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Datatization as the Next Frontier of Servitization – Understanding the Challenges for Transforming Organizations

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Abstract

Today, servitization has reached its saturation point as enterprises in almost every business and continent pursued it as a differentiation strategy. Data analytics may offer the next frontier of innovation and hold the potential for enterprises to create value for their customers. Nevertheless, organizations face a series of barriers when utilizing the technologies. We apply a rigorous qualitative analysis process based on grounded theory and interview data of 15 business-to-business companies that already successfully utilize data analytics to create value for their customers. We analyzed our results in the lights of the barriers organization face in servitization and reveal that data analytics adds an additional layer of complexity. Our work contributes to the fundamental understanding of organizational transformation and should provide concrete guidance to business leaders on how to address transformation regarding the utilization of data and analytics.

Keywords: Servitization, datatization, data analytics, big data, organizational transformation, grounded theory

Introduction

For manufacturers in the US and Europe, servitization has been a key strategy to capture additional value on top of their existing product portfolios and to differentiate themselves in commoditizing markets. By now, servitization has become a broadly adopted concept (Neely 2008). Since services in product-centered markets are moving towards commoditization, they are not a sufficient source for achieving competitive advantage anymore (Opresnik and Taisch 2015).

Recent developments in the field of data analytics create new potentials for services and business models (Davenport 2013; Hartmann et al. 2016; Porter and Heppelmann 2014; Schüritz and Satzger 2016; Wixom and Ross 2017). Consequently data analytics stands on par with capital, technology, and people as core assets of an organization (Porter and Heppelmann 2014). In fact, exploiting data analytics is expected to drive the next wave of servitization (Opresnik and Taisch 2015) – as a promising path to build competitive advantage (Lavalle et al. 2011).

Looking at the immense potential, the application of these technologies may not simply provide "some" competitive advantage, but rather turns out to be a necessity for economic survival. Thus, venturing into services that exploit data analytics is becoming an increasingly critical task for organizations. While already the transition into a servitized organization bears major managerial challenges (Oliva and Kallenberg 2003), further progressing this path towards the exploitation of data analytics in new and more complex service offerings poses additional difficulties (Coreynen et al. 2017). Solely relying on the available knowledge from servitization literature may not be sufficient to effectively guide organizations towards successfully offering these advanced services. Consequently, Ostrom et al. (2015) explicitly identify *big data* as a top priority in service research - as this topic is assessed to show the widest gap between the importance for the field and the available body of knowledge.

In this work, we aim to identify challenges that organizations face when utilizing data analytics to offer new services or to enrich existing products and services in a business-to-business (B2B) context. We as well are interested in the potential ways to overcome these barriers. For this purpose, we employ a rigorous qualitative method (Fernández 2004) based on a series of cases and a systematic literature review. By collecting data through in-depth interviews with service executives and product managers, we analyze 15 organizations across various industries that are already taking advantage of data analytics in their offerings today. Via the use of coding mechanisms, we extract relevant information from these cases and establish an understanding of the transformational challenges these organizations face. In addition, we compare the challenges to the ones posed by servitization in general. Thus, we aim to contribute to the body of knowledge in service and organizational transformation theory.

The paper is structured as follows: In section 2, we provide a brief description of servitization and outline the potential impact of data analytics. Section 3 describes our research methodology - detailing the steps of our method, including how we collected and analyzed our empirical data. Section 4 shows the result of the literature review on organizational challenges in servitization. In Section 5, these challenges are further elaborated and serve as a basis for analyzing potential changes that accompany the integration of data analytics. Section 6 highlights the changes on servitization that are triggered by data analytic. Section 7 briefly summarizes our results, acknowledges limitations and provides managerial implications as well as develops an agenda for future research.

Theoretical Foundations

This chapter puts our research in context to relevant extant literature. First, we summarize servitization literature, illustrating the concept of servitization and the rationale behind it. Second, we address the importance of data analytics for service innovation.

Servitization

The idea of providing services in addition to selling products or even entirely replacing them is not new. While the term servitization itself was only coined in the late 1980s (Vandermerwe and Rada 1988), Schmenner (2009) argues that organizations have in fact started to combine services with products since the 1850s. Accordingly, servitization – "the innovation of an organization's capabilities and processes to shift from selling products to selling integrated products and services that deliver value in use" (Baines, Lightfoot, Benedettini, et al. 2009, p. 555) - has attracted fairly broad academic coverage. Closely related topics include product-service-systems (PSS), service transition, and service transformation (Baines, Lightfoot, Benedettini, et al. 2009).

Reasons for organizations to pursue servitization, also referred to as drivers, motivations or rationales, have been discussed by many authors (e.g., Baines et al. 2009; Gebauer et al. 2006; Gebauer and Friedli 2005; Lay 2014; Martinez et al. 2017; Mathieu 2001; Olivia and Kallenberg 2003; Rouse 2005; Vandermerwe and Rada 1988; Wise and Baumgartner 1999). Many of them attempt to cluster these motives: Building on a comprehensive literature review, Baines et al. (2009) differentiate between financial, strategic (competitive advantage) and marketing-related factors. Similarly, Lay (2014) distinguishes three first-level rationales: growth, profit and innovation. Martinez et al. (2017), building on a longitudinal analysis of service journeys, separate competitive motivations, demand-based motivations and economic motivations.

A question that repeatedly appears in servitization literature is *how* to actually servitize in a successful way. Many papers attempt to provide more guidance on how to implement servitization (e.g. Alghisi and Saccani 2015; Baines et al. 2009b; Coreynen et al. 2017; Gebauer et al. 2005; Gebauer and Friedli 2005; Jovanovic et al. 2016; Kucza and Gebauer 2011; Mathieu 2001; Olivia and Kallenberg 2003; Rabetino et al. 2016; Shepherd and Ahmed 2000; Storbacka 2011). However, no standard reference on how to successfully servitize has yet emerged.

Today, servitization has reached almost every business and continent (Neely 2008), thereby becoming a necessity for companies to address in order to stay competitive. At the same time, when companies servitize in a basic manner, offering common services, they have little potential for differentiation. Enterprises need to identify other ways to offer unique value propositions and to stay competitive. In this context, the integration of technology is becoming a crucial element for organizations to develop, integrate and deliver novel services, and advancing the original limits of servitization (Dinges et al. 2015). Data analytics is expected to drive the next wave of servitization (Opresnik and Taisch 2015) and, therefore, has the potential to become a new source of competitive advantage (Lavalle et al. 2011).

Data Analytics for Service Innovation

Today, both academia and industry attribute great opportunities to the emergence of "big data", a term that not just addresses the volume of information, but also refers to its variability, variety, velocity, veracity, and value (Chen and Zhang 2014). By 2020, the amount of data is supposed to reach 44 zetabytes of valuable and "target rich" data, supposedly doubling compared to 2013 (Turner et al. 2014). To unlock value from data, the application of some form of analytics becomes a prerequisite (Ackoff 1989).

