The Impact of Digitization on Information System Design - An Explorative Case Study of Digitization in the Insurance Business

Rainer Schmidt[1(✉)], Michael Möhring[1], Florian Bär[1], and Alfred Zimmermann[2]

[1] Munich University of Applied Sciences, Lothstrasse 64, 80335 Munich, Germany
Rainer.Schmidt@hm.edu
[2] Reutlingen University, Reutlingen, Germany

Abstract. Digitization transforms business process models and processes in many enterprises. However, many of them need guidance, how digitization is impacting the design of their information systems. Therefore, this paper investigates the influence of digitization on information system design. We apply a two-phase research method applying a literature review and an exploratory case study. The case study took place in the IT service provider of a large insurance enterprise. The study's results suggest that a number of areas of information system design are affected, such as architecture, processes, data and services.

Keywords: Digitization · Digital transformation · Information systems

1 Introduction

Digitization [1] has a huge impact on economy and society and is questioning fundamental structures in the economy and society [2]. The business perspective of digitization is illustrated by the fact that a number of new companies in the market appear [3], at the same time established businesses have to fight for their existence [4]. Digitization is discussed also from a technological view. From a technological view, digitization is be described as the cooperation of several technologies [5]. However, the question how digitization impacts the design of information systems beyond technological considerations remains unanswered. On the other hand, information technology departments are eager to know which changes are necessary to fully exploit the potential of digitization.

Overall, the question driving our research is: *How does digitization impact the design of information systems in the insurance business?* Answering this question, we apply a two-phase research method comprising a literature review and an exploratory single-case study. While the former allows to identify digitization patterns and impact factors, latter is used to validate them and identify aspects that have not discussed in prior research yet. The case study addresses digitization in the insurance business. Digitization has an increasing importance in the insurance business. According to a study of Deloitte LLC [6], the percentage of Canadian consumers obtaining insurance

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quotes online went from 23% to 40% from 2008 to 2013. The key to understanding the upcoming changes is a fundamental change in the value creation model of insurance. The prevention of damage and the continuous monitoring of customers is at the center of customer interest and no longer the settlement of claims. In [6] this thought is summarized as "Consumers are expecting insurers to provide products, services and advice".

This article is structured as follows. In the next section we give a more detailed description of our research method. In the Sect. 3 the results of the literature review regarding digitization impact factors on information system design are discussed respectively. In Sect. 4 we provide a detailed description of the selected case including the examined sources of evidence and present insights on the case. Section 5 concludes the article and discusses the study's limitations.

2 Research Methods and Data Collection

To answer our research question, we implement a two-step research approach with well-known and applied research methods in computer science as well as information systems. Our research methodology comprises two separate phases with: First, we implemented a literature review to get insights of current research about digitization according to general literature review guidelines [7, 8]. As recommended by Kitchenham [8], we identified the need for this research already in the introductory section. Following the approach of [9] we identified primary research papers by selecting articles of leading computer science and information systems as well as management journals and leading conferences. To ensure a high quality, we only looked at research papers with a good ranking according to the CORE conference Ranking (we selected only A*, A, B publication) and the leading German management publication ranking VHB Jourqual version 3 (we selected only A*, A, B, C) [7, 10, 11]. Using this ranking for IS research is common practice (e.g. [12, 13]). Furthermore, we used key words like "digitization", "digital transformation" "information system" in research databases like AISNet, SpringerLink, Science Direct, IEEExplore, ACM Digital Library. We included research that appeared after 1999 (until mid 2016). The collected papers were than analyzed according to the relevance to the research topic (digitization) with respect to quality (e.g. trough quality assessment via e.g. external/internal validity, study design, bias) [7]. We excluded papers using other interpretations of the term digitization, e.g. the digitization of pictures. From an analysis of the literature, relevant patterns and impact factors to answer the research question are derived. Finally, we extracted the following research papers related to their digitization concept (Table 1):

To evaluate the extracted patterns, we used a single case study method according to [14]. Single case studies are often used in research (e.g. [15–17]) and generate interesting and deep insights and understandings [18]. Furthermore, single case studies are generizable and generate "empirical circumstances" [18]. Data are collected from a leading European enterprise in the insurance sector, that is selected based on a quasi-convenience approach to case selection. The enterprise has a dominant role in the German as well as European insurance business. Thus the enterprise has sufficient resources to implement even ambitious digital initiatives. On the other hand, there is an enormous amount of legacy systems and applications. To cope with these special

