DIGITAL TRANSFORMATION IN INFORMATION SYSTEMS RESEARCH: A TAXONOMY-BASED APPROACH TO STRUCTURE THE FIELD

Research Paper

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Abstract

Digital transformation becomes increasingly important to business research and practice. Transforming businesses poses various opportunities (e.g., creating novel business models) but, in contrast, constitutes numerous of challenges (e.g., changing processes and organizational structures). As Information Systems (IS) can support such transformation, it is assumed that it has great potential in digitalization too. Thus, there is a rising amount of digital transformation-literature in IS. However, because of the popularity as well as heterogeneous fields of application and types of research, a consolidated overview of digital transformation is necessary. Accordingly, this study derives a taxonomy of digital transformation to structure the field. Based on (1) a literature review and (2) a taxonomy-development approach, we developed a taxonomy that consists of research-relevant aspects (e.g., most studies use qualitative approaches; limited studies use design science research) as well as topic-related aspects (e.g., manufacturing and public sectors, enterprise architecture, knowledge and technology are focused). Additionally, through (3) a cluster analysis, four areas could be identified: business strategies/models, working culture, technology, and skills/knowledge. Overall, by providing such a taxonomy we aim to contribute to a better characterization of digital transformation in IS research.

Keywords: Digital Transformation, Taxonomy, Cluster Analysis, Literature Review.

1 Introduction

"*It is not the strongest of the species that survives, nor the most intelligent that survives. It is the one that is the most adaptable to change.*" (Charles Darwin, English Naturalist/Geologist)

The rapid digitalization across various fields is of great relevance and poses tremendous opportunities for both companies and society, for example by offering novel business models or enabling new forms of collaboration (e.g., Dellermann et al., 2017; Maedche et al., 2017). In order to make use of these benefits, as Charles Darwin already stated, businesses and people need to be able to change themselves. This change primary deals with the increasing use of information technologies and data available, which constitutes crucial challenges in different aspects of an organization. Because digital transformation focuses on the key of business operations, it incorporates changes in products, processes, organizational structures and management concepts (Matt et al., 2015), and thus, is virtually a holistic concept of a firm. Therefore, on a strategical level, four main dimensions should be considered, namely: use of technology (e.g., ability to adopt new technological standards), changes in value creation (e.g., business model), structural changes (e.g., skills, organizational setup and products) and finance (e.g., as a driver or bounding force) (Matt et al., 2015). Accordingly, there is a need for being trans-

formable on various levels, which is further emphasized by many researchers and practitioners, for example: "at least 40% of all businesses will die in the next 10 years (…) if they do not figure out how to change their entire company to accommodate new technologies" (John Chambers, Cisco Systems).

One important contributor to tackle these challenges and support the transformation is given by Information Systems (IS) research (e.g., Agarwal and Lucas, 2005; Gerster, 2017). Hence, digital transformation receives more attention in IS research since several years. While the keyword "digital transformation" has in the years 2000 to 2011 only less than 8 results, it has in 2015 43, in 2016 102 and in 2017 already 132 results (AISeL, accessed on 20th November 2017), which is an increase of about 16 times over the last few years. However, although digital transformation is of growing interest, it is still an emerging field and "the term [digital transformation] lacks a clear definition" (Haffke et al., 2016, p. 2). Moreover, prior studies have tended to address heterogeneous and mostly isolated aspects or fields such as mobility (e.g., Remane et al., 2016a), public sector (e.g., da Silva et al., 2016) or manufacturing (e.g., Hildebrandt et al., 2015) for which reason, to the best of our knowledge, no consolidated overview exists that structures the field of digital transformation. Hence, we currently lack of a consolidated classification (Nwankpa and Roumani, 2016) and a "rigorous theoretical frame" (Henriette et al., 2015, p. 10). In order to promote this evolving field, we aim to develop a taxonomy that structures the field of digital transformation including research aspects (e.g., research methods) and topics (e.g., fields of investigation) as well as their relationships. Accordingly, this study aims to answer the following two research questions:

- *What kind of IS research is conducted in digital transformation?*
- *What topics of interest are addressed from IS research in digital transformation?*

Our contribution is a taxonomy of research characteristics and topics of digital transformation in IS research. A taxonomy facilitates the characterization and analysis of a certain domain as well as orders the complexity and provides a foundation for IS research, potentially leading to future research directions (Nickerson et al., 2013). From a research perspective, our taxonomy can be used, for instance, to position own research and identify gaps which need to be addressed by future endeavour as well as to be oriented on how to conduct research (e.g., informed selection of research approaches). Further, according to Gregor´s (2006) 'theory for analysing' it can serve as the foundation for advanced theories, for example to explain how certain technologies influence the performance in businesses. For practice, our findings provide guidance in which fields research is already available and may serve as a starting point to transfer existing knowledge into practical settings. For developing the taxonomy, we in a first step briefly outline the background of transformation and digitalization (Section 2). Following our research design (Section 3), we conducted an extensive literature review to gather suitable publications, applied a taxonomy-development approach to classify the literature based on specified characteristics and carried out a cluster analysis to explore relationships between these characteristics (Section 4). Afterwards, we discuss the results and our implications (Section 5), outline limitations (Section 6) and conclude with our main findings (Section 7).

2 Background

In this section, to specify terms related to digital transformation that are used in our study, we introduce the concepts of business transformation and digitalization as well as the combination of both.

Business transformation. The need for elementary change has always been a significant issue of society and economy (Jensen, 2000; Collins, 2001). For example, for a long period, before the early 1800s, forms of transportation such as horses had not changed but within roughly 100 years, innovations (e.g., automobiles and aircrafts) revolutionary altered the entire industry. Within these innovations, new companies were formed and most of them who were able to adopt new situations, have been successfully until now (Rouse, 1996). In general, such business transformations are about fundamental change (Rouse, 2005) to perform current work in a different manner or perform different work due to deficiencies experienced (Safrudin and Recker, 2013). It can be defined as "orchestrated redesign of the genetic architecture of the cooperation" (Morgan and Page, 2008, p. 161). However,

carrying out changes in businesses implies high risk and results in significant failure rates (Safrudin and Recker, 2013). In addition, such transformation projects involve various stakeholders, affect multiple layers of a firm and require capital (Röglinger et al., 2016) as well as presume skills such as 'dynamic capabilities' which deal with integrating, building and reconfiguring organizational resources to address changing environments (Teece et al., 1997). Thus, it addresses four dimensions: reframing (e.g., corporate vision), restricting (e.g., high performance), revitalization (link corporate body with its environment) and renewal (e.g., employees) (Bhattacharya and Seddon, 2009).

