complex energy architecture, which has to be aligned to the IS and enterprise architecture. Therefore, EAM methods provide a positive impact for establishing an effective EnMS. They have been accepted in academia and practice [USDT13] for years. One of the most used EAM modeling languages is Archimate [Open16].

Today enterprises can seldom be viewed as isolated entities. Usually they are connected in an enterprise network forming an ecosystem [Krcm11]. Because enterprise energy systems are operated by different actors, the ecosystem approach seems to be appropriate [ChRo95]. Many enterprises have established energy value networks with cooperating partners. Therefore, it is necessary to model and integrate the value flow into the EnMS of each partner. Modeling value networks is a relatively new field in IS research. The most common modelling language is e3-Value (e3v). The focus of e3v is on identifying and analyzing how value is created, exchanged and consumed within a multi-actor-network in both qualitative and quantitative ways [GoAk01], [AkGo03].

4.1 Improving EnMS with the Balanced Scorecard Method

The BSC method offers several advantages: (i), it enables the monitoring of present performances as well as obtaining information about the future ability to perform. (ii), it assists in translating an organization's vision into actions through strategic objectives and a set of performance measures supported by specific targets and concrete initiatives. (iii), using the BSC facilitates the identification of success drivers, allowing managers to focus on a small number of critical indicators, thereby avoiding information overload [ViOS16]. Several adoptions of the BSC towards sustainability addressing social and ecological dimensions have been successfully implemented in recent years [FHSW02], [ArFK03]. However, the implementation of an energy viewpoint is hardly dealt with in scientific literature [ViOS16] or in practice [Laue16].

Based on the results of the case analysis an Energy BSC was modeled using the software "ADOSCORE" from BOC. A typical corporate objective was selected to demonstrate the usefulness of managing multi-dimensional corporate goals including energy

perspectives. “Increasing the number of park visitors (customers)” is a typical business goal and reflects the interdependencies between customer-, financial- and energy dimensions. The relations between these dimensions illustrates the impact of customer measures on financial and energy goals and vice versa. The energy BSC is illustrated in figure 2.

Pyramids with connected KPIs to enable an ongoing controlling process, symbolize objectives in each perspective. Red or green dots signal a positive or negative development according to pre-quantified goals. An aspired increase of visitors (green dot) leads in the financial perspective to a revenue increase and higher profits which result in a rise of the equity ratio. Simultaneously on the energy perspective due to higher power demands through e.g. higher catering activities, the KPI for decentralized renewable power generation is turning negative as well as the energy objective “Energy savings”. The Energy BSC signals the energy manager, and respectively the board of management, when there is a need for adjustments.

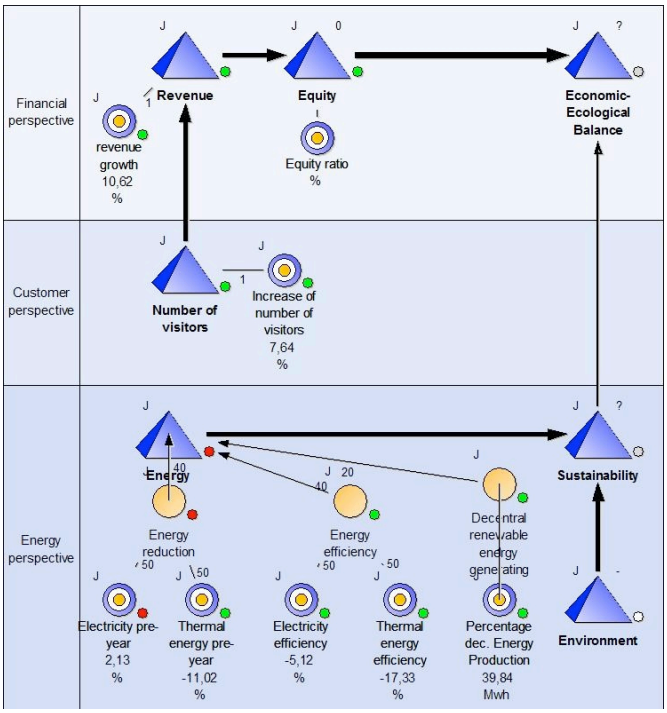

Fig. 2: Energy BSC

The implementation of an Energy BSC showed that the method provides corporate management with a transparent controlling process integrating energy goals into corporate strategy. Our case model indicates direct negative consequences on the energy goals through increasing visitor numbers. Identifying such goal conflicts between

strategic dimensions enables the management to set up compensating energy measures or to adjust customer goals.

For an effective EnMS an on-going controlling and decision making process with up-to-date information is necessary. A data-warehouse-based BSC standard software like ADOSCORE offers the opportunity to integrate energy data via Excel or SQL-database-statements. However, the studied case expresses a gap regarding data tracking, based on heterogeneous data formats, and non-existing digital data flows that significantly hinder the multi-dimensional controlling process.

The BSC offers the possibility to manage the multi-dimensionality of a corporate energy system. The transfer to the energy domain is possible and results in a positive impact. But the BSC method is only as good as the selected measures and KPIs.

The findings of the case study indicate clearly that a fully digital energy data process is the necessary starting point of effective and efficient BSC usage.

4.2 Modelling Decentralized Corporate Energy Systems with Enterprise Architecture Management

An enterprise is a complex and highly integrated system consisting of processes, organizations, information and technologies, with interrelationships and dependencies in order to reach common goals [RaAB11]. A common problem of many medium-sized enterprises is the diverse IT-landscape. A mostly unsystematic growth of applications in enterprises over time results in “accidental architectures” [Giro09]. The corporate energy system, with its high diversity and its unsystematic growth, leads to a similar development with similar difficulties. Taking the case study results (criteria “Tracking”), data heterogeneity and non-existing energy data processes resemble the IT-domain. Therefore enterprises need to be aware of their relations among strategy, business processes, applications, information infrastructures and roles.

Enterprise Architecture Management (EAM) contributes to solve these problems. It is a holistic approach providing methods and tools to establish a complete perspective for enterprises [Lank13]. According to [Lank13], EAM can be defined as “a coherent whole of principles, methods, and models that are used in the design and realization of an enterprise’s organizational structure, business processes, information systems, and infrastructure”. In this context, EAM provides an approach for a systematic development of organizations in accordance with its strategic goals [ASML12]. Thus, EAM has evolved as a best-practice method that positively assists an EnMS. Additionally Appelrath et al.[ApTW12] emphasized that changes of the energy system require an analysis of the corporate information systems as well.

In the findings of the case analysis, several characteristics were identified indicating EAM solution potential: First, the complex, unsystematic development of corporate energy architecture. Second, the different energy consumer units (e.g. catering facilities,

greenhouses, administration, event facilities), and third the heterogeneous energy data landscape (missing data recording spots, analog data only, highly aggregated, useless data, various metering spots without an interconnected digital data workflow).

For modelling the Enterprise Architecture, the ArchiMate 3.0 [Open16] modeling language was selected because the entity "physical elements" enables the modeling of power generation sites. For modeling the ArchiMate models, we used the tool Signavio. The modeled Energy Enterprise Architecture (figure 3) shows a simplified representation of the case study energy system. The model enables the visualization of the as-is energy data process, the identification of digital gaps, and the planning of a roadmap towards a better fitting, future to-be Energy Enterprise Architecture.

The Energy EA (figure 3) reflects the business case "increasing park visitors" and its resolution in higher energy demand in catering facilities (chapter 4.1). It describes the data sources for generated and consumed electrical power linked to side-by-side existing Excel-files. Today, the energy data recording process is carried out manually. The Energy EA displays the decentralized power generation system with its generation material as well as the catering electricity consumers. Producer and consumers are connected via the power grid.

The Energy EA reflects the as-is state of the decentralized energy system and enables the energy manager to identify data gaps, existing data flows, the quality of data (analog-to-digital), data sources etc. This information is the baseline for planning the to-be-model based on a corresponding roadmap.

Modelling an Energy EA provides a positive impact for an effective decentralized energy management system and is therefore a useful method for managing the energy domain in a digital, data driven process. Until now the modeling approach is simplified and represents only a small part of the decentralized energy system. Different viewpoints have to be integrated as well. Still, designing an Energy EA and the development of an EA-roadmap is the basis for the implementation of an effective Energy Scorecard and an enterprise-wide, multidimensional controlling system.

4.3 Value Network approach

Today, enterprises do not compete among individual companies, but among networks of interconnected enterprises [PeRy06]. Such interconnected enterprises are compounded to an ecosystem and can´t be viewed individually. Moore [Moor96] defines a business ecosystem as an "economic community supported by a foundation of interacting organizations and individuals –the organisms of the business world". The performance of an enterprise is influenced, or even determined, by the performance and behavior of its partners. Therefore, it is necessary to analyze the

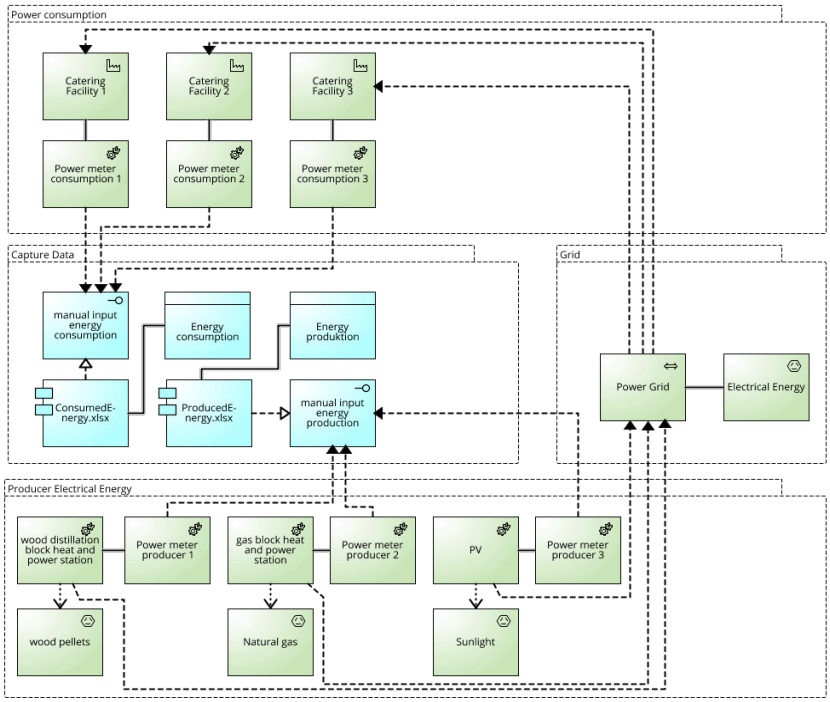

Fig. 3: Energy Enterprise Architecture.

cooperating partners and the exchanged values to provide the relevance for each enterprise. The focus of a value network (VN) is to collectively determine value for each party involved [AlAF13]. This trend can be seen in the energy sector as well [Hert16], [KüHK15]. It can be observed that especially new, smaller actors in the energy value chain are dependent on such partnerships [KüHK15].

Our case with its multiple-actors-landscape verifies this point too, so it is reasonable to examine and model the value exchanges between the different partners. A modeling approach including multiple actors is the e3v-method by Jaap Gordijn [Gord02]. It enables the visual representation of value exchanges between VN actors by modeling their interactions. E3v provides a set of components by representing the actors, the activities, the value exchanges and the value chains involved in the network. Based on the case the VN was modeled with the e3v-method (figure 4).

The diagram shows the actors of the ecosystem arranged around our case file (energy supplier, photovoltaic supplier, grid manager, wood pellets supplier). Several similar actors are aggregated into market segments (customer). Lines between the actors and market segments represent the value exchanges between the actors. These exchanges can be energy, money, energy generation sites, rent, governmental grant, material or data. Actors that do not have a direct value exchange are not pictured.

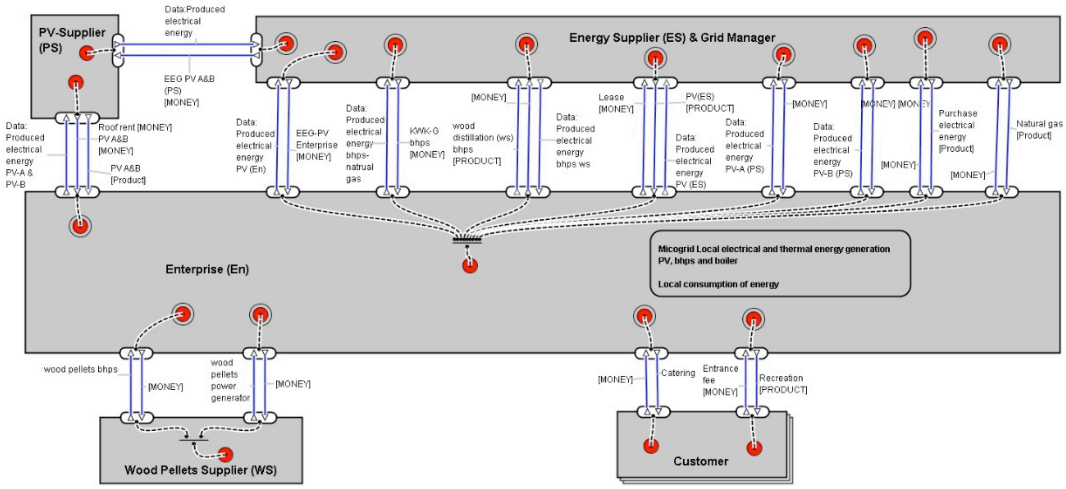

Fig. 4: Value Network

The VN demonstrates the interdependencies between the different actors. Our case study company achieves its energy goals (renewable decentralized energy production) with the help of the PV- and the energy supplier. In return the company offers its building roofs to the PV supplier. Each partner brings its competence into the VN which add up to the overall value. The modeled value network is also the starting point for describing the needed IT-services or data models between the actors and for expanding the Energy Enterprise Architecture towards an Energy Network Architecture. Currently, digitized energy data hardly flow between the network actors. Paper-based billing procedures takes place once a year. An online-energy-tool to monitor the energy demand of the case file company is set up by the energy supplier. The retrieved data hardly matches the energy information needs of the company. Therefore, a better alignment of energy information between the two actors is necessary. Additionally, it is currently not possible to automatically retrieve the energy information into the company´s energy management system. No digital energy information exchange exists at all between the PV supplier and the case company.

Modeling the VN clearly has a positive impact on the company's transformation towards a digitized decentral corporate energy system regarding the role and the importance of each actor as well as providing a starting point for establishing an Energy Network Architecture.

5 Conclusion

Decentralized corporate energy systems have evolved constantly in recent years, changing the role of enterprises to energy prosumers. Establishing an effective and

efficient EnMS depends on the digitization of the energy processes in- and outside of the company. The success of managing a decentralized EnMS relies on nine categories. Applying these to our conducted case, three main challenges were identified: Managing multi-dimensional target systems, energy enterprise complexity and relying on an energy value network.

Three practice-proven methods that address these challenges, the Balanced Scorecard, Enterprise Architecture Management and the Value Network approach were identified and evaluated in this paper. The BSC enables enterprises to manage complex multi-dimensional strategies. However, the current energy EA can´t deliver the necessary energy data for proper system management. EA Modeling enables the visualization of the energy enterprise architecture to identify gaps in data flow and digital processes. These gaps define the roadmap to-wards a future digitalized Energy Enterprise Architecture that copes with the planned future development. The Value Network Approach displays dependencies with other actors and shows additional value opportunities. All three methods clearly show the need for digitization to accomplish energy goals.

The transfer and partial integration of BSC, EAM and VN to the energy do-main seem to offer a promising impact for managing decentralized corporate energy systems. Further research in the integration of these methods is required to find standardized interfaces between business demand and necessary energy sys-tem data sources. Future research on conceptual models and their validation by empirical use cases will elaborate the data driven management of decentralized energy systems.

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Data Architecture for Digital Health Insurances

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Abstract: The increasing number of connected mobile devices such as fitness trackers and smartphones define new data sources for health insurances, enabling them to gain deeper insights into the health of their customers. These additional data sources plus the trend towards an interconnected health community, including doctors, hospitals and insurers, lead to challenges regarding data filtering, organization and dissemination. First, we analyze what kind of information is relevant for a digital health insurance. Second, functional and non-functional requirements for storing and managing health data in an interconnected environment are defined. Third, we propose a data architecture for a digitized health insurance, consisting of a data model and an application architecture.

Keywords: Data Architecture, Data Model, Digital Health Insurance, ArchiMate 3.0, Big Data and Analytics, Requirements Engineering

1 Introduction

As a result of advances in sensor system technologies new possibilities in health analytics arise, changing the traditional business models of health care providers.

The base for a digitization of health insurances is the more conscious and active lifestyle of an increasing percentage of the population. By using wearables much data is generated, though not evaluated efficiently enough yet. Enhanced data analysis enables health insurance companies to move away from the current reactive model of care towards a preventive one. Through proactive offers, such as fitness courses, support for therapies or rehabilitation, or simply reminders for medication or conscious food intake, the customer experiences direct added value. The customer also contributes to increasing the knowledge about disease risk and the effectiveness of interventions.

In this paper, we will describe a scenario which is divided in four use cases. The scenario is a simplified showcase for the possibilities emerging from the use of fitness trackers and sets the foundation for an exemplary data architecture of a digital health insurance.

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Participating roles are the insurance company, the customer himself and a doctor.

Main interactions between the participants are:

1. The individual calculation of insurance fees using a customer's current fitness status.

2. The customer can access an aggregated fitness data overview on the insurance portal.

3. The customer is heavily burdened with heart diseases and agrees to a pulse monitoring by the health insurance. In case of irregularities the responsible doctor will be informed.

4. By comparing data sets of the insured with the analytic database of the health insurance, undetected diseases may be discovered.

Sources analyzed in a preliminary literature review focused either solely on the business context of health insurances, mostly without including health personnel, or on collecting data from fitness trackers and other smart devices without consequential business models. The intended data architecture is supposed to fill the gap and include both business and technical prospects. Therefore, the specific research question is:

RQ How can a data architecture for a health insurance with a digital business model look like?

To approach this question, two further sub-questions were defined:

RQ1 What data is relevant for the digital health insurance and what insights about customers can be gained from this data?

RQ2 What are functional and non-functional requirements for health insurance data and its organization?

The paper is structured accordingly in the following chapters. Chapter 2 starts off with the methodology used. Then, chapter 3 covers the results of the sub-questions. The relevant data for the chosen scenario and the insights which can be gained from that data are presented in chapter 3.1. The following subchapter then covers the requirements that data yields towards both a data and application architecture before chapter 3.3 continues to introduce different data architecture modeling approaches and rate their suitability for the given use cases and requirements. In chapter 4, the chosen architecture approaches are modeled based on the results of the sub-questions. A discussion with input of a health professional and a big data specialist follows in chapter 5. Finally, the outcomes of this paper are summed up and an outlook is given in chapter 6.

2 Research Approach

In order to draw conclusions from the given use cases in the context of digital health insurances, we have performed extensive literature research. We started with several

research questions ranging from existing digital health insurance approaches via data and application requirements for such a one to the possibilities of Service Oriented Architectures in this context. In an initial keyword search in five electronic databases (IEEE, ACM, Springer, EDDI and Google Scholar), over 100 relevant documents were retrieved, including scientific journal papers, industry proposed data models for health care and insurance and documents describing the application structure of Big Data software. This basis allows further limitations to the scope of the initial research topics, leading to a focus on the data architecture of a digital health insurance. Designing the architecture will be performed in two steps. Firstly, the most important findings on data relevant to a digital health insurance and the ensuing functional and non-functional requirements identified from literature are aggregated into a suitable data model. Secondly, a corresponding ArchiMate 3.0 application architecture will be proposed.

3 Preliminary results

3.1 Relevant Data and Insights

Approaching the research question of relevant data and its insights, the first interesting point is: Assuming some kind of relevant data can be gathered, what could be done with this data?

The main aspect of upcoming insurance business models seems to be individualized policies based on the personal needs of the insured persons. In case of health insurances, this can be implemented by offering a certain policy model with a cheaper insurance contribution if the customer is proven to pursue a healthy lifestyle. Another policy model could be offered for people with chronic diseases, e.g. including a more intensive customer support. But which data is useful to categorize the customers in such way?

For this endeavor, some physical information is important like: age, gender, blood pressure, pulse, body weight, body height, (previous) diseases and disabilities. But most of these data artifacts are only helpful in conjunction with other information. The body weight can give relevant clues, but only by knowing the body height as well. Age and gender could also provide appropriate statements. Furthermore, not only physical information is important for such a classification. Additional information like possible hereditary diseases, eating habits, sports activities, alcohol and drug consumption, workplace or being a smoker or not can help the health insurance acquire a better picture of the customer. To enable a customer classification, certain criteria have to be derived from the available data, in order to match a customer to the most adequate policy model.

Fitness trackers are useful devices for collecting some of the mentioned data. A comparison of several models from different manufacturers showed that most of them can track the following metrics: number of steps, distance covered, calories burned, pulse and heart rate zone [Fi16]. This data could not only be helpful for categorizing the

customers into classes, the health insurances also get relevant information about the everyday life of the customers. To motivate the customers to share their fitness data, a health insurance could not only give discounts on the insurance premium [Mü16] but also offer a platform on which the customer can get a central overview of all his fitness activities. Furthermore, the insights about the customer given by his fitness data enables the insurance to suggest individual nutrition plans or fitness programs. In case of life-threatening conditions like heart diseases, the permanent usage of fitness trackers allows monitoring for irregularities. Moreover, the amount of collected data from different insured allows pattern-matching leading to improved diagnoses.

3.2 Requirements for a Data Architecture

The foundation of constructing a data architecture is to know which requirements need to be fulfilled. Therefore, requirements engineering is used, which is a systematic and disciplined approach for the specification and management of requirements. Requirements can be functional or non-functional [Ru14]. In the case of health insurance data, the functional requirements are defined by:

Structure of Health Insurance Data: Factors to be considered are the number and kind of stakeholders, record structure and storage location. Regarding the chosen use cases, only the insured and their respective doctors are relevant stakeholders. An enlarged use case would also include pharma industry, research, government, gyms, further healthcare providers, as well as insurance shareholders. Data records can be organized by source, in chronological order, by a predefined protocol structure or by assigning all records to certain problems [Sa12]. For fitness data which has a continuous inflow and may come from different sensor sources a chronological storage structure fits best. The data can be stored decentralized, centralized or in a hybrid structure [Sa12] [Br17]. In the evaluated use case the insurance acts as a central data host for all stakeholders.

Use Cases of Stakeholders: Each use case introduced by the stakeholders or the insurance company consists out of a process of sourcing, collecting, storing, processing and serving data [Gi17]. The individual process defines which data types are needed. Data sources of the observed use case are smart devices such as fitness trackers and smartphones providing different kinds of fitness data.

Data Governance and Data Management: The data needs to be governed and managed [DM17] to ensure quality, uniqueness and security. Especially the question of data control needs to be defined. Considering use cases in scope, aggregated fitness data can be created, updated and deleted by the insurance, while the other stakeholders have read permission only.

Health and Insurance Standards: To enable data exchange within the health community a common terminology, message exchange and object model are essential [Sa12]. Additionally, the different device manufacturers need to be considered.

Further important considerations for non-functional requirements are:

Availability: Critical health and insurance customer data must be at hand 24/7. Normally, fitness data is not critical. However, the case of patient monitoring requires high availability.

Performance: Real time data from health devices and certain analytics need to be processed in a fast pace, but data like archive documents and diagnostic reports do not require such a fast procedure. The architecture has a clear need for a type of two speed architecture.

Extensibility: To be future oriented, flexible and competitive the architecture must be open for new stakeholders, data types, contents, interfaces and applications.

3.3 Classification of Data Model and Architecture Approaches

The challenge within finding the right data architecture to model all the different data types for a digital health insurance is to get an abstract view. Therefore, we shortly introduce different data models and architectures and assess their suitability regarding the identified requirements from the previous chapter.

With a “data warehouse model” is it possible to model the process from gathering and transforming the data to storing it. The focus of this approach is not the data, but rather the transforming and loading of data into a data warehouse. With lots of different sources and data types, it gets inefficient and inflexible with new data sets [GIW97].