Organizations find a wide range of possible scenarios to benefit from data analytics for innovating their existing business. Various studies reveal, though, that in doing so organizations still have a strong internal focus (eg. Capgemini and Informatica 2016; IBM 2016; Manyika et al. 2011). In a broad multiple case study, more than 70% out of 115 data-based innovations analyzed were internally focused (Schüritz and Satzger 2016) – organizations optimize process efficiency, increase productivity, support strategic decision making and create additional insight into their customer base (Lavalle et al. 2011; Manyika et al. 2011; Philip Chen and Zhang 2014). As depicted in Figure 1, we refer to these internally focused endeavors as *data-enabled improvements*.

Figure 1. Potential Manifestations of Data Analytics
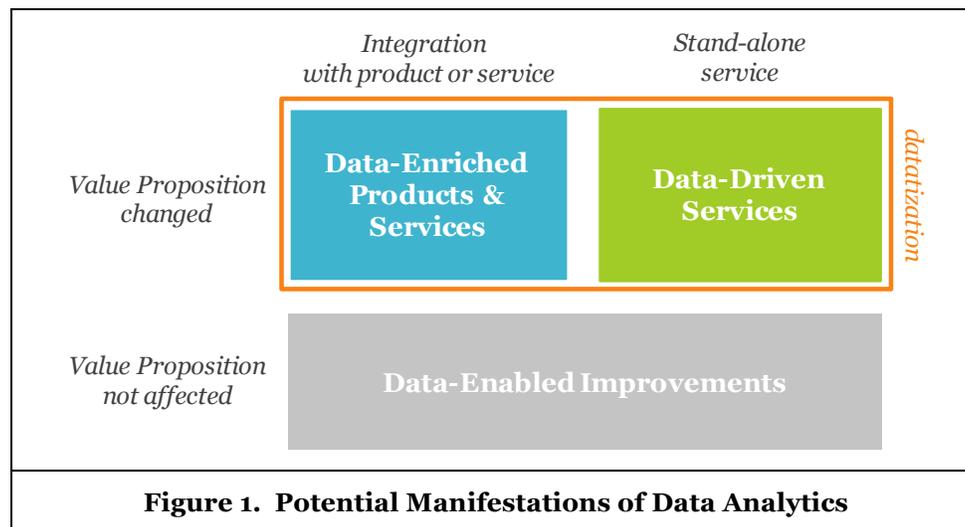
In contrast, only a small portion of organizations actually augment their (external) value propositions by applying data analytics (Schüritz and Satzger 2016; Zolnowski et al. 2016) – and thus in fact ride the "third wave" of analytics ("Analytics 3.0" in Davenport (2013)). This may either be achieved by *enriching products or services with data*, i.e. "wrapping" data services around them (Wixom and Ross 2017), or by creating completely new stand-alone *data-driven services* (Hartmann et al. 2016; Manyika et al. 2011).

Both, the design of new data-driven services or data-enriched products & services are by no means trivial. Any organization will have to develop capabilities to be able to reap the benefits of data-driven innovation, in particular when changing the value proposition (Wixom et al. 2017). As an advanced step of servitization, we refer to this transformation as *datatization* and define it as the *innovation of an organization's capabilities and processes to change its value proposition by utilizing data analytics*.

Methodology

Our work has the objective to extend the body of knowledge in service science and organizational theory by understanding the barriers organizations face in datatization. We apply a rigorous research process as suggested by Fernandez (2004) that is based on grounded theory (Glaser and Strauss 1967) and the collection of data case data via interviews. Figure 2 illustrates the pursued research process.
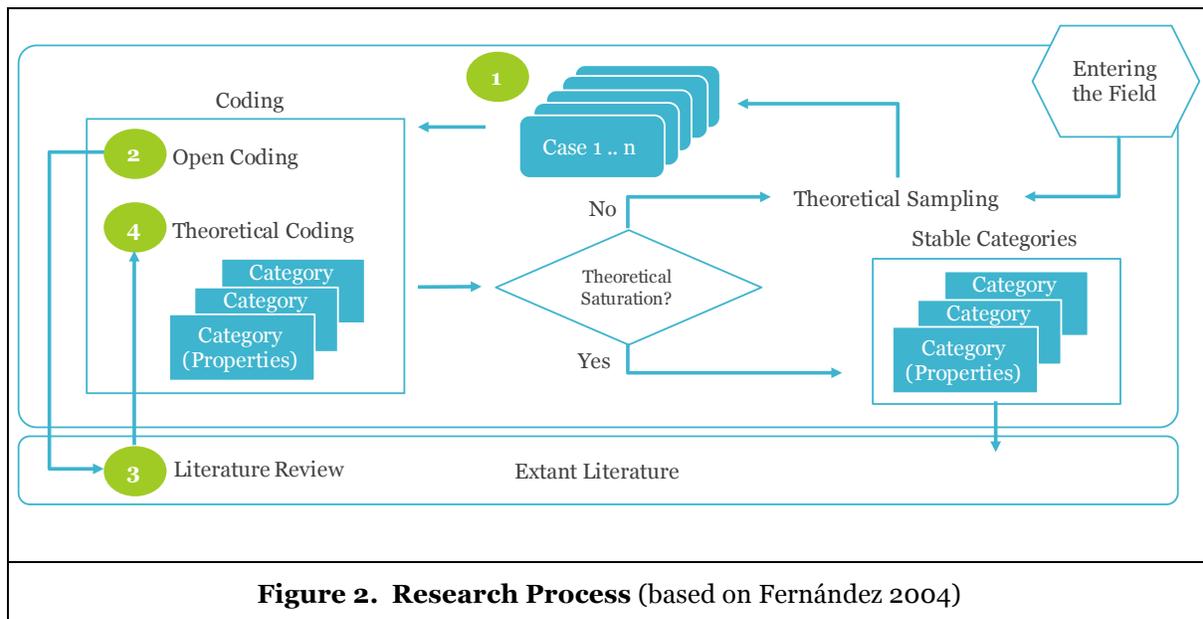

Figure 2. Research Process (based on Fernández 2004)

Following the process, the research field is entered with a general understanding of the phenomenon that motivates the research inquiry, i.e. in our case the challenges arising from datatization. Therefore, we collect data (step 1) from organizations that already offer data-driven or data-enriched services, as we assume that they have accumulated extensive experience and expert knowledge in the field. The corresponding in-depth interviews are analyzed applying an open coding approach (step 2). At this point, the research process by Fernandez (Fernández 2004) requires the enrichment of the intermediary results by extant literature, in line with the grounded theory methodology (Glaser and Strauss 1967). As the utilization of data analytics leads to new value propositions that are essentially services (Davenport 2013; Schüritz and Satzger 2016; Wixom and Ross 2017), we conducted a structured literature review (step 3) on servitization barriers in order to evaluate if the challenges organization face differ when pursuing this advanced step of servitization. The reviewed literature is then used to develop theoretical codes, which serve as orientation for categories in a second coding cycle (step 4). Following an iterative approach, open codes are created and assigned to categories.