Deficiencies—here seen as trigger for starting transformation—in organisations mostly base on the rapidly shifting environments (Someh et al., 2016), for example, the evolvement of innovations such as from IT technology or the need to act more responsible which is addressed by Sustainable Development (e.g., Ahmed and Sundaram, 2011). In this study, we particularly focus on innovation from digital technology because it concerns almost all industries (e.g., Downes and Nunes, 2013) from both views customers and businesses—even on physical value proposition-oriented firms.

Digitalization. Digital technologies can be described as the combination of information, computing, communication and connectivity technologies (Bharadwaj et al., 2013) that enables the development of new products, business models, services and organizational forms (Fichman et al., 2014; Yoo et al., 2012). Accordingly, digital technologies enhance innovation, disruption and competition of a company's environment (Downes and Nunes, 2013; Porter and Heppelmann, 2014). As Rouse (2005) already points out, technological changes are closely related to transformation, and in IS research, organizational changes resulting from IT are already highlighted many years ago (Scott Morton, 1991).

Digital transformation. However, although we currently lack of a well-accepted definition only limited studies aim to structure and specify the concept of *digital transformation*. Conducting a systematic literature review[1], we found only two articles that provide a first structure of the concept. Henriette et al. (2015) conducted a literature review and focused on selected aspects of digital transformation, however, did not include a holistic view on the field. Gerster (2017) analysed to which extent digital transformation on IT is already covered by leading IS journals, performing a bibliometric study. Nonetheless, it is limited up to the transformational impact of information technology and provided statistical results concerning bibliographical information. Following, to the best of our knowledge there is no research providing a holistic structure for the field of digital transformation, and there still seems to be a need for a widely accepted overview. Accordingly, in this study we aim to consolidate existing research in order to provide a proper basis for further research in the field of digital transformation.

3 Research Design

In order to develop a taxonomy of digital transformation, and therefore address our research questions, we conducted a three-stage research design that consists of (Stage 1) an extensive literature review and (Stage 2) a taxonomy-development method to classify the articles obtained. Based on the derived taxonomy, we carried out (Stage 3) a cluster analysis to identify relationships (Figure 1).

Stage 1: Literature review. As a first step, we searched for relevant literature based on the rigorous procedure from vom Brocke et al. (2009). We proceeded in three steps: First, in June and July 2017, we considered articles published in proceedings of renowned IS-conferences (Webster and Watson, 2002, p. xvi) that are provided by the Association for Information Systems (AIS). Due to the topicality and the faster way of publishing current findings, we focused on proceedings in particular. Second, as we wanted to catch the characteristics of digital transformation in a broad manner, we decided to use the keyword "digital transformation" for search. As a result, we found a total of 150 articles. Third, because various studies use the term but did not focus on the topic itself, we excluded articles that did not contain "digital transformation" in the title, abstract or keywords. Finally, we obtained 36 articles.

[1] We searched for existing research that classifies digital transformation. We used "Digital Transformation" AND (Classification OR Taxonomy) as search phrase in AISEL and Google Scholar (accessed on July 2017; updated on 2017-11-20).

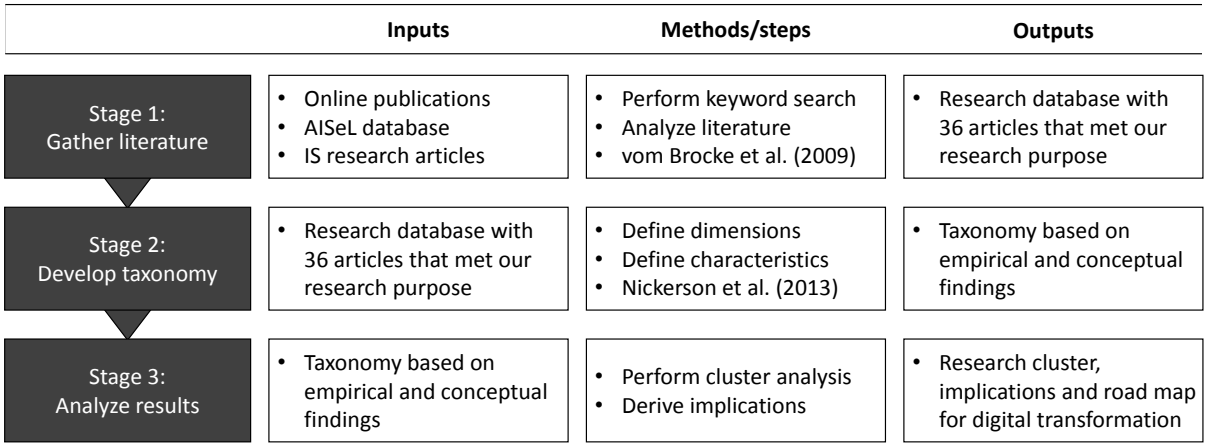

Figure 1. Research design.

Stage 2: Taxonomy development. The development of taxonomies has been often used to structure and analyse fields in IS (e.g., Hanelt et al., 2015; Haas et al., 2014; Schoormann et al., 2017). Moreover, taxonomies can be seen as a step towards developing analytic theories (Gregor, 2006; Williams et al., 2008). In our study, we build a taxonomy in line with the rigorous procedure of Nickerson et al. (2013). To do so, we defined the *meta-characteristics a*s the components of digital transformation distinguishing between research characteristics and research topics. Next, we adopted the *objective and subjective ending conditions* proposed by Nickerson et al. (2013, p. 344).

Following Nickerson et al. (2013) the taxonomy development process is an iterative one within we may choose between an *empirical-to-conceptual* and *conceptual-to-empirical approach*. In total, we run through four different iterations of which the first two deal with research characteristics and the last two with addressed topics and fields of application. As a *1st iteration (conceptual-to-empirical)*, to determine relevant dimensions, we used the framework for research defined by Creswell (2014) in combination with recognised attempts classifying research characteristics in IS research (Wilde and Hess, 2007; Recker, 2013). We triangulated the determination of dimensions to consider both IS research and social sciences as a basis for classification of research characteristics. Following, we introduced the dimensions research approach, research design, research method and philosophical worldview. Next, in the *2nd iteration (empirical-to-conceptual)*, the articles from the literature review (Stage 1) were investigated and classified by two researchers independently to contribute to the robustness. After consolidating the results in a following workshop, we assigned the research characteristics of each article gathered to the dimensions specified.

As a starting point for the fields addressed in digital transformation, in the *3rd iteration (conceptual-to-empirical)*, we particularly draw on Henriette et al. (2015) who specified four main aspects from digital transformation, namely: digital capabilities, business models, operational processes and user experience. Based on these conceptual findings, *the 4th iteration (empirical-to-conceptual)* focuses on analysis of the obtained literature (Stage 1) to (i) assign topics to the existing dimensions as well as (ii) extend the dimensions empirically. Therefore, again, two researchers carried out the analysis independently and identified research topics mentioned in the articles. Afterwards, we categorized the resulting characteristics and built the following taxonomy dimensions: field of investigation, strategic alignment, people, culture, information technology and models. In contrast with Nickerson et al., the characteristics of each dimension are not mutually exclusive.