Table 1. Reviewed literature

Year	Authors
2015	Goes [55]
2015	Piccinini et al. [58]
2003	Boland et al. [59]
2012	Lee and Berente [31]
2015	Matt et al. [36]
2015	Babar and Yu [34]
2014	Porter and Heppelmann [29]
2015	Westerman and Bonnet [20]
2013	Grover and Kohli [35]
2014	Henningsson and Hedman [54]

challenges the pragmatic solutions introduced in [18] can be applied. The project providing the input for the case study had the objective to identify the changes on IT systems of insurance enterprises triggered by digitization. It started in April 2015 and ended December 2015. Five workshops took place with several employees from the strategy department including the chief operating officer. During the workshops presentations were given, internal documents were reviewed and key aspects were discussed as part of open-ended interviews. Hence, as recommended in [25], we collected multiple sources of evidence and thereby strengthening our internal validity. For each workshop a protocol was created serving as our field notes. We created memo-files containing our explanations and comments on the obtained insights. As the explanations and comments are linked to the overall research question, this approach allows for the establishment of a chain of evidence [25].

3 Impact of Digitization on Information Systems

Based on the literature review described above, the influence of three domains of digitization [1] on information systems shall be investigated. They are: the relationship with the customer, the design of products and the value creation model. In each of these areas, we will develop hypotheses how these domains impact information systems. We will consider four areas of impact in information systems: architecture, processes, data and services.

3.1 Customer

Deep Integration with the Customer
Digitization fosters the deep integration with the customer [19, 20]. Thus it breaks with tayloristic [21] and fordistic [22] thinking that implied the separation of producer and consumer. Today, transaction oriented models are replaced with relationship oriented ones. Digitization enables the creation of a huge number of touchpoints with the customer on three classes of devices. Interfaces are available on mobile phones, tablets,

convertibles, notebooks or desktop PCs. The interaction may take place with intelligent gadgets such as smart watches, fitness bands etc. Third, the customer may interact using sensors such as cameras, microphones etc. Thus, the deep integration with the customer and the intensive use of self-service require additional meta-model elements for process modelling leads us to the following hypothesis:

Hypothesis 1: Digitization requires the extension of standard process-meta-model to represent processes appropriately.

Self-Service
An increasing number of customers prefers to use a web-based interface instead of a human counterpart. In the beginning the research on this topic was primarily focused on examining and explaining the role of the individual customers participating in self-service based service encounters [23–25]. With regards to this research, the customers of self-service offers should be viewed as partial employees or co-developers by the service organizations [23, 26]. This is because, in a self-service context the customers perform a significant set of activities regarding the production and delivery of services by themselves. Current studies suggest that the service organizations have to ensure a high level of customer satisfaction in order to reach an acceptable rate of customer adoption and usage rate [27, 28]. According to the studies, this is a basic requirement for the service organizations to leverage the advantages of the self-service concept [24]. To realize self-service in information systems domain-knowledge has to be created from a multitude of data sources. To represent their differences in quality, reliability etc., an extension of standard data-modelling is required. This leads us to:

Hypothesis 2: Digitization requires an extension of the standard data-modelling.
Furthermore, it is necessary to appropriately model flexible decisions. Therefore, we created the following hypothesis:

Hypothesis 3: Digitization requires flexible decision mechanisms.

3.2 Products

Dynamic and Personalized Products
Dynamic products are products whose functionality is not fixed during production but extensible in the field. Digitization achieves this by integrating the physical product with hardware, software and connectivity that enable the device to connect to the internet and use services in the cloud [29–31]. Dynamic products are the basis for mass customization [32] of products. Dynamic products can be easily configured and extended according to the individual customer requirements.

Life-Time Integration of Products
Digitization enables products to stay in contact with the producer during their whole lifecycle [29]. Products in the field can easily exchange data with their producers. Data send to the producer may contain information about the functionality used or not used, the status of the device, usage frequency and duration etc. The product can also inform the customer about interruptions and terminations of its usage.