The process is continued until additional cases do not yield new insights on datatization challenges, i.e. theoretical saturation is reached. We are adapting the approach of Fernandez (2004), which originally focuses on assessing human behavior phenomena, to explore organizational implications of datatization. The research process ends with a stable set of categories that explain the phenomenon and represent a

contribution to the general understanding instead of a substantive theory. (Muller 2014). A more detailed description of the research process and the applied methodology is given in the following.

Data collection (Step 1)

The novelty of the subject at hand - datatization - supports the approach of using an inductive approach, as there is a lack of theoretical foundations in this specific area (Eisenhardt and Graebner 2007). The cases draw on in-depth field expert interviews to gather insights from the companies' current endeavors to utilize data analytics for new service offerings.

The case selection is driven by theoretical sampling, leading to a sample of 15 companies (cf. Table 1). All of them operate in a B2B context and apply data analytics to offer data-enriched or data-driven products and services, thus have datatized over the last years. Available extant research on servitization has almost exclusively focused on the manufacturing sector (e.g. Gebauer and Friedli 2005; Olivia and Kallenberg 2003). To avoid contextual bias, though, we addressed other areas than manufacturing as well (Eloranta and Turunen 2015).

Table 1. Overview of Cases				
Number	**Case**	**Industry**	**Revenue**	**Employees**
1	Alpha	Manufacturing	€70B – €150B	>300.000
2	Beta	Manufacturing		
3	Gamma	Manufacturing		
4	Delta	Telco Provider	€20B - €50B	20,000-300,000
5	Epsilon	Medical equipment		
6	Zeta	Energy provider		
7	Eta	Manufacturing	900M - €7B	6,000 – 20,000
8	Theta	Manufacturing		
9	Iota	Manufacturing		
10	Kappa	Manufacturing		
11	Lambda	Insurance		
12	Ny	Financial services		
13	Xi	Technology provider	<€100M	<150
14	Omikron	Technology provider		
15	Pi	Technology provider		

Initially, web research is used to obtain a broad overview of publicly available information on a specific service offering (e.g. organization's website, newspaper articles, etc.), thereby generating a basic understanding of the respective service and enabling the researcher to identify critical aspects beforehand and to elaborate on more sophisticated questions for subsequent interviews. Afterwards, for each case an interview is conducted with a company representative, who is either responsible for the operation or the development of the service, and, therefore, has a comprehensive knowledge of service offering.

The interviewees are confronted with the three open questions: "What were the biggest challenges when developing and implementing the service?", "What is critical for the success of the service today?" and "What are your plans for the future and what are the barriers moving forward?". Further probing to deepen the understanding of the challenges is performed with respect to the situation, the topic and the case. This semi-structured interview approach combines structure with flexibility (King 2004). Almost all interviews are conducted over the phone, are run in either English or German and recorded in case permission is granted. The interviews have been conducted between August 2016 and March 2017. Each audio recording is transcribed and serves as a basis for analysis by means of coding.

Open Coding (Step 2)

The gathered data is analyzed via a coding mechanism based on grounded theory (Glaser and Strauss 1967). Codes can be interpreted as data points, which can be aggregated to form categories, which then may serve as a basis for theory development. In our case, we intend to derive a sound understanding of the industry reality and capture datatization challenges and management practices. So far, extant research neither provides comprehensive guidance on specific challenges nor on how they are tackled by practitioners, we apply *open coding*, i.e. we do not rely on predefined categories. The transcripts are independently coded by two researchers, who discuss their results after each case, thereby comparing their results and reaching an inter-coder agreement. If necessary, conflicting codes are resolved by including a third researcher familiar with the topic (Fastoso and Whitelock 2010). Within an iterative approach, the resulting coding system of all analyzed cases then forms the starting point for analyzing the next case until theoretical saturation is reached. The actual coding is supported by the coding software MAXQDA.

Literature Review (Step 3)

A systematic literature review is performed to gain a comprehensive understanding of the servitization concept and, especially, its associated challenges. Löfberg et al. (2015) point out that the term challenge is regularly used in servitization literature without clarifying its notion. We will view challenges as general hurdles and difficulties in achieving the objective of becoming more service-oriented and having an extended service offerings. The review is conducted in a structured two-step approach. First, we search four established scientific databases that we believe possess a comprehensive coverage of scientific publications (EBSCOhost, AISeL, SCOPUS, ScienceDirect) using strings of word combinations (cf. Table 2) to identify relevant article titles and abstracts. The chosen keywords focus only servitization, because we wanted to compare datatization challenges to servitization challenges. Second, we additionally use backward- and forward search as proposed by Webster and Watson (2002). Thereby, we can include several relevant contributions we did not detect as part of the initial keyword search. The combination of both approaches ensures that we are broadly covering relevant contributions. The identified servitization literature is then analyzed using a concept matrix and, subsequently, is synthesized based on a workshop among fellow researchers.

Table 2. Literature Research								
Search String 1		Search String 2	Databases				Sum (w/o duplicates)	Relevant
			AISeL	EBSCO	Scopus	ScienceDirect		
Servitization/ servitisation/ servitizing/ servitising	AND	Challenges OR barriers OR obstacles OR difficulties	13	40	111	40	136	43
Service Transition			2	3	29	8	35	4
Service Transformation			2	0	40	6	42	2
						Sum (w/o duplicates)		45
						Added through forward/backward search		13
						Total Sum		58

Theoretical Coding (Step 4)

The general servitization barriers in step 3 serve as a rich basis for theoretical codes, which are used to structure our existing categories and codes from the open coding in step 2. Starting with the set of theoretical codes, we extend and refine this list through the inclusion of new codes or the adjustment of existing ones (Saldaña 2009).

The next sections present the results of the study, starting with the outcome of the literature review in the form of a concept matrix, which is followed by a section looking at the barriers of servitization and additional challenges when pursuing datatization.

Barriers of Servitization

Although a number of publications attempt to give an overview over servitization challenges, these papers categorize the barriers very broadly by only providing high-level conceptual categorizations (e.g. Annarelli et al. 2016; Hou and Neely 2013; Martinez et al. 2010; Neely 2008), or do not have a transparent process of deriving the categories (e.g., Alghisi and Saccani 2015) and are therefore not helpful in our endeavor. Our analysis of the papers yields a total of 45 different challenges that can be grouped into ten categories. Table 3 shows the concept matrix, structured according to the ten synthesized categories as well as the papers in which they are mentioned. This gives us a comprehensive overview on servitization challenges that synthesizes findings from existing work and builds the basis for our analysis in the next section.

