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## **Beyond the hype:**

**A bibliometric analysis deconstructing research on digitalization**

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## **Abstract**

The accelerating emergent field of research addressing digitalization and related topics is complex, unstructured and hyped. Consequently, both research and practice lack a rigorous foundation of prior published research to underpin and direct future exploration into the opportunities and challenges provided by these exciting new digital technologies. This study employed a bibliometric analysis to explore extant published research within the digitalization field. We identified key articles that have enabled us to distinguish between interrelated digitalization concepts. Subsequently, we propose a taxonomy with characteristics for different levels of digitalization. The taxonomy contributes with dimensions that create different commercial and organizational opportunities and challenges at the different levels. The taxonomy offers a vantage point for subsequent empirical and conceptual research to extend insight on related digitalization themes, and especially related to innovation and strategy decisions on scalability, automation, channel selection and connectivity.

**Keywords:** Bibliometric analysis; Business models; Digitization; Digitalization; Digital transformation; Disruption; Innovation; Taxonomy.

## **Preface**

The dissertation you are about to read - “Beyond the hype: A bibliometric analysis deconstructing research on digitalization” - is a master thesis written to fulfill the graduation requirements of the study program Master of Science in Business Administration at Oslo Business School, Oslo Metropolitan University - OsloMet. The project the dissertation constitutes was undertaken as we are interested in technology and what opportunities technological developments creates for people and organizations, which made the theme of our master thesis a natural choice. Further, we have a major in strategy, organization and management, where the academic content has emphasized each subject area influence on people, organization and society. Some subjects have in particular focused on today's society, and especially gone in depth on how technological advancements affect people and organizations. Therefore, as technology and digitalization is hot topics undergoing rapid development, we found it exciting to contribute to the research area by conducting research on the topic.

The master thesis constitutes a small experiment performed with our supervisor Karl Joachim Breunig, where the goal was to write an article with the potential to become published during our project engagement. The experiment we have been part of has been incredibly exciting, and we take with us invaluable new knowledge about how research projects are conducted and completed to be shared with a wider audience. The submitted dissertation you are about to read constitutes the long version of our research project intended for submission as our master thesis. The final output of the experiment - this dissertation in a shorter article format - has been submitted to the ISPIM Innovation Conference and will be presented in Florence on the 18th of June 2019. The article submitted to ISPIM is included under Appendix 2.

We were engaged in the research project from the fall of 2018 to May 2019. Leading up to the research project and throughout the process we have had invaluable support. For this we would like to thank our supervisor Karl Joachim Breunig for excellent guidance and backing. Further, we would like to thank Njål Andersen for guidance on bibliometric methods. Finally, we would like to thank the administration at Oslo Business School, Oslo Metropolitan University - OsloMet for providing us with a travel grant to attend ISPIM Innovation Conference.

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## 1 Introduction

Anything relating to digitalization is certainly in vogue these days - and academic research is in fast pursuit. An initial search on Google Scholar reveal an overwhelming number of suggested articles for search terms, such as: "digitalization" with 58 100 suggestions, "digital disruption" with 5 570 suggestions, or "digital transformation" with 25 500 suggestions. In addition to this abundance of published research there is a lot of attention on digital technology developments driven by the technology vendors. Examples are reports describing new types of digital technologies such as: Internet of Things (IoT), machine learning (ML) and artificial intelligence (AI), virtual and augmented reality (VR and AR) or blockchain, to mention a few. There also exists a number of reports, for instance by consultancy firms, with speculative estimates of the numbers of workers affected by these technologies. In short, the accelerating emergent field of research addressing digitalization and related topics is complex, unstructured and hyped. Consequently, both research and practice lack a rigorous foundation of prior published research to underpin and direct future exploration into the opportunities provided by these exiting new digital technologies. A prerequisite condition to obtain a clearer picture of the contemporary phenomenon of digitalization is achieving an overview of it - beyond the current hype. There is a need for a uniform definition and clarifications of the multiple and interrelated terms used in current digitalization research. Therefore, the ambition of this paper is to address the following research question: *How can a structured literature search utilizing bibliometric analysis enable the deconstruction of current published scientific research to provide a rigorous conceptual foundation for research and practice alike?*

To explore the research question, we employed a structured literature search to extract a final search database that could be used for bibliometric analysis and to identify key articles for a content analysis. The search resulted in an initial sample of 1307 articles which were reduced to 197 for our bibliometric analysis, resulting in a final sample of 17 articles upon which we conducted a content analysis. Our study reveal that much of the research in this area is explanatory or conceptual, and not empirical, and that the different case studies are spread across different disciplines. Moreover, we utilize the bibliometric analysis to identify key articles that have enabled us to distinguish between the digitalization concepts, and on that basis, we propose a taxonomy. This taxonomy includes different levels of digitalization, relating to different dimensions that create varied organizational and commercial

opportunities and challenges. The taxonomy offers a vantage point for subsequent empirical and conceptual research to extend insight on related digitalization themes, especially related to innovation and strategy decisions on scalability, automation, channel selection and connectivity.

## **2 Theory**

McAfee (2009) refer to digitalization as the pace of change in society driven by digital technological development, involving multiple technologies at different stages of maturity that will converge and create new technologies. There exists no established framework within digitalization theory. Extant research offers a fragmented landscape, often driven by an understanding from informatics. This discipline often focuses on the technological complexity, rather than on the understanding of the organizational complexity in which the technology is implemented and utilized (Andal-Ancion, Cartwright, & Yip, 2003). Whereas digitalization - with related themes such as digital disruption and digital transformation (DT) - has been described as a homogenous phenomenon, some recent empirical studies are addressing contingency factors across e.g. different industries. However, since a majority of these studies take the perspective emphasizing technological complexity, they fail to elucidate important dimensions pertaining to the organizational and commercial application of these technologies. Consequently, there is a pressing need to identify core organizational and commercial dimension to further our understanding of how digital strategy and digital innovation can be practiced across different industries. Moreover, there exists a plethora of interrelated terms, such as digization, digitization, digitalization and DT (Negroponte, 2015). These terms are applied differently in different studies and are suggested to address everything from stages (Loebbecke & Picot, 2015) in the development of the application of different types of digital technology to the ambition underpinning the utilization of these technologies. Additionally, there exists no clarity regarding which concept that are used for describing different digital processes and the benefit this process seeks to achieve.

Although researchers have defined and evaluated the impact of digitalization on society and businesses, there are different conceptualizations of each term and their impact on organizations, and there exists no consensus to date on the different levels of digitalization. Loebbecke and Picot (2015) argue that the impact of digitalization on society and businesses

can be understood at 4 different stages: digitization, digitalization as digital automation, transformation and disruption. There have been several attempts to conceptualize the different stages Loebbecke and Picot (2015) refer to. E.g. Digitization refers to the conversion of analog to digital information (Negroponte, 1995). Digitalization takes place in the form of process automation or industrialization, where existing processes are improved (Aron & Waller, 2014). To the degree that the digitalization impacts the BM and transforms that business, one can talk of DT (Andal-Ancion, Cartwright, & Yip, 2003). In turn, disruption refers to a situation where existing companies are substituted by new ones (Bradley et al., 2015). Despite these efforts to define and collect the terms, it is evident in the bulk of research on digitalization and related themes that the terms are used interchangeably and that the concepts are used differently in and across studies to describe the same phenomenon and processes. Further, while some argue technological advances drives digitalization, others argue strategy, not technology, drives DT (e.g. Kane et al., 2015). Kane et al. (2015) found that maturing digital businesses are focused on integrating digital technologies in the service of transforming how their businesses work, and that talent engagement and BMs have a clear digital strategy in organizations where digital technologies has transformed processes. Terminological confusion and disagreement of digitalization drivers are however not the only obstacles in navigating through the current digitalization wave. Davenport and Westerman (2018) argue that hyping digitalization may upset companies and their managers. They base their argument on existing studies that suggest that the German Mittelstand - often referred to as the 'powerhouse' of the German economy - responds with resistance to the adoption of Industry 4.0 technologies. They claim the resistance in adopting these technologies stems from the common findings in these studies - that the conceptual confusion and perceived hype around the topic of Industry 4.0. restrain companies from engaging themselves in this topic as they were able to postpone, or ignore, other hypes in the past.

In recent time with advances in digital technology there has been several waves (Legner et al., 2017) of digitalization that has fundamentally transformed business and society, contributing to the complexity of the field. The first wave focused on conversion of analog to digital information, leading to higher automation in work routines. The second wave established Internet as a global communication infrastructure, resulting in e.g., changes in firm's value creation logic and new types of businesses, while the third wave - which we are experiencing today - are the converging SMAC (social, mobile, analytics, and cloud)

technologies that has made the vision of omnipresent computing become very close to reality. While digitalization has been a topic for information systems research for decades, the current wave of digitalization is different, according to Legner et al. (2017): it is driven by us. This calls for a broader field of research to merge their efforts to deal with the complexity the development poses, to further our understanding of the impact of digitalization and contribute to structure the field. Similar to Legner et al. (2017), Brenner et al. (2014) argue the power in information technology (IT) is shifting to users who increasingly are expecting sophisticated digital services and products. The increasing expectations from users and the rapid innovation of IT within the last three decades put pressure on leaders in commercial and public organizations that are being challenged by disruptive startups, calling for a better understanding of how different levels of digitalization impact their business. The IT innovation has come along with the development of new systems, software applications and standards that support and shape business activities in various ways, that force organizations to deal with an increasing amount of data and act in complex and growing networks (Heilig, Lalla-Ruiz, & Voß, 2017). This environment of continuing technological change may require or even promote shifts in organizational structures, processes, and strategies according to Heilig, Lalla-Ruiz and Voß (2017), and further underpins the need for structuring digitalization research in regard to organizational impact.

Digitalization is constituted by a variety of emerging technologies at different stages of maturity and market acceptance, and it has been suggested that these will converge and mutually strengthen each other in the digital revolution (Manyika et al., 2013). Notably, two main dimensions have been identified to enable comprehending the different emerging types of technology (Brynjolfsson & McAfee, 2014). First, increased machine power - including emerging technologies such as AI, Big Data, augmented reality, advanced robotics, autonomous vehicles and 3D-printing. Second, increased connectivity - including technologies such as mobile internet, social media, Skype, IoT, Cloud and Fog, as well as Blockchain. The combined effect of all of these emerging technologies are yet unknown. Any of these technologies - e.g. IoT - are assumed to have large consequences for firms marketing and business model (BM) (Ng & Wakenshaw, 2017). Existing research are pointing to professional service firms as a type of business where the impact of digitalization will be greatest (Manyika et al., 2013; Zott & Amit, 2017), and technologies in combination are likely to have a considerable impact on expert based businesses (Jesuthasan, Malcolm, & Zarkadakis, 2016). Similar to the widely accepted assumption that these technologies in

combination are likely to have a considerable impact on expert based businesses, existing research has also pointed to professional service firms as a type of business where the impact of digitalization will be greatest (Manyika et al., 2013; Zott & Amit, 2017).

The technological advances and conceptual confusion in the field of digitalization and its impact on organizations underpin the importance of having a clear distinction of different concepts as a navigation tool. While it is evident that the bulk of research on digitalization to date revolves primarily around technological complexity and usage rather than the organizational complexity in which the technology is being utilized, review papers typically consider only fractions of the field. There have nonetheless been efforts to define digitalization concepts and its effect on organizations (e.g. Bowersox, Closs, & Dreyer, 2005; Markus & Loebbecke, 2013; BMWi, 2015; Loebbecke & Picot, 2015), but definitions varies between studies for each digitalization concept. As a result, there exists a plethora of interrelated terms that are applied differently in different studies. The hype of the concepts is not slowing this confusion, and presses the need to create a consensus about the concepts effect and influence of them across research topics. This far studies have lacked the ambition and scope to deal with the terminological confusion, but as of recent years new alternatives to the traditional literature review has emerged.

### **3 Method**

In this article we employ science mapping from the discipline of bibliometrics with the aim to provide a systematic and thorough review of digitalization research related to disruption and transformation. Bibliometrics refer to “*the collection, the handling, and the analysis of quantitative bibliographic data, derived from scientific publications*” (Verbeek et al., 2002, p. 181). A systematic review adopts a replicable, scientific, and transparent process based on the theoretical synthesis of existing studies, thus differing from general reviews (Cook et al., 1997). In particular structural reviews that allows us to 1) examine relations between topic areas, and 2) use some form of quantification to shortly compile a large amount of literature (Porter, Kongthon, & Lu, 2002). While the common research paper cites around twenty references, providing an incomplete picture of the research context, a broad scan of a literature can, according to Porter, Kongthon, and Lu (2002, p. 351) “*extend the span of science by better linking efforts across research domains. Topical relationships, research*

*trends, and complementary capabilities can be discovered, thereby facilitating research projects.*” In addition, as structural reviews to some degree employ a form of quantification and objective analysis, such reviews “*improve the review process by synthesizing research in a systematic, transparent and reproducible manner*” (Tranfield, Denyer, & Smart, 2003, p. 207). Thus, structural reviews help overcome one of the traditional review papers limitations: their lack of rigor.

To provide a highly objective and systematic review of the literature containing keywords of both one or more of the digit\* concepts in combination with either transform\* or disrupt\*, we employ the VOSviewer science mapping framework (Van Eck et al., 2010; Van Eck & Waltman, 2014). By using VOSviewer science mapping, we are able to examine the intellectual content and structure of research on concepts of digitalization linked with transformation and/or disruption in rich detail. Further we employ content analysis to a selection of the papers in our final search database, selecting papers based on traditional- and bibliometric criteria. The content analysis allows us to make replicable and valid conjectures by interpreting the textual material.

### **3.1. Sample**

A four-stage process was used to identify papers for bibliometric analysis. First, we searched the Web of Science (WoS) for articles using the search string *Title=((Digit\* AND Transform\*) OR (Digit\* AND Disrupt\*))*, where 1 307 papers were identified. Second, we excluded only 2019 from publishing years, keeping all whole years to retain the opportunity to identify potential evolution of the field. Third, we included articles, proceedings papers, book reviews, reviews, book chapters and editorial material, meaning we excluded the following document types: note (14), letter (16), meeting abstract (20), reprint (1), news item (7), correction (5), correction addition (1) and film review (1). Fourth, we then excluded research categories in WoS that did not contain information about the concepts of digitization, digization, digitalization or DT, to ensure relevance in the included papers. Our aim of this final step was to remove research fields that focused on description and specifications of the technology itself (i.e studies that take the perspective emphasizing technological complexity), rather than the concepts of digital change. To consider whether categories were relevant to answer our research question we applied three different selection

methods based on the number of articles within the specific category. For categories with 30 or more papers, we did a bibliographic co-occurrence analysis. For this purpose, we used a threshold of 4 to include enough keywords to thoroughly analyze the research category while still ensuring relevance of these. Analyzing the clusters in each category revealed if the research category focused on technological attributes or digitization concepts. To ensure that high-impact articles within categories that was discarded by the bibliometric analysis was not overlooked, we read the abstract on the 20 most cited papers for each category. Finally, for categories with less than 30 results, we read the abstract on all papers to assess its relevance. Our final literature search downloaded from WoS following our four-step process contained 197 papers. For an overview of included and excluded categories see Appendix 1.