The “data structure diagram” is a predecessor of the entity-relationship model (ER model) which will be described subsequently. While the data structure diagram sets its focus on the relationship of the elements within an entity, the ER model is more about the relationship between entities. As in the contemplated use cases data is linked to a large extent, the relationships between entities are considered to be much more important.

A “data lifecycle model” provides a high-level overview over the stages in which the data is involved. It complements a data model to express an exact data process, but is no data model itself and will therefore not be used for the intended data architecture.

The “ER model” describes an abstract data structure which consists of entities, attributes and relationships. The entities represent objects in the real world. Entities are connected via relationships which represent the relations and dependencies between them. Each entity or relationship can have a number of attributes assigned, denoting their relevant characteristics [ES07]. To model all the different data types, data sources and their context, the ER model is the best option in this case.

In order to describe a holistic data architecture including not only the data itself, but also the data gathering, processing and storing, another modeling approach is necessary. For

this purpose ArchiMate 3.0, a modeling language for Enterprise Architectures specified by the Open Group, is used. ArchiMate is distinguished into a business, application, technology and a strategy layer [OG12a]. In this paper, the application layer, which models information system architectures, is used. It shows a set of elements, ranging from data objects via application services, processes and events to application interfaces and components, as well as the relationships between those elements [OG12b]. Hence, we can model a complete view of the data, the relationships and the process from gathering data to handling user requests.

4 Data Model and Architecture

In this chapter, the identified relevant data for each considered use case plus the requirements are aggregated into two models, functioning as data architecture.

The ER model in Fig. 1 shows the detailed composition of the required data artifacts and participants.

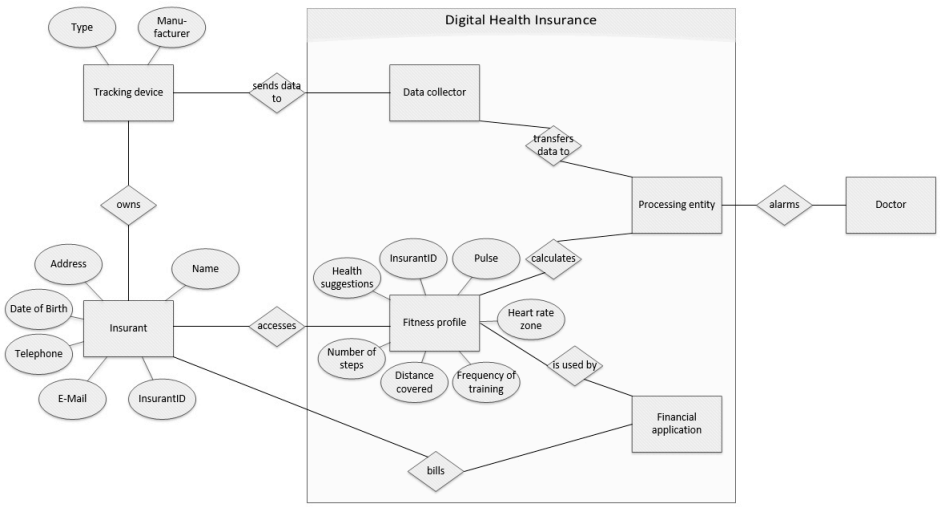

Fig. 4: ER model for the identified use cases

For each insured, personal data such as name, address, telephone and a unique InsurantID is stored. The insured may own a tracking device, e.g. a smartphone or a fitness tracker which acts as data source. The tracked data is sent to the central data collector provided by the insurance, which then transforms the data into a standardized form and transfers it to the processing entity. Here the analysis takes place, including the monitoring for irregularities as required in use case 3. If critical irregularities are detected, a doctor will be informed to contact the insured. After processing, the data is stored in the form of a fitness profile. This profile includes the correspondent InsurantID,

the tracked raw data and an analysis on the frequency of the training to determine the insured person's fitness status as well as individualized health suggestions. These suggestions may be recommendations of sport courses and other health-improving activities based on the current preferences of the insured, but also warnings or reminders if a medical check-up appointment seems to be necessary. The insured can access his fitness profile via a web platform. In the back end, the fitness profiles of the insured are also used by the financial application to calculate discounts on the insurance premiums based on the respective fitness status.

As data collection and processing are important elements for dealing with the described use cases, the application model in Fig. 2 shows them in a more detailed manner.

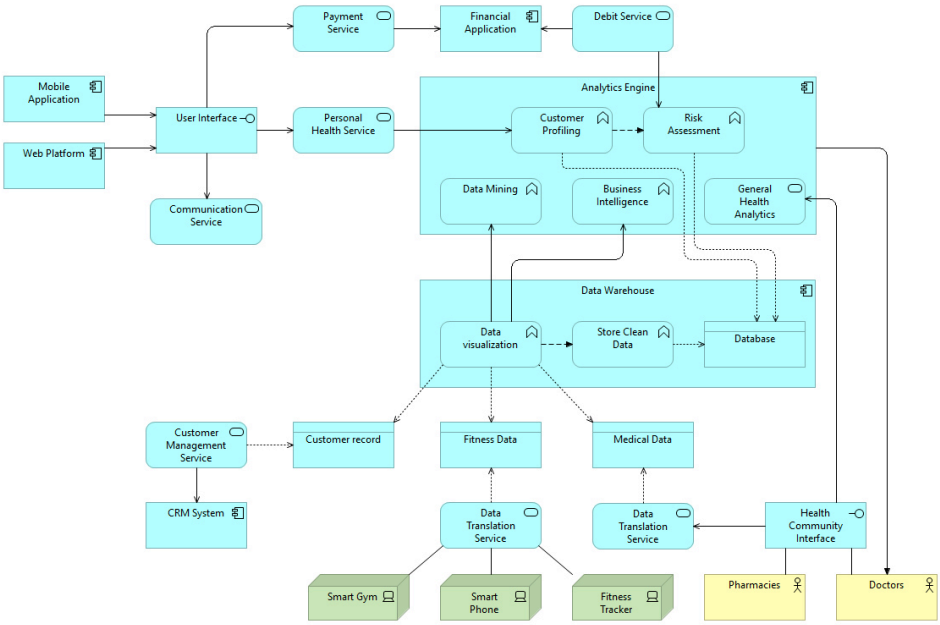

Fig. 5: Model of the ArchiMate 3.0 Application Layer

The central component of the architecture is data warehouse, but instead of falling back to the traditional ETL (Extract, Transform, Load) process, a more flexible approach is chosen. As ETL does not deal well with many data types from different sources [Ki16], it cannot fulfill the requirement of *Extensibility*. A solution is the usage of data virtualization as an abstracted layer across conventional customer records, specific medical data and fitness data. The latter is aggregated by a data translation service, which does not only collect the data from various devices, but also translates it according to a common standard. On top of the data warehouse an analytics engine is placed which combines different techniques from business intelligence and data mining. An exploratory data analysis evaluates (hidden) relationships among different variables

[Se09]. Thereby, undetected diseases may be revealed and prognoses on the world health may be derived. A detailed customer profile is generated which enables the personal health service to pass personal fitness statistics and health suggestions to the user interface. Based on the customer profile a risk assessment of the insured is conducted which determines the individual insurance premium. The requirement of *data control* is taken into account by exposing only small partitions of the data via services, so that no external party has direct access to it.

5 Discussion

In first validations of the proposed architecture with a health professional and a big data specialist, the architecture was perceived as reasonable for the chosen scope. However, several aspects were revealed that have not yet been taken into account. Both interviewees brought up ethical concerns, as an improved information flow about the health status of the insured may lead to disadvantages for chronical ill patients. Furthermore, fitness trackers are still quite easy to manipulate, so fraud may become a bigger problem. For the designed architecture, only a small number of data sources was regarded, but many more may be interesting for analyses. Insurances may be confronted with huge amounts of unstructured data, e.g. contracts of the insured with sports clubs or gyms, records of respiration, sleep screenings or data from medical devices like cardiac event recorders. Information security and privacy has to be ensured for all channels. The current architecture has to be augmented to match these additional requirements.

The health professional moreover suggested an integration of special software used in medical practices and hospitals. This could improve the user acceptance of the system, as it reduces time and effort to become acquainted with the new possibilities, compared to introducing an additional application.

6 Conclusion

The question of relevant data is not trivial as relevance is strongly dependent on the considered use case. The more data is available for an insurance, the more relations between behavior patterns and insurance claims can be found and predicted. Functional requirements are defined by the structure of the collected data, the use cases and the processes defined by the stakeholders. Data governance and management as well as national and international health and insurance standards, determine further requirements. Especially important non-functional requirements for the analyzed use cases are availability, performance and extensibility.

Two models were chosen to display the proposed architecture. An ER model defines the composition of the data whereas the ArchiMate model describes the interaction between the components and actors. It is difficult to examine the data architecture independent

from applications and technologies. Therefore, we do not intend to provide a generally valid model, but rather give an understanding of the steps necessary to derive requirements and a corresponding architecture from given use cases.

In future work, the data architecture has to be adapted as indicated in chapter 5 and further validations will be required. Additionally, an investigation of the state of practice in several health insurances could provide further insights on correctness and completeness of the proposed data architecture.

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Exploring User Adoption of Augmented Reality Applications based on Pokémon Go

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Abstract: Pokémon Go was the first mobile Augmented Reality (AR) game that made it to the top of the download charts of mobile applications. However, very little is known about this new generation of mobile online Augmented Reality (AR) games. Existing media usage and technology acceptance theories provide limited applicability to the understanding of its users. Against this background, this research provides a comprehensive framework that incorporates findings from uses & gratification theory (U&GT), technology acceptance and risk research as well as flow theory. The proposed framework aims at explaining the drivers of attitudinal and intentional reactions, such as continuance in gaming or willingness to conduct in-app purchases. A survey among 642 Pokémon Go players provides insights into the psychological drivers of mobile AR games. Results show that hedonic, emotional and social benefits, and social norms drive, vice versa physical risks (but not privacy risks) hinder consumer reactions. However, the importance of these drivers differs between different forms of user behavior.

Keywords: Mobile gaming, Augmented reality, AR, Pokémon Go, Gratifications, Risks, Flow

1 Introduction

During the last years, mobile technologies have diffused into all consumer segments [SN13]. Starting with devices for particular tasks (e.g. a cellphone for phone calls), technologies have converged into single devices. Recent technologies and apps aim at linking the real world and the virtual word with each other [Ra15]. Recently, Augmented Reality (AR) apps for mobile devices have entered consumer markets. Broadly speaking, AR is the name of a type of media in in which digital information is realistically integrated in the perception of the physical world [SS16]. Without doubt, one of these new and maybe even disruptive markets is AR gaming. Recent AR game launches brought worldwide interest to the opportunities of this type of games – for example, Pokémon Go in 2016. In Pokémon Go, virtual creatures are hidden in real-world locations and players are asked to locate and catch them with their smartphones or other mobile devices. Media have termed Pokémon Go as "the biggest mobile game in U.S. history" [Lo17].

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While AR games are emerging, consumer research in this domain remains scarce [tJ16]. In addition, established theories are limited in applicability to AR games for several reasons. First, most existing technology or media adoption theories do not incorporate AR specific factors. Second, mobile AR games are typically based on a freemium price model, which means downloading and playing the game is for free; however users are able to buy additional features (in-app purchases). Prior research is based on the implicit assumption that these purchases are driven by the same theoretical mechanisms that drive the intention to use a particular app. As we will theorize and empirically show in this research, this assumption is not valid. Third, most existing theories neglect the risks consumers incorporate in their decision-making. Therefore, this research concentrates on the following research questions: (1) What factors drive gamers' intention to play AR games? (2) What factors drive in-app purchases?
To answer these questions, we propose a conceptual model grounded in the literature on media acceptance, which is supplemented by prior research in gaming and AR. The model is then tested among 642 Pokémon Go players and analyzed using structural equation modeling.

2 Theoretical Foundation

2.1 Mobile Augmented Reality Games

According to Craig [Cr13], AR is defined as a "medium in which digital information is overlaid on the physical world that is in both spatial and temporal registration with the physical world and that is interactive in time". Thus, a user can see the real world, "with virtual objects superimposed upon or composited with the real world". Thus, in contrast to Virtual Reality (VR), AR is not closed off from reality, but melds the real and virtual worlds together [Ja16].

Pokémon Go is probably the most popular AR game so far. Players have to catch and fight Pokémon while exploring and experiencing the real world. Being an AR application, these virtual creatures appear on a user's device as if they are next to a user's same real-world location. As the game progresses, players are able to train their Pokémon to become more powerful and fight against competing players. Not surprising, public reactions on this game were intense and mixed. While supporters praised the potential to promote physical activity, critics raised various fears, such as accidents, distractions when used while driving, nuisance, and threats to a user's privacy [SV16].

2.2 Adoption Theories

Grounded in communication science, Uses & Gratification Theory (U&GT) addresses the fundamental question of why people use particular media. U&GT proposes that audiences are goal-oriented and proactively selecting media that satisfy particular needs

[Ka73, Ru02]. Although people's needs may vary depending on individual characteristics, they can be classified into five categories [Ka73]: First, cognitive needs, such as information gathering or increasing one's understanding of a particular issue. Second, social integrative needs, which represent the idea that media can help people creating new or maintaining existing relationships – for example, through social media [Ro16]. Third, tension-release needs encompass aspects such as escapism or diversion. Fourth, affective needs include all forms of emotions, pleasure and moods that people want to obtain. Fifth and finally, personal integrative needs describe the idea that people expose certain media to reassure their social status or to gain credibility among others.

U&GT is not without its critics [Ru00], but it remains one of the most widely applied theories in human communication research [Ru02]. Studies have applied and extended U&GT to various contexts, such as mobile social games [WL14]. However, there are only limited studies focusing on the AR-context. Therefore, further research is required in order to fully understand users' determinants to engage with AR [tJ15]. In addition, the importance of the development of a media framework within the mobile AR gaming context is supported by U&GT scholars, such as Ruggiero [Ru00].

3 Research Model

As discussed in the previous sections, existing theories are likely to lack of factors to explain consumers' reactions to mobile AR games. Therefore, we propose a new model which is presented on a high level of abstraction in Figure 1. The model proposes that users' evaluation and perception of various benefits, risks and social influences determine users' reactions and intended behaviors.

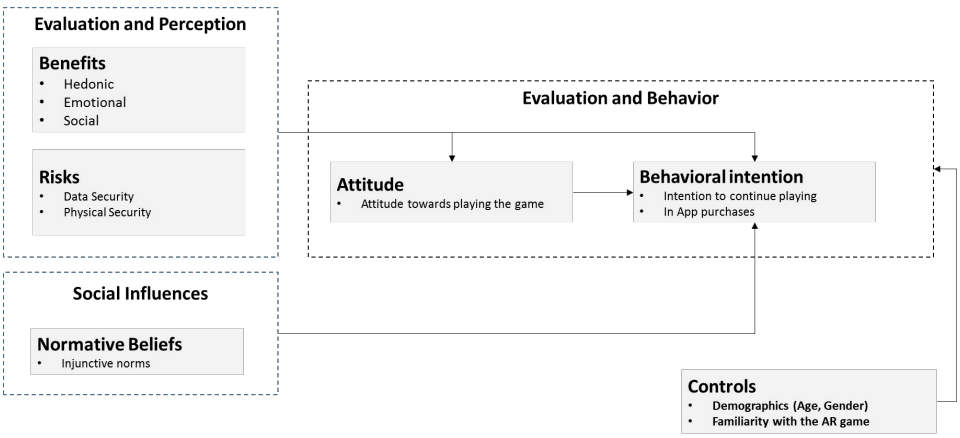

Fig. 1: Model Overview

U&GT provides the foundation for the conceptualization of benefits in the proposed model. As discussed in the theory section on U&GT, people use particular media to satisfy social integrative, tension-related, affective, personal integrative needs, and cognitive needs [Ka73, Ru02]. As AR games are hedonic media that are visibly played in public, we propose that the first four needs are relevant in explaining relevant benefits [Ru02]: social integrative and personal integrative needs are linked to benefits that drive from other people; in our model; we term this category of benefits (syn: gratifications) as 'social benefits' covering specific constructs such as image or the management of social relationships. Likewise, tension-related needs are linked to hedonic benefits, and affective needs to emotional benefits. In addition, we propose that risks have a negative effect on users. In this study, we add two risk categories – physical risk and data privacy risk.

3.1 Benefits

We propose that three different hedonic benefits are relevant to understand user reactions: Enjoyment, activity, and flow. In the subsequent section, we will outline why and how these factors are proposed to determine consumers' acceptance of mobile AR games.

We define enjoyment as the extent to which users perceive a mobile AR game as enjoyable [Ve12]. As gaming is associated with enjoyment and enjoyable is generally something that people find positive, we hypothesize:

H1: Enjoyment has a positive effect on attitude towards playing mobile AR games.

The rational why we propose that physical activity of gaming is proposed to a positive evaluation is grounded in neuroscience (e.g., [Ho12]). Neuroscientists have identified two main reasons why physical exercise makes people feel better: First, human evolution has linked physical exercise to stress, such as hunting or fighting enemies. To cope this stress, the human brain releases the so called BDNF protein which acts like a reset factor [Sw11]. Second, physical activities often lead to a release of endorphins. These neuropeptides lead to a feeling of euphoria, also known as 'runners high'. Recent research shows positive short-term effects of playing Pokémon Go on users' level of activity. Thus:

H2: Activity has a positive effect on attitude towards playing mobile AR games.

Flow theory, proposed by Csikszentmihalyi [Cs75], explains the phenomenon of optimal experiences. Flow is defined as "the holistic experience that people feel when they act with total involvement" [Cs75] and represents a predominantly hedonically characterized gratification [GP09]. When people experience flow, they become absorbed in their activity in a way that their awareness is narrowed to the activity itself. Finally, people usually perceive flow as something intrinsically rewarding, i.e. positive [SL13].

In order to achieve a flow experience, several conditions need to be fulfilled [Sc13, Cs75]. First, users need to have a clear understanding of what and how to play an AR game. An additional condition is to get feedback about one's performance while conducting a task. AR games usually present a user's scores or even high score lists. In situations where navigation is needed, Schaffer [Sc13] argues that knowing where to go is required. AR apps are based on a navigation to particular areas. Finally, as stated in the early work of flow [Cs75], flow requires a good balance between the task's challenges and the user's skills when performing a task.

While the above cited studies are examples of the widely replicated finding of the driving force of flow, we propose that flow is related to all three reaction variables in our model: First, replicating Hsu and Lu [HL04], we propose that flow has a positive effect on the attitude towards using mobile AR games (H3a) and the intention to continue playing them (H3b). In addition, we propose that flow also drives in-app purchases (H3c). This is because in-app purchases can enable the management of difficulty in a game. Prior research has shown that people are motivated to maintain the flow experience by proactively managing flow [Sc13]. Csíkszentmihályi [Cs75] stated that in situations where challenges are too low, people get back to flow by increasing them. In gaming, this means that gamers reach a more difficult 'level'. In many gaming apps with a freemium business model, users can also reduce challenges by buying certain in-game items they were not able to reach themselves. Therefore, we propose that in order to maintain flow experience, people tend to engage in in-app purchases.

H3a: Flow has a positive effect on attitude towards playing mobile AR games.

H3b: Flow has a positive effect on intentions to continue playing mobile AR games.

H3c: Flow has a positive effect on mobile AR game in-app purchase intentions.

In consumers' mind, long-term knowledge about anything is stored in associated networks [Fa86]. These associations are highly subjective, and people use these associations to create an overall evaluation of an item.

Human's long-term knowledge is also biased in a way that people tend to forget negative experience and overrate positive experiences. In research, this effect is termed the "Rosy view" [Mi97]. In line with this, the branding literature shows that many people value particular brands because that are linked to certain traditions (e.g., [St08]).

We propose that playing games is something that most people started experiencing when they were children. That is, playing a game might activate associations from the 'good old days' [Fa86], which are according to the rosy view predominantly positive [Mi97]. Thus, our research model proposes that the more a game activates nostalgic associations, the more positive a consumer should react to it. So called retro games (e.g. Space Invaders or Tetris) also make articular use of this. Thus, we propose:

H4: Nostalgia has a positive effect on attitude towards playing mobile AR games

It is a widely replicated finding among U&GT scholars that social integrative motivations (i.e. the motivation to improve one's social relationships) are a fundamental driver of media choice and use [Ru00]. For instance, social media such as Facebook help people connect with other people [Sh08, Ro16]. With regards to mobile AR games, we propose that social benefits, defined as the perceived benefits of creating new and maintaining existing social relationships through the use of a mobile AR app, drive the acceptance of the app.

Playing AR games might help users get in touch with other gamers. On the one hand, many games have online communities – similar to brand communities – in which users discuss game related and other topics. Probably more importantly, playing mobile AR games is highly visible to others. If people with similar interests get in touch while engaging in similar activities (i.e. playing the same game), it is likely that this leads to social interactions and form the basis for new relationships.

While the aforementioned section focused on creating new relationships, people can play mobile AR games with friends. As strong and close relationships with friends are something people usually desire and aim to manage with media [Ka73, Ru02], we propose that this factor drives the attitude towards using Pokémon Go. Moreover, we propose that this effect should also directly relate to the intention to continue playing a mobile AR games. Therefore, we propose the following:

H5a: Socializing is positively related to attitude.

H5b: Socializing is positively related to intention to continue using.

We define image as the degree to which an individual perceives that playing a mobile AR game will enhance his or her status in his or her social system [MB91]. We propose that this widely replicated finding is also relevant in the context of mobile AR games. Similar findings have been reported in the literature on brands, where people judge other people based on the brands they are using [EB03, St08]. Therefore, we propose that the perceived image of playing a particular mobile AR game directly transfers into the three dependent variables: First, people have a general preference for things that have a good image (H6a). Second, even if people do not like something (e.g. a product), they might still adopt it, if it has a positive image (H6b). Finally, if a mobile AR game has a good image, people might use it more intensely and thus might also be more motivated to achieve better results – in-app purchases might be beneficial in this case (H6c).

H6a: Image has a positive effect on intentions to attitude playing mobile AR games.
H6b: Image has a positive effect on intentions to continue playing mobile AR games.
H6c: Image has a positive effect on in-app purchase intentions.

Social norms are defined as the extent to which an individual believes that other people expect him or her to use a specific mobile AR game. According to Hsu and Lu [HL04], a large number of studies confirmed that social norms positively influence the use of technology and media. Thus, we hypothesize:

H7a: Social Norms have a positive effect on intentions to continue playing mobile AR games.
H7b: Social Norms have a positive effect on in-app purchase intentions.

3.2 Risks

Physical risk involves the "potential threat to an individual's safety, physical health and wellbeing" [Lu05]. Mobile AR gaming is distinct in terms of fully immersing its users while being in the normal environment. Therefore, it is not surprising that Sharma and Vassiliou [SV16] reported serious road traffic accidents because of Pokémon Go which people want to avoid. Thus:

H8: Physical Risk has a negative effect on attitude towards playing mobile AR games.

Information and media technology can pose threats to individual privacy, especially since users often pay for the use with personal information (e.g. Facebook) rather than with money [Co95]. As media and technologies become increasingly personal and ubiquitous, privacy concerns are growing in importance [Ac04]. Against this background, many scholars conceptualize privacy concerns as a risk factor that reflects an individual's inherent worries about possible his or her loss of personal information from using a particular media or technology [Ma04]. Because a user's perception of a media or technology's privacy concerns reduces its perceived trustworthiness, privacy concerns are linked to a psychological barrier of risk, involving vulnerability [BH94] and uncertainty [LW85], two antecedents to decrease the adoption of media and technology, thus:

H9: Privacy Risk has a negative effect on attitude towards playing mobile AR games.

3.3 Relationship between the endogenous variables

We propose that the attitude towards using mobile AR games is positively related to the intention to use a game [KH06]. Thus, we propose:

H10a: Attitude towards using has a positive effect
on intention continue playing AR games.

H10b: Attitude towards using has a positive effect on intention in-app purchases.