Table 3. Concept Matrix of Servitization Challenges	Processes	Org. Structure & Governance	Strategy	Skills & Capabilities	Culture	Market	Design of offering	Design of revenue model	Transformation	Co-creation
Adrodegari et al. 2015	x	x					x	x		
Ahamed et al. 2013		x	x		x		x			
Akram et al. 2014	x				x			x	x	x
Alghisi and Saccani 2015	x	x	x	x	x	x	x	x		x
Annarelli et al. 2016	x	x				x	x			x
Ayala et al. 2016	x									x
Baines and Lightfoot 2013	x	x	x	x	x		x	x		
Baines, Lightfoot, and Kay 2009	x	x	x		x	x	x	x		
Baines, Lightfoot, Benedettini, et al. 2009	x				x					x
Baines et al. 2011		x					x			x
Baines et al. 2017		x								
Bao and Toivonen 2015	x					x				
Brax 2005	x			x	x	x	x	x		x
Burton et al. 2017	x	x		x	x		x			
Buschmeyer et al. 2016									x	
Cenamor et al. 2017	x	x					x	x		x
Chakkol et al. 2014			x		x					x
Chen 2015	x									
Confente et al. 2015	x				x	x	x	x		x
Conger 2009		x								
Coreynen et al. 2017				x		x	x	x		x
Elfving et al. 2014			x		x				x	
Eloranta and Turunen 2016	x	x				x		x	x	x
Fang et al. 2008	x	x	x	x		x		x		
Gebauer and Friedli 2005	x	x	x	x	x	x	x	x	x	

Gebauer et al. 2006	x	x	x		x		x			
Grubic 2014	x	x	x		x		x			
Helms 2016	x	x		x	x		x	x	x	x
Hou and Neely 2013	x	x	x	x	x	x	x	x	x	x
Jovanovic et al. 2016	x	x		x		x	x	x		x
Kindstrom and Kowalkowski 2009	x		x	x	x		x			x
Kowalkowski et al. 2015	x			x	x		x	x	x	x
Laine et al. 2012	x	x	x		x		x		x	x
Lay 2014						x				
Lienert 2015						x				
Löfberg et al. 2015		x	x	x	x	x	x	x		x
Martinez et al. 2010	x	x	x	x	x		x	x	x	x
Martinez et al. 2017	x	x	x	x				x	x	
Mathieu 2001	x	x			x	x		x	x	x
Mont 2002	x	x			x	x	x	x		x
Novales et al. 2016	x					x				x
Nudurupati et al. 2016	x	x		x	x	x	x	x		x
Oliva and Kallenberg 2003	x	x		x	x	x	x	x	x	x
Opresnik and Taisch 2015	x			x			x			x
Ostrom et al. 2015	x									
Parida et al. 2014	x			x			x	x		x
Parida et al. 2015	x					x	x			x
Paslauski et al. 2016	x									x
Porter and Heppelmann 2014, 2015	x	x		x		x		x		x
Raja et al. 2010		x	x	x	x				x	x
Robinson et al. 2016	x					x		x		x
Roos 2015						x	x	x		
Turunen and Finne 2014	x	x				x				
Ulaga and Loveland 2014				x						
Ulaga and Reinartz 2011	x	x		x			x			x
Vandermerwe and Rada 1988	x	x	x		x	x			x	x
Wise and Baumgartner 1999	x	x	x			x	x	x		x
Challenged mentioned in total	**43**	**33**	**19**	**23**	**28**	**27**	**32**	**27**	**15**	**35**

Impact of Datatization

Datatization represents an advanced step of servitization – enabling organizations to offer services that exploit data analytics and potentially yield a competitive advantage for organizations (Davenport 2013; Opresnik and Taisch 2015; Schüritz and Satzger 2016; Wixom and Ross 2017). Datatization expands the current understanding of servitization, moving the frontier of knowledge. Pioneers exploring new areas still have to cope with existing, general servitization challenges, but are also confronted with new, specific datatization challenges.

In this section, we will briefly describe each servitization barrier an organization faces - based upon our literature review, and then for each illustrate any additional datatization challenges and observed ways to

overcome them - based on the analysis of our cases. Figure 3 shows a simplified category structure to guide the following sections.

Figure 3. Overview of Servitization and Datatization (Sub-)Categories
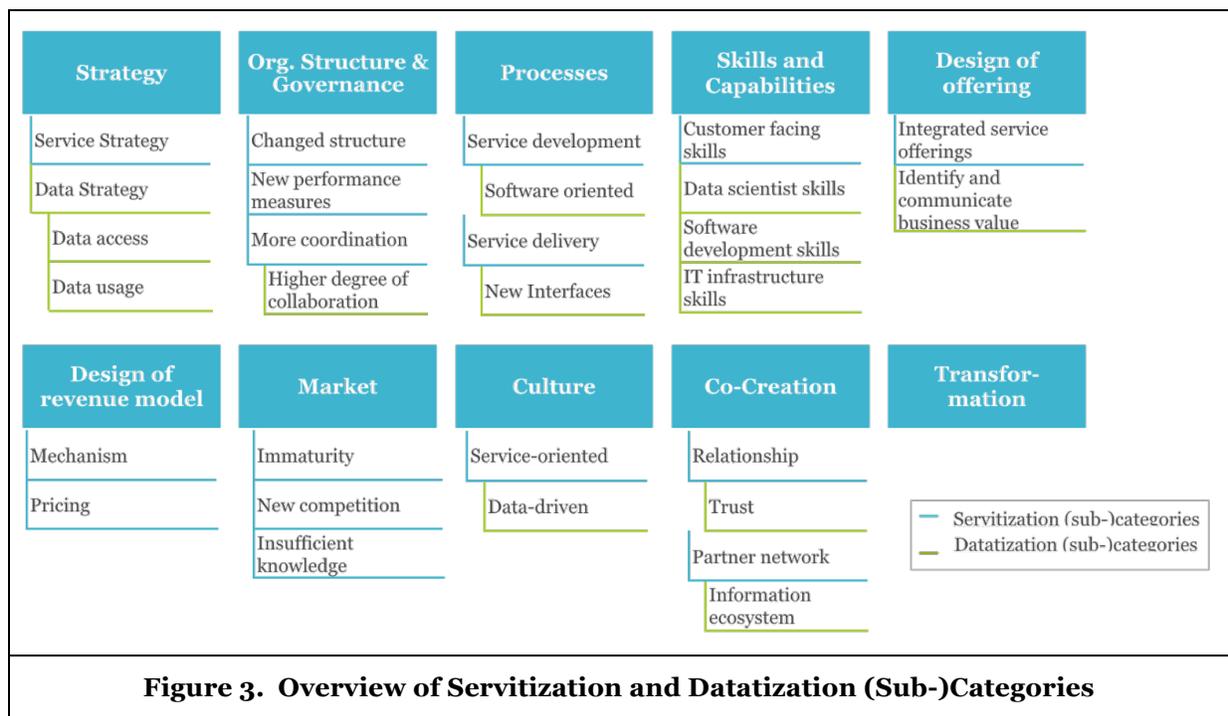
Strategy

When crafting a service strategy, organizations are challenged to achieve a fit with their overall strategy and vision. Pursuing both a product and a service strategy potentially diverts attention due to resource constraints and, therefore, poses a difficult managerial challenge (Fang et al. 2008). Turunen and Finne (2014) stress the impact of the business environment on selecting a service strategy, while Gebauer et al. (2006) emphasize the importance of involving all relevant parts of the organization in formulating it.