The same process was performed with a topic search using the same criteria as described above, but clusters from analyzing the resulting database revealed keywords mainly related to hardware attributes to technology. Abstract readings further confirmed that the papers in the database mainly described usage of different technologies. Thus, as initial analysis suggested the title search would make us better equipped to answer our research question, we chose to build our paper on the title sample resulting in a final search database containing 197 papers.

### ***3.2 Analysis***

The analysis was threefold. First, we did a descriptive analysis consisting of our final search database to identify the evolution on the field and the development within journals and disciplines. The purpose was both to identify which disciplines drive digit\* research, and to assess the distribution and impact of the various journals. Finally, to get insight on emerging concepts and conceptualization within disciplines, we approached the evolution of terms over time and across journal categories. Second, we did a bibliometric analysis based on the final search database to classify the relevant keyword clusters for each digit\* concept, and to categorize the different disciplines that are associated with the terms. This analysis further enabled us to identify the development of the keyword clusters over time to identify what concepts are emerging and “hot”, and which concepts are “not”. Additionally, the bibliometric analysis will enable us to pinpoint the most cited papers, thus helping us understand which main disciplines are referenced in the papers in our final search database. Finally, the bibliometric analysis is also conducted to contribute to the literature review as it

is used to identify the most influential articles by calculating network centrality, as we did a content analysis of the 17 most relevant papers in relation to our research to identify any conformity and contrasts of the digitalization concepts.

### *3.2.1 Descriptive analysis*

For the descriptive analysis we used the .txt file containing our final search database exported from Web of Science and converted this to an Excel file. We added a column for journal category (i.e. People and Organization, Strategy, Technology and IT, Business, Cross-disciplinary work, Economy, Law, Library and archival science and Management) and a column for concept of digitalization, both populated manually. The assessment of the appropriate value for the journal column was based on the journals discipline which was addressed by visiting each journal website. The appropriate value for the digitalization column was based on three factors; title, keywords and abstract of the paper. When all columns were populated with values the Excel sheet was connected to Microsoft's analytical service Power BI for visualizations of the data.

### *3.2.2 Bibliometric analysis*

To obtain a better overview of the identified articles we saved all 197 articles in one file to permit a thorough bibliometric analysis (Markoulli et al., 2017). To conduct the analysis, we applied the VOSviewer software and identified clusters of interrelated digit\* articles. We created a Thesaurus file to combine similar words with different spelling, where for example the label "Business models" was replaced by "Business model". This was done to have more trustworthy clusters. General terms like "Transformation" was not combined with "Digital transformation", as these grasps broader than digital change specifically. Thesaurus was also used for the co-citation analysis, but with the intention to make each point in the clusters more intuitive making the map easier to read visually. Several analyses were conducted in VOSviewer to receive relevant maps to answer our research question. Co-citation and Co-occurrence analysis were conducted to compute relevance of keywords and citations between them, and bibliographic coupling was conducted to find the most influential articles within the final search database. The discipline category for each cluster was identified by doing an Eigenvector Centrality (EC) analysis in Gephi for both the Co-occurrence and co-citation separately, which was further matched against each other to find the cluster category. The

GML files was imported to Gephi with graph type “undirected”, indicating that papers are not necessarily referred to each other both ways.

### *3.2.3 Content analysis*

To ensure relevance and identify the unit for further literature review we did a three step-process to make a selection from the 197 articles. First, we read the abstract of all 197 articles to ensure thematic relevance and selected the ones that informed or defined the phenomenon of digitalization and related terms. During the reading every article was scored on relevance related to the research question on the following scale: (A) Relevant; (B) Borderline relevant; and (C) Irrelevant. During this process the papers that did not contain concepts of digital change was discarded, e.g. papers with a core focus on hardware and technological attributes. Second, to ensure papers to our content analysis based on purely objective criteria, the five articles with the highest citation score was included. Finally, the five papers with the highest EC (i.e. network centrality) was added to the content analysis. EC measure approximate importance of each node in the graph, and the core idea in EC is that an important node usually is connected to important neighbors (Wang et al., 2012). Thus, EC identifies relevant articles in the final search database as the assumption is that each nodes centrality is the sum of the centrality values of the nodes it is connected to. To calculate the EC, we did a bibliographic coupling analysis in VOSviewer with “Documents” as the unit of analysis, saved the resulting map as a GML file, and imported it to Gephi to complete the analysis. The selection result included 17 out of 197 papers. Of the top five cited papers, four overlapped with the fifteen retrieved from abstract readings. Further, of the top five papers retrieved from EC two overlapped with the 15 retrieved from abstract readings.

The content analysis was conducted by reading and assessing the 17 papers identified through the three selection criteria. We read all papers and coded them in Excel to provide an overview of how each paper described the respective digit\* concept and how they defined the purpose of it. Further, the content analysis was split by collecting the information from all digitization-, digitalization-, and DT papers in separate tables to easier identify the content and common features of each concept.

## 4 Findings

### 4.1 Descriptive

To identify overall trends and key figures in our database we employed Microsoft Excel and Power BI. First, by looking at the publishing year for our database we identified an upward trend in the number of publications per year. The development in number of publications was stable between 1994 and 2012, but from 2013 there has been a steep positive development, with an average increase in number of annual published papers of 27 per cent between the years 2013 and 2018. It can be argued that the development from 2013 can be explained by the emergence of technology and IT solutions, creating new business- and social opportunities. The development indicates that the interest among researchers for the different digit\* terms is increasing and based on this trend and the current developments in technology we assume that the number of publications will increase in the years to come.

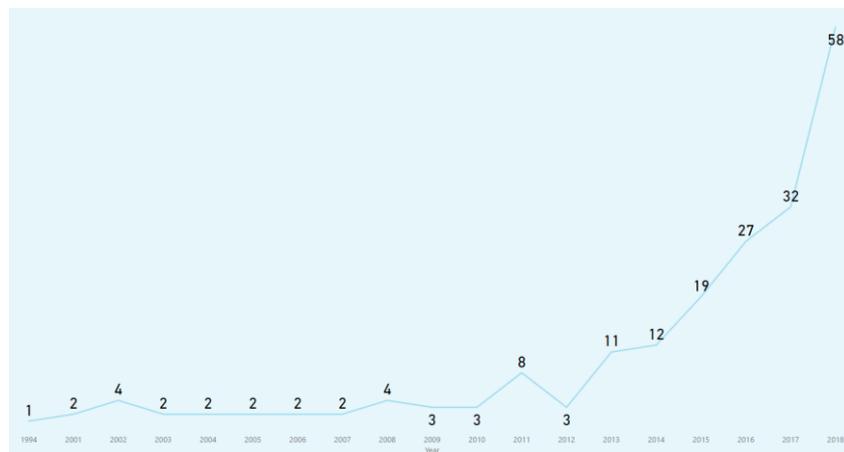
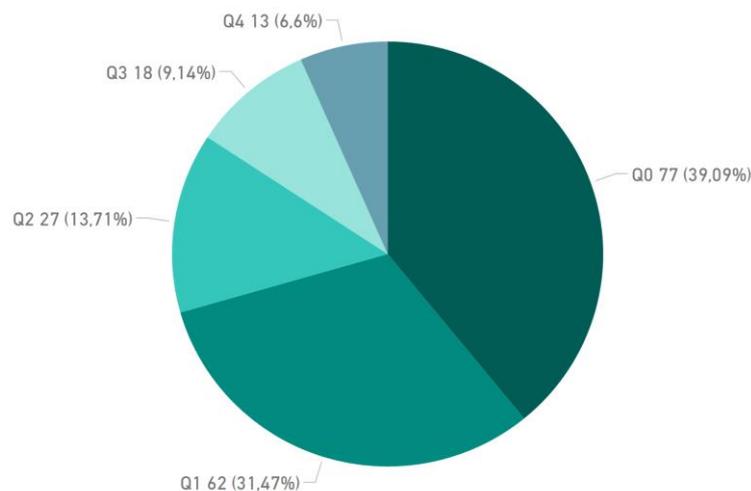


Figure 1 Development in publications per year within the database consisting of 197 papers

The 197 papers in our sample are published in 139 different journals. This gives an average of 1.4 papers per journal in our database. Based on the large number of journals represented, we found it beneficial to categorize the journals into more general categories for descriptive purposes. To do so we reviewed each individual journal and assigned it to the topic closest related to it (e.g. MIS Quarterly Executive was categorized in the journal subject area “Management”). Further to get a overview of the ranking and importance of the journals represented in our articles, we downloaded SJR Journal rankings and used Excel to find both the SJR value and the SJR Quartile for all articles in the final search database. The SJR value is a measure of a journal’s impact, influence or prestige, that express the average number of weighted citations received in the three previous years (SCImago Journal & Country Rank, s.a.). Figure 2 presents an overview of the distribution of SJR Quartile numbers for our papers, and figure 3 shows journals within each discipline category.



*Figure 2 Number and percentage of journals within each SJR Quartile*

SCImago Journal & Country Rank categorize journals in quartiles from Q1 (journals with highest prestige and impact) to Q4 (journals with the lowest prestige and impact). To illustrate the difference between the quartiles; the journal with the highest SJR score is in the Q1 Quartile and has an SJR score of 61.8, and the journal with the lowest SJR score and is in the Q4 Quartile has a SJR score of 0.1. We have added a fifth value (Q0) that is given to journals that was not included in the list of journals SCImago Journal & Country Rank offered. SCImago Journal & Country Rank is a portal that includes information contained in the Scopus database (SCImago Journal & Country Rank, s.a.), which indicates that several of our articles are not listed in the Scopus database. We did some random searches to consider if this was correct, which it turned out to be. We can conclude that Q0 journals score low on prestige and impact for two reasons; first, the average citation on the articles who are

included in the Q0 quartile is 1.3, and second, the journal not being represented in other databases such as Scopus indicates that the journal's impact, influence and prestige is rather low.

Figure 2 show that the largest proportion of the articles are published in Q0 journals (39.09 percent), while the remaining 60.91 percent is published in the remaining quartiles. That the largest represented Quartile is Q0, may indicate that smaller and poorer ranked journals have a higher focus on digital change than larger and more influential journals. A possible explanation for this distribution may be that highly ranked journals have a larger focus on traditional topics such as management, institutional theory and the like, leading to a deprioritization of newer research topics such as digital change. Despite this, we see that 31.4 percent of the articles are published in Q1 journals, indicating that digit\* research is not excluded from top ranked journals. If we look at the development of published articles within each quartile over the years (see table 1) we see that the various quartile journals have been relatively evenly distributed over the years. This indicates that the influential records do not necessarily lag behind, but rather that the total number of published papers are lower in more influential journals.

	Q1	Q2	Q3	Q4	Q0	Total
1994				1		1
2001		1		1		2
2002			1	1	2	4
2003	1			1		2
2004	1	1				2
2005	1				1	2
2006		1			1	2
2007					2	2
2008	2	1	1			4
2009	1	1			1	3
2010	3					3
2011	4			1	3	8
2012				1	2	3
2013	7	1	1		2	11
2014	6	2	1		3	12
2015	5	2	2	1	9	19
2016	9	4	2	3	9	27
2017	9	4	2	1	16	32
2018	13	9	8	2	26	58
<b>Total</b>	<b>62</b>	<b>27</b>	<b>18</b>	<b>13</b>	<b>77</b>	<b>197</b>

Table 1 Development in published articles within each SJR category

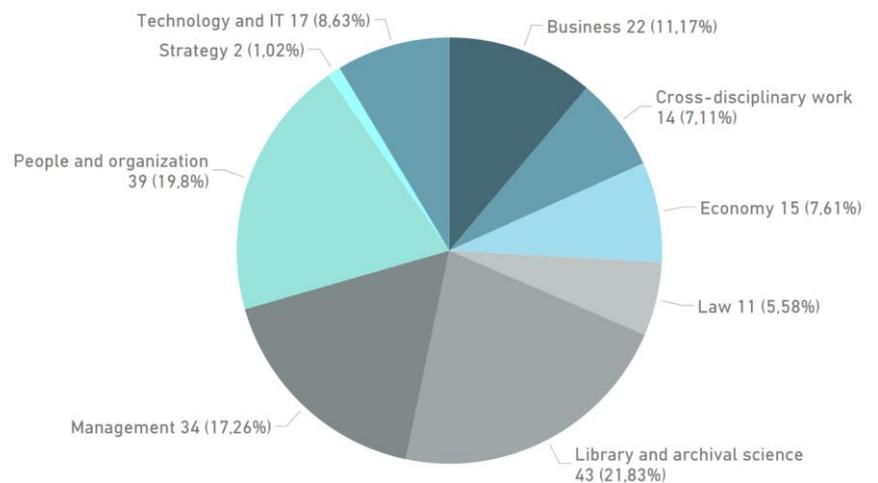


Figure 3 Number and percentage of publications within category

We further allocated all papers in their respective discipline category and created figure 3 to illustrate the distribution. "Library and archival science" have the largest amount of papers included with its 43 papers, which amounts to 21.8 percent of the database. One can speculate that this may be a result from the first wave of digitalization that focused on conversion of analog to digital information, thus affecting this discipline category in a fundamental way fairly early in the second machine age. Another explanation may be that it is due to the digital change that has taken place in the library and archive industry during all the digital waves - from digitization, digitalization and DT - as these digital waves are very aptly in our final search database. "People and Organization" follows with 39 papers (19.8 percent), and the "Management" category consist of 34 papers (17.3 percent). This may be due to the fact that we live in a information society, where digitalization measures affect individuals and organizations by e.g. relieving cognitive tasks and fundamentally altering the known. Additionally, management may be affected by new the opportunities and challenges digital disruption poses. The remaining papers are somewhat evenly distributed across the remaining categories, which indicate that the technological developments we see today affect several industries. Furthermore, figure 3 also reveals that there only exists two articles within strategic journals. This indicates that the field is immature and fragmented, as few strategic journals deal with the digit\* concepts. Digitalization is an important aspect of organizational change in today's society, and strategic development should follow. The lack of focus on digit\* concepts in relation to transformation and disruption in strategic journals could indicate a shortage of comprehensive description of how strategy should be adapted to technological adaptations. However, as this could be a result isolated to our database or our descriptive analysis, we cannot conclude that research to date haven't emphasized the link between the business strategy field and strategic issues from technological development. It might also be a result of papers being in progress or in proceedings, as Figure 1 reveals that there has been an exponential growth in the number of digit\* papers in recent time.