H11: The intention to continue playing AR games is positively correlated
with the intention to conduct in-app purchases.

3.4 Control variables

We also included several control variables in our model. First, as the amount of

knowledge consumers have about mobile AR games, we included familiarity with the studied game (Pokémon Go) as a control variable, as well two common demographic variables, age and gender.

4 Methodology and Research Design

We applied survey methodology to analyze the proposed model. Prior to data collection, we conducted a qualitative pre-study with 18 Pokémon Go users in Germany. The objective of this pre study was twofold. First, we aimed at ensuring that survey items were correctly understood by respondents. Second, we wanted to ensure that no relevant other constructs were missing in the questionnaire. This pre-study lead to some minor revisions on the wording. With the help of a professional market research firm, we surveyed 642 German respondents who reported having installed Pokémon Go on a mobile device.

If possible, we adopted established scales to the research context. We used seven point Likert scales (1=totally disagree;7=totally agree). The appendix provides an overview of the final measurement model. An inspection of the overall CFA indicates good psychometric characteristics ($\chi 2$= 1371, df=.624; p<.001; CFI=.972, NFI=.966, RMSEA=.043, SRMR=.043). In addition, on a construct level, all C.R., Cronbach's Alphas and AVE exceeded the established minimums of .7, .7., and .5, respectively. Correlations and descriptive statistics are available on request. Tests for common method bias and discriminant validity did not indicate any concerns.

5 Results

After having established the measurement model, we modelled the structural equation model using a Maximum Likelihood Estimator in Mplus 7.2 [MM13]. All fit measures were in line with the recommendations from the literature ($\chi 2$=1556.25, df=708, p<.001; CFI=.968; NFI=.963; RMSEA=.043; SRMR=.048).

Attitude towards playing Pokémon Go is driven by enjoyment (βH1=.52; p<.001), activity (βH2=.14; p<.01), flow (βH3a=.11; p<.01), nostalgia (βH4=.08; p<.01), and image (βH6a=.15; p<.01). In addition, higher levels of physical risks relate to lower attitudes towards playing Pokémon Go (βH8=-.06; p=.04). Thus, the results support H1, H2, H3a, H4, H6a and H8. No significant effects were found for socializing (βH5a=-.07; p=.27) and privacy risks (βH9=-.04; p=.18), rejecting H5a and H9. The control variables show significant effects on attitude variable (familiarity with the game: β=.07; p=.04; age: β=.08; p<.01; gender: β=.09; p<.01). All of these variables together explain 62.4% of the attitude's variance.

The model also identifies factors that relate to the intention to continue playing Pokémon Go: In line with the technology acceptance literature, attitude towards using Pokémon Go (βH10a=.58; p<.001) relates to higher levels of continued use, supporting H10a. In addition, flow (βH3b=.09; p=.02), image (βH6b=.11; p=.08) and norms (βH7a=.11; p<.10) show (partially) significant effects, whereas we did not find this effect for social benefits (βH5b=.01; p=.86). Results are also weakly influenced by the control variables (familiarity with the game: β=.08; p<.01; age: β=.16; p<.001; gender: β=.03; p=.33). All of these variables together explain 68.5% of the intention's variance.

Finally, results provide insights into the factors that drive the intention to spend money in in-app purchases. This target construct is driven by flow (βH3c=.11; p=.02), norms (βH7b=.28; p<.01), and image (βH6c=.25; p<.01), supporting H3C, H7b and H6c. Surprisingly, no significant effect was found for attitude towards using Pokémon Go (βH10b=.05; p=.30), rejecting H10b. In addition, some of the control variables weakly influence the in-app purchase variable (familiarity: β=.05; p=.225); age: β=.08; p=.01; gender: β=.03; p=.33). All of these variables together explain 40.2% of variation. Finally, we investigated the relationship between intention to play Pokémon Go and In-app purchases. In support with H11, these two constructs are correlated (rH11=.24; p<.001).

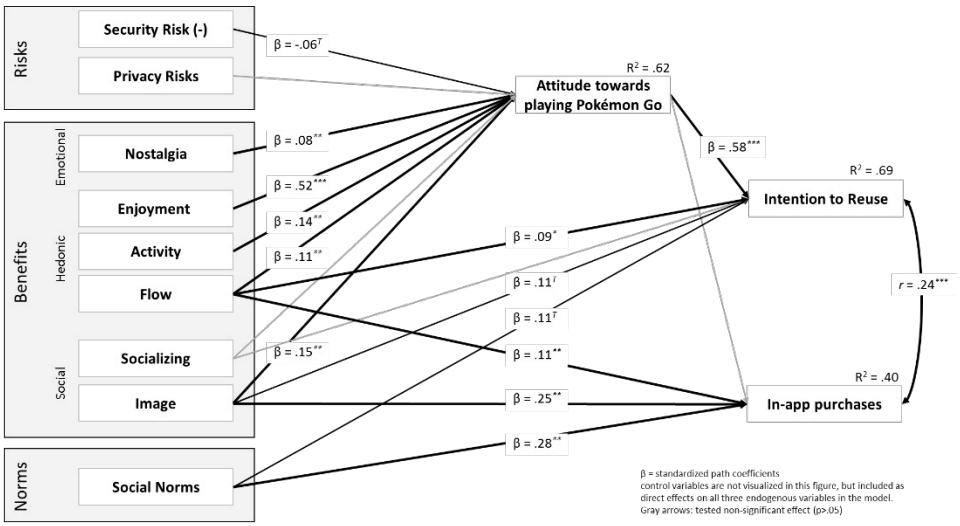

Fig. 2: Results

6 Discussion

As discussed, mobile AR games, such as Pokémon Go, have recently received attention. However, not much research has been done to investigate how and why consumers use

these games, and in addition, existing media and technology theories do not capture the specific characteristics of this new form of gaming apps sufficiently. To address this crucial research gap, we developed a theoretical framework grounded in the literature on technology and media use, and supplemented it with additional findings related research streams by incorporating the characteristics of mobile AR games. We then tested the model in an empirical study using the example of Pokémon Go. The effects identified for the investigated benefits are in line with those reported in prior research from related applications (e.g., [HL04]). In particular, the current study shows that consumers' attitude towards playing mobile AR games is mostly driven by the level of enjoyment and the image that playing a particular game has on other people. In addition, also nostalgic emotions, the flow experience, and the physical activity from playing contribute to a positive association. However, the risk of being injured or hurt while playing decreased this attitude. In addition, gamers' intention to continue playing a game is driven by their attitude towards playing it, and by the flow experience [HL04]. Surprisingly, although playing mobile AR games is a highly social activity, socializing was not found to be related to any of the target variables. Finally, we also investigate the intention to conduct in-app purchases. Findings support that in-app purchases are driven by social norms, image, and flow; however, findings did not support attitude towards playing the game as a driver of in-app purchases. This counter-intuitive finding is surprising, as it means that spending money in in-app shops is not particularly linked to a better attitude towards the game.

As any research, this study has some limitations. First of all, this study was conducted among users of mobile AR games. That is, this study identified variations in the constructs among users, but not among non-users. Therefore, factors driving the general interest in these games (i.e., whether they install and try these apps or not) remains an avenue for further research.

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Special Holiday Mobile Advertising

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Abstract: The current study addresses the effectiveness of special holidays (e.g., Thanksgiving) ads for GPS-aware mobile advertising to distinguish the effectiveness of specially targeted holiday ads from non-targeted ads during a specific holiday period. MANOVA and t-tests were conducted to test hypotheses. Findings show that scenario-based mobile app users' ad responses for the specially targeted holiday ad menu group differ from the non-targeted ad group between the high prior trust group and the low prior trust group. The key finding that the level of prior brand trust (high trust vs. low trust) between the specially targeted holiday and non-targeted ad menu groups had the greatest influence on intention to click and visit the brand of all the factors addressed in this study.

Keywords: Special holiday mobile advertising, scenario-based mobile app users' ad responses, mobile platform

1 Introduction

Digital marketing, especially advertising on mobile platforms, is an emerging area of research. Advertising agencies generate personalized or behavioural mobile advertising based on algorithm for targeting mobile app users. Previous studies have found that personalized or behavioural online ads are more effective than non-targeted ads (Turker 2014; Bleier and Eisenbeiss 2015). The current study focuses on mobile advertsing tailored to consumer's behaviour when they check in on the app during a holiday such as Thanksgiving Day. Past research establishes that holidays play a role in determining consumer needs (Wallendorf and Arnould 1991). The present research compares the effectiveness of mobile advertising between special holidays and non-special mobile ads with a moderator—prior brand trust. Trust has been a key factor that influences consumer behavior in previous studies (Gefen et al. 2003; Bleier and Eisenbeiss 2015; Toure-Tillery and McGill 2015). Thus, high brand trust will affect mobile advertising responses.

Based on previous studies, hypotheses 1 and 2 are proposed in the mobile platform:

Hypothesis 1: When specially targeted holiday menu mobile advertising (vs. non-targeted ad) in the mobile platform, (a) consumers' ad-clicking intention is higher, and (b) consumers' advertised-brand website revisit intention is higher.

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Hypothesis 2: Prior brand trust moderates the relationship between holiday-related menu advertising and ad responses such that higher brand trust increases (a) ad-clicking intention and (b) website revisit intention.

2 Method

2.1 Participants and Procedure

The sample consists of 292 participants, online consumers from Amazon Mechanical Turk in the United States (52.7%=male). Participants completed a scenario-based experiment online survey for monetary compensation.

Design and procedure. The scenario-based online experiment employed a between-subjects design based on two factors, brand trust and advertising type (holiday menu targeted vs. non-targeted ads). Thanksgiving Day is a holiday celebrated on the fourth Thursday of November in the United States (Brown 2012). Those who received the targeted ads read a scenario-based message about a special menu for Thanksgiving at Panera restaurant while those received non-holiday targeted menu advertising. Panera is a US chain of fast casual restaurants, that is, it provides a higher quality of food than fast food restaurants but require visitors to order at the counter (Moskin, 2014).

In the special holiday menu targeted advertising scenario condition, participants were asked to imagine that they had received an ad when they checked in through a mobile app during in the days before or just after Thanksgiving. The app instructions how the mobile app (i.e. Swarm) works were presented to participants with a step-by-step tutorial screen shot and explanation. They viewed a Panera Bread menu the researcher had manipulated to tie items into Thaksgiving (i.e., pumkin, turkey). In the *non-targeted* advertising condition, participants received a regular menu from Panera Bread in a non-holiday season. Likert scales (1=strongly disagree, 7=strongly agree) were used to determine brand trust (Verhoef, Franses, and Hoekstra 2002), ad-clicking intention (Yoo (2007), and website visiting intention (Yoo and Donthu 2001) after participants received ads. Prior trust was a measured continuous variable. Responses were split into two groups for analysis according to their prior brand trust.

3 Results

T-test. A t-test was conducted to test H1 (a) and (b) for two dependent variables (ad-clicking and website revisit). Hypothesis 1 posits that targeted mobile advertising increases (a) consumers' ad-clicking intention and (b) consumers' advertised-brand website revisit intention. H1 (a) and (b) were not supported ($t_{(290)}$=3.58, p>.05). The mean score of consumers' ad-clicking intention is M=4.10 (SD=1.74) for the specially targeted holiday ad, while the mean score of the non- targeted ad scenario condition was

4.02 (*SD*=1.83). Hypothesis 1(b) was not supported ($t_{(290)}$=1.14, p>.05). The mean scores for both conditions were below 4 on a Likert scale of 1 (strongly disagree) to 7 (strongly agree).

Multivariate Analysis of Variance (MANOVA). To test H2 (a) and (b), a MANOVA test was conducted for two dependent variables (ad-clicking and website revisit) using a post-hoc test on four groups: high trust with special holiday (Thanksgiving) targeted ad (HTS), high trust with non-targeted ad (HTN), low trust with special holiday (Thanksgiving) targeted ad (LTS), and low trust with non-targeted ad (LTN).

Hypothesis 2 posits that specially targeted holiday mobile advertising (vs. HTN, LTS, and LTN) leads to (a) higher ad-clicking intention and (b) higher revisit intention. Hypothesis 2(a) was partially supported. Findings show that compared to the low-trust groups, both LTS and LTN, the HTN group ($M_{clickIn}$=3.41, *SD*=2.04) had a higher intention to click on targeted advertising than the LTS group ($M_{clickIn}$ =2.42, *SD*=1.86) or the LTN group ($M_{clickIn}$ =2.44, *SD*=1.93) at $p \leq .05$ in the mobile platform. Thus, hypothesis 2(a) is supported. However, there is no significant difference between the high trust groups, HTS ($M_{clickIn}$=3.75, *SD*=1.99) and HTN ($M_{clickIn}$=3.41, *SD*=2.04), in terms of mobile ad clicking intention. The overall results might not be meaningful since the average, even for high trust group, is in the overall disagree range on the 1 (strongly disagree) to 7 (strongly agree) Likert scale.

Hypothesis 2(b) was also supported: when brand trust is higher, specially targeted holiday mobile advertising leads to higher website revisit intention as compared to the lower brand-trust group. There was significant difference (p<.05) between the high-trust group with a specially targeted holiday ad ($M_{revisit}$ =4.34 *SD*=1.65) and both low-trust groups, LTS and LTN ($M_{behanrevisit}$ =2.75 *SD*=1.68; $M_{Nonbeharevisit}$ =2.81, *SD*=1.94). Thus, hypothesis 2(b) is supported. However, there was no significant difference between speically targeted holiday ad and the non-specially targeted ad for higher revisit intention ($M_{revisit}$ =4.34 *SD*=1.65 vs. $M_{revisit}$ =4.22, *SD*=1.75, p>.05) in the high-trust group.

4 Conclusion

For H1, there was no significant difference between specially targeted holiday (Thanksgiving) and non-targeted ad for ad responses for Panera Bread. Participants answered similarly regardless of whether they received a specially targeted holiday ad. The special menu targeted at the holiday did not influence ad responses differently than the non-targeted food menu. This may suggest that Americans expect to have Thanksgiving related to food items (e.g. pumpkin lattes) around November and targeted food menus do not change their expectations. However, for H2, of greatest interest to researchers and managers in the current study is the key finding that prior brand trust had the greatest influence on intention to click and visit the brand of all the factors addressed. The current research may have been limited by the choice of brand. Non-restaurant brands might produce different results of special holiday advertising.

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Building Brand Love: A Dynamic Capabilities Approach

Alexander Rossmann[1] and Tim Wilke[2]

Abstract: This paper investigates the impact of dynamic capabilities (DC) on brand love. From a resource-based view, there is little clarity vis-à-vis the specific capabilities that drive the ability to create brand love. This paper focuses on three research questions: Firstly, which dynamic capabilities are relevant for brand love? Secondly, how strong is the impact of certain dynamic capabilities on brand love? Thirdly, which conditions mediate and moderate the impact of specific dynamic capabilities on brand love? Data from a multi-method research approach have been used to identify the specific capabilities that corporations need, to enhance brand love. Furthermore, a standardized online survey was conducted on marketing executives and evaluated by structural equation modeling. The results indicate, that customer expertise plays a major role in the relationship between dynamic capabilities and brand love. Furthermore, this relationship is more important in markets that have a low competitive differentiation in products and services.

Keywords: Dynamic Capabilities, Brand Love, Brand Management, Customer Expertise

1 Introduction

This research provides a systematic analysis of the impact that dynamic capabilities have on brand love. According to Batra, Ahuvia, and Bagozzi [BB12], the present construct of brand love is a well-established concept in marketing research. Based on this fact, related work identifies the impact brand love has on several marketing objectives [Za16], e.g. brand loyalty [BB12], Word of Mouth (WoM) [AM13], and purchase intentions [SS14]. The extent to which brand love has established itself in different customer segments, is the focus of another research stream [CA06].

Moreover, from a resource-based view, there is very little clarity vis-à-vis the specific capabilities driving the ability to create brand love. This is the case, in spite of the existence of a body of research on brand love. Because of this research gap, this paper aims to investigate brand love under the perspective of dynamic capabilities [TP94]. Therefore, we look into the different capabilities corporations need, in order to arouse brand love. Consequently, this paper focuses on three relevant research questions: (a) What are the relevant dynamic capabilities for brand love? (b) What is the level of impact of certain dynamic capabilities on brand love? (c) Which conditions mediate and moderate the impact of specific dynamic capabilities on brand love?

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Interviews involving marketing experts and marketing scholars were conducted to identify a specific set of dynamic capabilities. In addition, a systematic literature review was executed to examine the existing body of relevant research. Moreover, a standardized online survey was developed with the help of marketing executives and a PLS structural equation model was used to analyze the effects of a certain dynamic capability set on brand love.

Using this information, we were able to identify a set of specific capabilities, corporations need to develop in order to enhance brand love. Furthermore, the effects of most dynamic capabilities on brand love have a strong correlation to the degree of customer orientation. Finally, the relationship between dynamic capabilities and brand love is more important in markets that have low competitive differentiation in products and services.

2 Theoretical Foundation

2.1 Brand Love

The relationship between brands and consumers can be expressed in several different constructs. Brand satisfaction is to be seen as the lowest intensity relationship that consumers have with brands. Herein, satisfaction is simply based on positive experiences with the brand [HP05]. More intense relationships can lead to brand trust and brand loyalty [Ho08]. Several studies indicate that the highest level a relationship can evolve to - is brand love [BB12, FM99]. Brand love describes the degree of emotionality a consumer has with a particular brand. This includes positive emotions that the consumer experiences vis-à-vis a brand, as well as his/her loyalty and attachment to a specific brand.

Conventional consumer satisfaction is different to brand love, in that it is actually linked to a limited timeframe after the purchase. In contrast, brand love is an emotional devotion towards a brand that has been developed through a long-term relationship between the consumer and the brand [CA06]. Furthermore, this involves positive evaluations of the brand, declarations of love for the brand, as well as integration of the brand with the consumer's identity [CA06]. Research on brand love has been substantial and has revealed several associations.

Consumers, who have this affinity, tend to show a more desirable behavior post-purchase and this is expressed, for instance, in an intention to repurchase a particular product [BB12]. Studies also show that brand love has a positive impact on Word of Mouth (WoM), on engagement [KM15], on brand loyalty [CA06, Fo98, Th05] and on an increased willingness to pay higher prices [AM13, Ba09, Th05]. Furthermore, in case of failure of the beloved brand, the ability to forgive [Ba09].

Moreover, studies indicate that brands that are perceived as enhancing a consumer's social life or are perceived as reflecting his/her inner self, have a positive association with brand love [CA06, Es04, Hu15, Lo12, VE15]. This is especially true for hedonic products and self-expressive brands. They generally tend to be loved more [CA06].

Thus, the significant influence that brand love has on marketing objectives, cannot be ignored. For marketing executives, brand love represents an important construct, in that it differentiates and emphasizes the degree of affection consumers have for a particular brand [CA06]. Consequently, brand love is relevant as a core objective for a long-term emotional relationship with the consumers.

However, while the benefits of building brand love are well understood, little is known about the capabilities firms need to focus on, in order to gain their customers' affection. Related studies often concentrate on determining antecedents for brand love, such as brand identification and a sense of community [BB10]. This is also the case in product involvement and customer self-brand congruity [Ra13]. While these findings greatly enhance our theoretical understanding of the construct brand love, they have limited practical value when viewed from a managerial point of view. In order to facilitate their implemention, it seems worthwhile to consider an approach from a resource based view. As part of this approach, one explores the impact of specific capabilities on brand love.

2.2 Dynamic Capabilities

The dynamic capabilities view (DCV) originates from the resource-based view (RBV). This view describes how firms can achieve a competitive advantage based on their resources and capabilities [Ba86, Ba91]. Since the RBV cannot fully explain how and why certain firms end up having a competitive advantage in situations of rapid and unpredictable change, the DCV was introduced [EM00]. Dynamic capabilities (DC) were initially defined as the firm’s ability to integrate, build, and reconfigure internal as well as external competencies to address rapidly changing environments [TP97].

In contrast to ordinary capabilities, which allow firms to survive in the short term, DC are those that operate to extend, modify, or re-create ordinary capabilities [Wi03]. DC occur as sets of specific and clear processes, such as product development, strategic decision-making, and alliancing [EM00]. Although the specifics of any given DC may be specific to a particular firm, key features (popularly termed 'best practices'), generally linked with superior effectiveness can be seen amongst all firms [EM00].

In the field of marketing research, DC are integrative processes, which utilize the collective knowledge, skills, and resources of a firm to the market-related needs of the business [Lu15]. As this definition implies, such DC are of significant value in order to survive in the market, particularly in a highly competitive environment [Wi15]. This has led to a positive association of DC with a firm’s performance [Ho05, VM05]. In practice, DC allow firms to identify crucial market signals, evaluate new processes or

services, and design and execute effective responses to changes in the market [Wa13]. Furthermore, they also have an effect on a firm's product development, in its innovative service design, and its long-term customer relationships [Du03]. DC have also been examined in the contexts of product life cycle and market development [MA06]. In this paper, our emphasis is on the examination of DC in the context of brand management. Given the idiosyncratic nature of brands, DC around branding are very difficult for competitors to isolate and imitate, which is why they constitute a strategic advantage [Br16]. We posit, that an important part of DC refers to the ability of a firm to create and maintain brand-based competitive advantages. Thus, it is important to identify which specific DC are particularly important in order to drive brand relevant objectives like brand love.

3 Conceptual Framework

Our conceptual framework focuses on the impact of DC on brand love. The general model is presented in Figure 1. As part of an initial analysis, we conducted several explorative semi-structured interviews with three marketing scholars and four marketing executives. While the executives were questioned on specific objectives and strategies vis-à-vis brand love, the emphasis of the interviews with marketing scholars lay on the review of current research and relevant constructs. The interviews took about 30-45 minutes each and had to be recorded digitally for subsequent analyses. Initial insights served as a platform for the ensuing review of related work in this field.

As part of this process, several constructs for dynamic capabilities emerged, that could have a strong bearing on customer orientation and brand love. This refers to the questions, (1) how firms deal with the generation and usage of customer related expertise, (2) how firms interact with their customers, (3) if and how firms integrate their customers in the development of their core communication strategies, (4) if firms are integrated in customer processes with their products, services, and communication touchpoints, and (5) if firms are able to measure the success of their brand communication and, thereby, allowing for an on-going improvement in their overall communication strategy. We also found evidence to support the theory that the interplay of these five DC leads to a higher level of customer orientation. Therefore, the theoretical foundation of customer orientation provides us with a solid footing for our model and allows us to mediate the positive impact of DC on brand love.

The corresponding conceptual framework receives further support from related literature. For instance, Wang, Hu, and Hu [Wa13] argue that expertise in understanding and analyzing consumer behavior is a crucial DC that firms need to develop in order to meet customer's needs. Thus, firms that have comprehensive knowledge of their target customer tend to outperform competitors by being in a better position to identify customer's needs. They are then better able to provide more suitable products and services. Furthermore, Kaufmann, Loureiro, and Manarioti [Ka16] provide evidence for

the assumption, that customers increasingly want to be heard and to be taken seriously vis-à-vis their relationships with brands, e.g. as part of co-creation initiatives. Therefore, it is right to assume that the integration of consumers in the development of communication strategies might serve as a suitable DC for customer orientation. Furthermore, Luxton, Reid, and Mavondo [Lu15] have discovered that the ability of firms to devise effective customer interaction strategies is an important aspect that needs to be taken seriously when building strong brands. In fact, when it comes to building brand love, we believe that emphasizing and satisfying customer needs, allows for more effective brand communication strategies than traditional forms of communication around products and services. Additional related work refers to the integration of products, services, and communication touchpoints into core customer processes. Therefore, the offerings of firms need to act like a solution for customer needs [FM16]. For this to be successful, these offerings need to be strongly integrated into core customer processes. Finally, firms need to measure the ensuing outcomes of their marketing strategies. Therefore, the implementation of a suitable measurement framework could also be perceived as a DC for customer orientation and brand management [FR16].

As per the outcomes of the literature review and the explorative interviews, we expound the following hypotheses on the impact of DC on customer orientation.