Transformation to Hybrid Products
The possibility to increase and decrease the functionality of dynamic products and the tight integration of physical products during their whole lifecycle enables their transformation to services [33]. That means, the physical product is no longer sold to the customer but offered as a service [33]. In order to transform a physical product to hybrid, its functionality is split up into a set of services. Furthermore, service lifecycle management has to enable that the set of services can be tailored to the customer's requirements and to evolve the functionality seamlessly. Information systems that shall support dynamic products have to show the same level of flexibility [34]. It is important to flexibly reconfigure digital capabilities [35]. We therefore create the hypothesis 4:

Hypothesis 4: Information systems have to support service lifecycle management and in particular the tailoring service sets.

3.3 Value Creation

In [36] value creation is identified as one of four dimensions of digital transformation. Two ways of value creation shall be investigated: network effects and bidirectional value creation.

Network and Lock-in Effects
Digitization enables the creation of platforms [37]. In former times, establishing a physical product platform required a huge effort. Only huge enterprises had the necessary engineering capacities [38]. Now, digitization facilitates the creation of new digital platform significantly. On these platforms network and lock-in effects are activated. Thus digitization transforms value chains to value networks [33]. The value-in-use of products that are part of the platform is increased by the possibility of cooperation with user users. The tight integration of process into the platform creates lock-in effects that reduce the inclination of the customer to churn.

Bidirectional Value Creation in Value Networks
Changes in value-creation have been identified as one important element of digital transformation strategies [36]. Up to digitization, value creation had been influenced strongly by tayloristic [21] ideas. That means, value creation takes place separately from the customers, in the production site. Digitization enables a bidirectional networked model of value creation. Smart, connected products [29] and social software [39] provide a permanent feedback on the usage and perception of the product by the customer. Combined with the capability to configure and extend dynamic products a close feedback loop of product improvements using the customer feedback can be established. An information system that shall be able to support bidirectional value creation, therefore we create the following hypothesis.

Hypothesis 5: Digitization fosters bidirectional value creation by network and lock-in effects on platforms.

4 Evaluation via Case Study

In this chapter the hypotheses developed in Sect. 3 shall by evaluated in a case study in the insurance business, according to the research methodology described in Sect. 2. The following table (Table 2) defines an overview of the analysis done so far.

Table 2. Digitization domains, impact areas and hypotheses

Digitization domains	Impact areas	Hypotheses
Customer product value-creation	Architecture	Hypothesis 5: Digitization fosters bidirectional value creation by net-work and lock-in effect on platforms
	Processes	Hypothesis 1: Digitization requires the extension of standard process-meta-model to represent processes appropriately
	Data	Hypothesis 2: Digitization requires an extension of the standard data-modelling
	Services	Hypothesis 3: Digitization requires flexible decision mechanisms
		Hypothesis 4: Information systems have to support service lifecycle management and in particular the tailoring service sets

4.1 Case Description and Insights

The need for information systems in the insurance business can be described by the typical value chain, consisting of product development, sales and contract management including claims processing. Digitization influences nearly the whole Insurance life cycle. By digitization high quality data are available that can be used to determine risks and to develop new products. Accumulation risks [40] can be identified and the risk of infection can be determined. E.g. by the analysis of social networks new trends, behaviors, etc. can be identified that influence the risks. By using data from the Internet of Things [41] and of social software [39] cross- and upselling opportunities can be identified. In addition, complaints can be evaluated by customers on social platforms. The digitization can develop a range of useful services in the area of claims settlement. Thus, the occurrence of the damage can be detected by cross-linked products in many areas. Examples are cars that possess a crash detection or home automation systems detect the fire or water damage. This may already be able to help the loss amount to reduce by as soon as possible emergency measures are initiated. Simultaneously, the later claims can be prepared by an intensive data collection. The data collected can also be used to detect possible fraud. In claims management, the data can be used to accelerate the process of claims settling as much as possible. In addition, it is also possible any spurious damage seen by more accurate detection of the accident is used.

4.2 Results

Hypothesis 1: Digitization requires the extension of standard process-meta-model to represent processes appropriately

To capture systematically the influence of digitization on process design, perspectives [42] shall be used to categorize the points of impact digitization has on process design. Perspectives are disjoint sets of meta-model elements representing orthogonal domains of the business process. At the beginning [42], four perspectives had been identified, the functional, organizational, informational and behavioral perspective. Perspectives have been used to systematically describe flexibility [43].