To provide a deeper and more informative analysis regarding the content of papers in our database we categorized terms used in all papers based on their title and keywords. In doing so we are able to see which digit\* terms are best covered in research. For the papers where the keywords and title did not clearly inform what term was covered, we read the abstract to determine which category it belonged to. Some articles did not specify any of the digitalization concepts and is categorized under the more general term "digital" (e.g. articles

containing information about the digital era, digital age, digital manufacturing, and digital technologies). The results are presented in figure 4. We discovered that the terms “digital” and “digital disruption” are evenly distributed across the categories, which may give an indication that digital changes affect and disrupt all industries covered in our database. “Digital transformation” is also represented in all categories and dominates the management- and IT and technology field compared to other terms with 28 papers (82 percent) in the “Management” category, and 15 papers (88 percent) of the papers in the “Technology and IT” category. This may indicate that “Management” and “Technology and IT” are mature fields within digitalization research - addressing all levels of digitalization concepts, or that they are quick to pick up new trends in research (i.e. the third wave of digitalization). It may also be an indication that these research fields have been hit by disruption earlier than other disciplines, thus forcing them to address DT. Further, “digitalization” is the main theme in only 9 of the 197 papers and spread across several categories. This might be a result of our efforts to exclude papers relating to the description of technological attributes, and that digitalization has been big in research disciplines such as IT, computer science etc. Both “digital transformation” and “digitalization” are represented in most of the categories, which may indicate that these terms is not industry specific concepts. In the “Library and archival” category the terms “digitization” and “digital transformation” are heavily represented with respectively 19 and 14 papers, amounting to 44 and 32 percent of the respective category. This might indicate that the digital influence on industries covered in this research category mostly concerns digitization, as information goes from analog to digital, which is very applicable in this industry, and further that the product offered to consumers in the industry require a DT for businesses to stay competitive.

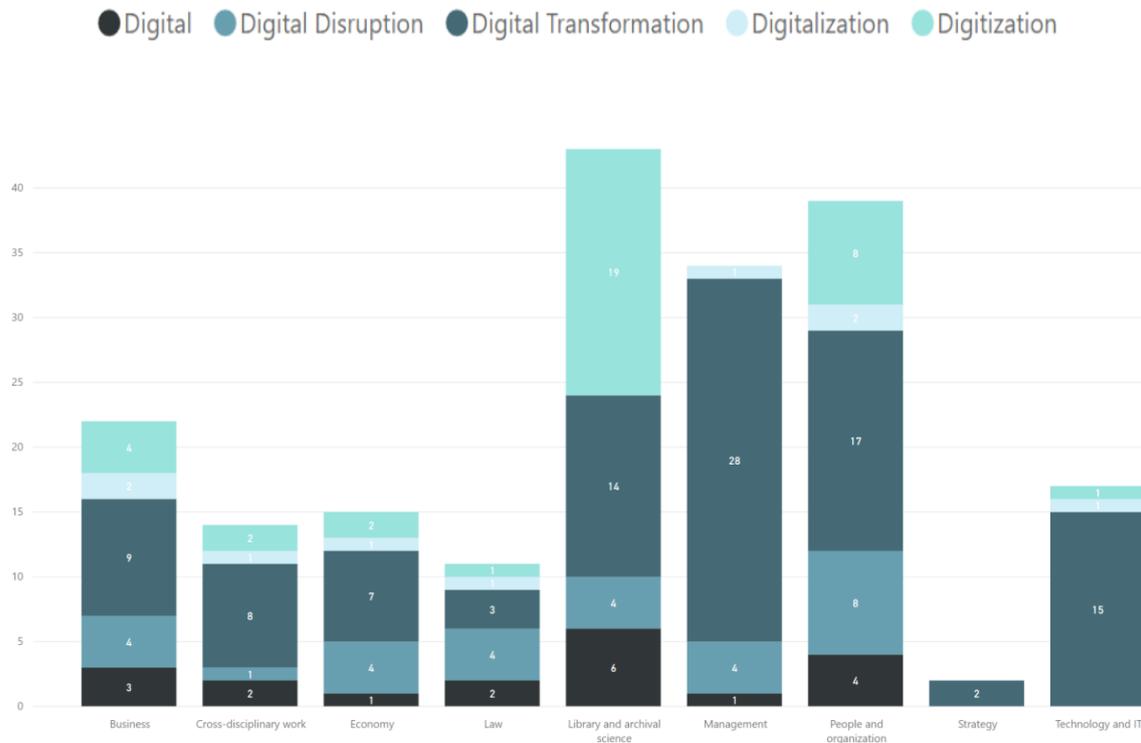


Figure 4 Digit\* term in title, keyword and abstract within each journal category

To complete the descriptive analysis, we examined the evolution of the terms covered in figure 4, and the development of each term over time is presented in figure 5. While “digital” does not have a clear development trend, “digital disruption” has grown since its first appearance in 2010. As IT and technological developments has grown rapidly the past ten years, it seems intuitive that technological breakthroughs (e.g. AI, machine learning, IoT) causes disruption to established practices. Further “digital transformation” goes back to 1994 but have had rapid growth in number of published papers in recent years. This growth may be explained by the omnipresent computing becoming close to reality with recent digital advancements, affecting traditional organizations strategy and BMs as they face disruptive competitors. Also, digital advancements pose greater opportunities (and challenges) to businesses and society, which may invite to- or press transformation. Papers regarding “digitalization” has been stable at 1-3 articles per year since it first appeared, while papers on “digitization” has had a modest growth until it started decreasing during 2016. Summarized the analysis of the term’s evolution shows that DT currently is a hot topic, that digitalization remains stable, and that digitization has decreased since its peak in 2016. The results and relating indications from the descriptive analysis will be discussed in relation to the bibliometric- and content analysis in the subchapter Compilation of findings.

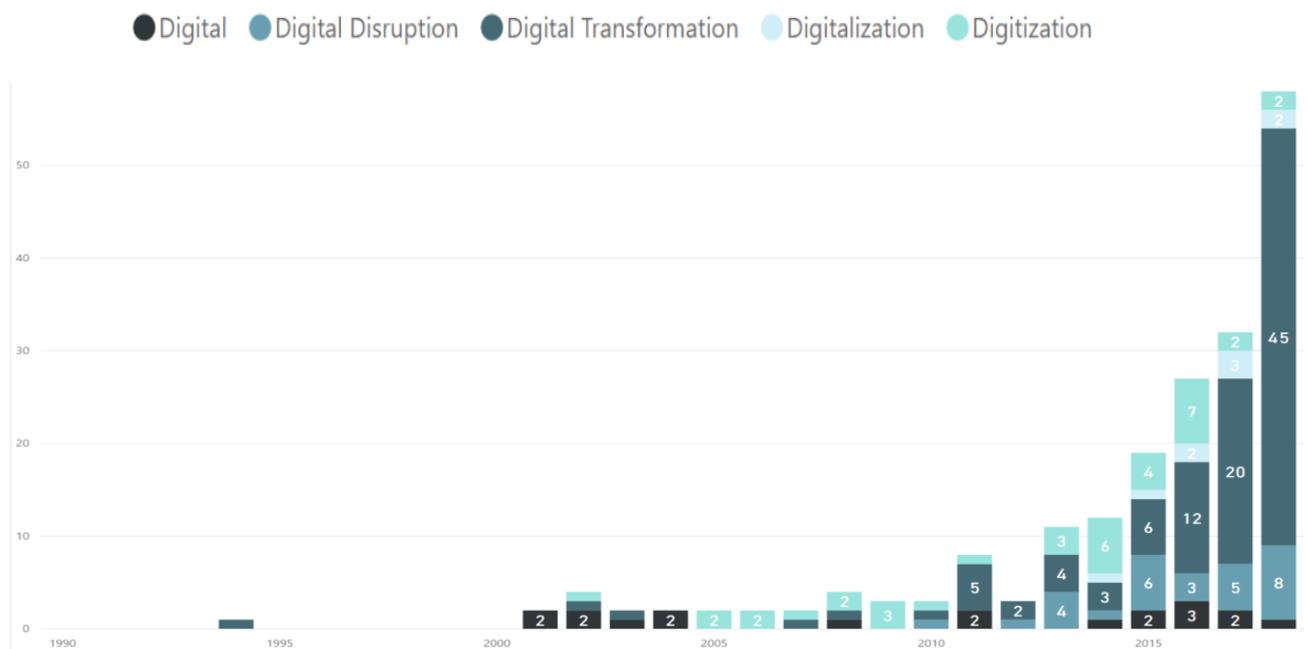


Figure 5 The development of terms written about in the period 1994-2018

#### 4.2 Bibliometric analysis

The following results stems from our co-occurrence analysis with keywords as the unit of analysis. For this purpose, we employed VosViewer. Using a threshold of five, three clusters consisting of 15 keywords and 65 links was identified. As this threshold is somewhat limiting in terms of the number of keywords, it is appropriate to reduce the threshold to four to include all relevant keywords for analysis purposes. This is justified by the fact that we only have 197 articles in our database, which results in a low number of co-occurrence keywords for higher thresholds. Reducing the threshold to three and requiring that the link strength is above ten gave us 25 keywords. The keywords excluded by link strength was “challenges”, “leadership”, “digital platforms”, “accountability”, “information-systems”, “internet”, “2-sided markets”, “digital”, “digital economy”, and “education”. The results from our co-occurrence analysis is presented in Figure 6.



Cluster 1 - Business				Cluster 2 - Management			
Word	LS	OC	EC	Word	LS	OC	EC
Organizations	27	10	0,85	Management	46	13	1
Technology	28	13	0,82	Innovation	22	10	0,84
Public Sector	24	5	0,81	Systems	15	6	0,71
Business	13	5	0,57	Performance	19	7	0,65
Digitization	6	7	0,44	Dynamic capabilities	13	4	0,51
Cluster 3 - Strategy				Cluster 4 - Library and archive			
Word	LS	OC	EC	Word	LS	OC	EC
Digital transformation	39	24	0,91	Information Technology	19	6	0,71
Strategy	26	14	0,78	Adoption	9	4	0,49
Big Data	16	6	0,57	E-commerce	10	4	0,46
Digitalization	15	9	0,45	E-government	12	4	0,44
Business Model	9	4	0,41				

Table 2 Summary of the bibliometric findings in the co-occurrence analysis

<b>Digitization</b>	<b>Digital Transformation</b>
Governance	Management
Technology	Innovation
Organizations	Organizations
Innovation	Strategy
Management	Public Sector
Digital transformation	Business models
	Dynamic capabilities
	Big data
<b>Digitalization</b>	Systems
Digital transformation	Performance
Technology	Information Technology
Big data	Adoption
Strategy	E-commerce
Information Technology	E-government
Performance	Digitization
Business model	Digitalization
	Social Media

Table 3 Keywords connected to digit\* concepts

Further, we found that “digital transformation” has the highest number of keywords in common with the other two digit\* concepts. “Digitalization” and “digital transformation” are the two terms closest related, with five common keywords (i.e. Big data, BM, IT, performance, strategy), while “digital transformation” and “digitization” has three common keywords (i.e. Organizations, innovation, management). “Digitalization” and “digitization” are the two concepts least related according to our co-occurrence analysis, with only “digital transformation” and “technology” as common keywords. The fact that both “digitalization” and “digitization” has “digital transformation” as one of their associated terms indicates that several papers in our database discusses more than one digit\* term. From table 2 we see that DT has a larger number of keywords associated with it outside the cluster it is represented in.

In addition to the keywords in cluster 3, DT is connected to other words such as ‘business models’, ‘innovation’, and ‘dynamic capabilities. This indicates several interesting relations as researchers in our final search database mentions these keywords in papers concerning DT - e.g. that DT affect BMs or that innovative BMs leads DT. The relation DT has to both innovation and dynamic capabilities may indicate that the organization's ability to adapt and catapult the organization’s resource base when facing a need to digitally transform - e.g. innovative BMs - is important. In the content analysis we seek to find why the concepts are appear as related in our co-occurrence analysis (e.g. if the terms are used interchangeably, if more than one concept is being discussed in a paper, or other reasons for the connection). Overall the co-occurrence analysis of keywords shows that “digital transformation” is the most cited term in our database and that it often occurs in articles with one of the two other digit\* terms, while “digitization” and “digitalization” is not cited together in articles.

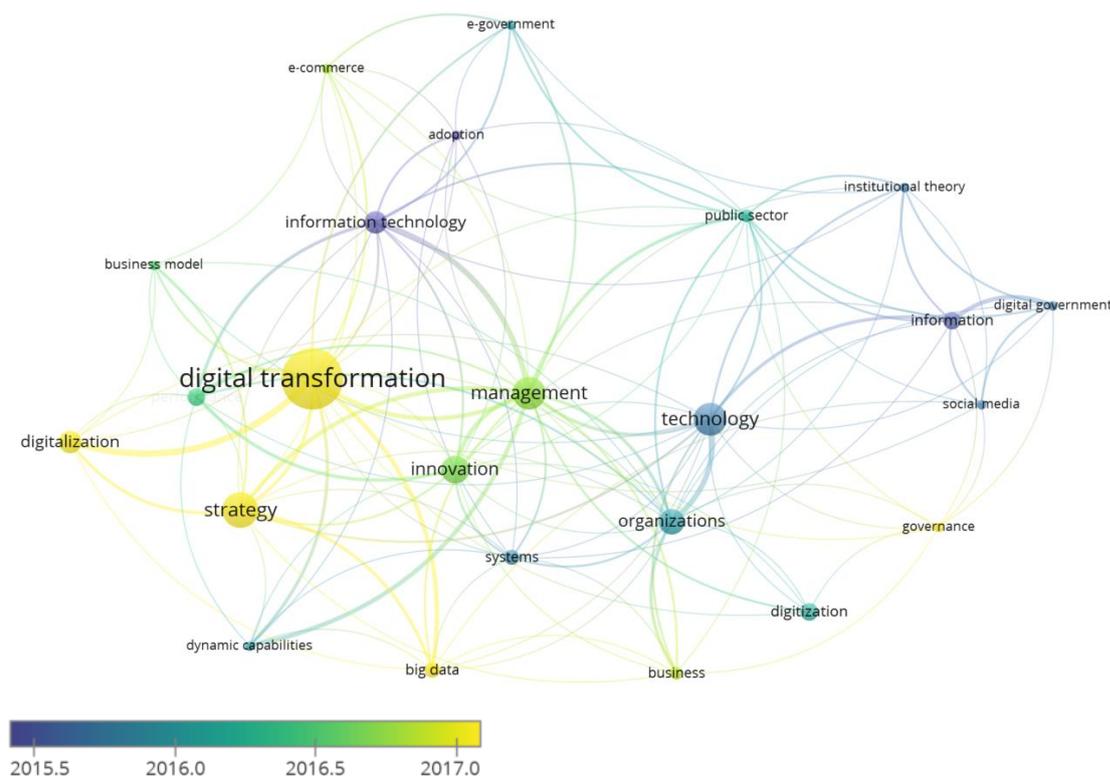


Figure 7 Keyword cluster development over time

Using the overlay visualization function in VosViewer (Figure 7) we categorized the digitalization terms to see which years there has been published articles containing them, and at what density. The results show that “digital transformation” is the hottest topic in recent years with an average publication year of 2017.5, with “digitalization” close up with an

average publication year of 2017.44. “Digitization” on the other hand peaks in 2016.14. Further, Figure 7 reveal that adoption and IT are the least recent concepts - thus they are not trending. Further, the link between “digital transformation” and “digitalization”, “strategy”, “big data” and “governance” is yellow, which indicates that these keywords are used frequently together in recent times. Whereas the link between “digital transformation”, “innovation”, “business model” and “e-commerce” is recent, but not shown in the newest papers in our final search database. “Digitalization” has a trending link with keyword such as “strategy”, “digital transformation” and “big data”, whereas digitization is not a trending term, and has no trending links either. The link between “digital transformation” and “information”, technology” and “information technology” are not trending and has not been written about together since approximately July 2015.