> H1: Expertise and analytical capabilities vis-à-vis customer behavior have a positive impact on customer orientation.
>
> H2: The capability of creating and maintaining valuable interactions with customers has a positive impact on customer orientation.
>
> H3: The integration of customers during the development of communication strategies has a positive impact on customer orientation.
>
> H4: The integration of products, services, and communication touchpoints into core customer processes has a positive impact on customer orientation.
>
> H5: The capability of measuring the effects of communication strategies and the usage of these insights for continuous improvement have a positive impact on customer orientation.

As mentioned earlier, we assume that an improvement in such DC leads to a higher level of customer orientation [At05]. Therefore, DC do not have a direct impact on brand love, but are an important antecedent for the aggregated level of customer orientation. Consequently, a higher level of customer orientation has a positive impact on brand love [Ku11]. Furthermore, branding effects based on marketing capabilities are more important in markets that have low competitive differentiation in products and services.

This has led to the conclusion, that customer orientation is particularly important in markets, where there are many suppliers offering standardized products and services. We integrated this specific market characteristics as moderation construct in the model.

The discussion of potential mediation and moderation effects has led to the following additional hypotheses.

> H6: A higher level of customer orientation has a positive impact on brand love.
>
> H7: The impact of customer orientation on brand love is stronger when market conditions entail low competitive differentiation in products and services.

4 Methods and Results

We tested the formulated hypotheses using data collected during a survey conducted on marketing executives in different industries. The questionnaire was developed on similar lines to what Churchill [Ch79] as well as Gerbing and Anderson [GA88] recommend. Whenever possible, existing scale items were adapted to the context, such as the established scale for brand love as per Bagozzi, Batra, and Ahuvia [Ba16]. Multi-item, seven-point, Likert-type scale items were used to measure the constructs in the proposed model. Furthermore, the survey development process incorporates the results of the pre-test done on a selected group of marketing executives and marketing scholars. Subsequently, the survey was sent out to the 789 marketing executives listed on a mailing list and we received 99 full responses, giving us a response rate of 12.54 %. The sample results include responses from marketing executives from different industries as well as data from 70 male and 29 female respondents who are on an average, 43 years old. Moreover, the data set includes both B2B and B2C firms.

The results of the online survey were analyzed using partial least square structural equation modeling (PLS-SEM) with SmartPLS. All items were loaded onto their respective constructs, and each loading was large and significant at the 0.01 level, thereby demonstrating satisfactory convergent validity on an indicator level [GA88]. Assessment of the reflective measurement models is displayed in Table 1 and incorporates Cronbach's α and composite reliability to evaluate the internal consistency, the indicator reliability, and the average variance extracted (AVE) - to evaluate convergent validity on a construct level. Furthermore, Fornell-Larcker criterion, cross-loadings, as well as heterotrait-monotrait ratio of correlations ($HTMT$) were applied to assess discriminant validity [He15]. The results of this analysis provide support for sufficient discriminant validity.

After the measurement models were deemed suitable, we provided estimations using a causal model in order to test the impact of the displayed DC constructs on customer

orientation and brand love. Furthermore, we ran a bootstrapping estimation using 5.000 subsamples to estimate the statistical significance of the causal relationships. The results of these analyses are displayed in Figure 1.

Therefore, we can conclude that roughly 33% of the variance in brand love comes about because of customer orientation. Furthermore, 47% of the variance in customer orientation can be explained via the five DC constructs. However, while all five DC constructs load positively on customer orientation, only the generation and implementation of customer expertise receives statistical significance in the sample data (t=2.686; p=.007). This indicates that the expertise dimension has a dominant role within the capabilities that have an impact on customer orientation and branding.

Other results are relevant concerning the proposed moderation and mediation hypotheses. Firstly, the impact of customer orientation on brand love is varied under specific market conditions, supporting our central moderation hypothesis (β=.259, p=.001). To be precise, the impact of customer orientation is strongest in markets that have low competitive differentiation in products and services. Other control variables like age, gender, or market form (B2B versus B2C) lead to no significant heterogeneity in the data set. Finally, mediation analyses show no significant "direct effect" of the existing DC constructs on brand love, supporting the mediating role of customer orientation.

	Cronbach's α	Composite reliability	Average variance extracted (AVE)
Expertise	.862	.899	.690
Interaction	.840	.893	.677
Integration	.889	.922	.747
Customer Processes	.880	.917	.735
Measureability	.933	.952	.833
Customer Orientation	.825	.920	.851
Brand Love	.862	.899	.642
Market Characteristics	.909	.943	.847

Tab. 1: Assessment of internal consistency and convergent validity

5 Implications and Discussion

The outlined research model has lead to several theoretical implications for customer orientation and brand management. To begin with, the influence DC has on customer orientation can be divided into five independent constructs, namely (1) customer related expertise, (2) quality of customer interaction, (3) integration of customers into co-creation strategies, (4) integration of products, services and communication touchpoints into customer processes, and (5) measurability of the effectiveness of marketing communication strategies.

In general, all five constructs have a positive impact on customer orientation, whereas only the effect of expertise is statistically significant in the customer sample (β=.290, p=.007). Thereby, it can be stated that the methods used by firms to generate customer expertise and how they use this expertise in order to create strong customer experiences has led to a higher level of customer orientation. Therefore, the specific interplay between expertise, customer orientation, and brand love might be a subject for exploration in further research projects. A strong limitation of the current study is the limited sample size. Therefore, the effects of the other four DC could turn out differently if an upcoming study were to be done using a larger data set.

A strong theoretical contribution in the research deals with the exploration of mediation and moderation effects on brand love. In this context it can be stated, that there is a strong correlation between the generation of brand love and the level of customer orientation (β=.457, p=.000). Therefore, the impact of internal DC on brand love could lead to a higher degree of customer orientation.

Further research, involving additional empirical parameters could delve deeper into this theoretical perspective. Additionally, the impact of customer orientation on brand love is stronger in markets that have low competitive differentiation in products and services. Therefore, firms that presently deal with standardized products in a transparent and dynamic marketplace might benefit the most from stronger DC and the corresponding customer orientation effects on brand love.

Overall, brand managers should reassess the orientation of corporate strategies if they want to increase brand love. Moreover, customer orientation is strongly affected by customer related expertise. Therefore, marketing executives need to specifically focus on different strategies for the generation of customer related expertise. Furthermore, they also need to re-think how they could use this expertise for further differentiation. Even more promising for brand managers are the managerial implications outlined in this research. Marketing executives need to enhance their capabilities in the five displayed areas. This would lead to a stronger emphasis on customer orientation and thereby act as a foundation for the generation of brand love.

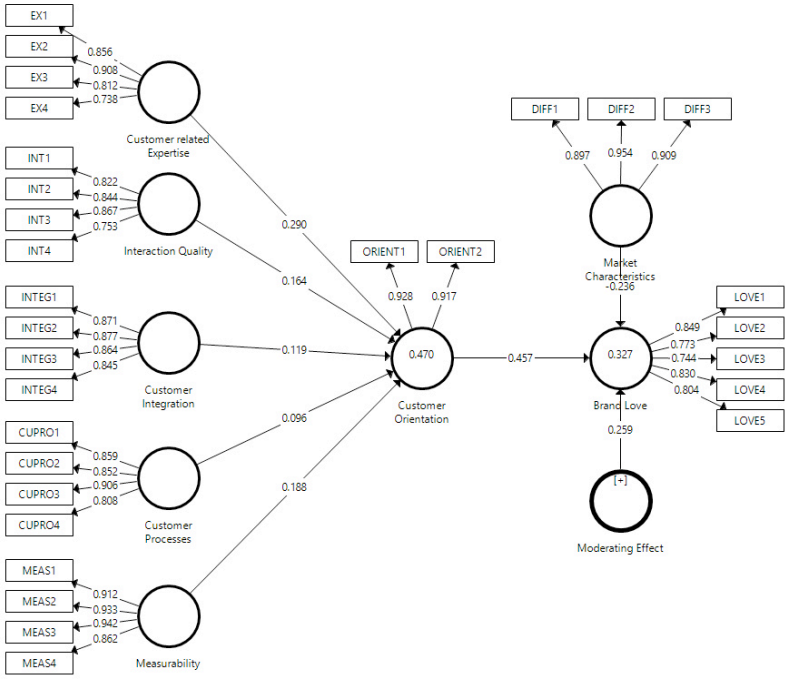

Fig. 1: Causal Model, Effect Size, and R^2

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Electronic Word-of-Mouth: A Systematic Literature Analysis

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Abstract: Electronic word-of-mouth (eWoM) communication plays an increasingly important role in modern business. The underlying concept of word-of-mouth (WoM) communication is well researched and has proved highly significant in respect of its impact on customers purchase behavior. However, due to the advent of digital technologies, decision-making among customers is progressively shifting to the online world. Consequently, eWoM has received a lot of attention from the academic community. As multiple research papers focus on specific facets of eWoM, there is a need to integrate current research results systematically. Thus, this paper presents a scientific literature analysis in order to determine the current state-of-the-art in the field of eWoM. Five main research areas were analyzed, supporting the need for further eWoM studies and providing a structured overview of existing results.

Keywords: eWoM, electronic word-of-mouth, communication, literature analysis

1 Introduction

Electronic word-of-mouth (eWoM) communication is increasingly gaining significance. This development is driven by the impressive proliferation of digital media in customer decision processes and the correspondingly large number of scientific papers published on digital marketing communication in recent years [AB11, He04, Zh10]. We now have research results bearing on a wide variety of issues in the area of eWoM. Yet, given that these issues are highly specific, a full overview on the research area has proved elusive. To relieve this situation, Cheung and Thadani [CT12] carried out a systematic literature analysis, and examined numerous research papers on and around eWoM from 2000 to 2010. As social media, consumer reviews and other facets of eWoM have grown rapidly in recent years, research activities have also registered a significant uptick, yielding a fill of numerous insights since 2010, Hence, the important contributions of Cheung and Thadani need to be assessed critically due to the timeliness of the results.

For purposes of an up-to-date overview on current research, we conducted an additional literature analysis on scientific publications from 2010 to 2016. In addition, we evaluated these papers for scientific significance based on their citation impact. The publications

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thus determined were then subjected to a deeper content analysis and categorized into five main research areas.

In the course of this paper, we address the following research questions: (a) how is current research on eWoM structured?; (b) which core areas can be identified in current research on eWoM?; and (c) which areas suggest themselves for future research? Our findings support the need for further studies on eWoM by providing a structured overview of existing research results and identifying relevant areas for further research.

2 Theoretical Foundation

In order to understand the concept of eWoM, it is, first of all, worth taking a closer look at word-of-mouth (WoM) itself. According to an early definition by Arndt [Ar67], WoM is a kind of oral communication about brands, products or services between a recipient and a sender; the sender is regarded as acting independently and not from commercial interest. In a more recent definition, Anderson [An98] emphasizes the informal nature of the communication processes by describing WoM as "communications between private parties […] rather than formal complaints to firms and/or personnel". Electronic word-of-mouth, in contrast, can be defined as a special kind of WoM, where the means of communication rely on electronic formats and digital media. Both Hennig-Thurau et al. [He04] and Stauss [St00] in their respective attempts to define eWoM, explicitly identify the Internet as the key communication medium. According to Cheung and Lee [CL12], the Internet offers an unparalleled degree of scalability and diffusion speed, which is facilitated by the broad spectrum of communication platforms and the advent of asynchronous communication. In contrast to traditional WoM, communication is no longer limited to small groups of individuals who usually share information in private conversations [CT12]. Instead, with the rise of mobile Internet access, any individual may join a conversation any place and any time.

3 Method

In order to focus on the presented three research questions, a systematic literature analysis was conducted. The underlying method was adapted from vom Brocke et al. [Br09] as well as Webster and Watson [WW02]. EWoM represents an interdisciplinary area of research, so databases from the business sciences and IT were included in the research process. Therefore, relevant work was captured from (a) the Association for Computing Machinery Digital Library (ACM); (b) EBSCO Business Source Complete; (c) Emerald Insight; and (d) IEEE Xplore Digital Library. In order to be considered for this study, publishers had to have published a minimum number of papers relating to the eWoM field. For databases (a), (c), and (d), a threshold of two was set and for database (b) a threshold of five. Search and analysis was conducted in March 2016 using the search criteria presented in Table 1.

Search criteria	Selection
Language	English
Search string	eWoM ∨ (electronic ∧ Word ∧ of ∧ Mouth)
Year of Publication	2010 – 2016
Only consider author-supplied keywords	Yes

Table 1: Search Criteria for Database Research

A total of 206 papers matched the given search criteria. This set of papers represented the basis for the subsequent manual evaluation. First of all, duplicates were removed which had arisen from the use of multiple literature databases. The remaining subset comprised 183 papers. In order to determine the most relevant papers from this subset, we assessed the number of citations for each paper in related research papers. The underlying idea is that highly cited papers generally provide superior research results, pointing to a major scientific impact.

In contrast, publications with few citations can be interpreted as less relevant and thus excluded from further analysis. We determined the number of citations by means of the Google Scholar search engine. In order to evaluate the importance of the different papers over time, the absolute number of citations per paper was normed by a division factor. This allows for the fact that older publications are expected to have a higher number of absolute citations. Table 2 provides an overview of the division factors applied for the different years. In the further analysis, only papers that revealed a citation quotient equal or larger than 10 were taken into consideration. Finally, 33 highly relevant publications could be identified and these papers are presented in Table 3.

Year	2010	2011	2012	2013	2014	2015	2016
Division factor	7	6	5	4	3	2	0.25*
* Database analysis until and including March 2016, i.e. the first quarter of the year							

Table 2: Applied Division Factors

Subsequently, the contents of these 33 research papers was analyzed in detail and categorized by means of structured content analysis on the basis of similarities and differences in the orientation, content, and results of research.

Authors	Publication year	Division factor	Citations	Citation quotient
Hennig-Thurau et al.	2010	7	557	79.57
Cheung and Lee	2012	5	209	41.80
Cheung and Thadani	2012	5	203	40.60
Ho and Dempsey	2010	7	278	39.71
Bronner and de Hoog	2011	6	184	30.67
Zhang, Craciun, and Shin	2010	7	196	28.00
Gupta and Harris	2010	7	159	22.71
O'Connor	2010	7	159	22.71
See-To and Ho	2014	3	60	20.00
Sotiriadis and van Zyl	2013	4	76	19.00
Amblee and Bui	2011	6	107	17.83
Lee et al.	2011	6	101	16.83
Eckler and Bolls	2011	6	99	16.50
Chu and Choi	2011	6	96	16.00
Utz, Kerkhof, and van den Bos	2012	5	79	15.80
Bae and Lee	2011	6	89	14.83
Cheng and Huang	2013	4	58	14.50
Lee, Law, and Murphy	2011	6	83	13.83
Baek, Ahn, and Choi	2012	5	68	13.60
Racherla and Friske	2012	5	67	13.40
Jalilvand and Samiei	2012	5	63	12.60
Kim, Mattila, and Baloglu	2011	6	74	12.33
Tham, Croy, and Mair	2013	4	49	12.25
Elwalda, Lü, and Ali	2016	0.25	3	12.00
Dickinger	2011	6	69	11.50
Kim and Gupta	2012	5	57	11.40
Levy, Duan, and Boo	2013	4	45	11.25
Munar and Jacobsen	2013	4	45	11.25
Yeh and Choi	2011	6	67	11.17
Yoo, Sanders, and Moon	2013	4	43	10.75
Reichelt, Sievert, and Jacob	2014	3	32	10.67
Lee, Kim, and Kim	2012	5	52	10.40
Ha and Im	2012	5	52	10.40

Table 3: Most relevant papers in eWoM Research

4 Results

Five distinct categories could be identified on the basis of the eWoM research literature considered: Participation in eWoM, typification of participants, impact on user behavior, used media, and used content. Allocation of the publications to the respective categories is illustrated in Table 4. Due to the limited scope of this paper, not all the results of the analysis can be presented in detail. For this reason, we will concentrate on the most significant.

Category	Subcategory	Publications
Participation in eWoM	Social factors	Cheung and Lee 2012; Ho and Dempsey 2010; Lee, Kim, and Kim 2012; Reichelt, Sievert, and Jacob 2014; Yeh and Choi 2011; Yoo, Sanders, and Moon 2013
	Help	Bronner and de Hoog 2011; Cheung and Lee 2012; Yoo, Sanders, and Moon 2013
	Personal factors	Ho and Dempsey 2010; Lee, Kim, and Kim 2012
	External factors	Ha and Im 2012
	Economic factors	Yoo, Sanders, and Moon 2013
	Trustworthiness	Reichelt, Sievert, and Jacob 2014
Typification of Participants	Gender	Bae and Lee 2011; Kim, Mattila, and Baloglu 2011
	Family status	Bronner and de Hoog 2011
	Age	Bronner and de Hoog 2011; Tham, Croy, and Mair 2013
	Income	Bronner and de Hoog 2011
	Expertise	Bae and Lee 2011; Lee, Law, and Murphy 2011
	Geography	Chu and Choi 2011
	Author	Dickinger 2011
	Self-presentation/ assessment	Lee, Kim, and Kim 2012
Impact on User Behavior	Purchase intentions and decisions	Amblee and Bui 2011; Bae and Lee 2011; Elwalda, Lü, and Ali 2016; Jalilvand and Samiei 2012; See-To and Ho 2014; Sotiriadis and van Zyl 2013; Tham, Croy, and Mair 2013; Zhang, Craciun, and Shin 2010
	Online purchase	Cheng and Huang 2013; Elwalda, Lü, and Ali 2016; Utz, Kerkhof, and van den Bos 2012
	Product choice	Amblee and Bui 2011; Gupta and Harris 2010; Zhang, Craciun, and Shin 2010
	Reputation	Amblee and Bui 2011
	Intention to pass on	Eckler and Bolls 2011

	Product review/assessment	Kim and Gupta 2012
	Trust	Elwalda, Lü, and Ali 2016; Utz, Kerkhof, and van den Bos 2012
	Customer relation	Hennig-Thurau et al. 2010
Used Media	Social networks	Chu and Choi 2011; Hennig-Thurau et al. 2010; Levy, Duan, and Boo 2013; Munar and Jacobsen 2013; See-To and Ho 2014; Tham, Croy, and Mair 2013
	Multimedia services	Eckler and Bolls 2011; Hennig-Thurau et al. 2010
	Messaging services	Munar and Jacobsen 2013; Sotiriadis and van Zyl 2013
	Blogs	Munar and Jacobsen 2013
	Travel agencies/websites	Hennig-Thurau et al. 2010; Jalilvand and Samiei 2012; Kim, Mattila, and Baloglu 2011; Lee, Law, and Murphy 2011; Levy, Duan, and Boo 2013; Munar and Jacobsen 2013; O'Connor 2010
	Online shops (incl. review platforms)	Amblee and Bui 2011; Baek, Ahn, and Choi 2012; Bronner and de Hoog 2011; Cheung and Lee 2012; Elwalda, Lü, and Ali 2016; Gupta and Harris 2010; Ha and Im 2012; Hennig-Thurau et al. 2010; Racherla and Friske 2012; Tham, Croy, and Mair 2013; Utz, Kerkhof, and van den Bos 2012; Zhang, Craciun, and Shin 2010
	Forums	Lee et al. 2011; Yeh and Choi 2011
Used Content	Positive/negative contents	Bronner and de Hoog 2011; Lee et al. 2011; Levy, Duan, and Boo 2013; O'Connor 2010
	Aspects included	Bronner and de Hoog 2011
	Bogus contents	O'Connor 2010
	Type of content	Bronner and de Hoog 2011; Eckler and Bolls 2011
	Emotions	Eckler and Bolls 2011; Kim and Gupta 2012
	Perception	Baek, Ahn, and Choi 2012; Dickinger 2011; Elwalda, Lü, and Ali 2016; Racherla and Friske 2012
	Online channel	Dickinger 2011

Table 4: Category System

4.1 Participation in eWoM communication

The category dealing with participation in eWoM communication covers research papers that deal with the motives to actively participate (e.g. creating or sharing eWoM content) or passively participate (e.g. consuming eWoM content). A frequently stated reason for participation in eWoM refers to emotional factors. Obviously, eWoM creates a feeling of belonging, particularly when sharing positive content [CL12, HD10]. In a similar way, self-presentation and self-assessment play an important role in the generation of eWoM. Thus, consumers register a greater intention to practice eWoM when they can identify themselves with other members of the group and share mutual traits [Le12]. This applies in particular to brand communities, where enthusiasts actively lobby for a positive evaluation of the brand [YC11]. Another motive can be linked to positive emotional benefits created by helping other Internet users [BH11, CL12] as well as a longing for interpersonal interaction and fondness [HD10]. However, all of the presented factors represent intrinsic motives. Consequently, monetary rewards play a minor role in eWoM communications [Yo13]. Furthermore, websites that are perceived as offering high quality content improve consumers' media and shopping experiences and, in turn, foster the sharing of positive experiences with others [HI12]. Only few research papers with high citation impact work on the consumption of eWoM. Nevertheless, in this context, it can be stated that the trustworthiness of the sender has a significant influence on the receiver's attitude and intention to consume eWoM content [Re14].

4.2 Typification of Participants

The second category of results covers research papers on the distinguishing factors of eWoM participants. Here the demographics of participants play a significant role, as too does their gender. With respect to the latter, research results prove that female consumers read reviews more intensively [Ki11] and are more strongly influenced in their purchase decision by online reviews than is the case with male consumers [BL11]. Another difference can be traced on the basis of consumer age. Previous research has established that older people participate less intensively in eWoM than younger people do [BH11, Th13]. Additionally, there are significant results pointing to a different eWoM usage for couples. Irrespective of the number of children, couples engage more frequently in eWoM than single people do [BH11]. Geographical and cultural differences could equally be observed. Chinese users, for example, develop a stronger trust in the recommendations of their digital peers and are, therefore, more influenced by them than is the case with, say, US users [CC11]. With regard to income, it can be determined that participants in the higher or lower middle bracket of income distribution are more likely to participate in eWoM communication [BH11]. In addition, participants can be differentiated based on the interdependencies within their social groups. Accordingly, we may distinguish two kinds of participant: on the one hand, there are participants that appreciate their independence and pursue their own goals; and, on the other hand, there are those who see themselves as strongly associated with other participants and, as a result, become more involved in helping others by e.g. sharing their experiences [Le12].

4.3 Impact on User Behavior

The category of impact on user behavior covers research that deals with the various effects of eWoM communications. Numerous researchers confirm that consumers are influenced by eWoM communication in their decision-making processes [El16, JS12, SH14, SZ13, Th13]. Adopting firms perspectives, this can be used specifically to improve the reputation of products and brands [AB11]. Furthermore, research results show that as the number of reviews increases, the judgment of products is driven in a positive or negative direction, as the case may be [KG12]. In general, however, consumers are more influenced by negative eWoM communications than by positive ones [BL11]. Yet the purpose of the product considered also plays a role. Positive eWoM contents are perceived as more convincing provided the product considered is associated with a promotion consumption goal (e.g. image processing software for optimizing photos). In contrast, negative eWoM contents are perceived as more convincing when products cover a preventive need (e.g. antivirus software to prevent damage) [Zh10]. In addition, research supports the assumption that online reviews unfold a significant influence on the consumer's intention to purchase via the Internet [El16] or in online shopping communities [CH13]. Although eWoM contents frequently contain valuable information, they do not necessarily lead to optimal decisions. Consumers with little motivation regarding the observance and processing of information tend to make suboptimal decisions on the basis of eWoM communication [GH10]. Furthermore, when judging the trustworthiness of an online sales platform, reviews are more important than the general reputation of the sales platform [Ut12]. Electronic WoM also has an impact on customer relations. Accordingly, a number of factors could be identified that firms should take into consideration when managing their customer relationship [He10].