Stage 3: Analyse results. Finally, to discover relationships of the identified characteristics we performed a cluster analysis by applying the K-means algorithm that is one of the most common methods for such a clustering (Elkan, 2003). This type of analysis is highly useful for taxonomies and often used in IS research for investigating correlations in differently-sized samples from 15 to 9025 items (Balijepally et al., 2011). First, we considered both research characteristics and research topics as taxonomy. However, the resulting clusters were insufficient because of the huge amount of characteristics. As we mainly wanted to structure the field of digital transformation and the majority of research

considered qualitative and mixed-method approaches, we decided to focus on the research topics for clustering in particular. Having clustered the topics, we are able go backward and look for the research characteristics used in the identified clusters. Following Punj and Steward (1983) and Remane et al. (2016b), we applied a two-step approach to explore clusters of digital transformation from our taxonomy by using the python module *scikit-learn* that provides a wide range of machine learning algorithms, both supervised and unsupervised (Pedregosa et al., 2011).

1. Step (Ward's method). The ward's method is a procedure to form hierarchical clusters of subsets on the foundation of their similarity. The method starts by combining two closest subsets into one cluster and repeats this procedure until all subsets are in one cluster (Ward, 1963). The number of identical characteristics along the taxonomy determined the similarity between two subsets (Remane et al., 2016b). We plotted a dendrogram to follow the sequence in which the subsets have been united in relation to the distances. Regarding the significant jumps in the distance of the joint clusters, we identified two or four clusters as useful numbers. To highlight more different cluster, we chose four clusters.

2. Step (K-means method). Second, we applied K-means method that aims to divide data into clusters, minimizing the within-cluster sum of squares (Hartigan and Wong, 1979). We selected initial cluster centres using 'k-means++' and the algorithm iterated 300 times. Within each iteration, the algorithm run with ten different centroid seeds to get the best results.

4 Characteristics of Digital Transformation

In this section, we present our main contribution, a taxonomy of digital transformation. For reasons of presentation, we distinguish between research characteristics (Section 4.1) and topics (Section 4.2).

4.1 Research characteristics

Within research endeavour, several decisions have to be made along the research process. The following dimensions (mainly based on Creswell, 2014) and characteristics (mainly based on the coded literature) summarize methodological aspects used in digital transformation.

Research approach. The broad plan or proposal to conduct research is called research approach. It contains all steps from assumption building to selected methods of data collection, analysis and interpretation (Creswell, 2014, p. 31 ff.). Within this dimension, we distinguish between *quantitative*, *qualitative* and *mixed methods* (Creswell, 2014; Wilde and Hess, 2007). Further, we add *Design Science Research* (DSR) as a research approach that has to be differentiated from mixed-methods (e.g., Recker, 2013). Within every step of DSR (Peffers et al., 2007) different research designs and research methods are available (Hevner and Chatterjee, 2010; Vaishnavi and Kuechler, 2008).

Research design. A researcher has to decide between types of study within a research approach. Reviewing the selected literature of digital transformation, we identified several strategies: *experimental design*, *survey design*, *grounded theory*, *case study*, *literature research* and *longitudinal study*.

Research method. In order to collect, analyse and interpret data, researchers may choose different research methods (Creswell, 2014, p. 45). We determined the following characteristics: *literature review*, *interview*, *questionnaire*, *observation*, *Delphi study*, *statistical analysis* and *content analysis*.

Philosophical worldview. The philosophical idea behind a research project is expressed by the philosophical worldview. A *postpositivist worldview* contains deductive proceedings starting with selected theories. Whereas a *constructivist worldview* aims at generating or inductively developing a theory or pattern of meaning (Creswell, 2014).

As indicated in Figure 2, we can state that the majority of articles used *qualitative* research approaches (21/36). Twelve articles focused on *mixed methods*, only three on *quantitative* approaches and two on *DSR*. The two most common used designs are *grounded theory* (11/36) and *case study* (11/36), even sometimes together (e.g., Horlacher et al., 2016; Haffke et al., 2017; Serrano and Boudreau, 2014). Only two of them used an *experimental* design identifying a sample to generalize to a population (Goes, 2015; Le Dinh et al., 2016). A *longitudinal* study in form of a panel study (Hildebrandt et al.,

2015), trend study (Remane et al., 2016a) or analysis over time (Serrano and Boudreau, 2014; Mihailescu et al., 2015) are used by only five articles. Most of the articles did a *literature review* (27/36) and *content analysis* (28/36). Further, conducting *interviews* was popular (20/36). Whereas *observing* objects or performing a *Delphi study* are rarely used (both 2/36). The majority of the reviewed literature (28/36) realized a "lack of prior knowledge and theory" (Piccini et al., 2015, p. 2). Following, as *constructivist*, they wanted to "create more robust theory" (Horlacher et al., 2016, p. 3). However, there are also eight articles that drew from existing theory (*postpositivist*), for example, resource-based view theory (Nwankpa and Roumani, 2016; Tan et al., 2017) or collaboration virtualization theory (Wilms et al., 2017).