Functional Perspective

The functional perspective describes how the overall goal of the process shall be achieved by decomposing it into tasks and subtasks. The functional perspective mirrors the operational perspective. While the functional perspective specifies what is to do, the operational perspective describes how it is be done. New functional elements are necessary to support the bidirectional creation of value in digitization enabled by a multitude of touchpoints [44]. Older process modelling approaches such as ARIS [45] did not provide explicit points of communication with the environment of processes. Later approaches such as BPMN [46] introduced modelling elements to represent the communication with the outside world. These elements have to be refined to represent the diversity of communication points created by digitization. The customer does interact with processes not only by sending explicit messages as conceptualized in BPMN but also be interactions with digitized products. An example is the Amazon Dash Button [47]. Pressing it initiates the delivery of the specified product.

Operational Perspective

The operational perspective describes the operations to fulfill the tasks specified in the functional perspective. From the operational perspective, digitized processes differ by replacing human operations with automated operations. Automation covers two main areas, decision making and customer interaction. Decisions making in digitized processes is based on Big Data [2] and Advanced Analytics [48]. It supplements descriptive analytics with predictive and prescriptive analytics [30]. Domain knowledge is embedded into software and replaces human decision making. To achieve this progress in analytical capabilities it is necessary to appropriately represent the data sources, the decision rules and their foundation as in Decision Modeling Notation Standard [49]. Here, the rule tasks of BPMN are augmented by a detailed modelling of decisions. Self-service is the automation of the customer interaction. Digital means to enable the customer to interact directly with a business process. Thus there are no intermediating employees.

Behavioral Perspective

The behavioral perspective [42] represents existence relationships between tasks. There are synchronous and asynchronous relationships. The synchronous relationship may be either temporal or rule-based. Temporal relationships express the sequence and simultaneity of tasks. Rule-base relationships select one or several other tasks to be

executed after the completion of a task. Digitization requires more asynchronous relationships. They are dependent on the existence of an event or the fulfillment of a condition. Such events may stem from smart, connected things, social media etc.

Informational Perspective

The informational perspective [42] defines the data in the process that is imported, created, exchanged, transferred and changed. Before digitization nearly all data was either structured [50] or handled as an opaque binary large object. Digitization introduced further kinds of data such as semi- and unstructured data. Semi-structured data [50] is data that has an implicit structure. Its schema information is not explicitly available but can be recovered by analysis. An important example are log files [51]. Unstructured data [50] has no recoverable schema. Extensions to several perspectives of process models are necessary. Therefore, hypothesis 1 can be confirmed.

Hypothesis 2: Digitization requires an extension of the standard data-modelling

Schema information is the most widely used type of meta-data in enterprises and organizations. In digitized enterprises, the use of data increases evidently. New types of data such as semi- and unstructured data are part of processes. The automation of tasks and decision is based on data. Much more than in the past, data originates from external sources. Not only the schema-information but also further meta-data has to be defined. Thus hypothesis 2 can be confirmed. These additional meta data cover security, quality and reliability. Data is used to create decisions either directly or indirectly. Data is directly used as variable in decision models. Indirectly data is used to capture domain knowledge. By forging data a malicious attacker could be able to influence decisions of the enterprise according to his interest. External data may contain errors of course. Therefore, it is necessary to know about the reliability of external data sources. Finally, external data sources differ in their technical reliability. There are reliable and less reliable ones, showing disruptions in the data provisioning.

Hypothesis 3: Digitization requires flexible decision mechanisms

In many processes, decision logic is embedded directly into the business process models or applications [52]. However, this method is unfavorable because process and decision logic evolve at different speeds. Therefore, the decision logic should be modelled separated in the form of decision models [52]. In this way, decisions can be managed and dealt with separately. In particular, the re-use of decision models in different contexts is possible. A further reason to separate decision logic and processes are their different characteristics [52]. Decisions are declarative, hierarchical and stateless. Processes, on the other hand, are imperative, sequential and stateful. The progress of process instances is represented by the positioning of tokens in the process graph. Due to the different evolution speeds business processes and decision-making a separate modeling of the two domains is advisable. Defining decision models separate the base for decision making processes and the data to be used. Decision models are implemented as decision services that use as decisions foundations, procedures, and data encapsulated as a service. Since these services can also be external, ensuring a reputation model that safety and quality requirements are met and are the provided meta-services.

