

MASTER

A Digital Servitization Maturity Model for the Manufacturing Industry

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A Digital Servitization Maturity Model for the Manufacturing Industry

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Abstract

The fourth industrial revolution – characterized by digitalization – is changing the way organizations create value. It pushes technologies, and challenges the manufacturing industry to keep up. Servitization allows manufacturing firms to exploit the possibilities, by transitioning from a product-centric to service-oriented business. For many, it is a way to differentiate themselves and excel among competition. To support these firms and provide them with some structure this research sets out to develop a digital servitization maturity model. This model comprises of elements manufacturers have to reconsider when pursuing servitization and is based on existing servitization maturity models. What sets this research apart is the model's focus on implementing data and generating knowledge, leaning on the innovations Industry 4.0 has to offer. The resulting digital servitization maturity model is then evaluated with four different case studies, operating in different manufacturing industries.

Preface

Eindhoven, August 2021

This thesis is the result of a six-month graduation project for the master Innovation Management at the Eindhoven University of Technology, performed at Atos. In these strange Covid times Atos provided me a stable environment, backed up with patience and care, trusting the end result will come. When the whole world was in crisis, Atos was something to hold on to, for which I am ever so grateful. I would like to take this blank sheet to thank the people who made it all possible.

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Chapter 1

Introduction

Over the last 30 years the manufacturing industry has developed drastically. Where manufacturing firms used to deliver products to their customers, they are now asked to go beyond that by delivering services also. This transformation journey that it puts firms through, by innovating the organisation's capabilities and processes, is known as servitization (Neely, 2008). Although it has been a research topic for quite some time, it is still relevant and researched extensively, for academia as well as business. This research project intends to develop a maturity model for firms pursuing a servitization strategy. It is conducted at Atos, a leading international IT services company.

1.1 Problem Introduction

The domain of manufacturing has been exposed to a new industrial revolution, which will heavily impact how it operates (Kagermann et al., 2013). This is known as the fourth industrial revolution. Figure 1.1 shows its position with respect to the previous three industrial revolutions. Moreover, it is expected to blur the lines between the physical and digital world, characterized by concepts as Cyber-Physical Systems, the Industrial Internet of Things (IIoT), and servitization. Also, many digital technologies have emerged, such as 3D printing and Virtual Reality. This fourth industrial revolution specifically targets the industrial environment, hence why it is often referred to as *Industry 4.0*. It encompasses a wide range of industrial process improvements, such as automation and advanced digitalization, triggered by changing demands such as individualization and more flexibility (Lasi et al., 2014).

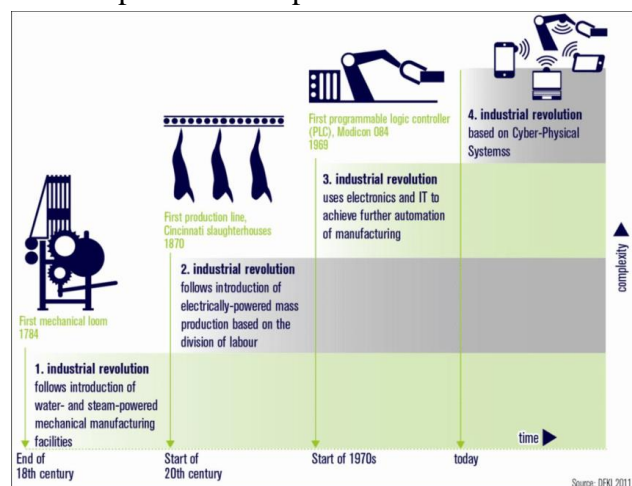


Figure 1.1: The industrial revolutions in time (Kagermann et al., 2013)