	Research approach				**Research design**						**Research method**							**Phil. view**	
Articles	quantitative	qualitative	mixed methods	DSR	experimental	survey	grounded theory	case study	literature research	longitudinal study	literature review	interview	questionnaire	observation	Delphi study	statistical analysis	content analysis	postpositivist	constructivist
Alexander and Lyytinen 2017	-	●	-	-	-	-	●	-	-	-	-	●	-	-	-	-	●	-	●
Andersen and Ross 2016	-	●	-	-	-	-	-	●	-	-	○	●	-	-	-	-	○	-	○
da Silva et al. 2016	-	-	●	-	-	-	-	●	-	-	●	●	-	●	-	●	●	-	●
da Silva et al. 2017	-	●	-	-	-	-	-	●	-	-	●	●	-	-	-	-	●	-	●
Frank 2017	-	●	-	-	-	-	-	-	●	-	-	-	-	-	-	-	●	●	-
Goes 2015	●	-	-	-	○	-	-	-	-	-	-	-	-	-	-	●	-	-	○
Haffke et al. 2016	-	-	●	-	-	-	○	-	-	-	○	●	●	-	-	-	●	-	○
Haffke et al. 2017	-	-	●	-	-	-	○	○	-	-	○	●	●	-	-	-	●	-	○
Hartl and Hess 2017	-	-	●	-	-	●	-	-	-	-	-	-	●	-	●	●	-	-	○
Heilig et al. 2017	-	●	-	-	-	-	-	-	●	-	●	-	-	-	-	-	●	-	○
Hildebrandt et al. 2015	-	-	●	-	-	-	-	-	-	●	○	-	-	-	-	●	●	-	○
Horlach et al. 2017	-	●	-	-	-	-	○	○	-	-	-	●	-	-	-	-	●	-	●
Horlacher et al. 2016	-	●	-	-	-	-	○	●	-	-	●	●	-	-	-	-	●	-	●
Klötzer and Pflaum 2017	-	●	-	-	-	-	●	-	-	-	-	●	-	-	-	-	●	-	○
Krüp et al. 2014	●	-	-	-	-	●	-	-	-	-	-	-	●	-	-	●	-	●	-
Le Dinh et al. 2016	-	-	●	●	○	-	-	-	-	-	○	-	-	-	-	●	○	●	-
Leyh et al. 2017	-	●	-	-	-	●	-	-	-	-	●	●	●	-	-	-	●	-	●
Liebe et al. 2017	-	-	●	-	-	●	-	-	-	-	●	-	●	-	-	●	-	-	●
Milhailescu et al. 2015	-	●	-	-	-	-	-	●	-	●	○	●	-	●	-	-	-	●	-
Nwankpa and Roumani 2016	-	-	●	-	-	●	-	-	-	-	●	●	●	-	-	●	-	●	-
Oesterle et al. 2016	-	●	-	-	-	-	-	-	●	-	●	-	-	-	-	-	●	-	●
Omar and Elhaddadeh 2016	-	●	-	-	-	-	-	-	●	○	●	-	-	-	-	-	●	●	-
Petrikina et al. 2017	-	●	-	●	-	-	○	-	-	-	●	●	-	-	-	-	●	-	●
Pflaum et al. 2017	-	-	●	-	-	-	●	-	-	-	○	●	-	-	-	●	●	-	●
Piccinini et al. 2015	-	-	●	-	-	●	-	-	-	-	-	-	●	-	●	●	-	-	●
Prifti et al. 2017	-	●	-	-	-	-	○	-	●	-	●	●	-	-	-	-	●	-	●
Remane et al. 2016a	-	-	●	-	-	-	-	-	-	●	○	-	-	-	-	●	●	-	○
Roecker et al. 2017	-	●	-	-	-	-	○	-	-	-	●	●	-	-	-	-	●	-	●
Schmid et al. 2017	-	●	-	-	-	-	-	-	●	-	●	-	-	-	-	-	●	-	●
Schmidt et al. 2016	●	-	-	-	-	●	-	-	-	-	-	-	●	-	-	●	-	-	○
Schmidt et al. 2017	-	-	●	-	-	●	-	-	-	-	●	-	●	-	-	●	●	-	○
Serrano and Boudreau 2014	-	●	-	-	-	-	○	●	-	●	○	●	-	-	-	-	●	-	●
Sesay et al. 2017	-	●	-	-	-	-	-	●	-	-	○	●	-	-	-	-	●	-	●
Tan et al. 2017	-	●	-	-	-	-	-	●	-	-	○	●	-	-	-	-	●	●	-
Weissenfeld et al. 2017	-	●	-	-	-	-	-	-	●	-	●	-	-	-	-	-	●	-	○
Wilms et al. 2017	-	●	-	-	-	-	-	●	-	-	●	●	-	-	-	-	●	●	-
# 36	3	21	12	2	2	8	11	11	7	5	27	20	10	2	2	13	28	8	28

Caption : not mentioned (-), directly mentioned (●), indirectly mentioned (○)

Figure 2. Taxonomy of digital transformation—research characteristics.

4.2 Research topics

As mentioned in the Introduction, in digital transformation research, several topics are addressed. These research topics are empirical derived from the literature gathered, classified in six dimensions and presented in the following section (Figure 3). Rarely addressed characteristics within a dimension are assigned to *other*. If an article does not address a special dimension, it is assigned to *none*.

Field of investigation. Each article focused on a certain field of application, which can be concrete or more abstract. First, *manufacturing industry* in which Nwankpa and Roumani (2016) collected data from CIOs in manufacturing industries or Pflaum et al. (2017) investigated the manufacturing industry's supply chain. Addressing *creative industries*, Roecker et al. (2017) focused on the challenges and practices from the creative industries, developing digitized products. Serrano and Boudreau (2014) considered a group of library professionals and Weissenfeld et al. (2017) investigated digital storytelling in social media. Further, *finance and insurance*, *retail*, *consulting* and the *public sector* are of interest—for example: higher education (Hartl and Hess, 2017; Wilms et al., 2017), healthcare (Haffke et al., 2016; Mihailescu et al., 2015) or the police (Sesay et al., 2017). Next, we combined automotive and shipping areas into *mobility* and, because of special interests, we specified *industry 4.0* as a field. Some articles dealt with various industries (Haffke et al., 2017) or varying sizes (Alexander and Lyytinen, 2017). The remaining articles addressed seldom considered fields such as sports (Tan et al., 2017) or startups (Remane et al., 2016a), which are both assigned to the characteristic *other*.

Strategic alignment. This dimension deals with the strategy of an organization, linking organizational structures, resources and processes into line with the business strategy. Here, for example, the effects of digital transformation on business *performance* (e.g., Nwankpa and Roumani, 2016; da Silva et al., 2016) are explored. As a key aspect, digital strategies (e.g., Haffke et al., 2016; Hildebrandt et al., 2015; Andersen and Ross, 2016) and novel business models (e.g., Piccinini et al., 2015; Hildebrandt et al., 2015; Remane et al. 2016a) are addressed, *strategy*. Further, the creation and alignment of a business *process* and an *enterprise architecture* contribute to the strategic alignment of an enterprise.

People. People are individuals with skills and knowledge that are essential in transforming businesses. Thus, the role of *CIO/CDO* within enterprises, the needs of *customers*, *partners* and *other actors* are topics of research. The collaboration and communication among human actors (Wilms et al., 2017; Klötzer and Pflaum, 2017; Schmidt et al., 2017) and socio-technical challenges in organizational work (Schmid et al., 2017; Sesay et al., 2017) are examples for *internal collaborations*. The collaborative efforts with external partners (Piccinini et al., 2017; Tan et al., 2017), competitors (Haffke et al., 2016; Tan et al., 2017) or the customer integration (Petrikina et al., 2017; Tan et al., 2017; Schmidt et al., 2017) are *external collaborations*. Due to the fact that knowledge and skills have to be adopted, Knowledge Management Systems (Le Dinh et al., 2016) or assessing and building capabilities, required for digital transformation (e.g., Nwankpa and Roumani, 2016; da Silva et al., 2016; Horlach et al., 2017) are exemplary topics for *knowledge*.