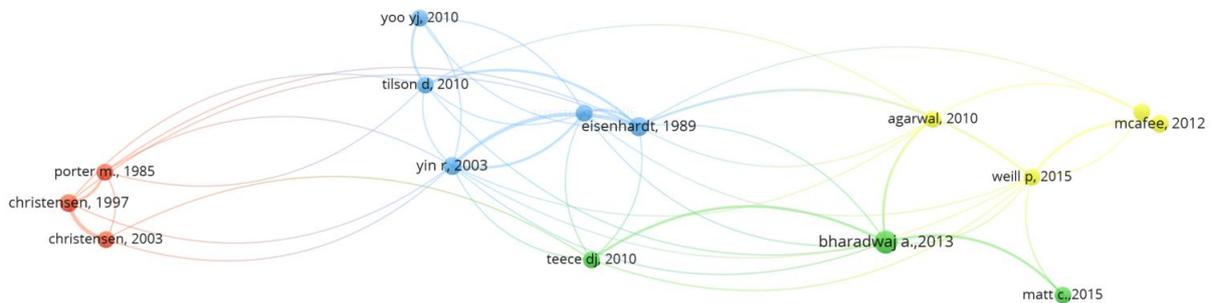


Figure 8 Co-citation analysis cluster

Cluster 1 - Method				Cluster 2 - Management			
Author	LS	OC	EC	Author	LS	OC	EC
Yin, 2003	14	5	1	Weill, 2015	10	4	0,69
Eisenhardt, 1989	16	6	0,99	Agarwal, 2010	6	4	0,53
Tilson, 2006	10	4	0,79	McAfee, 2012	4	5	0,27
Armstrong, 2006	9	4	0,69	Berman Saul, 2012	3	4	0,21
Yoo YJ, 2010	5	4	0,50				
Cluster 3 - Innovation				Cluster 4 - Strategy			
Author	LS	OC	EC	Author	LS	OC	EC
Bharadwaj, 2013	11	10	0,79	Christensen, 1997	8	5	0,52
Teece, 2010	7	4	0,65	Porter, 1985	6	4	0,52
Matt, 2015	3	4	0,21	Christensen, 2003	6	4	0,38

Table 4 Summary of bibliometric findings in the co-citation analysis

In the co-citation analysis, we chose four as the number of cited references for figure 8 and table 3. The most cited reference within our database, with 10 citations (OC), is Digital business strategy: toward a next generation of insights by Bharadwaj et al. (2013). The co-citation map creates four clusters, and table 3 summarize the findings. From the map we see

that the most cited articles can be categorized within four main disciplines, notably ‘method’, ‘management’, ‘strategy’ and ‘innovation’. Even though we have seen that there are only two articles within our database that are published in a strategy journal, we found that there are many citations to papers regarding strategy. Further, Table 3 show that the two most influential references within our database is theory built from cases (Yin, 2003; Eisenhardt, 2007). Both references deal with qualitative methods. To achieve a more throughout understanding of the most cited references especially associated with method, we made a map with two as the number of cited references and converted the map to an Excel sheet. The reason we reduced the number of cited references for this purpose was to obtain more information regarding all citations - not only the ones cited four times. This analysis revealed that there were 11 sources (6.3 percent) that was cited related to method within our database, whereas all of the references concerned qualitative method. In total, thirty of the papers in our final search database had citations to qualitative method sources, and none to quantitative method papers or books. This indicates that the research within digitalization still is young, since qualitative research normally comes prior to the quantitative research in order to have enough data to analyze with the quantitative methods. Further, we find that much of the research in this area is explanatory or conceptual, and not empirical, and that the different case studies are spread across all the other disciplines (e.g strategy, management and innovation), which means that there is no pattern in which disciplines (e.g strategy, innovation and management) that normally conduct case studies and performs other types of studies. The results from the bibliometric analysis will be discussed in relation to the descriptive- and content analysis in the subchapter Compilation of findings.

### ***4.3 Content analysis***

From a review of the literature, the main functionalities of the three main digitalization concepts has been identified. The common denominators in digitization is conversion of analog information into a digital form for cost- and efficiency purposes, as well as information sharing among stakeholders. Second, while some digitalization researchers highlight digitization purposes as facilitators for digitalization through investments into technology and information sharing, they commonly agree that this stage goes beyond purely digitizing information. While there is not explicit agreement across all authors about what digitalization may lead to, the common denominator is that changes are at the process level

with e.g. accelerating shifts from product to service-based businesses and is described as e.g. a sociotechnical process of applying digitizing techniques to a broader social and institutional context. The purpose of digitalization is commonly the ambition to be more efficient and reduce costs, and changing interactions and organizational structures. Finally, DT is commonly described as something concerned with changes digital technologies can bring about in a company's BM, resulting from e.g. the dynamic phase of technological progress and innovation that changes social behaviours - which in turn transforms an organization or networks of organizations on different levels. This level of digitalization is commonly described as something that affects business processes, structures, and relations, and thus go beyond automation by affecting organizational structures and network opportunities. Further, while some argue DT leads to cost reduction and increased efficiency like the latter two levels, the majority agree that it relates to BM innovation and increased opportunities in regard to e.g. value propositions, value creation, networks and relationships. These properties are argued to lead to opportunities in competitive advantage and has the potential to impact at ecosystem level - depending on the societal change.

### 4.3.1 Digitization

<b>Digitization</b>		
<b>Reference</b>		
Gaigher, S., Le Roux, E., & Bothma, T. (2014)	<b>Description</b>	Digitizing content by making format of books electronic and publish all titles. In the publishing industry the change is described as having been incremental rather than disruptive.
	<b>Purpose</b>	Making books digital to achieve cost- and efficiency improvements. Digital publishing and digitizing processes can result in e.g. shorter publishing value chain, better control over projects and budgets, cost reduction, better customer overview and -relations.
Bhimani, A., & Willcocks, L. (2014)	<b>Description</b>	Data on aggregate level.
	<b>Purpose</b>	Cost reduction, structure large amounts of data to use for market-, business-, customer-, and management purposes.
Desai, D. R. (2013)	<b>Description</b>	Digitization changes markets by opening the door to decentralized production, lower costs, and disruption of incumbents. However, digitization does not mean perpetual disruption is at hand.
	<b>Purpose</b>	Customer-focused industries can gain competitive advantage by digitizing products and services to make them more accessible to consumers. Further, digitization enables decentralization and cost reduction.
Janowski, T. (2015)	<b>Description</b>	Digitization involves the development, operation and maintenance of the technological environment, including the availability of technological capabilities, services and infrastructure within and between government organization.
	<b>Purpose</b>	Automating existing processes, services and offices; making services accessible to citizens in digitized format and through digital networks.
Valenduc, G., & Vendramin, P. (2017)	<b>Purpose</b>	Digitization promotes performance and is a strategic economic resource (i.e. data storage, collection and processing).

*Table 5 Digitization content analysis*

Schallamo, Williams, and Boardman (2017) refers to digitization to something that stands for the complete networking of all sectors of the economy and society, as well as the ability to collect relevant information, and to analyze and translate that information into actions.

Janowski (2015) describes four evolution stages for a digital government whereas digitization is the first stage which entails the representation of data, documents and other information in digital formats, when previously held by government organizations in physical or analog forms; making such information available to staff, partners and other stakeholders within and outside a government organization in digital formats. Janowski (2015) give the reader examples of initiatives undertaken at the digitization stage (e.g. Access to information in electronic formats and developing, analyzing and operating websites). Heilig, Lalla-Ruiz, and Voß (2017) refers to digitization as the process of converting analog sources into a digital form. Furthermore, Bhimani and Willcocks (2014) refers to the digitization as making data,

information and knowledge digital. Some researchers are not describing the digitization explicitly but use the concept of digitization to describe digital changes industries has gone through. For example Gaigher, Le Roux, and Bothma (2014) describes digitization as the process of making content digital and has a focus on the publishing industry, and Moreau's (2013) article is about remodel records into digital files which is referred to as digitization. There is broad concession in the reviewed articles in relation to how digitization refers to taking analog information to digital information so that computers can store, process, and transmit information (Moreau, 2013; Bhimani & Willcocks, 2014; Gaigher, Le Roux, & Bothma, 2014; Janowski, 2015; Schallamo, Williams, & Boardman, 2017; Heilig, Lalla-Ruiz, & Voß, 2017).

Although the purpose of the digitization is more fragmented throughout the reviewed articles than the descriptions of the concepts of digitization, there are some similarities. There is some consensus in research that the aspiration behind undergoing a digitization process is that this could lead to cost improvements (Desai, 2013; Bhimani & Willcocks, 2014; Gaigher, Le Roux, & Bothma, 2014). While Gaigher, Le Roux, and Bothma (2014) points out that digitizing processes can lead to cost - and efficiency improvements (e.g shorter publishing value chain, better control and customer overview and relations), Janowski (2015) specify that the digitization stage in principle does not involve redesigning, improving or any way changing existing processes, services or practices, but merely digitizing and automating what already exists and making the outcomes available to the same stakeholders and customers through digital networks. Janowski (2015) describe the digitization as a stage that alone offers limited value to government organizations in term of improving internal operations, which indicate the opposite of Gaigher, Le Roux, and Bothma (2014).

The focus of digitization varies across the reviewed papers, whereas some focus on digitizing the products offered to consumers (e.g. Desai, 2013; Moreau, 2013; Gaigher, Le Roux, & Bothma, 2014), others focus on internal organizational processes and activities (e.g Bhimani & Willcocks, 2014; Janowski, 2015). Commonalities between the articles that focus on digitizing products rather than organizational activities is that they describe the digitization as a disruptive technology that change how the market and industry play. Gaigher, Le Roux, and Bothma (2014) demonstrate that strategies must be developed and applied to cope with the disruptiveness of the industry and Moreau (2013) points out that industry players have to customize their BM to cope with industry changes and to stay competitive. The explanation

may lie in the fact that in both industries’ (i.e publishing and music production) operations and income largely rely on the product that is digitized, which indicate that their operations, strategy, and BM has to change as their offered products no longer are selling. As for the articles that merely focus on the organizational aspect of digitization, the focus lies on the activities level. Digitization facilitates cost reduction, structure large amounts of data to use for market-, business-, customer-, and management purposes (Bhimani & Willcocks, 2014), and to automate existing processes, services and offices; making services accessible to citizens in digitized format and through digital networks (Janowski, 2015). Thus, digitization as described in an organizational change setting is at the activities level and the organization achieve transparency, scalability, and asynchrony related to obtainable organizational information.

### 3.2 Digitalization

<b>Digitalization</b>		
<b>Reference</b>		
Hänninen, M., Smedlund, A., & Mitronen, L. (2018)	<b>Description</b>	Digitalization as a tool for business model innovation in the retail sector. Digitalization accelerate the shift from product to service based businesses affecting how firms compete and transact with consumers.
	<b>Purpose</b>	Create value-adding concepts and services for consumers and increased cost-efficiency, complemented by new digital business models that create opportunities to satisfy hedonistic needs through the facilitation of novel types of digital consumer-to-firm engagement, consumer experience and consumer value.
Stoekli, E., Dremel, C., & Uebernickel, F. (2018)	<b>Description</b>	Digitalization is already far progressed and goes beyond shifting from analogue to digital information. InsurTech as a part of FinTech is conceptualized as a phenomenon comprising innovations of one or more traditional or non-traditional market players exploiting information technology to deliver solutions specific to the insurance industry.
	<b>Purpose</b>	InsurTech impact the industry structure, namely by the rise of novel digital intermediaries (i.e., aggregation, facilitation, matching and trust) in the personal insurance market.
Heilig, L., Lalla-Ruiz, E., & Voß, S. (2017)	<b>Description</b>	Digitization is the process of converting analog sources into a digital form. Digitalization is described as sociotechnical process of applying digitizing techniques to broader social and institutional contexts.
	<b>Purpose</b>	Digitalization provides opportunities to enhance the productivity, efficiency, and sustainability of logistics.

*Table 6 Digitalization content analysis*

‘Digitization’ and ‘digitalization’ are two conceptual terms that are closely associated and used together in several of the papers we reviewed. Several papers describe digitization as

something that precedes digitalization, and others describes digitization as a part of the digitalization process. E.g. Valenduc & Vendramin (2017) refer to digitized information as one of four aspects of digitalization, and Heilig, Lalla-Ruiz, and Voß (2017) argue that investments into technology and cooperation for promoting information sharing are strong facilitators for digitalization. The latter authors further argue that digitalization goes beyond shifting from analog to digital information and describe the concept as a sociotechnical process of applying digitizing techniques to broader social and institutional contexts (Heilig, Lalla-Ruiz, & Voß, 2017). Thus, although the concepts are closely associated and used interchangeably, there is a clear distinction between concepts in parts of the digitalization literature. Similar to Heilig, Lalla-Ruiz, and Voß (2017), Stoeckli, Dremel, and Uebernickel (2016) argue that the concept of digitalization is far progressed and goes beyond shifting from analog to digital information, and Hanninen, Smedlund, and Mitronen (2018) says explicitly that digitalization is a tool for BM innovation as it can contribute to the shift from product to service-based businesses. They argue that the process of digitalization accelerates the shift from product to service, and affects how firms compete and transact with customers, i.e. affecting connectivity. Thus, descriptions of digitalization reveal that the concept goes beyond digitization (Stoeckli, Dremel, & Uebernickel, 2016), that it changes organizational strategy and competitive advantage (Hanninen, Smedlund, & Mitronen, 2018), and is a sociotechnical process of applying digitizing techniques to broader social and institutional contexts (Heilig, Lalla-Ruiz, & Voß, 2017).

In regard to the purpose of digitalization, there is a commonality that the ambition is to be more efficient and reduce costs (e.g. Heilig, Lalla-Ruiz, & Voß, 2017; Hanninen, Smedlund, & Mitronen, 2018). The researchers in our content sample overall agree that digitalization will change organizational structures, interactions internally and with customers. E.g. Stoeckli, Dremel, and Uebernickel (2018) denote that the digitalization process requires changes in the organizational structure, strategies and processes, while Hanninen, Smedlund, and Mitronen (2018) express that digitalization require managers to understand and react to the changing industry landscape at a faster pace. Compared to digitization, descriptions of the concept of digitalization focus more on the changes to workforce and organizational processes, rather than digital technologies as facilitators for e.g. conversion of information. I.e. some argue that the current wave of digitalization combines trends in the analysis of the information society (Valenduc & Vendramin, 2017), and - as we saw in the previous section - that it is a socio technical process of applying digitizing techniques to broader social and

institutional contexts (Heilig, Lalla-Ruiz, & Voß, 2017). Thus, it can be argued that digitalization is at the organizational process level and relates to e.g. elements in a process that can be automated and thus is sources of cost reduction and efficiency.