4.4 Used Media

The next category deals with research papers investigating the different media formats that consumers use for eWoM. Video and music streaming services, online video games, virtual worlds, portals, online shops, online travel agencies, whistleblower websites and social networks could be identified as the main media for eWoM communication [He10]. A conceptual framework which reveals the influence the short message service Twitter is having on decisions made by tourists, has already been developed [SZ13]. Furthermore, research papers have already examined the effects of eWoM on the evaluation of holiday destinations [Th13] as well as tourists' involvement in creating and sharing digital information [MJ13]. Also, numerous papers deal with the evaluation of travel websites [JS12, Ki11, Le11a, Le13, Oc10]. And there are also studies that analyze self-presentation and assessment [Le12] as well as the effects of eWoM in social networks on the purchasing intentions of consumers [CC11, SH14]. Furthermore, there are now numerous research results available on both retailer websites and review platforms [AB11, Ba12, BH11, CL12, El16, GH10, HI12, RF12, Ut12, Zh10] as well as forums [Le11b, YC11].

4.5 Used Content

This last category covers research papers that deal with the elements, perception, and effects of certain eWoM contents. Electronic WoM participants who have personal, i.e. self-involved, motives for participating in the communication (e.g. monetary rewards or self-presentation) include fewer aspects in the communication than do eWoM participants who wish to help others [BH11]. In addition, the former group shares more negative eWoM contents than the latter group [BH11]. Socially engaged participants, in contrast, tend to share suitable photos with other participants [BH11]. Furthermore, there are some research results that focus on emotional aspects of the communication. Thus, it has already been examined how consumers interpret emotional contents in reviews and how these interpretations affect the perception and judgement of products [KG12]. Viral advertising videos represent a special segment here. In the case of these, it could be proven that pleasing contents unfold stronger effects on the consumers' attitude than do, say, shocking or frightening contents [EB11]. Other researchers focus on the evaluation of the perceived usefulness of different content types. In this context, relevant factors for the usefulness of reviews have also been researched [Ba12]. Here it is evident that contents from participants with a high reputation are more frequently perceived as useful [RF12]. Background information (e.g. a real photo or name) about the reviewer, in contrast, has no influence on the perceived usefulness of the content [RF12]. Yet user-generated eWoM contents are deemed in principle as more trustworthy than editorial contents or contents prepared for advertising, although they frequently cannot compete on quality [Di11]. Hence, many firms have already taken to actively monitoring and controlling their reputation on corresponding review media by e.g. responding to criticism [Oc10]. This makes sense because responding to complaints is usually reflected in a better review of the firm [Le13].

5 Implications

The results presented in this paper convey an overall overview of the status quo of research in the field of eWoM. We conducted a comprehensive literature analysis and determined the 33 most relevant publications in the field on the basis of their citation frequency. Additionally, we grouped the content of these publications into five core research areas. The results provide a compact overview of where research currently stands in the field of eWoM, and may serve as a framework for further research. In addition, relevant gaps are identified for exploration in future research projects.

The majority of existing papers in the field concentrate on the sender of eWoM communications. Thus, there is need for complementary research into eWoM recipients. Among other options, research could focus on how contributions by paid reviewers, or even bogus reviews, affect the trust level of eWoM recipients. Existing research also backs up the assumption that eWoM has been mainly studied so far in terms of the impact on purchase decisions.

As a limitation of this study, it must be stated that analysis is confined to four relevant literature databases. However, we are confident that most of the relevant research papers are covered in these databases and were taken into consideration.

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Measuring preparedness of web communication for a positive digital experience of international prospects right at the beginning of the customer journey: Survey results

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Abstract: In an exploratory study about online communication of large and medium-sized B2B companies from the German state of Baden-Württemberg, their message content communicated via websites, and their websites' appeal for international prospects, has been analyzed. It revealed many basic content items absent, making the site less attractive for further exploration, and difficult for international prospects to enter into a dialog, become leads, and possible customers. The subsequent survey elicited organizational backgrounds, available resources, and objectives for online communication. It could trace deficiencies back to a lack of understanding of the importance of digital communication for lead generation, and the customer journey in general, absence of a communication strategy, lack of urgency, and lack of resources to implement desired changes and additions to communication content.

Keywords: Web Communication, Website, Digital Communication, B2B, Digital Experience, Lead Generation, Customer Journey, International Prospects, Quantitative Content Analysis, Machine-Building Industry, Baden-Württemberg, Large and Medium-Sized Companies, Message Content

1 Introduction

Compared to consumer business, business-to-business (B2B) contracts regularly involve larger sales volumes, repetitive sales for longer periods of time, higher legal risks, and greater complexities with associated risks of misunderstandings. Thus, for communication with international business customers, companies rely heavily on personal interaction to alleviate risks of dealing with problematic or even unwanted partners. This approach is costly, slow, and success is heavily dependent on the individuals involved.

In contrast to this, digital communication channels are not only gaining in importance for consumers in form of social media channels, but also for B2B communication, esp. in the lead generation phase. The promise of digital channels are lower cost, instant access and possible feedback, and potentially higher efficacy, and efficiency [PZ02] [HS04].

A cornerstone of B2B communication for lead generation has been the (physical) business fair where companies met prospects, made and nurtured leads, and tightened relationships with customers and partners. Though business fairs increasingly expand

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into the virtual world with add-ons and prolongations to the physical booth [Ga14], the traditional web site remains the digital cornerstone of B2B communication, shaping prospects' first impression, and their willingness to explore business opportunities, as well as enter into a personal dialog.

Therefore, it is of great importance to design a web site that is attractive for international prospects, and invites exploration and information seeking from all over the world [PK17]. Management has to come up with and decide, what it is a company has to provide information about in order to be attractive for international prospects. This necessitates an understanding, which communication elements contribute to website attractiveness, how attractiveness may be measured in order to find deficiencies and highlights, as well as compare one's own web communication to a competitor's. Finally, management, as well as staff, need guidelines for target- and goal-oriented web communication [Hi17].

Unfortunately, rapid changes of web technologies, and digitization of business processes make improvements of web communication a moving target, lacking the standardization of non-digital communication, and lagging behind possibilities digital communication allows for. Our research contributes to improved web communication via comparative measurement allowing for goal-oriented adaptation of message form and content.

2 Current state of web communication measurement

In general, web communication measurement is predominantly results-based, based on trial and error, i.e. a web shop may change its design, the type of information provided, a product description, the view angle of a specific product, or only the context of presentation. Then, these changes are tested on a fraction of website visitors, e.g. on every 15th surfer. When enough data has been gathered, and performance is sufficiently increased, for instance in form of higher click-through rates, or longer retention periods on the site, those changes are implemented for the rest of the product category, or the whole site, and rolled out in a relaunch of the website, often with accompanying marketing communication.[2]

An increasing number of market research companies is joining web design and communication agencies with offers for such market-tested website optimizations and relaunches. However, this approach is prone to primarily allow for incremental improvements on the basis of customer judgment, without measurements of success factors based on available theory and a broader, possibility-driven perspective, and without due comparability across website visitors.

One approach to improve on relevance of success factors is the sectional comparison of

[2] Westwing Home & Living, an "Interior Shopping Club", with the German URL www.westwing.de, reported the launch of 6 international sites at the time of market launch but subsequently cancelled 3 "nonperforming" sites already after the first 6 months of operation.

searches and product interests of the OVK bi-annual measurements[3] [OVK16]. In these, internet users are asked and/or tracked about their 16 top product interests on the internet, as well as their 16 top search and information topics. This is already a coarse determination of user interest in specific information subjects based on the AGOF study's industry segmentation, and respective product representation.

In addition, the OVK's approach is also elaborating on creative elements of web ads for success of lead generation on the basis of user interests[4]. In their latest study on mobile ads they had a catalog of 28 features and variations of mobile creations judged by 12.742 responses in 227 mobile ad formats. The study revealed the great importance of creation for website communication success, distinct from message content. The authors can break down creation's contribution to success into 7 factors[5]. However, they also demonstrate the difficulty to come up with prescriptive, or constructive, arrangements of the elements of creation to design a specific wanted effect. Nevertheless, they can show general effect and success tendencies of the presence, or absence, of specific elements of creation.

Disregarding fun sites, when a website's main objective is serious communication, i.e. conveying message content is the primary objective as in B2B relations, one of the most basic properties of company communication the web site should convey to visitors is credibility. A study by Fogg et al. in 2003 that set out to answer the question "What makes a website credible?" analyzed over 2600 comments on credibility judgments and classified them into indications for credibility. One comment could be classified into different categories at the same time. Considering the 5 most important indicators, it turned out that in 46.1% of the incidences, the "look of the design" was an important indicator of credibility of website content, followed by "information design/structure" with 28.5%, "information focus" with 25.1%, "company motive" with 15.5%, and "usefulness of information" with 14.8% of incidences, respectively[6] [Fo03].

The findings of Fogg, Eisend [Ei03] and others are plausible:
When a company and its products are not known, appearance and look of the design are site visitors' dominant indication of credibility of the information provided. In order to optimize, here, designers need to take heed of most current web design and usability guidelines. These are not industry-specific, but certain design elements may be more acceptable for, or better convey message content to a particular target audience.

[3] OVK Online-Report 201x/01 and OVK Online-Report 201x/02, especially since the methodological changes in 2011. Reports are published by the OVK (Online-Vermarkter-Kreis) within the BVDW under the URL www.ovk.de/ovk/ovk-de/online-werbung/daten-fakten/downloads.html, e.g. OVK Online-Report 2016/02 pp. 24-25

[4] The OVK study „Power of Creation“ in 2013 has been the largest German study of perception and efficacy of creations in the online world, focusing on online display ads on the desktop. The study in 2015 focused on creations of mobile ads, both leading to " Guidelines für die Erstellung wirkmächtiger Online-Display-Ads".

[5] Inducement of recall, appreciation of product, benefit transportation, helping attractiveness, enhanced understanding, increased valuation, creative surprise in "Power of Mobile Creation", cited in OVK Online-Report 2016/02, p. 30

[6] A more elaborate discussion of credibility of marketing messages including digital channels may be found in the dissertation of Martin Eisend: Glaubwürdigkeit in der Marketingkommunikation, DUV, Wiesbaden 2003

Unlike design, site content is company-specific, and management needs to define company specific information content and structure according to their knowledge of what may be useful content for potential international prospects. This knowledge may come from their sales reps and other parts of the company dealing with customers and prospects, from market research companies, as well as from scientific studies. All too often, however, in B2B environments, it is left to the web agency to decide upon web content. This resulted from a study that had originally been developed to understand the perceived bad web communication of internationally quite successful German machine builders from the state of Baden-Württemberg[7] [HŠ13]. They are often those hidden champions in their niche, market leaders in their product field, very successful all over the world but also often exhibit websites with communication far apart from their product championship: Products could not be found, subsidiaries and distribution partners were hard to find and identify, web communication of different parts of the company was not integrated, even inconsistent, and so forth[8].

In search of website excellence, the author, together with a business partner[9], set out to measure internationalization of web communication for B2B companies in select industries in Baden-Württemberg. We focused on low information and contact barriers for international site visitors, and the presence of some basic content elements amenable to lead generation. This seemed a reasonable limitation when considering type and scope of information provided by those industries on the web, as well as the objective pursued by companies with their website.

When type and scope of content needs to be measured, many researchers in the social sciences today use quantitative content analysis (QCA), a research methodology greatly advanced with the help of computers, and digitized data, during the last 3 decades ([RSC15a] [RSC15b] [Ne02]). It improves qualitative content analysis with respect to accuracy and comparability [Sc12] [RA04]. We chose quantitative content analysis for our study as creative design elements do not seem to be an important element of image creation in B2B industries, and the methodology allows for comparative quantification of message content.

3 Research approach

The state of Baden-Württemberg, for decades now, belongs to those regions in the EU with the highest export quotas, and greatest innovative capacity. For companies in this region, internationalization is nothing new, but a long-term successful strategy to overcome limitations of national market potential. B2B and investment type industries are

[7] Part 2, Online-Survey of the publication "Internationalisierung von B2B-Websites baden-württembergischer Unternehmen", available from the authors, Roland Heger and Deciderio Šonje, June 2013

[8] A grave example had been ILLIG Maschinenbau GmbH & Co. KG, a market leader in machines for thermoforming; today's website shows much better communication, however, there is still room for improvement

[9] dr. šonje webconsult GmbH

leading this approach to growth. Surprisingly, those companies' web communication did not fit their export success. Thus, we selected 120 companies from distinct industries for analysis of their web communication as shown in the following Fig. 1 on this page.

WZ 2008 [NACE] / Company Size	2711 [31.10] Electric motors, generators, transformers	2813 [29.12] Pumps, compressors	2815 [29.14] Bearings, gears, cog wheels, drive elements	2841 [29.4(0)] Machine tools for metals
50 - 249 FTEs	31 (30)	25	56 (55)	60
250+ FTEs	14 (13)	14	21 (19)	30 (28)
Sum total of companies in BW	101	86	157	193

Numbers in (parentheses) are companies left over after elimination of the same web addresses
Numbers in [square brackets] are WZ 2008 equivalent NACE Rev. 2 codes of the European Union

Fig. 1: Population universe of companies sampled, according to industry and size class

The sample consists of 4 times 30 companies with their main statistics classification according to the German federal statistics code WZ2008 [NACE Rev.2 equivalent] in the following four B2B industries: 2711 [31.10] electric motors, generators, and transformers; 2813 [29.12] pumps, compressors; 2815 [29.14] bearings, gears, cog wheels, and tractions parts; 2841 [29.4(0)] machine tools for metals.

In each industry, subsamples were drawn from medium-sized (50-249 FTEs[10]) and large (≥ 250 FTEs) companies according to the German statistics office, as far as possible from the number of companies available in respective groups. In each subsample companies were ordered according to FTEs, and the largest companies in decreasing order were chosen in each subsample. This approach ensures that the largest possible market coverage in terms of employees is chosen for each subsample. At the same time it ensures the greatest possible statistical distance between these two groups for easier detection of group differences.

Analysis consisted of two parts: Once, every company's website was analyzed with the German as well as 3 non-German languages, as far as available on the company's site, resulting in 420 language- or country-specific sites of 120 companies. Measurement was conducted with quantitative content analysis on the basis of 28 content items. These items represent 6 content areas deemed relevant for lead generation: language-/country-specific addressing of message content, contact possibilities, company self portrayal and references, press area, and business fairs. In 2 subsamples 100% of available companies were analyzed, in the other 6 subsamples market coverage in terms of turnover is over 50%, respectively, making the industry samples representative, and allowing for generalizations about the respective company universe.

[10] FTE: Full-time equivalent employees

Second, all 120 companies were invited to take part in a survey designed to elicit reasons for choice of content elements. Specifically, the survey was designed to reveal responsibilities for content elements, objectives for online communication, the share of international business, organizational backgrounds, available resources, and adaptations of message content to international target audiences. A slight majority (61 companies) of companies analyzed in the first part completed the survey, resulting in an extraordinary 50.8% response rate. As only 3 companies answered anonymously, the survey can be termed as representative of the industry subsamples in the state of Baden-Württemberg, too.

4 Results of the survey

Being technically minded, in most cases with high product complexity, and exhibiting a high share of international sales, analysis of websites revealed: Internationalization of web communication is staying behind possibilities, making access for prospects difficult for reasons of missing languages, incomplete contact information, missing information about presence at business fairs, and so on. Nevertheless, in general, in the survey, the necessity to cater to needs of international prospects seems to be recognized and accepted by respondents.

Picking out language, companies go through some efforts to address prospects in their respective language. In over 90% of company websites, visitors apart from German, are addressed in at least one other language, mostly in English. One quarter of companies offers information on their site in three to five languages, and one sixth of websites is available in more than six languages.

Relevance of international communication may be obvious with shares of turnover resulting from exportation: A little less than half of responding companies (47%) show export quotas of over 50%, and another 33% show export quotas between 25% and 50%. This means that 80% of companies in the state of Baden-Württemberg out of these industries show significant to extremely high export shares. One of the reasons for this is the high grade of specialization of respective companies, usually commanding a product leadership in their niches. It is obvious that these companies do have the necessity to deal with customers, and prospects, all over the world, and the necessity for a digital communication that caters to this need.

Relevance of international business for the selected industries may also be illustrated with Fig. 2 on the following page. A high share of 15% of companies was not able to provide figures of the number of countries they ship their products to. Of those who could, 44% distribute in less than 20 countries, 21% in 20 to 39 countries, 29% in 40 to 59 countries, and only a small fraction of 6% of those companies distribute in 60 and more countries.

In 41% of cases those foreign countries are handled with own subsidiaries, the majority of 54% of foreign countries are dealt with via external distribution partners. Especially medium-sized companies usually do not afford the resources to enter a country with own people. Often, they are too small to be able to devote resources to countries with lower turnover, and it may not make sense from a business point of view due to fixed cost.

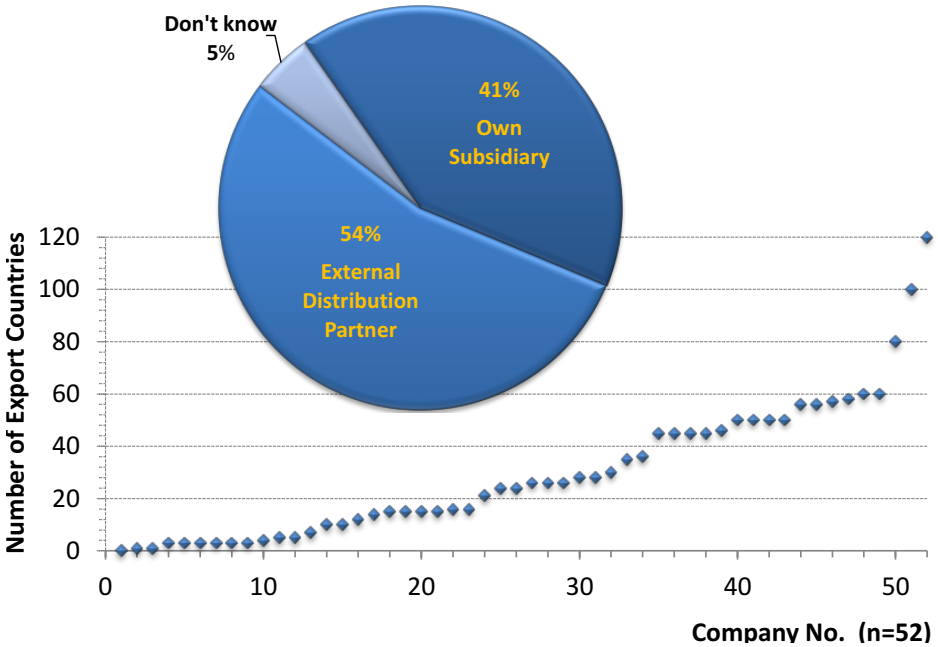

Fig. 2: Countries and form of international distribution

Though they may have found the right approach to international distribution, companies from the B2B industries chosen seem to have great difficulties finding the optimal organization for web communication: Headquarters are basically always driver, or involved in arrangement of web content. But overall, resource allocation in terms of headcount seems too limited.

Fig. 3 on the following page highlights distribution of responsibility for web communication. In about one third of companies (31%) one person is solely responsible for all web communication. Considering the dazzling array of online tools, and the importance of web communication as an information channel for prospects as well as for current customers, this allocation of resources appears at least a daring endeavor.

In more than two thirds of companies (69%), responsibility for web communication is shared. In a little less than half of these, i.e. another third (30%) of all companies, 4 or more colleagues share responsibility for web communication, and thus seem organizationally prepared for a balanced international website.

Out of the 69% of colleagues who share responsibility for the web, 95% of these involve colleagues from headquarters while only 19% are from some subsidiary. From an organizational point of view, relevance of the digital communication channel for the whole company seems already structurally established, but only partially the necessity to address local peculiarities, and the possibilities to increase attractiveness with local adaptations.

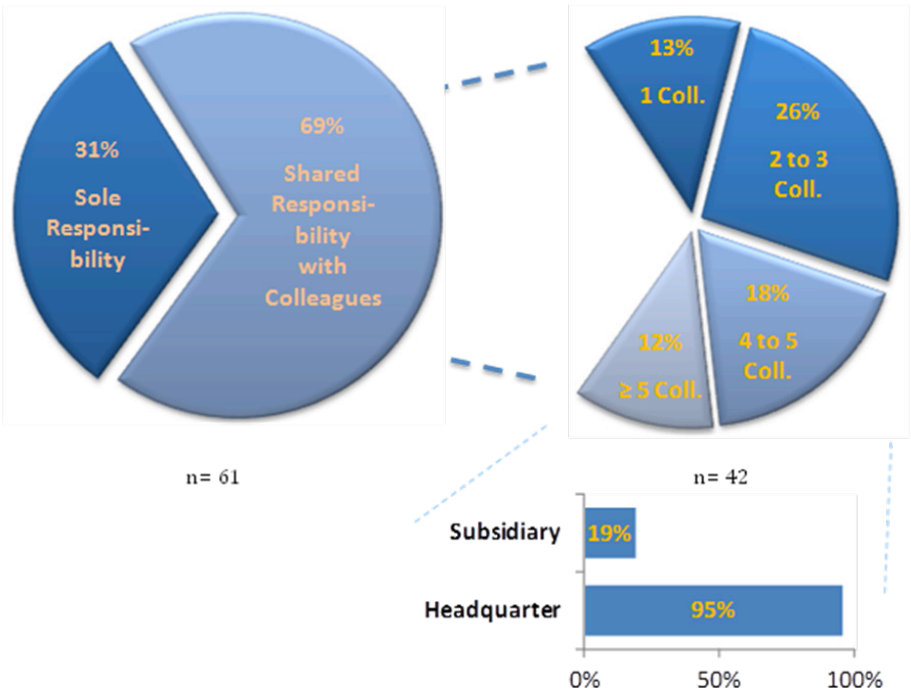

Fig. 3: Distribution of responsibility for web communication

Fig. 4 on the next page shows that only a small fraction (13%) of online marketers is able to solely focus onto these tasks while the great majority (87%) also needs to handle other marketing assignments. Sorting out these "other" assignments, 79% of online marketers also have to prepare and handle print, 72% involve organization and dealing with business fairs, and 53% of those who are also tackling non-online tasks have to handle additional marketing topics, e.g. public relations, social media, or simply all other marketing tasks.

When asked what fraction of working hours online marketers are able to spend for work in conjunction with their web offers, numbers in Fig. 5 are disillusioning: Over half of them (57%) is able to spend less than a quarter of their time for online communication, a total of 77% less than 50% of their time, and only 13% is able to spend more than three quarters of their time for online tasks. This also documents the too little effort due to

scarce resources that go into optimization of online communication.

Missing possibilities to specialize and focus for lack of manpower and time may be the primary reasons for suboptimal internationalization of web communication.

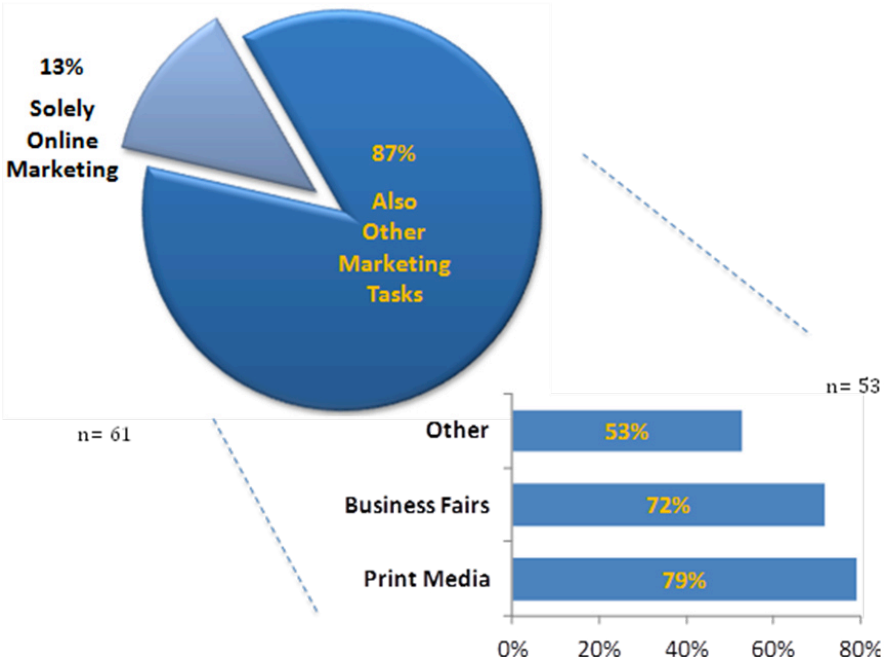

Fig. 4: Online-marketing focus

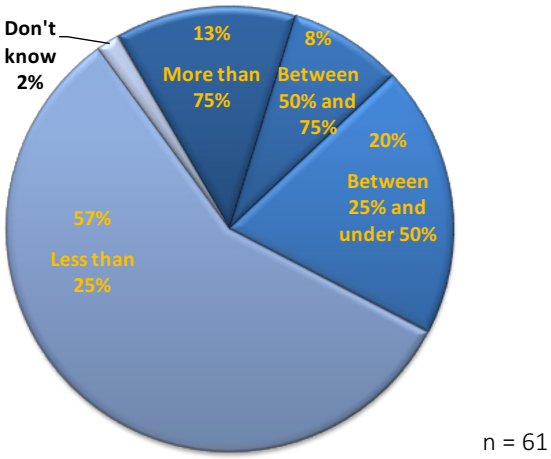

Fig. 5: Time for online-marketing

Referring to adaptations in terms of content, and/or design, for different languages or countries, only a minority of 18% of companies abstained from respective adaptations. When asked why, according to Fig. 6, 36% of respondents argued a lack of time, 27% blamed insufficient budgets, and 9% argued that internationalization of communication is difficult and introduces undue complexities. 55% of respondents cite sometimes very special reasons why they skipped adaptations, reaching from "too difficult" to "unnecessary". Excuses seem to be mixed with true barriers insurmountable by the individual.