Organizations that want to take advantage of datatization are challenged to make a clear decision about the role of data analytics in their service strategy as well as to develop a clear data strategy. Our interviews revealed that such a strategy involves series of decisions regarding the *access* and *usage* of data, should exhibit a fit with the overall strategy of an organization and follow local regulations and ethical boundaries.

Formulating how to obtain and maintain *data access* is a crucial element when devising a data strategy. This can be particularly difficult if necessary data is not in possession of an organization, but is generated and stored by its customers or another partner and needs to be transferred to the organization. Especially some manufacturing companies in our sample (Eta, Iota, Kappa) pointed out that they first need to establish a continuous transfer of customer data. Further, even if the service provider has already obtained customer data within a particular service or through product usage, the customer might still need to agree on accessing the data in a different context or for a different purpose. Alpha and Ny point out that receiving customer approval can be challenging.

As data builds the foundation of datatized services, organizations need to ensure a continuous data provision within their strategic orientation. Further research is needed to understand how data access can be facilitated. In our sample, Eta and Ny ensure continuous data access by including it as part of the initial service contract. Iota and Gamma provide a free online portal that gives its customers access to a dashboard with prepared data of the manufacturing equipment in use. Customers that sign-up for the service thereby

grant access to data of the products in use. Additional, more sophisticated services (e.g. predictions) are charged.

Apart from ensuring data access, organizations need to make decisions about the *usage of data* and align these decisions with their strategy and values. Ny describes, that there is a no organization wide understanding of how data can be used. This uncertainty is driven by a fear of "ruining [its] image and being perceived as a data leech, that is absolutely worst case" (Product Manager – Ny). Therefore, setting a data strategy ensures that data is handled correctly across the organization and new services can be developed within its boundaries. Current research started to investigate how company norms may help to develop acceptable data use principles (Wixom and Markus 2017)

In our sample, we can identify three approaches for handling data from client interactions: One group of organizations uses data resulting from such interactions solely in the service provision for the particular client, e.g. Beta produces manufacturing machinery. Based on the collected data, Beta offers a service on the energy consumption of the production line, but does not use the collected data otherwise. A second group uses data internally to enable improvements of products and services, e.g. Gamma, Zeta and Lambda use the collected data of every client to optimize the prediction models for their services. A third group uses the client data across customer boundaries, offering new services to a potentially new group of customers, e.g. Delta aggregates customer location data to create new services to a different set of customers.

Organizational Structure & Governance

Introducing services into a product-focused portfolio entails changes in the organizational structure and governance. It is often recommended to set up a decentralized structure in the form of a profit center or even a separate business unit with profit and loss responsibility (e.g. Gebauer and Friedli 2005; Olivia and Kallenberg 2003). This separated structure is helpful in fostering service thinking without having to sacrifice product-related manufacturing values (Baines, Lightfoot, and Kay 2009). However, other authors point out the importance of integrating the entire organization (Oliva and Kallenberg 2003) and, therefore, suggest a segmented structure, in order to spread service culture throughout the organization (Mathieu 2001). Thus, it is challenging for an organization to identify the appropriate structure for their individual servitization endeavor.

In addition to structural changes, services require new performance measurements to manage services successfully (Ulaga and Reinartz 2011). Furthermore, the coordination between formerly siloed departments in an organization needs to increase significantly with the adoption of service business models (Oliva and Kallenberg 2003).

Analogous to service transformation, organizations initiating datatization need to decide if involved teams are placed in a centralized, new unit that works more independently from the rest of the organization (e.g. Iota, Alpha, Beta, Delta, Zeta, Iota) or if the teams are segmented across the organization in line with their product or service association (e.g. Gamma, Epsilon, Lamda, Ny). The results of our analysis indicate, that the degree of autonomy of the datatized service and the connection to the core offering currently differ across organizations. Similar to servitization, we can see organizations building separate organizational units that differ across the sample as to their degree of autonomy. These separate units are enabled to explore data-driven and data-enriched services without the limitations of existing structures – often working in a more agile and explorative manner: *"[…] we decided it is much quicker and much nimbler for us to create our own little universe, […], because as you can imagine there are steering groups and lots of procedures and hearing rounds and things like that and we have to be quicker in our maneuvering"* (Head of Service – Iota). However, this separation might pose severe challenges in coordinating, aligning and collaborating with the core business.

Depending on the nature of the datatized service and the degree of embeddedness into its core product and service portfolio, we can also identify a high necessity for collaboration and coordination with other units such as R&D, production, sales, etc. - as suggested by Porter and Heppelmann (2015).

Processes

Servitization requires a new set of processes for developing, implementing, enabling and delivering services that differ from those of product-centered organizations (Oliva and Kallenberg 2003). In new service

development (Burton et al. 2017; Chen 2015), there is a need for an integrated development process considering product development and available technologies (Parida et al. 2014).

While most organizations have gained experiences on service development and service delivery through their servitization efforts, data analytics imposes a set of new challenges. While software may have been one of many elements in the service development before, now software becomes a cornerstone of the service. Furthermore, the service development also needs to define processes for data acquisition, generation and processing and infrastructure set-up to cope with the new requirements. A close integration with the development of the core product might be necessary: In our sample for example, one firm needed to integrate a set of sensors in heavy machinery equipment that can be used to capture the required data for the enablement of a predictive maintenance service.

While the provision of services might already be very different from the delivery of products, data analytics brings additional changes to the service delivery. As Ostrom et al. (2015) point out, a "dehumanization of service" can be noticed in some areas - leading to a transition from human-centered to technology-centered service delivery. This holds especially true in the cases of Gamma, Xi, Omikron, and Pi where "e-services" are delivered via web-interface or API and, thus, human interaction is not needed to the same extent as in traditional services (Fromm and Cardoso 2015). However, we can also see organizations challenged in areas where a deeper integration of human interaction and technology is needed: In the case of Beta, the company collects and analyzes the live data of a machinery used by the customer. In addition to providing aggregated information via an online portal, a consultant is in close interaction with the customer to make sense of the data and make suggestions to improve the efficiency of the product.