Culture. The culture of an enterprise includes collective values and beliefs that are another important factor to overcome the transformation of businesses. Accordingly, in regarding *culture + values*, some articles investigated value creation concerning digital transformation (e.g., Oesterle et al., 2016; Hartl and Hess, 2017) or focused on culture challenges (e.g., Roecker et al., 2017; Liebe et al., 2017).

Information Technology. Information technology includes hardware, software and communications technology. The digitalization, of course, is highly influenced by IT-based innovations that are introduced in businesses. Therefore, opportunities and challenges of *big data* and different aspects of the *IT sector* such as the role of bimodal IT (Haffke et al., 2017; Horlach et al., 2017) or the changing tasks of IT departments (Krüp et al., 2014) are focused. As an important part, *security* concerns resulting from digital transformation (e.g., Leyh et al., 2017) are researched. Furthermore, articles dealt with digital *innovation*, sometimes concerning with digital product innovation (Piccinini et al., 2015) and digitized products (Roecker et al., 2017; Andersen and Ross, 2016). The Internet of Things (Petrikina et al., 2017; Prifti et al., 2017), digital platforms (Wilms et al., 2017) or innovative infrastructures (Goes, 2015) are examples for such innovations. In addition, digital business models (Piccinini et al., 2015; Hildebrandt et al., 2015) and business process innovations (Heilig et al., 2017) are topics of interest in research.

Models. Models are abstractions of real world situations, reducing the complexity of a domain by a comprised representation of a problem and solution space (Hevner et al., 2004). Within research related to digital transformation certain models such as *maturity models* or *research models* are provided. Drawing on theoretical background, some articles explained relationships between objects of interest,

derived specific hypothesis and tried to validate them by collecting empirical data (e.g., Nwankpa and Roumani, 2016; da Silva et al., 2017). Moreover, *other* models like a business model canvas (Schmidt et al., 2017), process model (Serrano and Boudreau, 2014) or competency model (Prifti et al., 2017) are developed.

	Field of investigation									**Strategic alignment**					**People**								**Cul-ture**		**Information Technology**					**Models**			
Articles	manufacturing	creative industries	finance, insurance	retail	consulting	public sector	mobility	industry 4.0	other	performance	strategy	process	enterprise architecture	none	CIO/CDO	customer, end-user	partner	other actors	internal collaboration	external collaboration	knowledge	none	culture + values	none	big data	IT sector	security	innovation	none	maturity model	research model	other	none
Alexander and Lyytinen 2017	-	-	-	-	-	-	-	-	●	-	-	-	-	●	-	-	-	-	-	-	●	-	-	●	●	-	-	-	-	-	-	●
Andersen and Ross 2016	●	-	-	-	-	-	-	-	-	-	●	●	●	-	-	●	-	●	●	●	●	-	●	-	-	●	-	●	-	-	-	-	●
da Silva et al. 2016	-	-	●	●	-	●	-	-	●	●	●	-	-	-	-	-	-	-	-	-	●	-	-	●	-	-	-	○	-	-	●	-	-
da Silva et al. 2017	-	-	●	●	●	●	-	-	●	●	●	-	-	-	-	-	-	●	-	-	●	-	-	●	-	-	-	○	-	-	●	-	-
Frank 2017	-	-	-	-	-	-	-	-	●	-	-	-	-	-	-	-	-	-	-	-	-	●	-	●	-	-	-	-	●	-	-	-	●
Goes 2015	-	-	-	-	-	●	-	-	-	-	-	-	-	●	-	-	-	●	●	-	-	-	-	●	-	●	●	-	-	-	-	●
Haffke et al. 2016	●	-	●	●	-	●	●	-	●	-	●	-	-	-	●	-	-	●	-	●	-	-	○	-	-	-	-	●	-	-	-	-	●
Haffke et al. 2017	-	-	-	-	-	-	-	-	●	-	●	-	-	-	●	-	-	-	●	-	●	-	○	-	-	●	-	●	-	-	-	-	●
Hartl and Hess 2017	●	-	●	-	●	●	-	-	●	-	-	-	-	●	-	-	-	●	-	-	-	-	●	-	-	-	-	●	-	-	-	-	●
Heilig et al. 2017	●	-	-	-	-	-	●	-	-	-	●	●	-	-	-	-	●	-	●	●	●	-	○	-	-	-	●	●	-	-	-	-	●
Hildebrandt et al. 2015	●	-	-	-	-	-	●	-	●	●	●	-	-	-	-	-	-	-	-	●	●	-	-	●	-	-	-	●	-	-	●	-	-
Horlach et al. 2017	-	-	-	-	-	-	-	-	●	●	●	-	-	-	●	●	-	-	●	●	●	-	-	●	-	●	-	●	-	-	-	-	●
Horlacher et al. 2016	-	-	●	●	●	-	-	-	-	-	-	-	●	-	●	-	-	-	●	-	-	-	-	●	-	-	-	●	-	-	-	-	●
Klötzer and Pflaum 2017	●	-	-	-	-	-	●	-	●	-	●	●	-	-	-	●	-	●	●	●	●	-	-	●	●	●	-	●	-	●	-	-	-
Krüp et al. 2014	-	-	-	-	-	-	-	-	●	-	●	-	-	-	-	-	-	-	●	-	-	-	●	-	-	●	-	●	-	-	●	-	-
Le Dinh et al. 2016	-	-	-	-	-	-	-	-	●	-	●	-	●	-	-	-	-	-	●	-	●	-	-	-	●	-	-	●	-	-	-	●	-
Leyh et al. 2017	●	-	-	●	●	-	-	●	●	-	●	-	●	-	-	-	-	●	-	-	-	-	-	●	●	●	●	●	-	●	-	-	-
Liebe et al. 2017	-	-	-	-	-	●	-	-	-	-	●	-	●	-	-	-	-	-	-	-	●	-	●	-	-	●	-	-	-	○	●	-	-
Milhailescu et al. 2015	-	-	-	-	-	●	-	-	-	-	●	●	-	-	-	-	-	-	●	-	-	-	-	●	-	●	-	-	-	-	●	-	-
Nwankpa and Roumani 2016	●	●	●	●	-	-	-	-	●	●	-	-	-	-	●	-	-	-	●	-	●	-	-	●	-	●	-	●	-	-	●	-	-
Oesterle et al. 2016	-	-	-	-	●	-	-	-	-	-	-	-	-	●	-	●	-	●	-	●	●	-	●	-	-	●	-	●	-	-	●	-	-
Omar and Elhaddadeh 2016	-	-	-	-	-	●	-	-	-	-	●	●	-	-	-	-	-	●	●	-	-	-	○	-	-	-	-	●	-	-	-	-	●
Petrikina et al. 2017	●	-	-	-	-	-	●	-	-	-	-	-	-	●	-	●	-	●	●	●	●	-	○	-	-	-	-	●	-	-	-	-	●
Pflaum et al. 2017	●	-	-	●	-	-	-	-	-	-	●	●	-	-	-	-	-	-	-	●	-	-	-	●	-	-	-	●	-	●	-	-	-
Piccinini et al. 2015	●	-	-	-	-	-	●	-	-	-	●	-	-	-	-	-	●	-	-	●	●	-	-	●	-	-	-	●	-	-	-	-	●
Prifti et al. 2017	-	-	-	-	-	●	-	●	●	-	○	-	-	-	-	-	-	●	-	-	●	-	-	●	-	-	-	○	-	-	-	●	-
Remane et al. 2016a	-	-	-	-	-	-	●	-	●	-	●	-	-	-	-	●	-	-	-	●	-	-	-	●	-	-	-	●	-	-	-	-	-
Roecker et al. 2017	●	●	-	-	-	-	-	-	-	-	●	●	●	-	-	-	-	-	-	●	●	-	●	-	-	-	-	●	-	-	●	-	-
Schmid et al. 2017	-	-	●	-	-	-	-	-	●	-	-	-	●	-	-	-	-	●	●	-	-	-	○	-	-	-	-	●	-	-	●	-	-
Schmidt et al. 2016	-	-	●	-	-	-	-	-	-	-	●	●	●	-	-	●	-	-	●	-	●	-	-	●	-	-	-	○	-	-	-	-	●
Schmidt et al. 2017	-	-	●	-	-	-	-	-	-	-	●	●	-	-	-	●	-	●	●	●	-	-	-	●	-	-	-	●	-	-	-	●	-
Serrano and Boudreau 2014	-	●	-	-	-	-	-	-	-	-	-	-	-	●	-	●	-	●	-	●	●	-	○	-	-	-	-	○	-	-	-	●	-
Sesay et al. 2017	-	-	-	-	-	●	-	-	-	-	-	-	-	●	-	-	-	●	●	-	●	-	-	●	-	-	-	●	-	-	-	-	●
Tan et al. 2017	-	-	-	-	-	-	-	-	●	●	-	-	●	-	-	●	●	●	-	●	●	-	-	●	●	-	-	-	-	-	-	-	●
Weissenfeld et al. 2017	-	●	-	-	-	-	-	-	-	-	-	-	-	●	-	-	-	○	-	-	-	-	-	●	-	-	-	●	-	-	-	-	●
Wilms et al. 2017	-	-	-	-	-	●	-	-	-	-	-	-	-	●	-	-	-	●	●	-	●	-	-	●	-	-	●	○	-	-	-	-	●
# 36	12	4	9	7	5	11	7	2	18	6	22	9	9	9	5	10	3	18	18	15	22	1	13	21	6	10	4	30	1	4	10	4	18