### 4.3.3 Digital transformation

Reference		Digital transformation		Reference	
Hess, T., Matt, C., Benlian, A., & Wiesböck, F. (2016)	<b>Description</b>	Digital transformation is concerned with the changes digital technologies can bring about in a company's business model, which result in changed products or organizational structures or in the automation of processes.	Janowski, T. (2015)	<b>Description</b>	Digital transformation improves internal processes, structures and working practices of a government organization through the application of digital technology.
	<b>Purpose</b>	The purpose of the journey toward digital transformation is to reap the benefits of digital technologies, such as productivity improvements, cost reductions and innovation.		<b>Purpose</b>	Aims to improving internal processes, structures and working practices of a government organization through the application of digital technology.
Schallmo, D., Williams, C. A., & Boardman, L. (2017)	<b>Description</b>	The digital transformation framework includes the networking of actors such as businesses and customers across all value-added chain segments, and the application of new technologies. As such, digital transformation requires skills that involve the extraction and exchange of data as well as the analysis and conversion of that data into actionable information. This information should be used to calculate and evaluate options, in order to enable decisions and/or initiate activities. In order to increase the performance and reach of a company, digital transformation involves companies, business models, processes, relationships, products, etc.	Heilig, L., Lalla-Ruiz, E., & Voß, S. (2017).	<b>Description</b>	Digitization is the process of converting analogue sources into a digital form. Digitalization is described as sociotechnical process of applying digitizing techniques to broader social and institutional contexts. Digital transformation is a broader process of transforming an organization or a network of organizations on different levels (e.g., strategy, governance, leadership, culture, people, technology, etc.) by making use of digital technologies and concepts.
	<b>Purpose</b>	Use the potential of digitization to shape the business models digital transformation. The digital transformation of business models plays an essential role because business models' individual elements can be digitally transformed, e.g. though opening new networking possibilities and enabling cooperation between different actors, who, for example, exchange data and thus initiate processes.		<b>Purpose</b>	Digitalization provides many opportunities to enhance the productivity, efficiency, and sustainability of logistics. Digital transformation is used in order to achieve benefits that may lead to competitive advantages, and to achieve this a transformation of intra- and inter-organizational activities is necessary and often even fostered by the adoption and use of innovative digital technologies.
Loonam, J., Eaves, S., Kumar, V., & Parry, G. (2018)	<b>Description</b>	Digital transformation is the use of new digital technologies (e.g. virtualization, mobility, analytical systems, etc.) that are integrated with back-office ICT to provide a holistic view of the digital enterprise.	Liu, D. Y., Chen, S. W., & Chou, T. C. (2011)	<b>Description</b>	The integration of digital technologies into business processes.
	<b>Purpose</b>	Digital transformation in organizations are conducted to garner greater competitive advantages and significant strategic advantages within their respective industry.		<b>Purpose</b>	Structuring new business operations to facilitate and fully leverage firms' core competence through digital technology in order to attain competitive advantage.
Kotarba, M. (2018)	<b>Description</b>	Digital transformation is defined as the modification (or adaptation) of business models, resulting from the dynamic pace of technological progress and innovation that trigger changes in consumer and social behaviors.	Andal-Ancion, A., Cartwright, P. A., & Yip, G. S. (2003)	<b>Description</b>	Digitalization provides many opportunities to enhance the productivity, efficiency, and sustainability of logistics. Digital transformation is used in order to achieve benefits that may lead to competitive advantages, and to achieve this a transformation of intra- and inter-organizational activities is necessary and often even fostered by the adoption and use of innovative digital technologies.
	<b>Purpose</b>	Business model adjustments to the digital / technological and social changes can transform to a new organizational form better fit for functioning in the digital economy, in relationships to the digital clients and partners as well as with the increasing usage of digital assets.		<b>Purpose</b>	

Table 7 Digital transformation content analysis

According to Hess et al. (2016) DT is concerned with the changes digital technologies can bring about in a company's BM, resulting in changed products, organizational structures or automation of processes. Kotarba (2018) defines DT similarly, describing it as the modification of BMs resulting from the dynamic pace of technological progress and innovation that trigger changes in consumer and social behaviors. Similar to the former two definitions, Heilig, Lalla-Ruiz, and Voß (2017) describe DT as a broader process of transforming an organization or a network of organizations on different levels by making use of digital technologies and concepts. Further, this level of digitalization is described as something that affects business processes (e.g. Liu, Chen, & Chou, 2011; Janowski, 2015; Schallmo, Williams, & Boardman, 2017), structures (e.g. Janowski, 2015; Hess et al., 2016), and relations (e.g. Schallmo, Williams, & Boardman, 2017; Kotarba, 2018), i.e. it goes beyond automation and affects organization structures and network opportunities. So, while

some authors find that part of the purpose of DT is at the organizational activities level with e.g. cost reduction (e.g. Andal-Ancion, Cartwright, & Yip, 2003; Hess et al., 2016; Heilig, Lalla-Ruiz, & Voß, 2017) and efficiency (eg. Janowski, 2015; Heilig, Lalla-Ruiz, & Voß, 2017), the majority agrees that DT relates to BM innovation in e.g. value propositions, networks and relationships.

Kotabra (2018, p. 126) argue that the meaning of “digital” as a process to introduce the digital into a selected aspect of reality is *“the formation of new entities and relationships driven by application of information technology”*. In this statement, IT is an enabler of changes to the paradigms of organizations and individuals (e.g. new entities and relationships). Relationships with clients are being impacted by the growth and rapidity of connectivity within human and corporate networks (Kotabra, 2018), and Schallmo, Williams, and Boardman (2017, p. 2) argue that *“digital transformation opens new networking possibilities and enables cooperation between different actors”*. Similarly, Heilig, Lalla-Ruiz, and Voß (2017) argue that investments into technology and cooperation is strongly promoted by the improvements of information sharing and better coordination and collaboration. Further, while the partnership domain in the original BMC taxonomy describes cooperation arrangements between various market participants, Kotabra (2018) extended this with the concept of ecosystems. He argues that new partnerships are enabled by the DT through usage of advanced technologies, that in turn facilitates instant connectivity and access to the growing sources of data that support new cross-sell or cross-service opportunities (Kotabra, 2018). Thus, he relates DT to changes at the ecosystem-level, as he promotes that one of the key trends to recognize in the partnership domain is *“the creation of original ecosystems where new, digitally enabled products or services encourage the demand via nontraditional methods (e.g., with a dominating share of P2P networking)”* (Kotabra, 2018, p. 136).

Hess et al. (2016) state that the changes in value creation due to DT derive from the way in which digital technologies alter a firm’s BM. Kotabra (2018) argue that one of the major changes to organizations value proposition relates to the connectivity derived from digitalization, saying *“one of the core developments in the value proposition is related to multiservice platforms created to attract not only direct customers but also other service providers.”* Heilig, Lalla-Ruiz, and Voß (2017) also discuss value in relation to DT, stating that sources for business value creation stems from how digital strategies and related transformation allow new ways of creating value (e.g. co-creation and product- or service

complementation through network participants). As they state DT can lead to a business scope redefinition, they also argue new sources of business value creation may follow through new products and services. Further, Loonam et al. (2018) highlights the importance of striking a balance between human touch and digital opportunities when e.g. rethinking value propositions, by for example co-using advanced analytical insights to understand customer needs. They emphasize the importance of ensuring both internal systems and external digital systems are integrated and able to speak to one another, entailing that organizations embed processes that bring the customer in to understand the customer need and expectations (Loonam et al., 2018). This is in line with Westerman et al. (2011) as cited in Schallmo, Williams, and Boardman (2017) who state that using advances in digital technologies are used to change customer relationships, internal processes and value propositions.

Furthermore, several authors explicitly mention DT as a means to achieve competitive advantage. Heilig, Lalla-Ruiz, and Voß (2017) argues that innovative digital technologies often foster the transformation of intra- and inter-organizational activities that is necessary to achieve benefits that may lead to competitive advantages. They also emphasize that the success of DT lies especially in the adaption of organizational structures, and not only in using advanced technologies and methods (Heilig, Lalla-Ruiz, & Voß, 2017). In this regard, they observe that digital initiatives - despite of being innovative and purposeful - can fail if one does not aptly consider requirements, implications, and perspectives for individual actors, especially in complex ecosystems (Heilig, Lalla-Ruiz, & Voß, 2017). This emphasize that the alignment of strategies and cooperation among different actors play a crucial role in transforming ecosystems with common goals, and one has to consider intra-, inter-, and meta-organizational perspectives to what DT might bring about. Also, Loonam et al. (2018) argues that organizations can draw strategic advantages from DT. They state that organizations must successfully craft a vision that aligns internal business process integration with external digital technology opportunities to leverage significant strategic advantages in their respective industry. This implies, according to Loonam et al. (2018), that organizations need to develop a clear view of the required BM innovations when implementing digital technologies to make sure the organization aligns with the needs of the transformative initiative. Further, they emphasize the importance for organizations to view the transformation from a business perspective, and not driven as a technology solution.

## ***4.4 Compilation of findings***

### *4.4.1 Digitization*

In this subchapter we seek to assemble the three analysis results in order to identify relations between them. In the content analysis we found that there was broad consensus that digitization primarily revolves around conversion of analog information with the purpose of achieving cost- and efficiency goals. In the bibliometric analysis we revealed that “digitization” relates to “Technology”, which connects with the findings in the content analysis regarding digitizing information. Further, it connects with “Organization”, “Innovation”, and “Management”, which also can be explained by findings in the content analysis. E.g. we find some authors go beyond describing the concept as a conversion method for storage and information purposes and focus on the internal organizational processes at the activities level, where digitization is seen as a tool to facilitate cost reduction and automate processes, and in addition may be used for management purposes by structuring large amount of data for business. Some authors also describe digitization as a step in a DT process, describing digitization as a disruptive change through e.g. making digitized products available and thus affecting parts of the organizational strategy and BM. The content analysis thereby substantiates the findings in our bibliometric co-occurrence analysis.

This level of digitalization connection with “Digital transformation” may also be explained by the descriptive analysis, as most of the papers included in the “Library and archival science” journal category revolves around digitization and DT. This is a business area that traditionally has large amounts of analog information and will naturally be affected by digital storage and information sharing opportunities through technological advancements. This may also facilitate value creation, and fundamentally transform the BM innovation opportunities. Finally, it seems it is not a ‘hot topic’ in digitalization research as it peaked in february 2016, but there are still a large number of publications on digitization. This may be connected with the large percentage growth in digitalization and DT research in recent years, as digitization are described as a tool in these processes by some.

### *4.4.2 Digitalization*

Digitalization is closely related to the concept of digitization according to our content analysis, but authors commonly argue that digitalization goes beyond shifting from analog to

digital information. Digitization can be seen as a part of the digitalization process, where authors describe this level of digitalization as e.g. a sociotechnical process of applying digitizing techniques to a broader social and institutional context, and that it is a change at the process level through changing organizational structures, internal interactions, and transactions with customers and stakeholders. This information relates to findings in the co-occurrence analysis, where “Technology”, “Big data”, “Strategy”, “Performance” and “Information Technology” relates to the concept. Further, “Business model” and “Digital transformation” is closely related to digitalization, and findings in the content analysis suggest that digitalization is a tool for BM innovation as it can contribute to the shift from product to service-based BMs, which substantiates the findings in our bibliometric co-occurrence analysis. The content analysis also uncovered that while digitalization like digitization focus on cost- and efficiency opportunities, it also revolves around social changes in markets and the workforce and may facilitate for network- and value creation.

From the descriptive analysis we found that digitalization is evenly distributed across all journal categories, except for “Library and archive” and “Strategy”. In our final search database, digitalization papers were least represented out of the digit\* concepts. However, “digitalization” far precedes the other digitalization concepts when doing our initial search on Google Scholar, which may indicate that this term is used to describe technological attributes - a theme we systematically excluded from our search database. The first article involving digitalization in our final search database was in 2014, and there has been a stable distribution of digitalization articles in the period 2014-2018, although the number of digitization papers as a percentage of total published each year has been reduced during the time period. Published papers on this concept peaked in May/June 2017.

#### *4.4.3 Digital transformation*

In the content analysis we discovered that authors commonly agree that DT is concerned with the changes digital technologies can bring about in a company’s BM, or BM adaption or transformation as a result from technological progress and innovation. This supports several findings in the bibliometric co-occurrence analysis, revealing that DT relates to e.g. “Innovation”, “Business models”, “Dynamic capabilities”, “Performance”, “Adoption”, and “Organization”. Further, while some authors find that part of the purpose of DT is at the organizational process level, the majority agrees that it goes beyond the two previous levels

of digitalization and relates to BM innovation in e.g. value propositions, networks and relationships. These findings in the content analysis support relations “Social Media”, “Information Technology”, “Systems”, “Management” and “Strategy” found in the co-occurrence analysis. The co-occurrence analysis also reveals that this level of transformation relates to the former two, as digitization and digitalization often are being described as a part of DT. Thus, while DT commonly is being described as an organizational- and ecosystem level change creating opportunities in value creation, value propositions, networks and relationships, cost reduction and efficiency is also mentioned as part of the purpose of it.

Articles with a primary focus on DT is represented in all journal categories, but the largest share is found in the “Management” and “Technology and IT” category. Further, DT has the largest share of papers in all categories, except for “Library and archival science” and “Law” category where the theme digitization represents the largest share. This may be explained by the fact that both industries are heavily document and information focused. Further, the percentage of number of DT articles is increasing, and according to our bibliometric overlay visualization the topic peaked in July 2017.

#### *4.4.4 Other findings*

Overall, we uncovered that there has been an exponential growth in published digi\* themed papers over time, a trend indicating that there might be several research papers in progress and in proceedings. Further, we know that most of our papers are included in lower ranked journals, which initiates that research on digital change have an overweight in smaller and more niche focused journals. The journals are spread across nine different categories, whereas the strategy category only include two papers. We have seen that strategy is a very relevant aspect of the digitalization process, so the lack of strategy journals writing about these changes indicate that research is lagging behind. We have categorized journals based on subjective criteria, which could be considered a limitation of our data material. Furthermore, we have also categorized journals into digital concepts based on only title, abstract and keyword with also could be a source of error. The co-citation analysis revealed that there were four different disciplines that most papers referred to, whereas method was one of them. Furthermore, we saw that 30 of the papers in our final search database had citations to qualitative method sources and none to quantitative method sources. This might indicate that the research on digitalization is at a young and growing stage.

#### ***4.5 Conceptualization***

We have identified articles that have enabled us to distinguish between concepts that have made it possible to create a taxonomy. The taxonomy creates different opportunities and challenges on each digitalization level through associated dimensions. The model consists of three dimensions (cost reduction, connectivity and value creation). The cost reduction dimension involves both the effect of efficiency improvements and cost reduction that can be explained through asynchronous information, scaling of production and the death of distance. The concepts that tick off the connectivity dimension have opportunity to reap connectivity benefits by application of IT, through e.g. network possibilities, opportunities for cooperation between actors, and better coordination and collaboration through information sharing. In relation to digitalization connectivity describes the accelerating shift from product to service and affect social and institutional context - how firms compete and transact with customers. Whereas connectivity in DT is highlighted as the possibility to cooperate between different actors, or create ecosystems where new, digitally enabled products or services encourage demand via nontraditional methods. The value creation dimension derives from the way in which digital technologies alter a firm's BM. This relates to the connectivity dimension according to some authors - as illustrated in the content analysis under DT - as one of the core developments in the value proposition relates to multiservice platforms created to attract customers and service providers. Further, some discuss value creation in relation to DT as how digital strategies and related transformation allow new ways of creating value. This emphasize that the dimension creates opportunities and challenges, as value creation not necessarily derive directly from the DT, but the actions organizations can take in the transformation process. Several authors highlight this, emphasizing the importance of ensuring both internal- and external digital systems are integrated and able to speak to one another, entailing that organizations embed processes that bring the customer in, changing customer relationships, internal processes and value propositions.