Skills and Capabilities

For product-focused companies seeking to add services to their portfolio it is inherently challenging to acquire a variety of necessary skills and capabilities. Creating integrated service offerings leads to a greater number of customer encounters, resulting in a broader range of employees being exposed to the customer than was the case before (Martinez et al. 2010). Organizations that want to cultivate services, therefore, need to build customer interfacing skills (Coreynen et al. 2017). Further, Ulaga and Loveland (2014) underline the importance of building new sales capabilities that are able to sense market opportunities. This is quite challenging because existing sales personnel is typically biased towards selling products and tends to lack both intention and skill to sell service offerings (Kindstrom and Kowalkowski 2009; Ulaga and Loveland 2014). Similarly, product-focused companies now face the challenges to hire and train personnel with customer orientation and the necessary domain know-how (Brax 2005; Helms 2016), to deploy people and services in an effective and efficient manner (Burton et al. 2017), and to appropriately manage these service employees (Gebauer and Friedli 2005; Raja et al. 2010).

When it comes to data analytics, it is claimed that data scientists hold "the sexiest job of the 21st century" (Davenport and Patil 2012). They are broadly demanded by the market and seem to be in tremendous shortage right now. Interviewees point out, though, that data scientist is rather an umbrella term, while needed profiles include "[...] *a whole bandwidth of skills and the differences are huge, really huge*" (Product Manager – Ny). In fact, the collected codes regarding required data science skills show a much broader variety and sophistication compared to required skills in servitization.

Due to the strong technological focus of these new offerings, IT capabilities become an essential cornerstone for datatization as well. One interviewee states: *"Along the way we had many challenges in going from being a machine manufacturer, which we are, to become a software player. [...] It is two very different processes required and two very different skill sets required to do these things"* (Head of Service – Iota). Organizations are challenged to build these skills and capabilities that enable the infrastructure, develop the software, ensure the required level of security, as the integration of new services into a *"[...] grown IT landscape can be real drama"* (Product Manager – Zeta).

Design of offering

A foundation for successful servitization efforts is the careful design of service offerings (Ahamed et al. 2013). Designing service-based offerings is significantly different to the design of products (Baines, Lightfoot, Benedettini, et al. 2009; Burton et al. 2017). Jovanovic et al. (2016) stress the importance of matching service offerings to product operations as a key success factor. In designing the service offering,

servitizing organizations need to take into account that risk formerly borne by the customer might now be transferred to the provider (Baines, Lightfoot, and Kay 2009). The design of the offering needs to allow for a service delivery that meets customer expectations and ensures ethical compliance (Grubic 2014; Martinez et al. 2010). As a consequence of their product-focused background, companies may also need to design new infrastructure or networks as part of the service offering and to enable service delivery in the first place (Mont 2002). Another important aspect in service offer design consists in identifying a communication strategy that clearly describes the value proposition to the customer (e.g. Mathieu 2001; Ulaga and Reinartz 2011).

Designing new data-driven services or enriching existing products or services brings to bear new challenges for organizations. First, it is still particular challenging for some organizations to identify business value in the gathered data, develop innovative offerings on top of them and *"[…] identifying the right functions that make sense in practice"* (Product Manager – Gamma). Once developed the added value needs to be presented to the customer requiring "[…] new websites [and] new communications" (Product Manager – Lambda).

Further, at this point another major challenge is to ensure scalability through standardization: For Beta every analytics solution is individualized, fulfilling a diverse base of customer requirements as well as integrating heterogeneous input data. But in this context, Beta's product manager *"believe[s] that industry specific approaches must be rendered possible, so that not every solution needs to be developed from scratch. For our teams that consult the customer we are starting to deploy more and more such templates"* (Product Manager – Beta). Smaller specialized providers such as Xi or Zeta seem to aim for standardized solutions from the start: "[We] don't want to develop an individual solution for every client, but instead offer a standardized solution that we can improve over time" (Product Manager - Xi). That is why "[…] the biggest mistake is, if you identify a valuable use case with a client to believe this is the standard. You immediately need to evaluate and prioritize with other market participants. Otherwise you develop an individual solution."

Design of revenue model

Designing a revenue mechanism for service-based offerings becomes a challenge (Eloranta and Turunen 2016; Novales et al. 2016; Wise and Baumgartner 1999), because transitioning from product-oriented to service-oriented offerings creates a need to change the earning logic (Storbacka et al. 2013; Ulaga and Reinartz 2011): Discrete payments change to continuous cash flows, giving customers full access to the offering without transferring the ownership (Chesbrough 2010; Porter and Heppelmann 2014), and thereby taking the risk from the customer and shifting it to the provider (Baines, Lightfoot, Benedettini, et al. 2009). In addition, customers are often reluctant to pay extra for services (Löfberg et al. 2015) and exhibit what can be called a service-for-free attitude (Coreynen et al. 2017). This makes service pricing highly difficult and poses an issue that has not been solved as of today (Ulaga and Reinartz 2011).

Organizations moving into services may on top be challenged by something referred to as the 'service paradox'; a situation in which adding services to the offering portfolio of a product focused company leads to increased revenues, but decreasing profits (Baines and Lightfoot 2013). This phenomenon has been discussed by multiple authors (Gebauer et al. 2006; Neely 2008) and further emphasizes the challenge of designing a profitable revenue model. To avoid running into the 'service paradox', a servitizing product-focused company must solve the challenge of maintaining cost levels (Cenamor et al. 2017; Confente et al. 2015), achieving critical mass (Roos 2015) and scalability (Mathieu 2001).

The design of the revenue model for datatized offerings can be challenging, but shows similarities to the servitization endeavor. In our sample, we could see a variety of approaches organizations have taken:

In the case of Lambda or Gamma, data analytics is bundled with and, thus, is an integral part of the core offering. In these cases, the organization receives an indirect pay-off through an uplift of the product or service via a higher price or additional sales.

Organizations that decides to uncouple it from the core product have the potential to open up a new revenue stream and take advantage of new revenue models (e.g. subscription, usage fee, gain-sharing (Schüritz, Seebacher, et al. 2017)). Ny, Aplha, Epsilon, Theta and Iota offer data analytics as an add-on that can be optionally ordered and utilize a different revenue mechanism compared to the core offering. For Beta, Delta, Zeta, Xi and Omikron, the offering is a stand-alone service that works without the core offering, thus is a

new data-driven service and utilizes a new revenue model as well. However, organization are challenged by the configuration of the revenue mechanism such as the definition of suitable tiers in subscription models that may differ in features or in volume.