Caption : not mentioned (-), directly mentioned (●), indirectly mentioned (○)

Figure 3. Taxonomy of digital transformation—research topics.

Overall, as in Figure 3 highlighted, regarding the field of investigation, there is a wide dispersion of different fields (18/36). However, both the *manufacturing industry* (12/36) and the *public sector* (11/36) are popular fields. Only limited articles considered *creative industries* (4/36). Moreover, surprisingly, *industry 4.0* has been considered by only two articles (Leyh et al., 2017; Prifti et al., 2017). The majority of articles (22/36) focused on business *strategy*. Only a few articles (6/36) addressed business *performance*. Considering digital transformation, the *knowledge* of people is often examined (22/36) and a large number of articles dealt with *internal* (18/36) and/or *external* (15/36) collaborations. Culture is rarely addressed (only 13/36). Almost all articles addressed *innovation* (30/36), but in contrast, only a minority dealt with *security* (4/36) or *big data* (6/36) concerns. Drawing on theoretical background, some articles provided a *research model* (10/36). Sometimes, *maturity models* or *other* models (both 4/36) are developed. However, half of the articles did not provide any model (18/36).

4.3 Clusters of digital transformation

Following the cluster analysis method (Section 3), we identified four major clusters, each comprises between six and eleven articles. Each cluster has a different focal point along the dimensions and characteristics of digital transformation (see the explanations of topics in Section 4.2). As the characteristics within a dimension are collectively exhaustive, the results can be read as percentages. For example, 32% of the articles in Cluster 1 address manufacturing industry and 26% of the articles mobility as fields of investigation (Figure 4). The darker the colour of a cell, the higher the percentage of articles that belongs to a characteristic of an associated dimension. Therefore, the higher the percentage of a characteristic within a dimension, the more it is shaping a cluster. Next, we present the identified clusters, highlighting the most typical characteristics (in form of italic terms) of each cluster and utilizing demonstrative examples.

Cluster 1—digital business strategies and business models. Especially in *manufacturing industries, mobility, finance and insurance*, the strategic alignment (*strategy*) appears as a key activity. Therefore, changed or new business strategies and business models, influenced by *digital innovations*, are developed. For instance, Remane et al. (2016a) analysed business model types employed by start-ups from the mobility sector. Hildebrandt et al. (2015) focused on business model innovations of automobile original equipment manufacturers entering the digital transformation. In accordance with strategic alignment, both *business processes* and the *enterprise architecture* have to be considered. Andersen and Ross (2016) explained the transformation of the LEGO Group to a digital company. They presented how the company became digital in its products and processes, adapting the enterprise architecture. Furthermore, new forms of collaborations have to be established (Andersen and Ross, 2016). Investigating the digital supply chain of the future, Pflaum et al. (2017) analysed digital innovations and new business models. Schmidt et al. (2017) investigated directions of the strategic management and changing business models, analysing multiple stakeholder on strategic alignment. As all examples already exemplify collaborations, digital transformation also require new or changed forms of *internal and external collaborations* among several *actors*. For example, to innovate business models and solve specific tasks, it is of great relevance that companies and *customers* are jointly working together (Oesterle et al., 2016)—discussed with terms like co-creation and co-production. Even though most of the research do not provide a *model* as a result (*none*), a *maturity model* for digitalization within the manufacturing industry's supply chain (Klötzer and Pflaum, 2017) or a business model canvas (*models, other*) modelling changed business models (Schmidt et al., 2017) are provided.