We have identified that the tree concepts of digitalization concern digital change at different levels in the organization. The digitization concept is at an activities level, whereas the other two is at an organizational level. Although some of authors of the articles we read for the content analysis points out that processes can be digitized (Gaigher et al., 2014), the focus of

all of the articles are digitizing existing activities (e.g information, physical or analog documents, knowledge, content). Thus, digitization concerns changing and automating activities that already exists in organizations. There exists consensus in the articles reviewed that digitalization goes beyond digitization and that it involves application of technology to a broader social and institutional context. Digitalization contribute to servitization of organizations and affects how it compete and interact with consumers. Hence, digitalization takes on a more organizational focus, where the business processes are changing. DT is described as a broader process of transforming an organization and affects organization's business processes (e.g change products, structures, processes, organizational behaviors) and thus has to be complemented by changes in BM. Further, DT facilitate new social networks and new partnerships, and is therefore related to changes at the ecosystem-level.

The **cost reduction** dimension ticks off for all the digitalization concepts. Digitization can lead to asynchronous information, opportunities in scaling of production, a shorter publishing value chain, and better control and customer overview. As for digitalization, it is described as something that precedes digitization, as its span is a broader sociotechnical process of applying digitizing techniques in a larger scale to social and institutional contexts, with e.g. cost reduction and efficiency as consequences. Similarly, the content analysis revealed that part of the purpose with DT is cost reduction and efficiency, but like digitalization, it has a broader span of opportunities and challenges beyond these benefits.

The **connectivity** dimension comprises both digitalization and DT. For digitalization it represents an opportunity to connect activities together as more activities have been digitalized. The researchers in our content sample overall agree that digitalization will change organizational structures and interactions both internally and with customers and affects how firms compete and transact with customers. For DT this dimension represents an opportunity to cooperate between different actors or create ecosystems where new, digitally enabled products or services encourage demand via nontraditional methods. The process of DT further poses an opportunity to form new entities and relationships driven by the application of IT, that works as an enabler of changes to the paradigms of organizations and individuals. Thus, new partnerships are enabled at this level through usage of advanced technologies, that in turn facilitates instant connectivity and access to the growing sources of data that support cross-cell or cross-service opportunities.

In the last dimension, **value creation**, only DT is represented. Both digitization and digitalization can achieve value but represented by opportunity cost for available resources that can liberate time for other value retrieving activities. DT on the other hand represents opportunities for value creation, as explicitly uncovered in the content analysis. The changes in value creation due to DT derive from the way in which digital technologies alter a firm's BM. While organizations can go through a BM innovation regardless of whether they include digital processes, the value creation in DT relates to the connectivity derived from digitalization (e.g. developments in value proposition related to multiservice platforms created to attract customers and service providers). Further, some authors claim value creation in relation to DT stems from how digital strategies and related transformation allow new ways of creating value (e.g. co-creation or product- and service complementation through network participants).

The model is deterministic in the sense that the level is dependent on that the previous level is completed to have the opportunity to achieve complete gain of the next level, e.g. digitization is described as a stage that alone offers limited value in terms of improving operations, digitized information is referred to as an aspect of digitalization, digitalization is a tool for BM innovation as it can contribute to the shift from product to service based businesses. This is shown by the blue arrow upwards in Figure 9. Thus, it is necessary to start at the activities level, and digitize existing activities in your organization in order to utilize the potential opportunities at the digitalization stage. If your goal is to implement new technologies to create new value for your organization, you have to complete both digitization and digitalization stages in your organization first.

		Presuppose previous level		Dimensions		
				Challenges and opportunities		
Level				Cost reduction	Connectivity	Value creation
Digital transformation	Organizational and ecosystem level		↑	X	X	X
Digitalization	Organizational process level			X	X	
Digitization	Activities level			X		

Figure 9 Taxonomy

If your organization is about to go through a digitalization process, it is important to bear in mind that you have to start at the digitization level (e.g. the model is deterministic). Further,

you have to acknowledge that the digitalization processes and changes are just tools for cost reduction, connectivity and value creation that has to be complemented with effort, culture and willingness to change. The concepts of digitization facilitate the achievement of the dimensions, but it is crucial that the technology is used to achieve opportunities. The technology remains only a tool.

## **5. Concluding comments**

### ***5.1 Contribution***

By conducting a rigorous assessment of extant published research to address: How can a structured literature search utilizing bibliometric analysis enable the deconstruction of current published scientific research to provide a rigorous conceptual foundation for research and practice alike, this study provides a foundation for researching the currently hyped phenomenon of digitalization and related topics such as digital disruption and DT. The study confirms that the field remains immature and fragmented, and despite revealing that all identified articles in our content analysis sample address digitalization as an important aspect of changes in organizations and related strategy development, few strategy journals deal with the digit\* concepts. Indeed, there exists no comprehensive description of how strategy should be adapted to technological adaptations. There is also limited published quantitative research, probably relating to the limited understanding of how different technologies relates to different organizational outcomes.

In order to provide a vantagepoint upon which such research efforts could be based, we offer a taxonomy with a clear delimitation of interrelated terms and themes emphasizing the organizational and commercial implications of different related terms rather than identifying the type of technology applied or degree of technological complexity involved. The taxonomy identifies the level of analysis associated with each of its constituting terms; digitization, digitalization and DT connected in a stepwise process; eg. digitization is described as a stage that alone offers limited value in terms of improving operations, digitized information is referred to as an aspect of digitalization. Digitalization is a tool for BM innovation as it can contribute to the shift from product to service-based businesses. DT relates to the intra-organizational level, involving the external environment with implications for all the three dimensions. Therefore, the taxonomy offers a vantage point for subsequent empirical and conceptual research to extend insight on related digitalization themes, especially related to innovation and strategy decisions on scalability, automation, channel selection and connectivity.

## ***5.2 Practical implications***

Deciding on digital innovation and digital strategy is currently of primary concern to practitioners when navigating an increasingly disruptive environment. Our study condensed an overwhelming amount of digitalization research into a digestible 17 papers spanning across five interrelated disciplines. Moreover, we proposed a taxonomy that can be utilized to inform the innovation and strategy discussions within firms when deciding on future directions for their digitalization efforts. In particular, our suggested taxonomy offers an explicit emphasis on organizational and commercial consequences of different digitalization ambitions. We suggest that managerial teams discussing the selection and implementation of digital technologies to consider the organizational perspective underpinning our suggested taxonomy when addressing their digital innovation strategy in general, and in particular when deciding on, BM innovation, digital disruption, DT, disruptive innovation and Industry 4.0.

## ***5.3 Limitations***

The set of papers on concepts of digitalization identified for this sample may differ from those one might identify using other search strings and/or sampling strategies. For example, an alternative search string would be a title search on digit\* exclusively or using the same search string in a topic search. Further, an alternative sampling strategy would have been to manually review all articles in the initial database and identify every single paper that touched upon a concept of digitalization. Although this manual process also would have significant limitations (e.g. introducing considerable subjectivity into the article selection process, time intensiveness), such a process could capture articles with digitalization concepts that did not meet any of our sampling parameters (e.g. not mentioning digitalization concepts or related terms in their title or abstract). However, we believe that the systematic criteria we applied are reasonable for identifying relevant articles to better our understanding of the different digitalization concepts.

## ***5.4 Further research***

Bibliometric research is a good method for identifying overall trends in research fields, and a larger scale study would be expedient to further clean up the research field and create consensus on the different digitalization concepts. One alternative research would be to

conduct a similar analysis as this research project with a topic search to retrieve a search database with a larger scope. Another option could be to analyze the distribution of research in different countries, as we discovered interesting data through our analysis on this topic which we did not proceed with due to relevance to our research question and space considerations. The latter suggested research could give interesting insights on various demographic trends relating to digitalization and uncover local focus areas in technological development. Further, we found that research in our search database is mostly conceptual, we therefore call for a collective effort to mature research on digitalization. Finally, a surprising finding in our research is the low number of strategy research on digitalization - especially knowing that we designed the sample selection to purposefully include research fields focusing on organizations and related themes. We therefore call for efforts to increase strategic knowledge related to digitalization.

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## **Figures**

Figure 1 - Development in publications per year within the database consisting of 197 papers

Figure 2 Number and percentage of journals within each SJR Quartile

Figure 3 Number and percentage of publications within category

Figure 4 Digit\* term in title, keyword and abstract within each journal category

Figure 5 The development of terms written about in the period 1994-2018

Figure 6 VosViewer map showing the results of the co-occurrence analysis with keywords as unit of analysis

Figure 7 Keyword cluster development over time

Figure 8 Co-citation analysis cluster

Figure 9 Taxonomy

## **Tables**

Table 1 Development in published articles within each SJR category

Table 2 Summary of the bibliometric findings in the co-occurrence analysis

Table 3 Keywords connected to digit\* concepts

Table 4 Summary of bibliometric findings in the co-citation analysis

Table 5 Digitization content analysis

Table 6 Digitalization content analysis

Table 7 Digital transformation content analysis

**Appendix 1** - excluded and included WOS categories and reasons for the choice

*1.1 Excluded WOS categories*

Number of documents	Category/Dicipline	Reason for exclusion
287	Engineering electrical electronic	VosViewer: Algorithm, *Watermarking, Design, wavelet transform, system.
141	Optics	VosViewer: Microscopy, Digital holography, interferometry, system, wavelet transform, numerical reconstruction
74	Computer science information systems	VosViewer: algortim, digital watermarking and information technology
62	Instruments Instrumentation	VosViewer: Spectroscopy, spectrum. digital signal processing, interferogram
51	Computer science Artificial intelligence	VosViewer: algoritm, images and image processing
51	Telecommunications	VosViewer: Digital image stabilization, Seqence stabilization, global motion estimation
51	Communication	VosViewer:work, digital media, journalism and media

46	Computer Science software engineering	VosViewer: digital watermarking, algorithm and scheme
39	Education educational research	VosViewer: education, higher education, digital transformation (but low linkage between education and digital transformation).
21	Computer science interdisciplinary applications	VosViewer: identification, diabetic retinopathy, extraction
22	Multidisciplinary sciences	VosViewer: Video watermarking, algorithm, digital camera, image
22	Chemistry analytical	Space grids, chemistry such as glucose. Application of the technology within the field and not relevant.
15	Biotechnology applied microbiology	genetic transformation, medicine
15	Radiology Nuclear medicine medical imaging	microwaves, cancer, wavlet transform segmentation, different diagnoses
13	Engineering Multidisciplinary	Image watermarking, wave digital filters, wavelet transform
13	Mathematics applied	Watermarking, color image, coding, binary image,

		transformation of digital shapes.
11	Materials science multidisciplinary	applied technology, calculations, signal transformation, monolithic 3D, wavelet digital filter
10	Geoscience multidisciplinary	Terrain correcting using digital elevation model, fast fourier transform, digital filters
Under 10	Asian studies, theater, agriculture dairy animal science, agriculture economics policy, water resources, Audiology speech language pathology, religion, physiology, physics nuclear, pharmacology pharmacy, obstetrics gynecology, nursing, medical laboratory technology, mathematical computational biology, intergrative complementatary medicine, imaging science photographic technology, geology, ergonomics, engineering petroleum, computer science cybernetics, Engineering aerospace, chemistry medicinal, cell biology, cardiac cardiovascular systems, biochemical research methods, astronomy astrophysics, agronomy, zoology, polymer science, green sustainable science technology, geochemistry geophysics, evolutionary biology, environmental studies, engineering mechanical, engineering chemical, dentistry oral surgery medicine, anthropology, spectroscopy, psychiatry, physics applied, microscopy, medicine research experimental, mathematics, food science technology, energy fuels, education scientific disciplines, construction building technology, architecture, social sciences biomedical, plant sciences, neurosciences, environmental sciences, engineering manufacturing,	

	<p>developmental biology, acoustics, veterinary sciences, public environmental occupational health, material science paper wood, history philosophy of science, film radio television, engineering civil , chemistry multidisciplinary, sociology, social sciences interdisciplinary, medical informatics, mechanics, material science characterization testing, engineering biomedical, computer science theory methods, art, physics multidisciplinary, engineering industrial, health care sciences services, urology nephrology, surgery, sport science, social work, social science mathematical methods, rehabilitation, physics condensed matter, otorhinolaryngology, orthopedics, oncology, mycology, music, medicine legal, medicine general internal, materials science textiles, litterature German Dutch Scandinavian, literary reviews, linguistics, language linguistics, gerontology, geography physical, criminology penology, development studies, computer science hardware architecture, classics, biophysics, biochemistry molecular biology, psychology applied, psychology, hospitality leisure sport tourism, urban studies, regional urban planning, geography</p>
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*1.2 Included WOS categories*

Number of documents	Category/Dicipline	Reason for inclusion:
93	Information science library science	VosViewer: Information technology, management, innovation
55	Management	VosViewer: innvation, strategy, performance, digital tranformation, management.

30	Business	VosViewer: Strategy, innovation, digitalization
16	Humanities Multidisciplinary	Disruptive nature of digitization, disruptive technology, impact of disruption and technology.
13	Economics	Digital disruption, transformation, organizational readiness for digital transformation
12	Law	Digitization, decentralization, disruption, legal relationships in digital era
11	Automation control systems	Industry 4.0, digital potential, process of digital transformation
10	Remote sensing	Digital transformation geographically
Under 10	International relations (9), Political science (8), Business finance (5), Area studies (4), Public administration (4), history (3), Industrial relations labour (3), Operations Research management science(2), Cultural studies (2), Ethics (1)	

TI=((Digit\* AND Transform\*) OR (Digit\* AND Disrupt\*)) AND PY=((1980-2018)) AND WC=(MANAGEMENT OR BUSINESS OR LAW OR ECONOMY OR BUSINESS FINANCE OR INFORMATION SCIENCE LIBRARY SCIENCE OR HUMANITIES MULTIDISCIPLINARY OR LAW OR REMOTE SENSING OR AUTOMATION CONTROL SYSTEMS OR BUSINESS FINANCE OR AREA STUDIES OR PUBLIC ADMINISTRATION OR INDUSTRIAL RELATIONS LABOUR OR ETICS.

## Appendix 2

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# Beyond the hype: A bibliometric analysis deconstructing research on digitalization

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**Abstract:** The accelerating emergent field of research addressing digitalization and related topics is complex, unstructured and hyped. Consequently, both research and practice lack a rigorous foundation of prior published research to underpin and direct future exploration into the opportunities and challenges provided by these exiting new digital technologies. This study employed a bibliometric analysis to explore extant published research within the digitalization field. We identified key articles that have enabled us to distinguish between interrelated digitalization concepts. Subsequently, we propose a taxonomy with characteristics for different levels of digitalization. The taxonomy contribute with dimensions that create different commercial and organizational opportunities and challenges at the different levels. The taxonomy offers a vantage point for subsequent empirical and conceptual research to extend insight on related digitalization themes, and especially related to innovation and strategy decisions on scalability, automation, channel selection and connectivity.