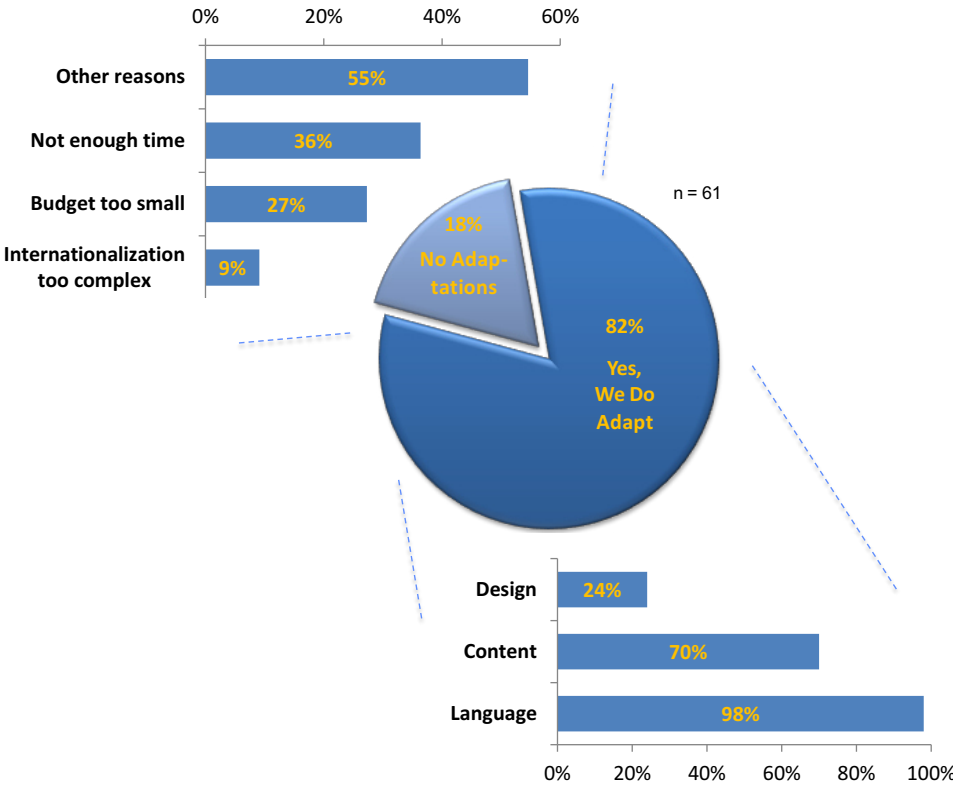

Fig. 6: Reasons for abandonment and conduct of international adaptations

The great majority of respondents (82%), however, implemented one or the other adaptation for an international audience, even with the expected priority: Nearly all companies (98%) communicate over the web in at least one other language than German, adapting to target languages and countries. 70% do adapt their content to different audiences, sometimes with special landing pages, usually in specific sections of the website. And just under a quarter (24%) also adapts website structure and design towards their international target segments. In addition, visual displays, pictures, and product references are common areas of regional or local adaptations.

When asked about wishes for future changes, 48% of respondents were content with current variations of web communication and do not see any urgency to change. With four fifth of companies already adapting content it may be surprising that a slight majority of 52% still has larger wish lists, interesting enough with the same priority as those who already implemented regional/local adaptations: 72% of them want more or other languages, 56% seek to expand and restructure content, and 28% want to strive for greater local appeal with adaptations in information structure and design.

In terms of process improvements, there are long wish lists, too, with priorities for "simpler contact and lead generation" (83%), "improved information possibilities for local prospects and customers" (83%), "website support of services" (43%), "more and better support for buying and sales" (38%), and "better support with closing and order processing" (23%).

5 Discussion

The great majority of respondents seem to recognize possibilities of web communication in general, for their B2B business, as well as for international prospects and customers. At the same time, they recognize the deficiencies, and limitations, they currently have to live with. Management in these industries does not seem to feel the same urgency as their staff. Allocation of resources is broadly seen as too scarce, and from a researcher's perspective, with experience of digital approaches in other industries, are obviously miniscule. The wish for (additional) local adaptations (74%), or even a local site (30%) is an indication of further improvement potential.

Online marketing of sampled industries is hampered by low staffing, and from being distracted by traditional marketing tasks (print, business fairs, etc.). A majority of staff (57%) can only devote a small fraction of their time (less than 25% of work hours) to online activities. The wish to optimize lead generation, communication, and processes, with digital marketing is limited by insufficient resources.

Online activities appear well integrated into the general marketing organization, with headquarters already financing a third of local adaptations. In addition, with headquarters being involved in basically all project in this area, the prerequisite for a central push of online activities is already available.

Development and extension of online activities of select B2B industries is primarily hampered by 2 barriers:
Perception of management about the importance of online communication for information gathering and lead generation is lagging behind current developments in other industries. Second, and in the wake of the aforementioned, increase and redistribution of resources from traditional marketing to digital ones is much slower than for instance in the consumer industry.

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Digital value selling: Status quo and opportunities

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Abstract: Digitization will require companies to fundamentally reengineer their sales processes. Adapting the concept of value selling to the digital age will enable them to deliver superior value to their customers. Specifically, social selling will provide them with an answer to the ever-increasing complexity of customer journeys. This article, based on a survey among 235 German companies, assesses the status quo and outlines opportunities. Moreover, it introduces a novel approach for developing well-grounded social selling metrics.

Keywords: value based selling, customer experience, value to customer, digital value selling, social selling, social selling metrics, LinkedIn's Social Selling Index

1 Introduction

Digitization has already changed the way we work dramatically. Increasingly, it also entails the necessity to reinvent traditional business models and sales processes. With respect to the second point, it will lead to an accelerating use of digital tools for managing and operating sales processes in order to satisfy customers' needs even better. Why? One canonical starting point for any sound sales strategy is the customer journey. In this regard, matters have become more complicated in recent years: Being in touch with a customer only at the time of purchase is not good enough anymore. Instead, sales agents must strive to be present with relevant and compelling content throughout the entire customer journey in order to seize the role of a trusted advisor – a goal which cannot be achieved without capable technology. But note that digitization in sales is not primarily about technology. It rather is about a forward-thinking mindset, about aligning sales processes with digital possibilities, and about the leadership and change management skills to make a sales organization embrace digitization in a fundamental way. This paper explores how to strengthen the link between customer experience and value using value selling as the philosophy and digitization as the key enabler. Moreover, it explores the status quo and opportunities related to social selling, one of the most significant digital value selling instruments, based on a survey among 235 German companies.

Business and the way it is conducted is on the eve of an extensive digital revolution. The ongoing digitalization of the vast majority of areas of life, as is widely acknowledged,

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inherently bears the potential to change the priorities in global trade and to be accompanied by substantial implications for all types of enterprises. The digital development does not exclude certain businesses per se, but offers participation to every business capable of successfully adapting to the new digital environment.

This means: Companies are required to adapt quickly. Albeit, the change from a traditional company into an entity firmly situated in the digital world has been a significant challenge for most market participants. In general, digitalization from a sales point of view can be structured into three periods of change: In the first phase, a one-way flow of information from the company to the customer is established. In the second phase, the flow of information becomes multilateral. Companies exchange information with customers in a two-way relationship and additionally, customers start to exchange information between each other. In the third phase, companies start to systematically convert leads generated from digital conversations into sales – a true challenge for most German companies. This means, companies frequently are not able to translate online connections and interactions with potential customers into actual sales in a systematic and reproducible way.

The traditional sales funnel, consisting of the four linear steps awareness, evaluation, purchase, and loyalty is destined to lose its linear persistence due to substantial changes in the way of conducting the selling process [Be14]. In order to adapt to the dynamic and digitized environment of modern day business, selling necessarily needs to be amplified with a digital component. In this context, Moore, Raymond, and Hopkins already examined the influence of social media on customer relationship management (CRM) acknowledging the importance of merging traditional selling approaches with digital tools [MRH15] Thus, existing standards in sales will have to be re-evaluated and adjusted as well. The process of selling itself needs to become more digital. Thus, companies will increasingly be forced by customers and competitors to make use of the benefits provided by digital tools including social media.

2 Characteristics and relevance of digital value selling

Digital value selling is a rather young, constantly evolving concept still lacking a definite definition. Nonetheless, a growing body of literature explores the concept and provides a good overview of its key characteristics and its relevance for selling in the digital age.

The paper “Digital Sales Excellence” stresses the importance of using digital technologies in a useful manner. Binckebanck proposes a framework to assess and select appropriate digital instruments. He examines how to integrate suitable concepts into structures and processes of corporate sales organizations [Bi15, BE16].

“The digital future of B2B sales” assesses the potential digital technologies hold for B2B sales in terms of boosting revenue and productivity [Lä15]. Here, Lässig et. al. state that engaging in digital selling must be done early. Companies that hesitate can learn from

established practices that were implemented by digital leaders. It is also emphasized that one key success factor for successful implementation is a motivated sales staff. Companies are forced to adapt to customers' changing demands. The B2B environment will undergo dramatic changes in terms of digitization. Unfortunately, a lot of companies a reluctant to change their sales force and tasks. So, they cannot exploit the full potential of digitization in sales.

"Die eigentliche digitale Revolution – Neue Geschäftsmodelle statt (nur) neue Kommunikation" explores the issue of companies assigning too little importance to digitizing their sales processes [JP14]. Conducting an empirical study based on four key assumptions, Jahn and Pfeiffer stress that the digitization of sales can only drive company success if strategically supported by C-level executives.

The paper "How B2B digital leaders drive five times more revenue growth than their peers" shows that competitive advantages can be gained if companies correctly implement goal-oriented digital practices [Ca16].

So, customers will increasingly choose their own buying approach. Some of them hate the idea of being contacted by a sales agent. They want to decide on their own if to use digital tools or if to pick up the phone, contact a sales agent and ask for a face to face meeting. Companies must adapt to this new customer behavior by offering a menu of different contact channels. But it is the customer who decides which channel to use when for his convenience. Thus, the steered sales interaction is the old world. Supported customer journeys are the future. This also implies a higher demand for self-service. Sales agents will lose control over their sales interaction points. Non-digital touchpoints will become digital touchpoints. And digital touchpoints will dominate in the future not solely because they are cheaper to implement. They also enable the collection of useful information about the customer journey. To lift this hidden treasure, all phases of the customer journey must be scrutinized. Moreover, the resulting data must to be transformed into knowledge using data mining techniques to exploit its full potential. By analyzing data in depth, sales organizations will have the chance to generate value and to bring sales processes to a higher level. Companies that neglect this opportunity will experience inferior performance and struggle to build compelling value propositions. Thus, there is a strategic need for future sales leaders to build digital assets and develop corresponding digital capabilities.

All this can result in the following definition of digital value selling:

Digital value selling is a selling philosophy that leverages digital technologies to guide and accompany customers and to deliver customer-specific value and experiences along the entire customer journey in order to drive profitable sales.

3 How to generate value for the customer with digital value selling

The value offered at the different touchpoints throughout the customer journey will be differentiated heavily, depending on the customers' specific needs and the willingness to pay. This may imply the necessity to reinvent the business model and increase revenue e.g. by smarter price models and intelligent services, while not neglecting cost. The key outcome of digital value selling is a sales process with shorter funnel throughput times, more qualified contacts and, in consequence, a significantly higher success rate. All in all, this will lead to more and better business at a lower cost.

The value selling concept [Be16, Sc08] has the goal to generate strategic customer advantages [Si88]. It comprises the following two perspectives: When focusing on the "value from the customer" companies try to acquire profitable business from repeat customers based on strong customer relationships. When focusing on the "value to the customer" the concept emphasizes the importance of better value delivery, e.g. by bespoken customization and by identifying opportunities for Pareto improvements in contracts based on superior information. This article will focus on the "value to the customer" perspective. Examples within a framework will be presented where companies offer solutions that result in better experiences and higher value for their customers.

Social selling, customer relationship management, email marketing and search engine marketing are part of the digital selling concept. This means that there is a plethora of different tools that shape and drive any digital selling strategy. In order to structure the subsequent discussion in its search for best-in-class examples for value generation, the sales process will be split into three phases: pre-sales, sales, and after-sales.

3.1 Value generation in the pre-sales phase

Product comparisons are a useful tool in the pre-sales phase for generating value to the customers. This is why expert programmers of websites like Christian Rothe from Laufstar.de make it easy for the customers to compare the different products. Firstly, they provide an easily accessible structure for all relevant product information. Secondly, they reveal these features in a visually compelling way, e.g. when a customer hoovers the mouse over the product [Lä15].

Ebay gives a best practice example for perfect personalization. Let us assume the customer is looking for a pair of shoes. Then, he can add this need to his personal Ebay search profile. After having done so, whenever the customer visits Ebay in the future, he will be shown appropriate offers right on his personalized starting page.

Communication also provides a good opportunity for value generation in the pre-sales phase. Users love to exchange information and chat with the community about the desired products. Moreover, they like to ask other expert users about their experiences with the products of various suppliers or about different practical challenges. Bosch's

Bob Community, a platform for professional power tools, can be named as a best practice example for value delivery through communication in the pre-sales phase.

3.2 Value generation in the sales phase

One key concern of successful producers is the enhancement of their products with extended benefits enabled by digital technology. The goal is to provide customers with more usage value. E.g. video games like FIFA 17 or Clash Royale make it possible to play the game online – and teenagers love to play such games against their friends as this is when the real competition starts. Another example: A benchmark test of fitness watches on Germany`s premier website on computers, mobile devices and home entertainment concludes that the Garmin Fenix 3 HR Saphir is the best watch. Some value for the customer is generated from the health tracking feature of the watch itself. But significant additional value stems from the competition with others enabled by the option to share training data.

The Swiss company Blaser Swisslube has developed the so-called Blaser Liquid Tool. Before signing a contract with the customer, sales reps conduct a profound analysis of the customer's situation. Using an iPad, they analyze data on machines, materials, tools and cooling at the customer's site. At the end of this value analysis process, they make the customer a bespoken offer showing concrete productivity improvements in different dimensions. Prospects can easily understand the underlying promise before the customer relationship even starts. Moreover, these value promises are tracked during the whole collaboration. And very often, customers get more than what was promised. Customers increasingly demand such measurable productivity improvements from suppliers of C articles. For Blaser Swisslube, this a challenge but also a great opportunity to prove their competence in the cooling business to their customers. Moreover, Blaser can substantiate the great value of its solution to prospective customers.

The Hilti ON!Track asset management system improves efficiency and prevents the loss of tools by using RFID technology on individual tools. This is a huge value for construction business customers: According to Hilti research, more than $1 billion in tools, consumables and commodities are lost each year. And most of these tools end up in the hands of people who did not obtain them by legal means. Thus, Hilti's solution is a real game changer in this industry, because it detects the absence of tools quickly. Moreover, it also provides valuable information for making maintenance more forward-looking and efficient.

3.3 Value generation in the after-sales phase

One important opportunity to generate value in the after-sales phase is to provide useful information to the customer. For instance, one can provide relevant and timely information per email in order to reduce replacement dissonances. And if a customer wants to change his order after the purchase one can give him an easy and quick way to

do so online. The key idea: These changes should be forwarded to the seller's production process almost in real time in order to reduce cost.

Moreover, the communication process will be easier for the producer when he is able to identify his customers. Dell gives a perfect example for this kind of service value: It invented a personal service tag linked to each computer, which is requested from customers visiting Dell's support site. The express service for example is also linked to the customer's account. There is value in the existence of the Dell service tag for Dell as producer and as well for the customer. The Dell service tag can help to identify the computer for online support and drivers. Customers can also reset their password with the tag and do not need further information about their computer when contacting the Dell service. It serves as a quick and perfect identification code. Customers identify themselves and no additional communication is necessary. And finally, customers get preventive maintenance information and automatic software updates from Dell.

Finally, one can provide customers with individual information related to logistics, thereby allowing them to understand the status of the delivery process. For instance, DHL provides valuable information on when the products are shipped. Moreover, customers can easily change the delivery time proposed by DHL according to their requirements.

In the following we will focus on social selling as a digital selling tool and present research results from an empirical study on social selling in Germany.

4 Social selling

4.1 Social selling as a key digital value selling tool

Genuinely, social media has been defined as digital content and network-based interactions that are developed and maintained by and between people [Ag12, p. 334]. Andzulis et al. expand this definition and focus on value co-creation [APR12, p. 308]. Therefore, the core of the social selling concept combines relationship building and reaching out to customers through social media channels and social communities with the aim to engage them in conversations that result in a beneficial relationship for both partners. Therefore, according to Belew, "both the value of the information you provide to the prospect and the quality of the relationship you build are critical to getting and keeping customers" [Be14, pp. 5-6]. Social selling means a change of selling in so far, as the importance of pure outright selling will decrease, whereas listening to customers will become more important. She refers to this as "un-selling" [Be14, p. 6]. In line with this rather passive perception of the digital sales process, a loss of control with respect to the information flow from the salesperson to the purchaser is indicated by Belew, stressing that, because of the great amount of available information, buyers can act more independently from the seller [Be14, p. 71].

Nevertheless, the research at hand suggest that the sales process can still be proactively influenced. Therefore, social selling will be defined as an integrative and reciprocal process with a focus on the establishment of sustainable relationships and trust with customers via the comprehensive usage of social media in order to identify and meet their preferences and core needs.

4.2 Empirical study of the utilization of social selling by German companies

In order to examine the status quo of social selling in Germany, a study was conducted among respondents from 235 companies. As a first step, qualitative research was conducted. Afterwards, precise questions for a survey were formulated. This survey in turn provided quantitative data which was analyzed to develop insight and to capture the status quo of social selling in Germany. Consequentially, the study represents a mixed method design, to be precise, a sequential exploratory approach which consists of qualitative research followed by quantitative data collection [Cr09, pp. 211-212]. At first, three interviews with leading experts in the relatively young field of social selling were conducted. In combination with the findings of an extensive research process, these interviews have been leveraged for formulating the research question more precisely and for defining the appropriate variables which might reveal the stages of development of social selling within a company's ecosystem. Then, an online questionnaire was developed. During May 2015, this questionnaire was answered by 235 German companies enabling a comprehensive analysis and, therefore, relevant recommendations for stakeholders. The survey was open to companies which are officially registered in Germany. There was no specific exclusion of companies based on size, industry or business model. In the following subsection, selected results of this study will be presented and interpreted.

4.3 Selected results

The most fundamental result concerns the prevalence of social selling in German companies: For 55% of all respondents, social selling plays no role in their day-to-day operations, whereas only 14% value social selling greatly. Given the many starting points for social selling that have been identified above, this is a surprisingly low fraction. Out of 131 participants which answered the question "Does Social Selling have an impact on your company's financial statement?", only 13% indicated that they value social selling greatly, whereas 25% stated that social selling has zero effect on their company's financial situation. Thus, it can be concluded that German companies lack expertise in this particular field of digital value selling. And even if used, social selling seems not to be evolved sufficiently well to be acknowledged as a driver of a company's financials. This raises the question if the current, unsatisfactory situation stems from insufficient awareness and knowledge or from the inability to implement social selling in a company's day-to-day sales processes. Based on qualitative interviews conducted with sales managers, the main reason appears to be a lack of knowledge – a finding which is

also in line with the results from the literature research. Another reason could be the German "Angst" to adapt too quickly to new and innovative business concepts while financial figures are still satisfactory. Why should a company change when it still earns enough? What an immense misconception!

A closer look at the survey results requires an understanding of the concepts of external and internal social selling: External social selling describes the explicit acquisition of leads supported by social media. Thus, external social selling offers the opportunity to quickly adapt traditional sales processes to social media, but at the same time falls short in exploiting its full potential. Any more fundamental approach requires reengineering the sales process. Sashi proposes to move from the tradition sales funnel with phases such as awareness, consideration, inquiry, purchase, and retention to a so-called sales engagement cycle, which comprises the seven phases connection, interaction, satisfaction, retention, commitment, advocacy, and engagement [Sa12, p. 260]. The declared goal of this approach is to leverage social media for forming trust and commitment between buyer and seller over a long-term period. In the survey, out of the companies which were applying social selling, 65% stated that they solely use external social selling. Merely 13% of the respondents use social selling predominantly in internal processes, and about 22% apply a combination of external and internal social selling. The tremendous potential of an appropriate mix of internal and external social selling is, therefore, largely unexploited.

Based on the qualitative and quantitative surveys, one can also make well-grounded conjectures about how to raise the identified potential: Firstly, through the systematic analysis of social media customer data, it should be possible to identify needs-based customer segments which have not yet been targeted by the company. Thus, social selling may provide a means to expand the core client base, with network effects amplifying this opportunity. Secondly, it appears to be of utmost importance to establish actionable metrics for social selling.

5 Metrics for social selling

An obvious starting point in search of social selling metrics are existing social scores as provided by the platform Klout. Meyer-Gossner dubbed such scores Personal Scoring Indices (PSI) and defined them as a "unique individual selling proposition based on scores humans achieve during their lifetime via i.e. school, university, business, hard knowledge skills & qualification, soft personal identification skills & personal network" [Me16]. However, these scoring approaches fall short in a business setting, as they simply reflect the engagement social media users show in terms of being proactive in their peer groups on social networks [Me10].

A newer, more advanced metric has been provided by professional social network juggernaut LinkedIn: the Social Selling Index (SSI). This index comprises four pillars of equal weight with several key drivers [Li17]:

6. Establish your personal brand!
   a) Provision of a complete LinkedIn profile
   b) Provision of rich additional content such as a company presentation
   c) Sharing of relevant professional content
   d) Endorsement by customers and colleagues
7. Find the right people!
   a) Usage of advanced search features and LinkedIn's Sales Navigator tool
   b) Usage of network to reach out to 2nd degree connections
   c) Participation in LinkedIn groups and lead management using LinkedIn's Sales Navigator tool
   d) Active usage of "Who's views your profile" feature
8. Engage with insights
   a) Posting of relevant content
   b) Usage of industry data and news provided by LinkedIn leveraging LinkedIn's Sales Navigator tool
   c) Commenting on posts by others
   d) Customization of messages when reaching out
9. Build relationships
   a) Building a large network
   b) Connecting with senior-level people
   c) Connecting with colleagues using LinkedIn's TeamLink feature
   d) Interacting with established connections

Obviously, LinkedIn's SSI incorporates many relevant factors of social selling based on the in itself best professional social media database. So, the question arises if companies should rely on the SSI as the one and only social selling metric? The answer is quite clear, even though LinkedIn claims that professionals with a comparably high SSI generate 45% more opportunities than their peers and are 51% more likely to reach quota. But this does not need to come true for your company; a higher average SSI score for your entire sales force will not automatically result in higher sales!