Cluster 2—working culture in a digitized environment. Digital transformation demands cultural changes within the workforce of an enterprise. It affects the *culture* of working and transforms, for example, the traditional IT function (*IT sector*) in the digital business era (Haffke et al., 2017). Here, the *public sector* and the *manufacturing industry* in particular are addressed. Asking research and industry experts, Hartl and Hess (2017) identified *cultural values* critical for success in digital transformation. However, cultural changes are widespread over many fields. Large organizational transformation initiatives are often impeded by inertia that results in resistance to change (Schmid et al., 2017). The successful strategic alignment (*strategy*) and development of new *digital innovations* depend on the individual employee's willingness to accompany with this new approach. Hence, the motivation of employee's individual entrepreneurial motivation should be influenced (Krüp et al., 2014). Also at a higher level, companies are challenged by realizing the desired impacts of digitized products and the new approaches (Roecker et al., 2017). However, digital transformation does not only influences the employee's motivation but also the physical work environment resulting in a new workplace identity (Serrano and Boudreau, 2014). Consequently, different *actors*, as the basis of the working culture, have to be considered. Both *internal and external collaborations* have to be formed, to transform the working culture. In accordance, new and changed competencies and skills (*knowledge*) are necessary. In Cluster 2, the majority of research developed a *research model* and derived hypotheses, trying to explain relationships between objects of interest (e.g., Krüp et al., 2014; Omar and Elhaddedeh, 2016).

Dimensions	Characteristics	Cluster 1	Cluster 2	Cluster 3	Cluster 4
Number of articles per cluster		9	11	10	6
Field of investigation	manufacturing	32%	13%	6%	12%
	creative industries	0%	7%	13%	4%
	finance, insurance	16%	7%	13%	12%
	retail	5%	7%	6%	16%
	consulting	0%	7%	13%	8%
	public sector	5%	20%	25%	12%
	mobility	26%	7%	0%	4%
	industry 4.0	0%	0%	0%	8%
	other	16%	33%	25%	24%
Strategic alignment	performance	6%	0%	10%	40%
	strategy	47%	50%	0%	50%
	process	29%	22%	0%	0%
	enterprise architecture	12%	22%	20%	10%
	none	6%	6%	70%	0%
People	CIO/CDO	5%	5%	4%	9%
	customer, end-user	16%	10%	9%	0%
	partner	5%	0%	4%	0%
	other actors	14%	14%	30%	27%
	internal collaboration	19%	29%	17%	9%
	external collaboration	22%	19%	9%	9%
	knowledge	19%	24%	22%	45%
	none	0%	0%	4%	0%
Culture	culture + values	44%	70%	22%	0%
	none	56%	30%	78%	100%
Information Techonology	big data	7%	7%	23%	10%
	IT sector	21%	36%	0%	20%
	security	7%	0%	15%	10%
	innovation	64%	57%	54%	60%
	none	0%	0%	8%	0%
Models	maturity model	11%	18%	0%	17%
	research model	0%	55%	0%	67%
	other	11%	9%	10%	17%
	none	78%	18%	90%	0%

Caption : the darker the colour of a cell, the higher the percentage within a dimension

Figure 4. Results of the cluster analysis.

Cluster 3—digital innovations and technologies. *Digital innovation* is addressed in many fields of investigation, especially in the *public sector*. For instance, differences and changes in the usage of collaboration and communication platforms of university members are examined (Wilms et al., 2017). As digital innovations influence processes and infrastructures in a holistic manner, research in Cluster 3, also addresses entire *enterprise architectures* (Horlacher et al., 2016). Further, *big data* initiatives as the transformation of data to knowledge (Goes, 2015) is often a topic of interest. In order to successfully transform organizations with big data approaches, organizations, again, need to build special competencies (*knowledge*) (Alexander and Lyytinen, 2017)—see also Cluster 4—for example: new computer-based technologies require augmenting human capabilities (Sesay et al., 2017). Moreover, applying such technologies, various *security* and control issues regarding privacy or confidentiality (Goes, 2015; Wilms et al., 2017) have to be considered.

Cluster 4—knowledge as driver for digitalization. *Knowledge* is a fundamental and crucial research topic, and thus, is recognized in many fields and studies related to digital transformation as well. For instance, in *retail*, *manufacturing*, *finance*, *insurance* and the *public sector*. Novel digital technologies (*innovation*) influence the strategic alignment of an enterprise, especially the entrepreneurial *strategy* and *performance*. Within the transformation of strategy and organizational structures, several new (digital) capabilities are required as a driver for digital business performance (da Silva et al., 2016; da

Silva et al., 2017). Hence, the influence of IT capability on organizational performance (Nwankpa and Roumani, 2016) and the necessary employee competencies in general (Prifti et al., 2017) are investigated by various studies. In order to manage and develop such competencies, Competence Management Systems can contribute. Accordingly, for example, Le Dinh et al. (2016) proposed a service-oriented architecture for big data-driven Knowledge Management Systems to enhance and facilitate managing knowledge. Addressing knowledge in research always ends with a proposed model. The majority of the literature analysed, developed a *research model* and derived hypotheses (da Silva et al., 2016; da Silva et al., 2017; Nwankpa and Roumani, 2016). A competency model for employees (Prifti et al., 2017) or a maturity model for industry 4.0 (Leyh et al., 2017) are further examples for such outcomes (*models, other*).

5 Discussion and Future Directions

Structuring the field of digital transformation, several aspects demand for more reflection and discussion. However, for reasons of space limitations, we discuss selected issues for enforcing digital transformation and present possible research directions that are particularly based on the taxonomy (see Figure 2 and Figure 3) in the following section.

Conduct more design science research in digital transformation. As digital transformation receives more attention, the majority in research proceeded inductive, investigating selected, environmental problems to generate some patterns or theories (28/36 articles captured the constructivist worldview, see Figure 2). Only a few research projects built on existing theory, testing, defining or refining them (Creswell, 2014). However, to contribute to both theory and practice by *designing innovative artefacts* in the form of constructs, models, methods or instantiations (Baskerville, 2008; Winter, 2008; Hevner and Chatterjee, 2010), design science research may support (only 2/36 articles integrated DSR, see Figure 2). Based on existing theories and experiences of the knowledge base and environmental requirements, the design cycle iterates between the design of an artefact and its evaluation. The results of the design cycle will be returned into both the environment and the knowledge base (Hevner, 2007). Therefore, the presented taxonomy may serve as a step towards the development of more analytic theories (Gregor, 2006; Williams et al., 2008) that contributes to the knowledge base of digital transformation. Besides designing, the *evaluation of new artefacts,* as an essential activity in design science research, may leverage rigorousness. Evaluation serves at demonstrating the utility, quality and efficacy of an artefact. Therefore, the 'degree' of how the artefact supports a solution of the actual problem should be observed (Peffers et al., 2007). DSR evaluation can be conducted ex ante (formative) or ex post (summative) the design as well as in an artificial or naturalistic setting (Venable et al., 2016). Consequently, we assume that conducting design science research in digital transformation can be worthwhile for future research and suggest (a) design new artefacts as well as (b) evaluate them.