The emergence of research on Industry 4.0 has pushed the research focusing on servitization. Servitization was first described by Vandermerwe and Rada (1988) as a way to incorporate services in the final product to create customer value. Industry 4.0 is an enabler of servitization, as digital technologies facilitate how services can be delivered (Vendrell-Herrero, Bustinza, Parry & Georgantzis, 2017; Parida, Sjödin & Reim, 2019). For example the addition of sensors to a product makes it possible to track the product's functioning real time. This enables one to make smart decisions using this data. Oliva and Kallenberg (2003) regard products and services as a continuum, where firms can progress along the axis by including more product-related services. Product-service systems as a term have been used to describe the combination of products, services, networks, software, and infrastructures delivered to the customer (Rapacinni et al., 2013; Tukker, 2004). By changing how value is created for the end user, firms inherently alter their business model. Rolls-Royce for example transitioned from selling engines to offering customers a service package "Power by the hour" wherein there is paid by the hours of flight time (Neely, 2008).

Research has been trying to determine how servitization can benefit firms, and promising results have been posited. Among others, revenue growth (Eggert et al., 2014) and creation of new revenue streams (Baines et al., 2017) are reasons firms opt to pursue a servitization strategy. Although servitization research has been extensive, traditional manufacturing firms struggle to successfully transition from a product-centric to a service-centric business model (Kowalkowski, Gebauer & Oliva, 2017; Kohtamäki et al., 2019).

More recently, some researchers have stated convergence is happening between servitization and Industry 4.0 (Frank, Mendes, Ayala & Ghezzi, 2019). This phenomenon called *digital servitization*, entails the creation of new services and/or improvement of existing services with help of digital technologies. For instance, this enables firms to develop new digital business models or generate knowledge from data (Paschou et al., 2019; Vendrell-Herrero et al., 2017). Sklyar et al. (2019) stress that firms often encounter difficulties when implementing a digital servitization strategy; especially what the impact is on their business and industry, and where to begin their servitization process. Throughout this research within the boundaries of servitization, specifically digital servitization will be focussed on, as it combines the two research streams (servitization and Industry 4.0) disrupting the manufacturing industry.

1.2 Problem Formulation

The general challenge where firms transition from a product-centric company to a service-deliverance company, is one Atos specifically handles with their clients in practice. Atos, being an IT corporation, guides clients through their digital transformation. With Industry 4.0 disrupting servitization and the manufacturing industry primarily, more research is required how firms can successfully mature in a servitization strategy. Atos found that some of their clients indeed encounter difficulties with the requirements needed to implement this strategy effectively, and a roadmap lacks to guide firms as they mature in servitization. This notion forms the starting point of this research.

Transitioning from a typical, product-centred manufacturing firm to a service provider cannot be considered insignificant. The former strategy is based on improving productivity (increasing production volumes, whilst reducing costs), without too much involvement of the customer during product design (Vargo & Lush, 2004; Lush & Vargo, 2006). The impact is company-wide: every domain of the firm should adhere to this strategy and act accordingly. Unsurprisingly, some firms need guidance. Atos acknowledges the importance of both digital technologies and servitization in manufacturing, and how it complements the digital transformation process of manufacturing firms. Therefore, they feel the need to have an instrument to support these firm. A way to provide this support is by creating a maturity model, where the requirements and elements needed to reach a certain level of servitization maturity are present. Maturity models help integrate traditionally separate organizational functions (Gomes et al., 2013), and are used as an evaluative and comparative basis for improvement (De Bruin et al., 2005). Not only would this help firms in assessing their “as-is” state, but also guide them in how to progress to a “to-be” state if the ambition is known. Moreover, maturity models provide a structured overview for an organization and assist firms in taking informed decisions for increasing certain internal capabilities (De Bruin et al., 2005). Such a solution enables manufacturing firms to overcome the stated problems, helps them to improve their business, and helps Atos to better serve its customers. Besides, practitioners are in need of tools to master the transition and the extant research is lacking for digital servitization (Paschou et al., 2019).

Moreover, more research is needed on the influence of digital technologies on servitization (Kamp & Perry, 2017). This research fits this research gap with the development of the DSMM.