Further, again finding the right price is challenging as well: *"Pricing is extremely hard and you never quite know how to do that" (CEO – Omikron)*. Similar to services, when the data analytics is utilized to enrich a current product, the service is expected to be free: *"We come from a world where all customers are accustomed to receive free software"* (Head of Service – Iota). Defining the added value of the enrichment was a challenge among all cases in our sample.

Market

Servitizing an existing business eventually leads to offer services, which face the organization with entering a new market. This is connected to challenges such as insufficient market knowledge due to the former product-focused orientation (Parida et al. 2015), potentially low market maturity as services in that field may have just emerged (Coreynen et al. 2017; Wise and Baumgartner 1999) and/or new competition through other service providers (Mathieu 2001).

Gaining a comprehensive understanding of the market and the industry structure is necessary for the successful development of a service strategy (Gebauer et al. 2006; Turunen and Finne 2014). Apart from knowing the market and its structure, an immature market poses an extensive challenge to servitizing companies as customers may not be willing to engage in the offered services (Wise and Baumgartner 1999). This inertia can be explained by both dominant industry logics and mindsets as well as the manufacturing company's rather product-oriented marketing focus (Roos 2015). Furthermore, product-focused companies looking to expand into the field of services have to be aware of new competitors outside their familiar domain from unexpected rivals, who may include their own suppliers, distributors, and customers (Mathieu 2001; Oliva and Kallenberg 2003; Robinson et al. 2016; Vandermerwe and Rada 1988).

Organization in our sample striving towards datatization describe the same challenges as organizations that pursue a servitization strategy. Analogously, it is crucial to gain a sound understanding of the respective market in order to develop a data strategy. The market for data analytics offerings is still immature. Some customers are reluctant to take advantage of such services. A manufacturing company stated, that in some cases they *"[…] cannot identify the correct contact person"* (Head of Service – Iota) and some customers have trouble to gain approval for purchasing such services. Unexpected competition is also entering the market: Theta is now in competition with small specialized software companies that offer services based on the data that is generated by their machinery.

Culture

In order to facilitate servitization efforts, organizational culture often needs to be adapted (Ostrom et al. 2015). Establishing a service-oriented culture in product-focused companies has been stated as the one key factor of servitization success and the biggest challenge since the inception of this research field (Vandermerwe and Rada 1988; Mathieu 2001), as servitization requires a shift of corporate mindset from product centricity to service-orientation and customer centricity (Oliva and Kallenberg 2003). This entails managing customer relationships as long term engagements instead of transaction-based encounters (Alghisi and Saccani 2015). Further, firms with a manufacturing background tend to focus on technical product features and need to integrate and emphasize services at an earlier point in time in their innovation efforts (Ulaga and Reinartz 2011). Additionally, services often demand a 24/7-mindset and customer-oriented employees with great communication capabilities to embody the service-oriented culture (Baines and Lightfoot 2013; Brax 2005). For that matter, it is necessary for the entire organization to internalize this new culture, reaching from a service employee to a management level (Gebauer and Friedli 2005). Oliva and Kallenberg (2003, p. 166) state that "at the core of this cultural transformation, then, the manufacturing firm must learn to value services."

Organizations that want to take advantage of data analytics face the challenge of incorporating data analytics specific aspects in their culture. As addressed in organizational structure and governance, a high degree of collaboration across departments is necessary. While not pointed out by our interviews as a challenge, other research suggest that organizations or at least their analytics departments need to adapt a culture that accepts failure at an early stage as it is sometimes tedious to find value in data sets (Schüritz,

Brand et al. 2017). This change of mindset can be particularly difficult for organizations with a strong product-focus as they entail a culture, which is used to long and extensive development cycles.

Co-creation

The nature of services inherently implies a co-creation of value. That means that value is always co-created "jointly and reciprocally, in interactions among providers and beneficiaries" (Vargo et al. 2008, p. 146). Therefore, product-focused companies pursuing a service strategy need to learn how to collaborate with customers and partners more intensively both in developing meaningful services as well as in delivering them in a fashion that meets customer expectations (Brax 2005; Coreynen et al. 2017; Oliva and Kallenberg 2003). In order to perform a service in a mutually beneficial way, it is necessary to re-think customer interaction from being transaction-based to being relationship-based (Baines, Lightfoot, and Kay 2009; Martinez et al. 2010). Apart from collaborating with customers, there is also an increased need to integrate and coordinate with third parties (Kowalkowski et al. 2015). Managing these partner and supplier network configurations becomes an increasingly complex task, when advancing in servitization (Chakkol et al. 2014). Facilitating the transfer of knowledge among different functional areas within a servitizing organization as well as network partners is an essential task and a complex challenge (Paslauski et al. 2016).

When utilizing data analytics to deliver new innovative services, co

-creation even seems to be of higher importance. Data becomes a resource to which an organization needs reliable access and which may not exclusively be generated in the spheres of an organization but very well be created within the boundaries of the customer. Alpha, Iota and Ny describe that they need to work closely together with their customers and establish a high level of trust, which builds upon the long-term relationship that evolved during servitization and is further deepened.

However, co-creation does not solely include customers. In all our cases, companies have to collaborate with existing partners or engage with completely new partners - the CEO of Omikron describes this in the following way: *"That´s the hardest part, to find the right people and the right partners". However, it is necessary to engage with partners* in order to gain access to data and capabilities that are needed to offer the desired service - *"We would like to do the core things ourselves but if someone is better in doing them, we engage with a third party. You can't do everything yourself"* (Head of Services - Eta).

Transformation

Servitization requires the transformation of the entire organization, which is often underestimated regarding its complexity and management of behavioral change (Buschmeyer et al. 2016). Transforming an organization from solely selling products to marketing integrated products and services is likely to lead to severe internal resistance, because the inherently characteristic of both people and organizations to be reluctant towards change (Mathieu 2001). This resistance may be caused by having little insights on the functioning and the content of the service strategy (Gebauer and Friedli 2005) or be due to the fear of change (Baines, Lightfoot, and Kay 2009). Not only the belief system of the organization must be transformed, but also its business models (including its value propositions, customer relationships, channels, cost structure, and revenue streams). Since servitization progresses gradually (Oliva and Kallenberg 2003), both the old product-oriented and the new service-oriented business model need to be managed simultaneously (Martinez et al. 2017).

When pursuing datatization, organizations face change in many aspects of their business, posing a variety of obstacles as described above. Our interviews have shown that organizations, just as in servitization, are challenged by managing this transformation coping with resistance to change.

From servitization to datatization

Datatization represents the next frontier for many servitized organizations to explore. Our analysis shows that, while pursing this journey, companies experience an extract of servitization challenges, which are further extended by distinct data-specific hurdles. Thereby, data analytics leads to an evolution of certain transformation characteristics, which organizations encounter during their endeavor. Building upon the analysis of last section's servitization and datatization challenges, we now summarize (cf. Table 4) how datatization has progressed the characteristics of servitization.