Develop more methods for digital transformation. Due to the high importance of methods (Yoo, 2013) for example, as artefacts of design science research, we like to highlight them in a separate, second future direction. Methods are goal-oriented and propose systematic procedures to solve problems and achieve goals (Braun et al., 2005). In order to solve a problem, certain activities have to be conducted by different roles (e.g., people or organizational units). Results of the activities are recorded in certain specification documents. In order to develop such documentations, special techniques have to be considered. A meta model supports the consistency of the whole method, specifying the conceptual data model of the results (Gutzwiller, 1994; Braun et al., 2005). Although methods are beneficial and supporting, only limited research developed methods. Our taxonomy already indicates that knowledge, skills and competencies are of great relevance in digital transformation (22/36 articles addressed knowledge, see Figure 3). For instance, Prifti et al. (2017) confirmed the importance of competencies, developing a competency model for industry 4.0 employees. Therefore, a competency model for the digital transformation could combine the research, investigating capabilities in digital transformation. Furthermore, Klötzer and Pflaum (2017) started analyzing maturity levels of digital transformation, investigating companies within the manufacturing industry's. Also, maturity levels in industry 4.0 (Leyh et al., 2017) and healthcare (Liebe et al., 2017) have been identified. As the taxonomy identified

further fields of investigation, we like to highlight that, in the short term, the maturity levels of digital transformation concerning other fields, might be interesting. Therefore, in the long term, we suggest that the maturity levels of different fields can be compared, resulting in a cross-field maturity model of digital transformation. In order to build such models, certain modeling techniques are required. We assume that, to contribute to the characterization of digital transformation and to solve problems within this field, especially domain-specific modelling approaches can be a valuable starting point for further research. In contrast to 'general purpose modelling techniques', domain-specific techniques can increase effectiveness and efficiency during the modelling process or provide easy to manage and reusable model instances (e.g., Guizzardi et al., 2002; Kishore and Sharman, 2004). In consequence, to explain those new techniques, also the development of meta models is required. Developing such methods, for example, concepts of situational method engineering (e.g., Bucher et al., 2008; Winter, 2008) can be adopted, to support the systematic design of certain artefacts related to digital transformation.

Research creative industries in digital transformation. Creative industries including music, book, art, film or design industry are highly affected by digital transformation, however at the same time, they hesitate to pursue transformation. For instance, classical kinds of products and business models such as artworks, sculptures or film distribution are challenged to produce or integrate digitized products (Roecker et al., 2017). Nonetheless, our taxonomy indicates that only the minority in IS research of digital transformation explores creative industries (4/36 articles investigated this field, see Figure 3). For example, Nwankpa and Roumani (2016) interviewed CIOs of the art industry to investigate the influence of IT capability on organizational performance, is exemplary for taking creative industries into account. As a future direction, we suggest to (a) adopt and transfer existing research from well-researched fields (see taxonomy, for example: manufacturing industry) as well as (b) develop new methods, theories etc. (e.g., effects of digital transformation on the strategic alignment) that support transformation in creative industries. In doing so, this could provide orientation regarding the business strategy, business models, business processes and enterprise architecture. Moreover, changed expectations on people—both consumers and employees—as well as on the working culture in digitized environment can result in future investigations.

Investigate security issues in digital transformation. With regard to the identified research topics of digital transformation, surprisingly, security issues are rarely considered (4/36 articles addressed security, see Figure 3). Building clusters from the taxonomy, we only identified Cluster 3 that addresses security and control issues such as privacy or confidentiality (Goes, 2015; Wilms et al., 2017). However, the increasing use of digital innovations and the resulting shift in business strategies demand extensive handling with security, for example, regarding data (e.g., Heilig et al., 2017). As IT security standards serve as rules for compliance (El Kharbili et al., 2008), the boosting interest in regulatory compliance (Abdullah et al., 2009) can be further related to digital transformational endeavours. Questions on how digital transformation impacts compliance or whether existing concepts need to be adapted arise. Moreover, Cluster 2 already covers research according to transformation inertia (Schmid et al., 2017) which may be extended, investigating the information security culture (e.g., Lim et al., 2010) in digital transformation. Consequently, we like to suggest, considering security aspects in future research in particular.

6 Limitations

Although we derived helpful insights for the field of digital transformation, our study is not free of limitations that allows various opportunities for future research. First, our investigation is limited to the keyword and search sources selected—further keywords and sources may provide additional articles. However, to start structuring the field and to catch the characteristics of digital transformation in a broad manner, we decided to proceed as described above. Second, the classification of the articles is based on our own decisions and interpretations. In order to contribute to the reliability and robustness, two researchers classified the results independently and consolidated the results afterwards. Moreover, according to Nickerson et al. (2013), taxonomies are never perfect. While the developed taxonomy

fulfills the ending conditions, the general validity of our literature sample cannot be guaranteed. Nevertheless, we would argue that our results are useful for structuring the field of digital transformation, opening up with possible research directions within an emerging field. Third, discovering clusters from the taxonomy, the number of clusters is affected by the interpretation of the dendrogram developed. Although we followed established approaches such as the Ward´s method and the K-means method that are used in further cluster building studies based on a taxonomy, determining another amount of clusters might have influence on the results of the clustering.

7 Conclusion

In order to provide a better characterization for both research and practice, and therefore, to develop a taxonomy to structure the field of digital transformation, we carried out an extensive literature review, classified IS literature and built a taxonomy of research characteristics and research topics. Regarding the *types of IS research that are conducted in digital transformation*, we identified that the majority used qualitative approaches (e.g., grounded theory and case studies). Only a minority followed the paradigm of design science research. Further, a "lack of prior knowledge and theory" (Piccini et al., 2015, p. 2) is often realized, and therefore, they want to "create more robust theory" (Horlacher et al., 2016, p. 3). Investigating the *topics addressed from IS research in digital transformation*, various fields of investigation were determined. However, the manufacturing industry and the public sector are the most popular fields. Further topics such as strategic alignment (e.g., performance, business strategy, process and enterprise architecture), people (e.g., certain actors and different forms of collaboration, knowledge), culture issues (e.g., culture values and workplace identity), information technologies (e.g., big data and IT security) as well as use of models (e.g., maturity model and research model) to solve research problems are identified. Performing a cluster analysis, we discovered certain areas of digital transformation: (I) digital business strategies and business models, (II) working culture in a digitized environment, (III) digital innovations and technologies as well as (IV) knowledge as driver for digitalization. Based on this, we derived some directs for future endeavours including the calls for (a) conducting more design science research—design and evaluate artefacts in particular—, (b) developing more methods, (c) considering new fields of application such as creative industries, and (d) investigating security issues.

Overall, our findings contribute to the ongoing research in digital transformation and aim at better characterizing and analysing the field. Based on our taxonomy, we would argue that academics can position their own research, derive research gaps which need to be addressed by future endeavour and they can be oriented on how to conduct research (e.g., informed selection of research approaches). Moreover, according to Gregor´s (2006) 'theory for analysing', such classifications can serve as the foundation for more advances theories (e.g., that attempt to explain relations of several objectives such as people or culture related to digital transformation).

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