Otherwise, a new attack vector would be opened for fraudulent activities. An attacker could influence by manipulating the output data, procedures or bases the decisions of the attacked company in his favor. These considerations confirm hypothesis 3.

Hypothesis 4: Information systems have to support service lifecycle management and in particular the tailoring service sets

The transformation of physical products to services implies that these services can be appropriately adapted to the customer's requirements. They should allow him to enlarge or decrease the set of services booked (and billed). Therefore, hypothesis 4 can be confirmed. To avoid any misunderstandings, both service provider and service user should have a common definition to which extent the set of services can be changed and how much services can be tailored to individual needs. To do so, operations on the services provided have to be offered to the customer. To the customer it is important to not only know about the kind of changes but also about their quality. That means they want to know how fast these changes can be accomplished, when are these changes available and how reliable are the changes executed. Such a combination of functionality provided together with a description of its quality is nothing else than a service. Because these services act upon other services, they shall be called meta-services [53].

Hypothesis 5: Digitization fosters bidirectional value creation by net-work and lock-in effect on platforms

An architecture supporting bidirectional value creation is illustrated in the following figure (Fig. 1). Thus hypothesis 5 can be confirmed. The architecture has an integration layer to open up and consolidate data in particular from the Internet of Things, Social Media and Open Data. The integrated information will be used in two ways. In order to implement the co-creation oriented value creation model, it is necessary to constantly interact with the customers. Therefore, in the IT architecture an event processing mechanism is provided which detects relevant events in the incoming data. These events may be, to externally triggered events such as loss events, or other, also by the customers themselves, triggered events. In addition, a new decision function is necessary, which is able to process semi- and unstructured data from external sources. Furthermore, this architecture should be a continuous process. Both events and analysis results are then included in the process support, which controls the interaction with the customer. Since there may be incidents that are relevant to analysis, there is a connection from process support to the event detection and analysis.

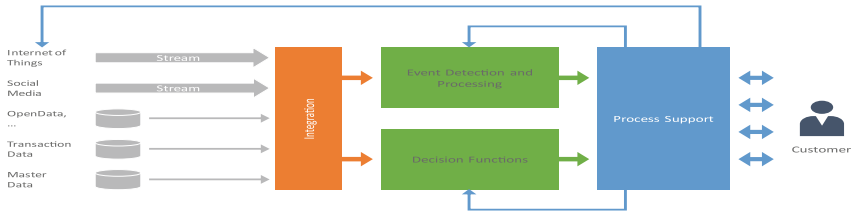

Fig. 1. Generic information system architecture for digitized insurances

5 Conclusions and Limitations

As the research at hand is based on only one case selected not on a random, but subjective basis, we are not able to make general assumptions about its representativeness. Nevertheless, we provide detailed descriptions and insights on the case, allowing the reader to transfer the study's results to its own similar and contextual settings of interest. We showed, that digitization has impact on several areas of information system design. The modelling of processes and data has to be extended. Service definitions have to be supplemented by meta-service in order to define their lifecycle. Decisions have to be separated from processes in order to achieve flexibility. In all, a stream- and event-oriented architecture is necessary in order to support bidirectional value creation.

Research can benefit in different ways from our research. First, we extent the current IS literature by exploring new effects of digitization of information systems via a literature review and case study. Second, industry specific insights in the use and adoption of information through digitization in the financial industry is presented. Furthermore, our research can help to get a better understanding of further impacts of digitation in practice. There are also practical implications. Managers can use the results to evaluate their current state of digitization and can further develop their enterprise architecture. Decisions related to digitization in the financial industry can be supported by our work.

Limitations of our work can be found in the used research methods as well as samples. We looked at a sample of the literature according to the literature method. Furthermore, we validate our findings in one case study. Furthermore, the case study was implemented in the financial industry in a European country. Therefore, future research should evaluate our findings via different case studies in different industry sectors as well as countries. There should be great opportunities for future research according to the different adoption of digitization via information systems in different countries (e.g. EU vs. South Africa).

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