**Keywords:** Bibliometric analysis; Business models; Digitization; Digitalization; Digital transformation; Disruption; Innovation; Taxonomy.

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## 1 Introduction

Anything relating to digitalization is certainly in vogue these days - and academic research is in fast pursuit. An initial search on Google Scholar reveal an overwhelming amount of suggested articles for search terms, such as: "digitalization" with 58 100 suggestions, "digital disruption" with 5 570 suggestions, or "digital transformation" with 25 500 suggestions. In addition to this abundance of published research there is a lot of attention on digital technology developments driven by the technology vendors. Examples are reports describing new types of digital technologies such as: Internet of Things (IoT), machine learning (ML) and artificial intelligence (AI), virtual and augmented reality (VR and AR) or blockchain, to mention a few. There also exists a number of reports, for instance by consultancy firms, with speculative estimates of the numbers of workers affected by these technologies. In short, the accelerating emergent field of research addressing digitalization and related topics is complex, unstructured and hyped. Consequently, both research and practice lack a rigorous foundation of prior published research to underpin and direct future exploration into the opportunities provided by these exiting new digital technologies. A prerequisite condition to obtain a clearer picture of the contemporary phenomenon of digitalization is achieving an overview of it - beyond the current hype. There is a need for a uniform definition and clarifications of the multiple and interrelated terms used in current digitalization research. Therefore, the ambition of this paper is to address the following research question: *How can a structured literature search utilizing bibliometric analysis enable the deconstruction of current published scientific research to provide a rigorous conceptual foundation for research and practice alike?*

To explore the research question we employed a structured literature search to extract a final search database that could be used for bibliometric analysis and to identify key articles for a content analysis. The search resulted in an initial sample of 1307 articles which were reduced to 197 for our bibliometric analysis, resulting in a final

sample of 17 articles upon which we conducted a content analysis. Our study reveals that much of the research in this area is explanatory or conceptual, and not empirical, and that the different case studies are spread across different disciplines (e.g. strategy, management, innovation and informatics). Moreover, we utilize the bibliometric analysis to identify key articles that have enabled us to distinguish between the digitalization concepts, and on that basis we propose a taxonomy. This taxonomy includes different levels of digitalization, relating to different dimensions that create varied organizational and commercial opportunities and challenges. The taxonomy offers a vantage point for subsequent empirical and conceptual research to extend insight on related digitalization themes, especially related to innovation and strategy decisions on scalability, automation, channel selection and connectivity.

## 2 Theory

McAfee (2009) refers to digitalization as the pace of change in society driven by digital technological development, involving multiple technologies at different stages of maturity that will converge and create new technologies. There exists no established framework within digitalization theory. Extant research offers a fragmented landscape, often driven by an understanding from informatics. This discipline often focuses on the technological complexity, rather than on the understanding of the organizational complexity in which the technology is implemented and utilized (Andal-Ancion, Cartwright, & Yip, 2003). Whereas digitalization - with related themes such as digital disruption and digital transformation (DT) - has been described as a homogenous phenomenon, some recent empirical studies are addressing contingency factors across e.g. different industries. However, since a majority of these studies take the perspective emphasizing technological complexity, they fail to elucidate important dimensions pertaining to the organizational and commercial application of these technologies. Consequently, there is a pressing need to identify core organizational and commercial dimensions to further our understanding of how digital strategy and digital innovation can be practiced across different industries.

Moreover, there exists a plethora of interrelated terms, such as digitization, digitalization and DT (Negroponte, 2015). Researchers have defined the terms digitization, digitalization and digital transformation in previous research (Loebbecke & Picot, 2015; Negroponte, 1995; Aron & Waller, 2014; Andal-Ancion, Cartwright, & Yip, 2003). However, these terms are applied differently in different studies and are suggested to address everything from stages (Loebbecke & Picot, 2015) in the development of the application of different types of digital technology to the ambition underpinning the utilization of these technologies. Furthermore, there exists no clarity regarding which concept that are used for describing different digital processes and the benefit this process seeks to achieve. Indeed, there are different conceptualizations of each term, and to date there exists no consensus on the different levels of digitalization. Related is also the term disruption, referring to a situation where existing companies are substituted by new ones (Bradley et al., 2015). Additionally, while some argue technological advances drive digitalization, Kane et al. (2015) conducted a research where they suggest that strategy, not technology, drives DT. They found that maturing digital businesses are focused on integrating digital technologies in the service of transforming how their businesses work, and that talent engagement and BMs have a clear digital strategy in organizations where digital technologies has transformed processes (Kane et al., 2015).

While the Industrial Revolution in the late eighteenth century relieved manual labour, the second machine age with computers and other digital advances are predicted to relieve cognitive tasks (Brynjolfsson & McAfee, 2014). Recently, different waves of advances in digital technology has fundamentally transformed business and society, contributing to the complexity of the field (Legner et al., 2017). The first wave focused on conversion of analogue to digital information, leading to higher automation in work routines. The second wave established Internet as a global communication infrastructure, resulting in e.g., changes in firm's value creation logic and new types of businesses, while the third wave - which we are experiencing today - are the converging SMAC (social, mobile, analytics, and cloud) technologies that has made the vision of omnipresent computing become very close to reality. Moreover, digitalization is constituted by a variety of emerging technologies at different stages of maturity and market acceptance, and it has been suggested that these will converge and mutually strengthen each other in the digital revolution (Manyika et al., 2013). Notably, two main dimensions have been identified to enable comprehending the different emerging types of technology (Brynjolfsson & McAfee, 2014). First, increased machine power - including emerging technologies such as AI, Big Data, augmented reality, advanced robotics, autonomous vehicles and 3D-printing. Second, increased connectivity - including technologies such as mobile internet, social media, Skype, IoT, Cloud and Fog, as well as Blockchain. The combined effect of all of these emerging technologies on employees, customers or organizations are yet unknown. Any of these technologies - e.g. IoT - are assumed to have large consequences for firms marketing and business model innovations (BM) (Ng & Wakenshaw, 2017). Similar to the widely accepted assumption that these technologies in combination are likely to have a considerable impact on expert based businesses (Jesuthasan, Malcolm, & Zarkadakis, 2016), existing

research has also pointed to professional service firms as a type of business where the impact of digitalization will be greatest (Manyika et al., 2013; Zott & Amit, 2017).

While digitalization has been a topic for information systems research for decades, the current wave of digitalization is different, according to Legner et al. (2017): it is driven by us. This calls for a broader field of research to merge efforts to deal with the complexity this development, and to further our understanding of the impact of digitalization and its potential societal, organizational and commercial implications. Similar to Legner et al., Brenner et al. (2014) argue the power in information technology (IT) is shifting to users who increasingly are expecting sophisticated digital services and products. The increasing expectations from users and the rapid innovation of IT within the last three decades put pressure on leaders in commercial and public organizations that are being challenged by disruptive start-ups, calling for a better understanding of how different levels of digitalizations impact their business. The IT innovation has come along with the development of new systems, software applications and standards that support and shape business activities in various ways, that force organizations to deal with an increasing amount of data and act in complex and growing networks (Heilig, Lalla-Ruiz, & Voß, 2017). This environment of continuing technological change may require or even promote shifts in organizational structures, processes, and strategies according to Heilig, Lalla-Ruiz and Voß (2017), and further underpins the need for structuring digitalization research especially in regards to organizational impact. Consequently, there is a pressing need to take stock of the body of current published research addressing organizational implications of digitalization, and related terms, with a specific emphasis on how different concepts are characterised, the relationship between terms.

### 3 Methods

We employ science mapping from the discipline of bibliometrics with the aim to provide a systematic and thorough review of digitalization research related to disruption and transformation. Bibliometrics refer to “*the collection, the handling, and the analysis of quantitative bibliographic data, derived from scientific publications*” (Verbeek et al., 2002, p. 181). A systematic review adopts a replicable, scientific, and transparent process based on the theoretical synthesis of existing studies, thus differing from general reviews (Cook et al., 1997). In particular structural reviews that allows us to 1) examine relations between topic areas, and 2) use some form of quantification to shortly compile a large amount of literature (Porter, Kongthon, & Lu, 2002). While the common research paper cite around twenty references, providing an incomplete picture of the research context, a broad scan of a literature can, according to Porter, Kongthon, and Lu (2002, p. 351) “*extend the span of science by better linking efforts across research domains. Topical relationships, research trends, and complementary capabilities can be discovered, thereby facilitating research projects.*” In addition, as structural reviews to some degree employ a form of quantification and objective analysis, such reviews “*improve the review process by synthesizing research in a systematic, transparent and reproducible manner*” (Tranfield, Denyer, & Smart, 2003, p. 207). Thus, structural reviews help overcome one of the traditional review papers limitations: their lack of rigor.

To provide an objective and systematic review of the literature containing keywords of both one or more of the digit\* concepts and either transform\* or disrupt\*, we employ the VOSviewer science mapping framework (Van Eck et al., 2010; Van Eck & Waltman, 2014). By using VOSviewer science mapping, we are able to examine the intellectual content and structure of research on concepts of digitalization linked with transformation and/or disruption in rich detail. Further we employ content analysis to a selection of the papers in our final search database, selecting papers based on traditional- and bibliometric criteria. The content analysis allows us to make replicable and valid conjectures by interpreting the textual material.

#### 3.1. Sample

A four-stage process was used to identify papers for analysis. First, we searched the Web of Science (WoS) for articles using the search string Title=((Digit\* AND Transform\*) OR (Digit\* AND Disrupt\*)), identifying 1 307 papers. Second, we excluded only 2019 from publishing years, keeping all whole years to retain potential evolution of the field. Third, we included articles, proceedings papers, book reviews, reviews, book chapters and editorial material. Fourth, we systematically excluded research categories in WoS that did not contain information about the concepts of digitization, digitalization or DT, thus removing categories focusing on description and specifications of technology rather than digital change. To assess categories relevance to answer our research question we applied three selection methods based on the number of articles within each category. For categories with 30 or more papers, we performed a bibliographic co-occurrence analysis using a threshold of 5 to identify relevant keywords. Analyzing the clusters in each category revealed if it focused on technological attributes or digitalization concepts. Further, to ensure that high-impact articles within categories that was discarded by the bibliometric analysis was not overlooked, we read the abstract on the 20 most cited papers for each category.

Finally, for categories with less than 30 results, we read the abstract on all papers to assess its relevance. Our final literature search downloaded from WoS following our four step process contained 197 papers.

The same process was performed with a topic search using the same criteria as described above, but clusters from analyzing the resulting database revealed keywords mainly related to hardware attributes to technology. Abstract readings further confirmed that the papers in the database mainly described usage of different technologies. Thus, as initial analysis suggested the title search would make us better equipped to answer our research question, we chose to build our paper on the title sample resulting in a final search database containing 197 papers.

### ***3.2 Analysis***

The analysis was threefold. First we performed a descriptive analysis of our final search database to identify the evolution on the field and the development within journals and disciplines. The purpose was both to identify which disciplines drive digit\* research and to assess the distribution and impact of the various journals. Finally, to get insight of emerging concepts and conceptualization within disciplines, we approached the evolution of terms over time and across journal categories. Second, we did a bibliometric analysis of the final search database to classify the relevant keyword clusters for each of the digit\* concepts, and to categorize the disciplines that are associated with the terms. This analysis further enable us to discover the development of keyword clusters over time, identifying emerging and “hot” concepts. Finally it will enable us to pinpoint the most cited papers and thus help us learn which main disciplines are referenced in the papers in our final search database. The bibliometric analysis is also conducted to contribute to the literature review as it is used to identify the most influential articles, as we did a content analysis of the 17 most relevant papers in relation to our research to identify any conformity and contrasts of the digitalization concepts.

#### ***3.2.1 Descriptive analysis***

For the descriptive analysis, we used the final search database and converted this to an Excel file. We added a column for journal category (i.e. People and Organization, Strategy, Technology and IT, Business, Cross-disciplinary work, Economy, Law, Library and archival science and Management) and a column for concept of digitalization, both populated manually. The assessment of the appropriate value for the journal column was based on the journals discipline which was addressed by visiting each journal website. The appropriate value for the digitalization column was based on three factors; title, keywords and abstract of the paper. When all columns were populated with values the Excel sheet was connected to Microsoft’s analytical service Power BI for visualizations of the data.

#### ***3.2.2 Bibliometric analysis***

To obtain a better overview of the identified articles we saved all 197 articles in one file to permit a thorough bibliometric analysis (Markoulli et al., 2017). To conduct the analysis we applied the VOSviewer software and identified clusters of interrelated digit\* articles. We created a Thesaurus file to combine similar words with different spelling, where for example the label “Business models” was replaced by “Business model”. This was done to have more trustworthy clusters. General terms like “Transformation” was not combined with “Digital transformation”, as these grasp broader than digital change specifically. Thesaurus was also used for the co-citation analysis, but with the intention to make each point in the clusters more intuitive making the map easier to read visually. Co-citation and Co-occurrence analysis was conducted to compute relevance of keywords and citations between them, and bibliographic coupling was conducted to find the most influential articles within the final search database. The discipline category for each cluster was identified by doing an Eigenvector Centrality (EC) analysis in Gephi for both the co-occurrence and co-citation separately. The GML files was imported to Gephi with graph type “undirected”, indicating that papers are not necessarily referred to each other both ways.

#### ***3.2.3 Content analysis***

To ensure relevance and identify the unit for further literature review we did a three step-process to make a selection from the 197 articles. First, we read the abstract of all articles to ensure thematic relevance and selected the ones that informed or defined the phenomenon of digit\* terms. During the reading articles was scored on

relevance related to the research question on the following scale: (A) Relevant; (B) Borderline relevant; and (C) Irrelevant. During this process the papers that didn't contain concepts of digital change was discarded as irrelevant, e.g. papers with a core focus on hardware and technological attributes. Second, to ensure papers to our content analysis based on purely objective criteria, the five articles with the highest citation score- and the five papers with the highest EC (i.e. network centrality) was included. EC measure approximate importance of each node in the graph, and the core idea in EC is that an important node usually is connected to important neighbours (Wang et al., 2012). Thus, it identifies relevant articles in the final search database as the assumption is that each nodes centrality is the sum of the centrality values of the nodes it is connected to. To calculate the EC we did a bibliographic coupling analysis in VOSviewer with "Documents" as the unit of analysis, saved the resulting map as a GML file, and imported it to Gephi to complete the analysis. The selection result included 17 out of 197 papers. Of the top five cited papers, four overlapped with the fifteen retrieved from abstract readings. Further, of the top five papers retrieved from EC two overlapped with the 15 retrieved from abstract readings.

The content analysis was conducted by reading and assessing the 17 papers identified through the three selection criteria. We read all papers and coded them in Excel to provide an overview of how each paper described the respective digit\* concept and how the purpose of it was defined. Further, the content analysis was split by collecting the information from all digitization-, digitalization-, and DT papers in separate tables to easier identify the content and common features of each concept.