Table 4. Transformation characteristics			
	Product-focused organization	**Servitized organization**	**Datatized organization**
Strategy	Product-focused strategy	Integrated Product-Service-Strategy	Additional Data Strategy
Network	Supplier Network	Partner Network	Partner Information Ecosystem
Customer Relationship	Short-term transaction-based relationship	▪ Long-term Relationships ▪ New customer facing roles	▪ Deep-Relationships (if data access is required) ▪ New interfaces (API, Portal, Apps, etc.)
Development Practice	▪ Product-oriented ▪ Separate and function based	▪ Service-oriented ▪ Partially separated and function based	▪ Analytics and software oriented ▪ Integrative and cross-functional
Revenue stream	One revenue stream	Additional revenue stream or replacing of existing revenue stream	▪ Additional revenue stream ▪ Indirect pay-off through product or service uplift
Culture	Product-oriented culture	Service-oriented culture	Data-driven culture
Skills & Capabilities	Manufacturing capabilities	Customer facing skills	Data Science, IT infrastructure capabilities and software development skills

Organizations that pursue servitization needed to realize the potential of services and turn their strategy from a product-focus into an integrated product-service-strategy (Gebauer et al. 2005). Additionally, datatization requires a data-strategy that defines how data is accessed and used.

In product-focused organizations, effectively managing the supplier network is a critical success factor, whereas in servitized organizations a partner network becomes a necessity for delivering integrated product-services (Alghisi and Saccani 2015). In addition to the partner network, organizations that want to datatize need to establish and maintain a *partner information ecosystem*, in which information is shared between relevant parties for developing, delivering and consuming data-driven and data-enriched services.

In product-focused organizations, customer relationships usually have a short-term and transaction-based nature. Through servitization, this relationship is transformed into long-term engagements with a much broader range of potential customer encounters (Nuutinen and Lappalainen 2012). This requires new customer facing roles and, thus, service personnel becoming an important asset in a servitized organization. Datatization requires a deepening of this relationship, if the provider needs to gain access to the data of the customer. A deep relationship in data-driven or data-enriched products and services is characterized by a high level of trust and a close integration of the operating infrastructure between a provider and its customer. This technical integration also changes the interaction and new touch points are creating new interfaces (API, portal, etc.) that contribute to some extent to a "dehumanization" of services (Ostrom et al. 2015).

Development practices change from being product-oriented to being service-oriented as services gain importance (Oliva and Kallenberg 2003), while development practices are still rather separated and function-based in servitized organizations (Nuutinen and Lappalainen 2012). Porter and Heppelmann (2015) already emphasize that in order to leverage the potential presented by data analytics, organizations must develop new services in an integrative and cross-functional manner. Further, rooted in the digital nature of data-driven and data-enriched products and services the respective development practices need to become highly software-oriented.

Servitization, and subsequently datatization, enable additional revenue streams for their business. Adding services creates revenue streams that tends to be more stable and of a higher margin than the initial product-based revenue stream (Opresnik and Taisch 2015). In datatization, an additional revenue might be realized by adding an additional stream or by an indirect pay-off through product and service uplift.

Converting the culture of a product-focused organization into an organization that embraces and values services, is an essential step in the transformation path (Oliva and Kallenberg 2003; Vandermerwe and Rada 1988). Servitized organizations pursuing datatization need to cultivate a data-driven culture, that allows the discovery of value in data.

Transformation towards a datatized organization requires new skills. As part of servitization, organizations need to attain customer facing skills since offering services exposes the organization to unfamiliar but critical customer encounters (Baines and Lightfoot 2013). In order to utilize data analytics for new or enriched service offerings the organization needs to build up data science and software development skills.

Conclusion

Our qualitative analysis of 15 datatized organizations provides a comprehensive overview of the barriers organization face when pursuing this advanced step of servitization. An exhaustive literature review regarding serivitization barriers serves as foundation and is compared and extended with datatization challenges. Our analysis has revealed that datatization builds upon similar challenges. However, data analytics add an additional level of complexity to some aspects of the transformation such as the necessity of an additional data strategy, a closer integration of stakeholders, an increased importance and impact of the customer relationship, various changes in the service development practice, the management of new revenue streams, a data culture, and skills & capabilities, enabling a new source of competitive advantage.

This paper, therefore, contributes to the general understanding of service transformation by providing a comprehensive overview of challenges and, furthermore, unveiling the additional barriers organization face when utilizing data analytics to enrich their offerings. Based on these findings, this paper lays the foundation for future research and opens a research agenda, addressing the described challenges.

Managerial Implications

The analysis of barriers organization face when pursuing datatization have direct implications for managers. Organizations that plan to start this endeavor can benefit from this study and can manage the transformation more effectively and efficiently.

First, the paper at hand gives insights on the crucial challenges an organization faces when pursuing datatization. Besides the more obvious necessities around skills & capabilities, the study reveals additional challenges in the areas of strategy, culture and the customer relationship.

Second, the paper uncovers some of the strategies organizations chose to overcome their transformation hurdles. It, therefore, offers guidance to datatizing organizations to overcome the barriers in their own transformation.

Limitations and Outlook

The research strategy, the ways of gathering data and the selection of the sample certainly do pose a number of limitations that will be further addressed in future research.

First, the paper focuses on the use of data analytics for *new value propositions*. However, organization may also use data analytics *internally* to improve decision making. Our research does not cover the challenges connected with this strictly internal focus.

Second, in our cases we focused on the business perspective by choosing interview partners such as service executives and product managers. Thereby, we were able to distill transformational challenges and did not focus on the non-trivial IT challenges.

Third, in our research we have identified a series of best practices to overcome the mentioned challenges. Both the identified practices and challenges have a high need and potential for future research, e.g.: (1) new value propositions that can be created by data analytics, (2) revenue mechanisms that apply, (3) new networks that form and (4) integration of data analytics in the development process of the organization.

Fourth, as we solely address challenges, which were mentioned in multiple interviews, thereby seeking qualitative saturation, we do not pursue a quantitative verification of the results. Future research should, therefore, be used to quantify and verify our results.

Still, there is more work to be done to systematically reap the benefits of datatization. Data analytics has added an additional layer of complexity and change: collaboration with a broader range of internal & external stakeholders, evolution of information systems from enablers to essential drivers of service offerings, higher requirements to information systems, uncertainty regarding security and legal issues, cultural change and new skills, capabilities and processes. Managing these difficulties of the transformation opens up a whole research agenda on its own. However, creating awareness for a well-founded systematic set of challenges should enable practitioners to professionally manage transformation as well as academics to structure their research agenda.

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