A major drawback of the SSI is that is limited to the LinkedIn platform itself – a potential pitfall e.g. for Germany, where LinkedIn's competitor XING has approximately 10 million users. If a sales agent is solely active on XING and not on LinkedIn, his social selling performance is not reflected by the SSI.

Furthermore, the SSI focuses on certain activities on the LinkedIn platform. While this is a workable idea, it does not reflect the business impact of social selling at all. Because in sales, figures like sales effectiveness, hit-rate, generated leads or even the revenue share of solution sells are also vastly important. The SSI falls short in this regard. Particularly the last three pillars must be viewed as problematic, as they incorporate the usage of several of LinkedIn's value-added features such as the Sales Navigator. Not using "Saved accounts" or "Saved leads" effectively prevents a sales person from achieving a top score, similar penalties will be given for not using LinkedIn InMails and Groups. And would it not be better to track customer acquisition progress of a sales person in the company's own database, rather than in LinkedIn's? Granted, if a company uses Salesforce or Microsoft Dynamics, it can connect the two worlds, but in reality, the connection may fail to work for IT, compliance or legal reasons. Moreover, the SSI's fourth pillar cannot be high if a sales person is simply only selling to second level managers. In many realistic sales settings, this property of the SSI simply does not make any sense.

In his seminal work "The Tipping Point", Malcolm Gladwell elaborates on the difference between a sales person and a networker: As a matter of fact, these are two vastly different archetypes and the one cannot sell without the other [Gl06]. Thus, a strong sales organization needs a healthy mix of personalities, some social networkers and some salesmen at heart. The danger of relying on the SSI as the sole social selling metric is that if favors sales people who are very active on LinkedIn, build huge networks and use the assets of the LinkedIn Sales Navigator, regardless of their actual sales success … or even instead of sales success, because time spend on LinkedIn may be missing for closing deals. In conclusion, any reasonable social selling metric must incorporate several factors, one of them possibly being LinkedIn's SSI. Moreover, any metric must be linked to actual sales success in a convincing manner.

How can this idea be implemented? A reasonable starting point is to collect data on all sales persons' social media activities across all relevant platforms in systematic way. For reasons or practicality, this requires channelizing all social media activities through a central tool. Letting sales people interact with different platforms by the respective web interfaces will inevitable result in an incomplete or fragmented database. Using social media management and cross-posting tools such as Hootsuite and Socialpilot or task automators such as IFTTT can be helpful in this regard. This data should be merged with CRM data in order to build a rich database on all social media and sales activities and associated sales success. As a last step towards a bespoken social selling metric, companies should explore the statistical connection between social selling activities and actual sales success, using standard methods such as regression analysis while considering time lags. The reward will be a social selling metric which rests on a broad factual foundation and has a proven impact on a company's future sales success.

6 Conclusion

Nowadays, almost every company should have a sound digital selling strategy. Unfortunately, companies frequently take only impulsive action that is later garnished with a strategic superstructure. A more promising approach starts with reengineering the entire sales process for the digital age, including a systematic use of digital value selling to deliver more value to the customer (cost reductions, profitability improvements, etc.) across the entire sales process. Companies who develop their products and solutions with this conscious focus on digital value delivery will be the winners in future markets. Moreover, instruments of social selling must be integrated into revamped sales processes in an effective, efficient and measureable way. Any company that acts quickly on this advice has a true opportunity to get ahead in the never-ending rat race that is sales.

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Challenges with Problem Exploration and Validation in the B2B Domain

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Abstract: Developing new products and services, which create value for customers in dynamic business environments, is highly challenging. A deep understanding of potential customers and their problems is required before deciding which features or capabilities to develop. In order to gain a better understanding of the problems it is helpful to engage with potential customers, ask them about their pains and listen closely to what they say. Lean and agile product management approaches provide techniques for exploring problems, revealing the underlying problem-related assumptions, and validating problems. Until now, these methods have been mainly used in Business-to-Consumer (B2C) domains. There is a lack of reported experience and knowledge about challenges when applying problem exploration and validation techniques in the Business-to-Business (B2B) domain. This article presents a case study about a product development effort in a large IT company offering software-intensive products and services in the B2B domain. The objective of the study is to identify the B2B-specific challenges with respect to problem exploration and validation. Results from the case study show that the huge number of various problems and their variations in B2B contexts, partially caused by different company environments, makes it difficult to identify the most relevant problems and to align them with a suitable customer segment. By utilizing an approach that iterates problem exploration and problem validation, it is possible to create a ranked problem list that can support customer segmentation and guide the product development.

Keywords: Product management, Continuous experimentation, Lean Startup, Problem exploration, Problem interview, Problem validation, B2B

1 Introduction

Product innovation and innovation management is gaining increasing importance. The business models of many existing companies are getting closer to the end of their life cycle and need to be replaced. New companies want to conquer existing markets or create new markets with product innovations. With proceeding technological progress such as cloud computing or open-source software in place, the costs for developing products are considerably low. But still most companies fail at launching new innovative products that meet customer needs and deliver business value. Studies reveal product

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failure rates of almost 90 percent [Ge09]. In many cases this is caused by insufficient or even missing problem understanding; instead companies often focus on developing solutions when creating new products. For healthy growth and a strong position within the market a company has to be able to build and establish new products that deliver both customer and business value. To achieve this, it is vital for companies to listen to the market which comprises its current customers, potential new customers and even customers of competitors and therefore apply a rather customer-driven approach [Al17]. It is not the product that matters at first but the problem a customer encounters. This is when a company has to understand the customer's problems and needs initially in order to build and launch a product successfully. To sustain and grow revenue it is fundamental to have a good understanding of the customer problems and needs. This can be achieved by talking and especially listening to customers thus identifying and validating their most important requirements [Al17].

Methods for identifying and validating customer problems and needs mainly evolved from the Business-to-Consumer (B2C) environment. However companies operating in the Business-to-Business (B2B) domain face additional challenges when managing innovative products. This is due to the long-term nature of the relationship which highly depends on the customer being interested in and attracted by the company and its products. Therefore the company's success is closely linked to creating and fostering a long-lasting relationship with the customer. This aspect emphasizes the main difference in addressing business customers and engaging with private customers [Za11]. Yet there is hardly any reported experience to be found in literature about problem exploration and validation in B2B environments. Therefore, a case study was conducted to better understand the challenges that occur when exploring and validating customer problems. This is where the present paper ties up: The aim of this paper is to investigate the Business-to-Business specific challenges and problems of problem exploration and validation in the context of product development in a large IT company.

In order to provide an adequate analysis, the paper is structured as follows: At first the selected methods for problem exploration and validation are described followed by the introduction of the corresponding case study which also forms the core of this paper. The case study puts emphasis on the problem exploration and validation in a B2B environment. Therefore, the design as well as the preparation and execution of the study are outlined followed by the analysis, reporting and discussion of the results. The discussion on the topic is followed by a glance at related work on this field of study. A brief summary and an outlook towards further research concludes this paper.

2 Methods for Problem Exploration and Validation

Modern product management refers to providing a value embedded solution that satisfies the customer needs [HH13]. But how can this value be added to a product solution such that the customer recognizes and appreciates it? As stated above, listening to the market

and thereby its associated customers contributes to identifying and learning from their pains [Ne07]. Holding this knowledge, a potential solution may be developed and be subsequently tested. This course of action is an iterative process accompanied by multiple different techniques [Ma12].

But when creating and delivering value embedded products, risk is an actual incidence that may influence the outcome in some way. Therefore, it is vital to consider the general risks that may impact the aspired solution [JS14]. According to Maurya [Ma12], there are three categories of risks that can be distinguished: *product risk* (i.e., risk related to getting the product right), *customer risk* (i.e., risk related to building a path to customers), and *market risk* (i.e., risk related to building a viable business). One approach to manage these risks properly is to introduce experiments that are organized in staged iterations to ensure continuous and additive learning. Maurya [Ma12] proposes to apply a systematic procedure which is composed of four stages:

Step 1 – Get the problem right: Interview customers to reveal and understand if the assumed problem exists and if it is worth solving.

Step 2 – Specify the solution: With the information of step 1 in place, define a respective solution, visualize it for better understanding and test it by collaborating with customers. The aim of this procedure is to ensure the successful operation of the solution as well as to make sure the pricing model works. In addition, expose potential customers that are willing to buy the product in an early stage.

Step 3 – Validate qualitatively: Now compose the smallest possible solution, i.e. the minimal viable product (MVP) and introduce it to the relevant early adopters. In the first place, this is to find out if the unique selling proposition (UVP) is detected and appreciated.

Step 4 – Verify quantitatively: Improve and refine your product and make it available to a larger group of customers. Test if the product appeals to customers and expose if your business is marketable.

This paper focuses primarily on step one in the B2B context as this is the starting point and a significant milestone for delivering an innovative and value-embedded product. We consider two important methods for problem exploration and validation: (1) assumption mapping and (2) problem interviews with potential customers. These two methods represent several key activities with respect to addressing risks in early product development stages, especially hypotheses identification and prioritization, problem exploration, and problem validation. Despite several other approaches for identifying and validating customer problems, these two were chosen as they serve the special requirements Hewlett Packard Enterprise faces by developing an innovative conferencing and collaboration product. Thereby the assumption mapping method supports stating assumptions evolving from internal experience and helps in structuring the collected thoughts. However, customer problem interviews were conducted to validate these assumptions by extending the group of potential end users across company boundaries and thus receiving accurate feedback.

Assumption Mapping

Assumption mapping is a qualitative technique to identify and deal with complex problems. Bland [Bl17] distinguishes between three types of assumptions:

- *Desirability assumptions* address the problem a customer struggles with as well as the hurdles which prevent him from solving this problem. These assumptions also center on the qualitative and quantitative result the customer wants to obtain.
- *Viability assumptions* concentrate on the channels new customers will be acquired through, the purpose why customers come back to buy products and the corresponding frequency as well as the way value and thus revenue is generated in the long term.
- *Feasibility assumptions* focus on the challenges when building the product such as technical or engineering obstacles, legal and regulatory risks. In addition, the capabilities of the team have to match the requirements in order to be well positioned in a competitive market.

With all these assumptions mapped out they can be allocated in a two-by-two manner. The axes of the coordinate systems are labeled with the attributes important vs. unimportant and known vs. unknown. The assumptions are then pinned to where they apply the most, accompanied by a lot of conversation and healthy discussions throughout the team. The debates are the most important part of the mapping as different points of view create a completely new perspective on the current situation. By looking at the assumption map, most of the time, effort and energy is spent on the upper right quadrant also referred to as the "leap-of-faith assumptions". Based on the assumption map, hypotheses can be created, experiments around these assumptions designed and thus the uncertainty of the general strategy be reduced [Bl17].

Customer Problem Interviews

Talking to customers is a good way to learn quickly about the problems they are currently encountering. By engaging customers one can also experience if and especially how the problem is handled to date. Furthermore structured problem interviews support the validation of the pre-determined assumptions. Maurya [Ma12] proposes the following structure for a problem interview: It starts off with a brief introduction on the setup of the interview followed by the collection of the demographics. Now the context of the problem is to be set by telling a story the interviewee can relate to. In the next step the top problems are explained and thereafter ranked by the interviewee. Afterwards it is all about exploring the stance of the prospects towards the problem by asking how the problem is handled today. This is the part when the interviewer holds back and listens to the narration of the interviewee and observes its facial expressions and gestures. Follow-up questions may be asked for clarification which serve as qualitative add-on information for further problem analysis. This step is fundamental for understanding the problem and validating the provided ranking of the interviewee. A high-level

explanation of the future product as well as gaining the permission to follow up and suggestion of further potential subjects conclude the problem interview. A detailed documentation of each interview supports future research. During the course of action the interview script needs to be reworked several times: checking on the results might lead to narrowing down the problems, refining the group of early adopters and how to address them, as well as gaining awareness of competitive solutions that the product is about to compete with.

3 Case Study

The goal of our case study is to identify Business-to-Business specific challenges of the problem exploration and validation methods *assumption mapping* and *customer problem interviews*. The research is conducted in the context of a lean product development project initiated by Hewlett Packard´s acquisition of Aruba Networks in 2015 [CN15]. Under of the umbrella of the newly founded Hewlett Packard Enterprise (HPE) the company offers a portfolio of advanced wireless network technologies but lacks in providing unique, customer-proven products to address future B2B use cases. The project aims at building a product based on location-based wireless technologies which solves real-world customer problems in the context of physical and virtual conferencing and collaboration.

A *case study* was chosen as a research method in order to investigate the challenges of assumption mapping and customer problem interviews in the B2B field, and to reveal domain specific challenges. Commonly used in psychology, sociology, politics, business and other domains, a case study "allows investigators to retain the holistic and meaningful characteristics of real-life events" [Yi09]. Using a case study as research method allows to increase knowledge and deepens the understanding of problems in reality [Ru12]. Furthermore, it acts as a documentation of why decisions are made in which situations, how they are implemented and finally which results were derived [Sc71]. The applied research process consisted of five main steps [Ru12]: study design, data collection preparation, study execution, data analysis and reporting. In the following chapter the study´s design, the evolution of data collection during the study as well as research execution and results will be presented.

3.1 Study Design and Problem Context

The goal of the product development project is to develop a new and innovative conferencing and collaboration product for organizations. Conferencing is pervading the complete B2B environment including all company sizes, organizational structures and industries. As expected variations due to those factors, a binary differentiation in *single-* and *multi-case studies* [El96] is not sufficient and has to be extended by the dimension of analyzed units within the given context. Following the classification of Yin [Yi09] the basic type of the case study is *single-case embedded* running multiple subunit analysis

within the very same context. This context involved potential B2B customers, meaning all companies using physical and virtual conferencing for their employees. The case selection strategy for subunits is *information-oriented* by creating *paradigms* but keeping *maximum variation* between the following interviewee characteristics that are the subunits [Fl06]: industry sector, size (enterprise and medium businesses) and customer segment, defined by their job role (e.g. normal users as salesmen or consultants, power user as secretaries, and special users as facility management and administration). Furthermore, conferencing is not a new use case. Nevertheless, to allow open-minded thinking and new innovation, both an *inductive* and a *deductive* approach [Ru12] is applied within this research. The case study is limited by the fact that those who perform the study are the same people as those observing and interpreting it and the limited number of cases whose selection is based on the described strategy but is restricted by the willingness and availability of potential interviewees. Additionally, the methods to be applied in the study are chosen by the researchers based on the underlying product development project.

The main objective of formulating and validating assumptions lies in the reduction of the problem context's complexity [Lo11]. By establishing assumptions in the early stages of product development the danger of designing not-needed, unwanted, or unachievable products is averted and the risks of product development are reduced [PB16]. The focus of this case study is on establishing assumptions in the context of customer problems and needs, i.e. *desirability assumptions*. In a joint brain-storming session conducted by the research team desirability questions are discussed and amongst others the following assumptions are formulated and identified as "leap-of-faith assumptions" [Bl17]:

- Potential business users struggle with orientation inside their office and have difficulties to find conference rooms.
- Potential business users have problems in detecting the current availability status of conference rooms (e.g. available, reserved, in use).
- Potential business users solve their conference booking problems today using Outlook or Lotus Notes.
- Potential business users want to achieve flexibility, simplicity, and efficiency.
- Potential business users find faults with the provision of room equipment.
- Potential business users are impaired in their meeting quality by airing, temperature, and noise.
- Potential business users find their current booking process inconvenient.
- Potential business users have to use separate tools to order catering or additional equipment.

The established assumptions are tested and validated or falsified during the customer problem interviews.

3.2 Data Collection

Following the method of Customer Problem Interviews, data is collected in regularly iterated interviews. Hence the study is raising *qualitative data* in a written format but offers a *flexible design* that can be adjusted [Ru12]. As required by the method, multiple possible customers (*data sources*) have to be interviewed which assures research validation by *data source triangulation* [Ru12]. A semi-structured script is created leading the interview along collecting meta-data, focused questions and space for open-ended explanations through the interviewee [BGM87].

Besides name and contact information, the meta-data contains the interviewee´s industry, job role and company size to classify each interview into the suitable subunit. The interview´s main part covers openly formulated questions regarding the previously described assumptions:

- How is conferencing organized in your company?
- How do you ensure professionally equipped conferencing facilities?
- How do non-local participants get to their conference room?

To drive an inductive approach, a field for any additional information by the interviewee is provided. Through the regularly iterated revision, formal as well as content-related adjustments are made. Based on experience, useful questions and phrases to keep the interview running are provided in the script. Example questions are (based on [Ma12] and [Al14]):

- If you had a magic wand, what would you change?
- Which activities are always required before / after conferencing?
- Why is X [placeholder for a feature the interviewee mentioned] required?

Based on detected possible customer problems, questions regarding catering, room availability and the inappropriate use of rooms are introduced as well. Orientation problems are differentiated between external guests and non-local employees. In the last iteration (about 10% of the interviews) data collection is used for validation only. Therefore, instead of asking for new information, the current results with respect to top problems are polled for prioritization.

3.3 Study Execution and Analysis

During the case study 44 potential business users from 25 enterprises and 15 industry sectors are interviewed about their problems, challenges and experiences with booking and using conference rooms as well as in-door orientation and navigation. The consulted user groups consist of managers, office assistants, sales representatives, consultants, and administrative workers. The interviewees are categorized into three categories: (1) *bookers* who schedule and organize meetings frequently, (2) *users* who attend meetings and rarely use the booking system themselves, and (3) *bookers and users* who do both at a similar rate. During the first round of interviews the interviewees are contacted via e-

mail and instant messaging as first-level contacts. They are asked for suitable referrals, e.g. a manager might propose his or her assistant for additional insights into the company's room booking process. Second- and third-level contacts are contacted with personalized e-mails which contain the project description and the referral of the mutual first-level contact, suggested time slots and locations for the problem interview. Each interview has a duration between 20 and 40 minutes, whereas the average interview is scheduled for a 30-minute time period.

3.4 Ranking of Customer Problems

In order to prioritize customer problems a ranking system with three levels is developed and applied. After finishing all interviews a weighted problem-priority-index is calculated for each problem:

$$\begin{aligned} &Weighted\ problem\ priority\ index \\ &\quad = number\ of\ low\ priority\ mentions{*}1 \\ &\quad + number\ of\ medium\ priority\ mentions{*}3 \\ &\quad + number\ of\ high\ priority\ mentions * 5 \end{aligned}$$

Ordering the list of customer problems by the weighted problem-priority-index reveals a ranking of important problems to be addressed as shown in table 1. The maximum value for the weighted problem-priority-index is $44\ interviews * 5\ \frac{index\ points}{interview} = 220\ index\ points$.

Customer Problem	Weighted Problem Priority Index
Room reservations without usage	64
Shortage of rooms	63
In-door orientation difficulties	50
Uncertainty concerning the current room availability	38
Room usage without reservation	34
Separate tool for catering	33
Room equipment unknown	28
Assistant dependency for room bookings	26
Sub-process for extra equipment	26

Tab 1: Prioritized problem list ordered by weighted problem-priority-index

In addition to the prioritization of the problems, a great deal of insights such as information about the potential business user's strategies to deal with or to avoid problems are discovered. For example, a strong correlation is detected between the alleged shortage of rooms and the discrepancy of reservation and usage of rooms. The deviation between the booking system and actual room occupancy occurs especially for recurring appointments since users neglect or forget to cancel their assigned rooms. It becomes apparent that often business users simply fail to find the available rooms within the building. Furthermore, it becomes clear that many enterprises still rely on assistant-

aided room management and on tracking room occupancy on manual lists apart from the previously identified existing alternatives *Outlook* and *Notes.* The interview results show that employees not only have difficulties with in-door but also with on-campus navigation since many enterprises maintain multiple office sites for their employees. For security reasons enterprises demand consistent attendance for external guests and abstain from letting them move freely.

The results of the customer problem interviews are further used for envisioning the possible product features. All solution ideas are assessed on whether they address a high priority problem or vastly contribute to the realization of it. Additionally, the use cases for testing prototypes during customer solution interviews are derived from the prioritized problem list.

4 Research Results

The case study shows several challenges when conducting problem exploration and validation in a B2B-domain. The challenges the research team faced during the conducted case study are related especially to obtaining a representative group of potential users and early adopters due to the huge number of variations in the business environments. In consequence, it is also highly challenging to compare and prioritize customer problems. Table 2 sketches these B2B-specific challenges and how they were addressed by the research team during the case study.

Challenges	Solution Approaches
Obtaining a representative group of potential users for the customer problem interviews	A non-representative group of potential users is chosen for the first interviews. Further potential interviewees are acquired through referrals and suggestions from interviewees and selected based on their suitability.
Identifying the group of early adopters within the enterprise	Early adopters are defined as those users who benefit most from the new product. Thus, assistants are identified as early adopters for all booking functionalities; whereas new hires and non-local employees are identified as early adopters for all in-door navigation functionalities.
Prioritizing problems with qualitative customer feedback	Interviewees are explicitly asked for their assessment of the relevance of their mentioned problems. Comparability is ensured by introducing the weighted problem-priority-index and a careful consideration of the different contexts.

Tab 2: Challenges and solution approaches during problem exploration and validation

Based on the experiences from this study the following initial guidelines for running problem exploration and validation in a B2B environment are derived. They address

possible problems which lead to insufficient understanding of customer problems or misinterpretation of interview results as we had to learn along our case study.

Choose the right interviewees: Steve Blank´s quote "Get out of the building" on customer development [Ma12] has been proven as highly recommendable also for building B2B products. Starting the first interviews on colleagues was a good learning experience on how to run interviews, but generated only limited valuable insights. People in the same company using the same tools in the same way have similar problems. It is necessary to go out and find external interviewees.

Ask your interview partners for referrals: Most people have private or business contacts into other companies which provides the opportunity to stretch a large network of diverse interview partners. For example, in this case study a referral chain starting from an average useful interview (medium business with little conferencing) into two very informatory interviews with employees from enterprise sales and engineering companies is used.

Understand your interviewee´s characteristics: Whereas in consumer business customers (i.e., people who pay) and users are typically the same, in B2B environments these are roles of different people with complicated relations. Within the user role, a lot of additional differentiations occur regarding the product usage and therefore expectations. Company structure and characteristics are influential as well. When choosing interviewees to conduct the study, it is critical to understand those variations to either focus on one of those subgroups or to be able to separate them during the analysis. As an example, it is recognized that employees in medium-sized companies have other problem priorities than those in large enterprises, as conferencing does not play a big role in their company.

Don´t trust your interviewee's perception - use validation: For sure, most interviewees try to tell the truth. But when it comes to problem prioritization, people are misled by their perception and provide a very subjective ranking when asked. Therefore, it is recommended to use additional factors to estimate a discussed problem´s priority. For example, if a problem barely occurs, and only affects a small number of people or there is no alternative solution, the problem is not important even if the interviewee thinks it is.

Additionally, a validation phase at the end of the study´s execution is recommended, in which the final results are crosschecked with new, unbiased interviewees.

5 Discussion

This paper and its underlying case study show that lean product management methods, especially problem exploration and validation methods, can be used for Business-to-Business environments. Challenges arise especially around identifying and accessing

potential customers and early adopters as well as around problem prioritization. The challenges are due to the many different business contexts that exist and complex and sophisticated role models in B2B environments. The study results are limited by the scope of the project under study. In terms of generalizability, the characteristics of the case company, the domain, and the product need to be carefully analyzed before transferring results to other contexts. Threads to internal and external validity are addressed by data source triangulation and researcher triangulation with respect to accuracy checking. The results of an interview were reviewed with the other researchers that are not involved in conducting this interview. Nonetheless, the roles of the researches as observers and interviewers are mixed throughout the case study and were not strictly separated. We hope that the results contribute to a better understanding of the specific B2B challenges of problem exploration and validation and will be enriched with further research.

6 Related Work

Related research on problem exploration and validation in B2B product management mainly confirms the results as the following examples state.