## 4 Findings

Overall our study reveals that there has been an exponential growth in published digi\* themed papers over time, a trend indicating that there might be several research papers in progress and in proceedings (figure 1).

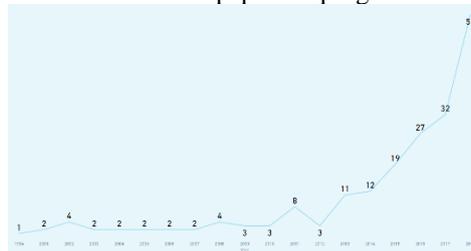


Figure 1 Development in publications per year (N=197 papers)

Moreover, a majority of the papers are published in lower ranked journals, indicating that research on digital change is primarily represented in smaller- and niche journals. The journals are spread across nine different categories, where the strategy category only include two papers. As strategy is a highly relevant aspect of the digitalization process, the lack of strategy journals writing about these changes indicate that research still remains in its incipient stage (figure 2). We have categorized journals based on subjective criteria, which could be considered a limitation of our data material. Further, the categorization of journals into digital concepts was based on title, abstract, and keyword only, witch could be a source of error.

	Q1	Q2	Q3	Q4	Q0	Total
1994				1		1
2001		1		1		2
2002			1	1	2	4
2003	1			1		2
2004	1	1				2
2005	1				1	2
2006		1			1	2
2007					2	2
2008	2	1	1			4
2009	1	1			1	3
2010	3					3
2011	4			1	3	8
2012				1	2	3
2013	7	1	1		2	11
2014	6	2	1		3	12
2015	5	2	2	1	9	19
2016	9	4	2	3	9	27
2017	9	4	2	1	16	32
2018	13	9	8	2	26	58
<b>Total</b>	<b>62</b>	<b>27</b>	<b>18</b>	<b>13</b>	<b>77</b>	<b>197</b>

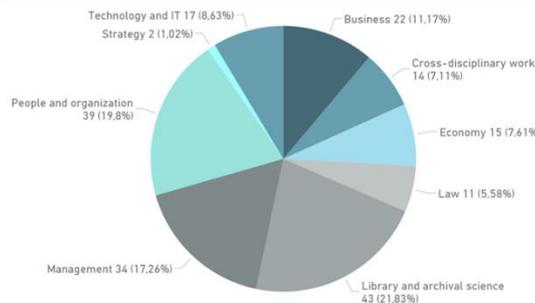
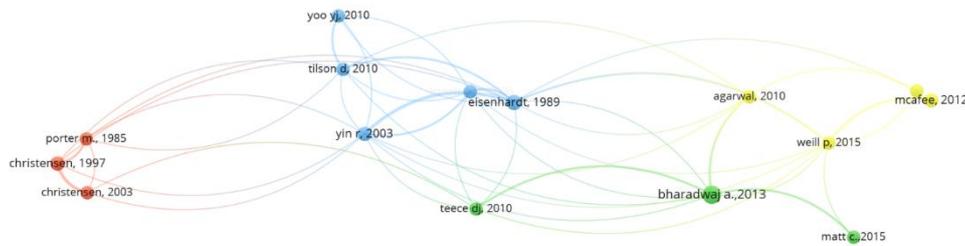


Figure 2 Publication percentage within each SJR category per year

The co-citation analysis revealed that there was four different disciplines that most papers referred to, where method was one of them. Moreover, 30 of the papers in our final search database had citations to qualitative

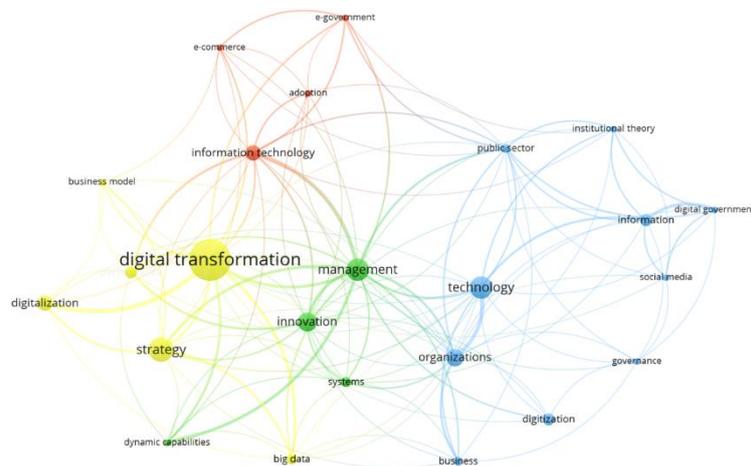
method sources (figure 3) and none to quantitative method sources. This may further indicate that the research on digitalization is at a young and growing stage.



**Figure 3** VoS-Viwer map showing co-citation analysis cluster

#### 4.1 Digitization

The content analysis revealed a broad consensus on digitization primarily revolving around conversion of analogue information with the purpose of achieving cost- and efficiency goals. This is consistent with the findings in the bibliometric analysis that disclosed relations between ‘digitization’ and ‘Technology’. Further, digitization connects with ‘Organization’, ‘Innovation’, and ‘Management’, which also can be explained by findings in the content analysis. E.g. we find some authors go beyond describing the concept as a conversion method for storage and information purposes, rather focusing on the internal organizational processes at the activities level where digitization may be used for management purposes by structuring large amounts of data for business, and is seen as a tool to facilitate cost reduction and process automation. Some further describe digitization as a step in the DT process, viewing digitization as a disruptive change through e.g. making digitized products available, thus affecting parts of the organizational strategy and BM. The content analysis thereby substantiates the findings in our bibliometric co-occurrence analysis (figure 4).



**Figure 4** VoS-Viwer map with co-occurrence analysis with keywords as unit of analysis

Digitization’s connection with ‘Digital transformation’ may also be explained by the descriptive analysis, as most of the papers included in the ‘Library and archival science’ journal category revolves around digitization and DT. This business area traditionally has large amounts of analogue information, and will naturally be affected by digital storage and information sharing opportunities through technological advancements. This may also facilitate value creation, and fundamentally transform the BM innovation opportunities. Finally, while there is a large and consistent number of publications on digitization, it appears it is not a ‘hot topic’ in digitalization research at this time as it peaked in February 2016. This may be explained by the large percentage growth in digitalization and DT research in recent years, as digitization is described as a tool in these processes.

## ***4.2 Digitalization***

According to findings in the content analysis, digitalization is closely related to the concept of digitization. However, authors commonly argue that digitalization goes beyond shifting from analogue to digital information. Digitization can be seen as a part of the digitalization process, where authors describe this level of digitalization as e.g. a sociotechnical process of applying digitizing techniques to a broader social and institutional context, and as a change at the process level through changing organizational structures, internal interactions, and transactions with customers and stakeholders. This information relates to findings in the co-occurrence analysis, where “Technology”, “Big data”, “Strategy”, “Performance” and “Information Technology” relates to digitalization. Further, “Business model” and “Digital transformation” is closely related to digitalization, and findings in the content analysis suggest that digitalization is a tool for BM innovation as it can contribute to the shift from product to service based BMs, which substantiates the findings in our bibliometric co-occurrence analysis. The content analysis also uncovered that while digitalization like digitization focus on cost- and efficiency opportunities, it also revolves around social changes in markets and the workforce, and may facilitate for network- and value opportunities.

The descriptive analysis revealed that digitalization is evenly distributed across all journal categories, except for “Library and archive” and “Strategy”. In our final search database, digitalization papers was least represented out of the digit\* concepts. However, “digitalization” far precedes the other digitalization concepts when doing our initial search on Google Scholar, which may indicate that this term is used to describe technological attributes - a theme we systematically excluded from our database. The first article involving digitalization in our final search database was in 2014, followed by a stable distribution of digitalization articles throughout the period 2014-2018. The number of digitization papers as a percentage of total published each year has however been reduced during the period, and publications on this concept peaked in May/June 2017.

## ***4.3 Digital transformation***

The content analysis revealed that authors commonly agree that DT is concerned with the changes digital technologies can bring about in a company’s BM, or BM adaption or transformation as a result from technological progress and innovation. This substantiates several findings in the bibliometric co-occurrence analysis, e.g. that DT relates to “Innovation”, “Business models”, “Dynamic capabilities”, “Performance”, “Adoption”, and “Organization”. Further, while some authors find that part of the purpose of DT is at the organizational process level, the majority agrees that it goes beyond the two previous levels of digitalization and relates to BM innovation in e.g. value propositions, networks and relationships. These findings support the relations “Social Media”, “Information Technology”, “Systems”, “Management” and “Strategy” found in the co-occurrence analysis. The co-occurrence analysis also disclose that this level of digitalization relates to the former two, which may be explained by digitization and digitalization being described as steps in DT. Further, while DT commonly is described as an organizational- and ecosystem level change creating opportunities in value creation, value propositions, networks and relationships, cost reduction and efficiency are also mentioned as part of the purpose of DT.

Articles with a primary focus on DT is represented in all journal categories, but the largest share is found in the “Management” and “Technology and IT” category. Moreover, DT has the largest share of papers in all categories, except in the “Library and archival science” and “Law” category where digitization represents the largest share. This may be due to both industries being heavily document and information reliant. Finally, the percentage of DT articles is increasing, and according to our bibliometric overlay visualisation the topic peaked in July 2017.

## **5 Conceptualization**

We identified articles that has enabled us to distinguish between concepts, making it possible to suggest a taxonomy (figure 5).

Presuppose previous level			Dimensions		
Level			Challenges and opportunities		
			Cost reduction	Connectivity	Value creation
Digital transformation	Organizational and ecosystem level		X	X	X
Digitalization	Organizational process level		X	X	
Digitization	Activities level		X		

**Figure 5** Taxonomy for the interrelated digitalization terms with dimensions and levels

The taxonomy creates different opportunities and challenges on each digitalization level through associated dimensions. It identifies three dimensions (cost reduction, connectivity and value creation) that varies across the three digitalization levels.

The **cost reduction** dimension involves all three digitalization concepts. Digitization can lead to asynchronous information, opportunities in scaling of production, a shorter publishing value chain, and better control and customer overview. As for digitalization, it goes beyond digitization as a broader sociotechnical process of applying digitizing techniques in a larger scale to social and institutional contexts, with e.g. cost reduction and efficiency as results. Similarly, the content analysis revealed that part of the purpose with DT is cost reduction and efficiency, while having a broader span of opportunities and challenges beyond these benefits. Cost reduction through efficiency gains are in literature closely related to emerging discussions of automation.

The **connectivity** dimension comprise both digitalization and DT. For digitalization it represents an opportunity to connect activities as these are digitalized. The researchers in our content sample overall agree that digitalization will change organizational structures and interactions both internally and externally, affecting how firms compete and transact with customers. For DT the dimension represents an opportunity to cooperate between different actors or create ecosystems where new, digitally enabled products or services encourage demand via non-traditional methods. The process of DT further poses an opportunity to form new entities and relationships driven by the application of IT, that works as an enabler of changes to the paradigms of organizations and individuals. Thus, new partnerships are enabled at this level through usage of advanced technologies, that in turn facilitates instant connectivity and access to the growing sources of data that support cross-cell or cross-service opportunities. Connectivity is in literature related to discussions of channel selection and scalability.

In the **value creation** dimension, DT is represented. Both digitization and digitalization can achieve value represented by opportunity cost for available resources that can liberate time for other value retrieving activities. DT on the other hand represents opportunities for value creation, as explicitly uncovered in the content analysis. The changes in value creation due to DT derive from the way in which digital technologies alter a firm's BM. While organizations can go through a BM innovation regardless of whether they include digital processes, the value creation in DT relates to the connectivity derived from digitalization (e.g. developments in value proposition related to multiservice platforms created to attract customers and service providers). Further, some authors claim value creation in relation to DT stems from how digital strategies and related transformation allow new ways of creating value (e.g. co-creation or product- and service complementation through network participants).

Our study reveals that the tree concepts of digitalization concerns digital change at different levels in the organization. The digitization concept is at the activities level, whereas the other two is at the organizational level increasingly extending beyond the intra-organizational context into the inter-organizational context and the entire ecosystem. Although some claim that processes can be digitized (e.g. Gaigher, Le Roux, & Bothma, 2014), they describe digitization of existing activities (e.g. information, physical or analogue documents, knowledge). Thus, digitization concerns changing and automating activities that pre exists in organizations. There is consensus in the articles reviewed that digitalization goes beyond digitization. Digitalization involves application of technology to broader social and institutional contexts, contribute to servitization of organizations, and affects how it compete and interact. Hence, digitalization have an organizational focus, where business processes change. Finally, DT is described as a broader process of transforming an organization affecting organization's business processes (e.g. products, structures, processes, organizational behaviours) and is thus complemented by changes in BM. DT also facilitate new social networks and new partnerships, relating to changes at the ecosystem-level.

## 6 Conclusion

By conducting a rigorous assessment of extant published research to address: *How can a structured literature search utilizing bibliometric analysis enable the deconstruction of current published scientific research to provide a rigorous conceptual foundation for research and practice alike*, this study provides a foundation for researching the currently hyped phenomenon of digitalization and related topics such as digital disruption and DT.

The study confirms that the field remains immature and fragmented, and despite revealing that all identified articles in our content analysis sample address digitalization as an important aspect of changes in organizations and related strategy development, few strategy journals deal with the digit\* concepts. Indeed, there exists very limited no comprehensive description of how strategy should be adapted to technological adaptations. There is also limited published quantitative research. Probably relating to the limited understanding of how different technologies relates to different organizational outcomes.

In order to provide a vantage point upon which such research efforts could be based, we offer a taxonomy with a clear delimitation of interrelated terms and themes emphasising the organizational and commercial implications of different related terms rather than identifying the type of technology applied or degree of technological complexity involved. The taxonomy identifies the level of analysis associated with each of its constituting terms; digitization, digitalization and DT connected in a step-wise process; eg. digitization is described as a stage that alone offers limited value in terms of improving operations, digitized information is referred to as an aspect of digitalization. Digitalization is a tool for BM innovation as it can contribute to the shift from product to service based businesses. DT relates to the intra-organizational level, involving the external environment with implications for all the three dimensions. Therefore, the taxonomy offers a vantage point for subsequent empirical and conceptual research to extend insight on related digitalization themes, especially related to innovation and strategy decisions on scalability, automation, channel selection and connectivity.

Deciding on digital innovation and digital strategy is currently of primary concern to practitioners when navigating an increasingly disruptive environment. Our study condensed an overwhelming amount of digitalization research into a digestible 17 papers spanning across five interrelated disciplines. Moreover, we proposed a taxonomy that can be utilized to inform the innovation and strategy discussions within firms when deciding on future directions for their digitalization efforts. In particular, our suggested taxonomy offers an explicit emphasis on organizational and commercial consequences of different digitalization ambitions. We suggest that managerial teams discussing the selection and implementation of digital technologies to consider the organizational perspective underpinning our suggested taxonomy when addressing their digital innovation strategy in general, and in particular when deciding on, BM innovation, digital disruption, DT, disruptive innovation and Industry 4.0.

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