Nirwan and Dhewanto [ND15] present a case study on implementing the complete lean startup methodology in an Indonesian B2B startup. When running their problem interviews, they noticed that it is quite difficult to identify suitable customers as early adopters within the few number of possible B2B customers. The interaction with customers was quite challenging due to the customer's initial low priority on scheduling the interviews as they might not expect any advantages for their business from participating in this research. Furthermore, they struggled in iterating fast due to the regulations and administrative work required by their product.

Rissanen and Münch [RM15] investigated continuous experimentation on B2B customers. In their study, "almost 100% of the completed features have been determined by the customer", so product development is fully led by the customer. Hence many B2B customers might even expect this proceeding whereas consumers do not. They also perceived challenges in rapidly iterating software releases as deployments into production systems should not imply downtime during working hours. Frequently changing user interfaces resulted in dissatisfaction due to the disturbed work routine. The customers´ user acceptance testing which is required for productive systems could not follow the iteration speed.

Due to Croll and Yoskovith [CY13] B2B startups can adapt lean product management methods but have to face significant differences. Croll and Yoskovith see companies´ buyers as regulated and formal which is challenging for product development and sales teams. Furthermore, they consider a higher competition with legacy and incumbent products in B2B environments.

Conclusion

Both this and related research shows that customer-focused product development in the early stages faces various B2B-specific challenges but does not require new techniques. By utilizing an approach that iterates problem exploration and problem validation, it is possible to address these challenges in the case study. Based on the experiences of the case study, initial guidelines for conducting and reasoning about problem interviews are identified. However, there is space for further research: to complement the research results, the application of additional problem exploration and validation methods in similar and other B2B contexts might provide new insights. Besides that, a research extension on further product management steps is possible, e.g., prototype testing based on transforming identified problems into features of minimum viable products. Finally, more advanced ideas for problem exploration and validation could be considered, e.g. based on questions like the following: Is data-driven problem exploration possible by saving time and money and does it create the same valuable insights as personal interviews? How can problem exploration be realized when "customers" are autonomous machines or artificial intelligence? This might lead to new interesting research avenues.

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A Product-Service System Proposal for Agile Modelling Method Engineering on Demand: ADOxx.org

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Abstract: The importance of Modelling Method Engineering is equally rising with the importance of domain specific modelling methods and individual modelling approaches. In order to capture the most relevant semantic primitives that address domain specifics needs, it is necessary to involve both, method engineers as well as domain experts. Due to complexity of conceptualization of a modelling method and development of regarding modelling tool, there is a need of a guideline-, corresponding tools- and services-bundle supporting actors with different background along this complex process. Based on practical experience in business, more than twenty EU projects and other research initiatives, this paper introduces a product-service system to support the conceptualization of a modelling method on demand. The proposed product-service system is introduced and evaluated by three EU-funded research projects in the domain of multi-stage manufacturing, e-learning and cloud computing as well as additionally by an in-house development project in the area of decision modelling extensions. The paper discusses the evaluation results and derived outlooks.

Keywords: Meta-modelling, Modelling Method Design, Agile Modelling Method Engineering, Conceptualization, Modelling Method Engineering, Servizitation.

1 Introduction

The importance of Modelling Method Engineering is equally rising with the importance of Domain Specific Conceptual Modelling Methods and individual modelling approaches. In addition to existing (de-facto-) standards (e.g. Business Process Modelling Notation (BPMN), Decision Model and Notation (DMN), Case Management Model and Notation (CMMN)), a growing number of groups around the world design their individual modelling-methods (in accordance with the definition of such a method by [KK02] [Ka15]) for a variety of application domains.) The engineering of such applicable modelling tools as a result of the conceptualization process of modelling methods, is complex, especially when considering the mapping of the entire spectrum from language artefacts and corresponding functionality to concrete implementable and deployable modelling tool capabilities.

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This is often seen as necessary, when model-based approaches are transferred in new application domains and hence require adaptations for modelling methods. A simple sample can demonstrated using the well-known standard for business process BPMN. Although BPMN can be used to design an administrative process, such as sending an invoice, it cannot be used to design a simple production process like producing a chair. The successor relation that indicates that one activity follows the other does not have properties like distance to the station, which is not necessary when sending an invoice, but is of utmost importance, when producing a chair. When analysing more complex scenarios like a car manufacturer shop floor (we faced in projects DISRUPT [DISRUPT17b], GO0DMAN [GO0DMAN17]), the adaptation requirements for a modelling language like BPMN becomes quite complex. Hence, providing well-known model-based approaches requires the adaptation by e.g. introducing the concept "distance" between two activities. On the one hand, in order to capture the most relevant semantic primitives that address domain specific needs, it is necessary to involve both the method engineers as well as domain experts; on the other hand for success of process for generation of modelling tools from design to deployment, it is necessary to enable knowledge exchange all stakeholders with varying backgrounds.

Challenging question is, how to support the generation of modelling tools that can range from a minor adaptation like the one introduced above, till the complete realisation of totally new modelling approach like a cyber threat modelling for cloud computing .

Today, there are different approaches, guidelines, tools and practices for the conceptualization of modelling methods and development of concrete modelling tools available that do not consider or support the full spectrum of the design and collaborative development of a modelling method, which unavoidably leads to limitations in the conceptualization of it [HKW13]. There is a need of a guiding framework, corresponding tools and services supporting method engineers along the complex conceptualization process taking all phases into consideration and ensuring collaboration among stakeholders involved in the process. Karagiannis proposes in [Ka15] the Agile Modelling Method Engineering (AMME) framework and authors of [ADOxx17b] propose the Modelling Method Conceptualization Process that based on AMME, guides the method engineers during conceptualization. The work at hand proposes a product-service system, whose core introduced in [EWU16], which supports agile modelling method engineering and conceptualization process. The product-service system (PSS) so-called "ADOxx.org PSS" aims to enable (1) efficient development lifecycle to produce professional modelling tools, (2) re-use of existing modelling method snippets/fragments, (3) re-use of existing platform functionalities (meta-functionality), (4) Involvement of domain experts in design of modelling method, (5) meta-model merge patterns to integrating mechanisms and algorithms, (6) multi-tool/standard merge mechanisms and finally (7) sustainability of results, while services supporting method engineering along conceptualization process taking Modelling Method Conceptualization Environment as basis.

Moreover the work evaluates the product-service system in four modelling method engineering cases, within three European Research projects, and one additional in the context of an in-house research project,

The remainder of the paper is structured as follows: Section 2 introduces the product services system and outlines Modelling Method Conceptualization Environment and Section 3 presents shortly Modelling Method Conceptualizations Services around Modelling Method Conceptualization Environment as product. Section 4 presents evaluation cases and results, while section 5 concludes the paper and gives an outlook on future work.

2 Modelling Method Conceptualization Environment

Having roots in software engineering, like in agile software development, during the modelling method engineering, involved stakeholders need procedures, structures and supportive tools allows high iterative process with as less as possible bureaucracy, and offers agile value and follows principles in Agile Manifesto [Pr17].

AMME is proposed in [Ka15] to support modelling method engineering during propagation and evolution of modelling requirements. The OMiLab Lifecycle [OMILab17] instantiates AMME and defines the internal cycle of a modelling method conceptualization with five phases; (1) “Create” as a mix of goal definition, knowledge acquisition and requirements elicitation activities that capture and represent the modelling requirements; (2) “Design” specifies the meta-model, language grammar, notation and functionality as model processing mechanisms and algorithms; (3) “Formalize” aims to describe the outcome of the previous phase in non-ambiguous, formal representations with the purpose of sharing results within a scientific community; (4) “Develop” produces concrete modelling prototypes and finally (5) “Deploy/Validate” involves the stakeholders in hands-on experience and the evaluation process as input for upcoming iterations.

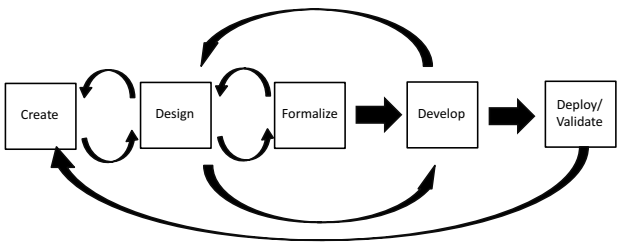

Fig. 3. Modelling Method Conceptualization Process

Due to the involvement of several stakeholders with varying knowledge backgrounds, perspectives and different objectives, in the conceptualization of a modelling method, the authors of [EWK15] propose so-called Modelling Method Conceptualization Process (as depicted in **Fig. 3**) by adding additional feedback channels into the OMiLab Lifecycle between: (1) Create and Design, to prove, if the designed modelling language covers the identified application scenarios and considers the identified requirements; (2) Design and Formalize to ensure formal approval of modelling language, as well as (3) Design and Develop - to improve modelling language in earlier stages before it is released and deployed. The work at hand introduces a new version of so-called "Modelling Method Conceptualization Environment toolbox that initially has been introduced in [EWU16] and that instantiates the above process and supports method engineers during each phase. The only exception is that of the "Create" phase, as this part is regarded as the most creative phase and standard tools and methods (also in some cases pen and paper can be the most appropriate tools) shall be freely selected. Modelling Method Conceptualization Environment proposes a combination of tools in sense of Integrated Development Environment (IDE), such as the Modelling Method Design Environment (MMDE, available at [LearnPAd17b]) for the Design, the ADOxx Library Development Environment (ALDE) and ADOxx, for Formalize and Develop, 2.3 Adoxx.org Build, Test and Deployment Services (available at [ADOxx17a]) for Deploy/Validate Phases.

As depicted in **Fig. 4**, typical life-cycle / usage scenario would be during the create phase domain experts and method engineers come together, identify requirements for modelling method, in design phase method engineers with tight collaboration of domain experts specifies the meta-model, language grammar, notation and processing functions on MMDE, as method engineers formalize design of modelling method collaboratively and commit on ALDE, developer(s) based on that formalization implements concrete modelling toolkit prototype within ALDE and ADOxx Development Toolkit. Developer(s) uploads the prototype into ADOxx.org build server, semi-automatic service behind starts completeness check, building installation package, testing of installation package and optionally deploy it on selected developer to download the toolkit, test it, validate by community members get feedback from them or the build services sends a link to owner to download and/or share the modelling toolkit. It is worth to mention that one of the objectives is to provide loosely coupled tools, so involved actors have the flexibility to decide to use one, a combination of tools from the toolbox or even use other appropriate tools of their choice, (e.g. method engineer uses MMDE during the Design Phase, but formalize the modelling method design with mathematical models or use another development tool during the Develop Phase and deploys them at the Developer Spaces and enable validation).

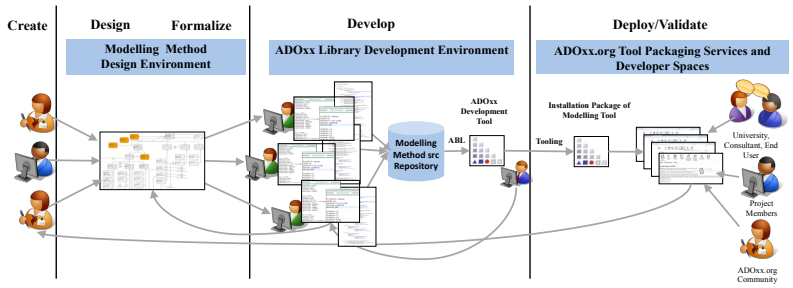

Fig. 4. Life-cycle within Modelling Method Conceptualization Environment from Users' Perspective

In the following sub-sections current abilities of the tools from the environment are shortly presented

2.1 Modelling Method Design Environment.

The Modelling Method Design Environment (MMDE) is itself a modelling tool to design other modelling methods. MMDE has been implemented based on lessons learned and the experience of the authors, who have been involved in modelling method/tool development activities in more than 20 EU research projects for varying domains. Based on these lessons learned and the results of a state of the analysis that we discussed in [EWK15], UML [OMG17] has been identified as a fitting starting point. Hence, the MMDE takes a subset of UML and extends it with required concepts and functionalities in order to overcome the following challenges **(Ch)**, which are identified by [EWK15] based on a state of the art analysis about specification of conceptual modelling methods:**Ch1,** "Requirements" model type is implemented that allows the elicitation of requirements, specifying their status as well as dependencies among them. The described requirements in this model type can be referenced to (a) all the modelling classes modelled in the related model type "Meta-Model" classes, (b) graphical notation (concrete syntax) definitions modelled in the "Graphical Notation" model type, (c) the "Modelling Stack" definition and (d) to the functionalities modelled in "Mechanisms & Algorithms" models. For **Ch2,** we extend the class diagram from UML with concepts, so method engineers can differentiate between class and relation class as well as relate different meta-models (-fragments) with each other using "Weaving" techniques as they are introduced in [EWK15][Wo14]. The modularization and layering of modelling language is essential to avoid complexities during the design of domain specific modelling methods [Se11] [KHW11]. Hence, we propose representation of the modelling stack as the "Meta-models Stack model type allowing method engineers to differentiate meta-models in sense of different model types that target different fragments of the system. In order to target **Ch3** and specify a proper graphical representation (concrete syntax) of each concept in a meta-model, we introduce another model type called "Graphical Notation" model type(allows definition of concrete syntax

of model types with specifying graphical representations for each constructs in meta-models. This model type allows the description of graphical representations either assignment of vector graphics code written in GraphRep Language [ADOxx16] or with the assignment of concrete images including a description of the functionalities in the notation (e.g. attribute-value dependent visualization, context related views) In order to target **Ch4** to define the applicable modelling technique as steps and corresponding results we propose a model type called "Modelling Procedure" model type". The Modelling Procedure Model Type allows method engineers to define the steps with their required inputs and produced outputs, as well as the sequence of steps based on input – output relationships, in order to introduce case specific proper usage of their modelling method. Based on this procedural view. Further details about MMDE can be found in [EWK15].

2.2 ADOxx Library Development Environment.

The ADOxx Library Development Environment (ALDE) aims to enable formalization and parallel development of modelling tools libraries based on the designs deriving from Design Phase, merging different libraries and ensuring maintainability. As an experimental prototype ALDE uses the Resource Description Framework (RDF) as a format for data interchange [W3C17a] ALDE is a development environment based on the Eclipse IDE [Eclipse17a] and includes a meta²model defined in RDFS, the ALDE vocabulary. Having the vocabulary and utilizing Apache Ant® as a build mechanism [Apache17], the environment enables the definition of the transformation processes from ADOxx Library Languages to RDF and vice versa. Moreover ALDE serializes libraries in an arbitrary RDF format; for the prototypical realization RDF Turtle [W3C17b] has been used and includes the RDF XTurtle Editor developed by [AKSW17]. Having libraries in RDF Turtle format and a RDF Turtle Editor available, method engineers can adapt declaratively and script libraries collaboratively using standard functionalities of source-code management systems. Merging several libraries or integration of parts of libraries in each other becomes possible. The most important improvement is the integration of an ADOXX-JAVA-MM-DSL, which is developed based on feedbacks coming from evaluation cases of previous versions. The ADOXX-JAVA-MM-DSL is a framework that creates several abstraction layers over the ADOxx Library Language (ALL) format, the ADOxx internal language that describes a meta-meta-model. Every layer simplifies and adds features to the bottom one. The framework give so the possibility to operate and easily perform modification on a meta-model without dealing with its complexity. In order to assure that, an internal structure is managed that represents the ALL structure of the meta-model. This internal structure can be loaded from an existing ALL meta-model and can be exported as ALL as well. All the constraints and rules present in the ALL syntax are managed, so the framework can guarantee that only syntactically valid ALL meta-models will be loaded and generated.

2.3 Adoxx.org Build, Test and Deployment Services.

Adoxx.org Build, Test and Deployment Services [ADOxx17a] are web-based services that allow method engineers of the ADOxx community to build verified, professional and installable distribution packages that can be distribute to interested stakeholders. The service combines and validates all available inputs, integrates all elements, compiles the necessary artefacts and signs the outcomes and creates the actual installer as a download archive. As a collaboration space for the development and deployment phases, the concept of "Developer Spaces" has been introduced in ADOxx.org [ADOxx17b]. These spaces enable sharing of intermediate/release results, discussing development resources from all pre/past phases in the form of source code, snippet, examples and distribution packages with the community.

3 Modelling Method Conceptualization Services

In addition to the conceptualization tools described in the previous chapter, an appropriate support services are foreseen to support the modelling method engineers. The services are provided on the ADOxx.org portal, supporting a community of more than 1.300 modelling method engineers world-wide. The services are provided as follows;

1. **Download:** For the download, ADOxx.org provides the Meta Modelling Platform ADOxx in combination, Installation Instructions, Frequently Asked Questions, Startup-Package as well as a set of more than 30 available application libraries, which can be used to start with.
2. **Get Started:** For getting started, ADOxx.org provides important readings, provides a Forum that is structured according active communities, lists tutorial and training events that are offered free of charge, provides tutorial material for both the students – in form of guide samples and slides – as well as for the trainer – in form of a trainer handbook and offers tutorial videos and webinars.
3. **Development and Support:** For the development, ADOxx.org provides aforementioned tools and additional developer utilities, 3rd parties add on like but not limited to simulation, documentation, dashboards or Web-APIs. A collection of 200 graphical representations that introduce the major elements conclude the development support.
4. **Community:** For collaborative development within the ADOxx.org community a map is provided indicating the ten laboratories – nine in Europe, one in Asia, indicating the hot spots of developers, the participating research institutes, a set of 24 modelling tools as a result of [KMM16], and development spaces that enable a collaborative development and enable the use from solutions and tools from other projects.

5. **Documentation:** A complete specification and documentation is offered, where each relevant element of the modelling method is (a) explained based on the corresponding theory, (b) introduced with hand-on samples, (c) demonstrated with real-world scenarios, (d) mapped to forum entries of the community and finally (e) supported with tools where possible.

The operation of this service centre is provided via the portal, social media like Twitter, Facebook and LinkedIn, or via email. In justified cases an onsite support is also provided, where either the method engineer is trained, supported or critical implementation steps are performed by the ADOxx.org service centre.

4 Evaluation

Given that usually each modelling method engineering case differs from each other in sense of complexity of domain, variety of aspects to be targeted, number of involved actors, to calculate quantified evaluation means is difficult, and – to best of our knowledge - there is no similar conceptualization environment, hence, it is difficult to bench-mark our proposal and quantify the evaluation and provide statistically objective results. On the other hand, the most important tangible and objective evaluation result would be deployed and ready to use modelling toolkits, specification of modelling methods and communication of community members as proofs of concept. Those proofs of concepts for each are online and freely accessible (with exception of in-house project case). The links to access those proofs of concepts for each case are provided under regarding sub-section below.

The conceptualization environment introduced above has been applied in four different cases for evaluation: three EU-funded research projects in the domain of multi-stage manufacturing, eLearning and cloud computing and additionally in an in-house development project, in the area of decision modelling extensions into business process management.

Case 1: Conceptualization of a Modelling Method for E-Learning: The FP7 project Learn PAd [LearnPAd17a] proposes a process-driven-knowledge management approach based on conceptual and semantic models for transformation of public administration organizations into learning organizations. Learn PAd proposes a model-driven collaborative learning environment. In this case, 4 domain experts and method engineers have been involved. In addition, two developer teams, each consisting of 4 developers worked on the implementation of the tool. The results of the conceptualization process of this modelling method can be found at Learn PAd Developer Space [LearnPAd17b]as well as the developed prototypes [LearnPAd17c] can be downloaded and feedback can be given.

Case 2: Conceptualization of Modelling Method for Cloud Computing: The H2020 project CloudSocket [CloudSocket17a] introduces the idea of Business Processes as a Service (BPaaS), where conceptual models and semantics are applied to align business processes with Cloud-deployed workflows [WU15] . In this case, 6 domain experts and method engineers have been involved, as well as two developer teams, one with 5 developers, the other one with 2 members. The results of the conceptualization process of this modelling method can be found at CloudSocket Developer Space [CloudSocket17b], as well as developed prototypes [CloudSocket17c] can be downloaded and feedback can be given.

Case 3: Conceptualization of Modelling Method for holistic Manufacturing System Management: The H2020 project DISRUPT [DISRUPT17a] deals with the integration of innovative technologies into a holistic manufacturing system and optimization of production flow. The DISRUPT projects needs a modelling method to describe manufacturing system from supply-chain level down to shop-floor level. In this case 2 domain experts, one requirement engineer and one method engineer have been involved. Preliminary results can be found on DISRUPT Developers Space [DISRUPT17b].

Case 4: Integration of existing BPMN and DMN Modelling Methods: The in-house project requires integration of an already implemented DMN Modelling Method into existing BPMN 2.0 realization as part of a commercial product. In this case, 3 domain experts and method engineers, and a team of two developers have been involved.
The evaluation process was enacted in the following steps: (1) Provisioning: the tools -of the toolbox have been provided to the stakeholders in the involved cases. (2) Team Formation: representatives, - of the stakeholders in the project created development teams consisting of domain experts and method engineers following the conceptualization process and developing tools individually. (3) Feedback Phase: individual results have been consolidated periodically through video conferences and workshops, constituting the evaluation results.

Feedback on MMDE; Pro: It is possible to specify requirements and dependencies among them as well as tracing them; (2) to define modelling language fragments and modules, (3) layering the modelling language with navigational constructs; (4) definition of syntax, semantic and assignment of notation (concrete syntax); (5) definition of weaving among construct in different meta-models; (6) assignment of (multiple-) graphical notation (concrete syntax); (7) explicit definition of modelling procedure; **Contra:** It is not possible to define application scenarios and use cases, and design results can be exchanged solely using ADOxx specific formats or as static content (image, PDF or HTML). Hence, double effort in the design and in the formalisation and or development is currently necessary; **Outlook:** The MMDE is currently updated, to offer an XML export, which then can be transformed into different formats like the one that is used for the ADOxx-Java-MM-DSL.

Feedback on ALDE; Pro: it is possible to transform libraries in a machine as well as human interpretable format, ability to use reasoning algorithms, due to standard semantic formats; reduces complexity to edit, merge and maintain libraries; **Contra:** To take over

results from Design Phase require manual steps.; it re-quires different transformation scripts for different meta-modelling technologies (such as ADOxx, EMF); **Outlook:** The semantic-based verification of meta model is seen as a useful extension of the ADOxx-Java-MM-DSL, hence an integration will be experimented. However, we see the necessary skill level for the meta model developer currently as inappropriate and tend not to follow this path.

Feedback on ADOxx-Java-MM-DSL; Pro: It is possible to merge libraries and start libraries from scratch. Furthermore, the code base can be stored and versioned in a versioning system enabling several developers in parallel to work on one library. Built scripts enable the automatic generation and deployment of the tool; **Contra:** The current code maturity needs improvement and documentation, enabling also non specialists to handle the tool; **Outlook:** This tool will be further improved and tested in two EU-H2020 research projects and will consequently be taught at the ADOxx.org Training Days and Webinars to achieve the required maturity.

Feedback on ADOxx.org Tool Packing Services and Developer Spaces; Pro: It is possible to have an installation package to distribute to interested stake-holders, building your own community around the modelling method, and get feed-back from them; **Contra:** Setting up and handling issues of a certain Developer Space involves certain manual steps, such, as the interested stakeholder has to send an e-mail to the administrator with a request of an own Developer Space; **Outlook:** This tool packaging service will be stepwise opened, so that the developer can also include own software components, which are then composed into a single tool package.

5 Conclusion and Outlook

In this paper we propose a product-service system instantiating the Modelling Method Conceptualization Process, which supports method engineers to develop their own modelling method and corresponding modelling software on demand with following agile modelling method engineering principles. The product-service system has been evaluated through an analysis of four different cases: three EU research projects and one in-house project. The evaluation results put forward that having an approach, a corresponding product and service bundle following the idea of model-driven engineering is effective in terms of transferring knowledge from the analysis of requirements up to the development of solutions. Being two main tools, MMDE and ALDE, experimental prototypes that are at very early stage of development, lack of full integration or automatic data exchange ability, and the need of manual steps building Developers Spaces came out as major limitations of the product-service system. As an outlook the following items derived from the evaluation: (1) currently we are evaluating development more integrated Modelling Method Conceptualization Environment, (2) and working out service-offerings for demands regarding development in productive settings.

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