Due to changing customer needs and technological developments, manufacturing firms are faced with problems, as well as ample opportunities to set themselves apart from competitors. One of these opportunities is (digital) servitization, however the concept's broadness and depth can hamper firms to successfully pursue it as a strategy, and consequently reach a desired maturity level. The problem statement is therefore defined as follows:

Manufacturing firms do not have sufficient knowledge and expertise to structure the practices for digital servitization to reach the desired maturity level, forced by changing customer needs and enabled by rapid technological developments. Consequently, benefits like revenue growth and creating new business may not be fully reaped.

1.3 Research goal

The goal of this research is to provide manufacturing firms with the right knowledge and practices to mature their product-service system to the desired end state. This is fully in line with the fundamental developments Neely et al. (2011) described, with a shift to the product-service system. To support these companies, a digital servitization maturity model (DSMM) will be designed, by structuring the key elements of digital servitization. According to De Bruin et al. (2005), maturity models “are used as an evaluative and comparative basis for improvement and in order to derive an informed approach of increasing the capability of a specific area within an organization” (p. 2). The goal is thus to design an artefact that will support the solution for manufacturing firms. The objective can thus be stated as follows:

The research goal is to design and develop a solution framework that supports manufacturing firms pursuing a digital servitization strategy to reach their desired maturity.

1.4 Main Research Question

To reach the desired goal of this study as depicted in section 1.3, certain research steps have to be undertaken to create the solution framework. The main research question is therefore the following:

What practices are deployed at the different stages of maturity for manufacturing firms pursuing a digital servitization strategy?

1.5 Sub-Questions

To answer the main research question, it is necessary to provide answers to the following sub-questions. Table 1.1 shows an overview of the sub-questions, as well as how they will be answered.

First, digital servitization is researched thoroughly, by performing a systematic literature review. This helps in defining the concept, the effects it has on a business and explains why some firms opt to transform their business (RQ1). Then, the literature is reviewed once again to assemble a collection of servitization maturity models (RQ2). These models will be used to create a new model (DSMM), in conjunction with focus group research (RQ3). Finally, case study research is used to validate the created model (RQ4) and draw the final conclusions (RQ5).

Table 1.1: List of sub-questions for this research

Sub-question	Answering method
RQ1 What are the critical factors for manufacturing firms when pursuing a digital servitization strategy?	Literature review
RQ2a What servitization maturity models have yet been developed?	Literature review
RQ2b What is the structure of these models?	Literature review
RQ3 What is the structure of the DSMM?	Literature review
RQ3a What are the dimensions of the DSMM?	Literature review Focus group
RQ3b How are the maturity dimensions measured?	Literature review Focus group
RQ4 How can the DSMM be validated?	Case studies
RQ5 How can the DSMM improve the manufacturing firm's servitization strategy?	Case studies

1.6 Thesis structure

The remainder of this research study follows the publication schema of Gregor and Hevner (2013). In chapter 2, the theoretical background is outlined by presenting the setup and results of the systematic literature reviews. In chapter 3, the adopted research method is explained. Chapter 4 discusses the final version of the DSMM in detail. Chapter 5 describes the results of the evaluation of the model, and chapter 6 concludes this research study with the most important findings, limitations, and directions for future research.

Chapter 2

Literature review

Chapter 2 gives an in depth overview of the two performed Systematic Literature Reviews that took place in January 2021. The first literature review aimed to grasp servitization in the context of Industry 4.0. The second literature review had the objective to get an extensive overview of servitization maturity models constructed by other researchers.

This chapter contains four parts. In the first part of this chapter the first systematic literature review is discussed, presenting the findings and defining digital servitization, its challenges and how it affects the manufacturer's organization. In the second part of this chapter the systematic literature review on the servitization maturity models is discussed, presenting an overview of the found models. Thereafter, an initial version of the DSMM is synthesized. Finally, the chapter concludes with the main findings of the systematic literature reviews.

2.1 Systematic Literature Review: Digital Servitization

A systematic literature review was conducted on the subject of servitization to retrieve more information and receive a thorough understanding of the topic. When detailing the research project and discussing the initial research goal it became apparent the topic servitization and Industry 4.0 are intertwining. This is resembled in the way this review is set up. A way to properly execute a systematic literature review is described by Wolfswinkel et al. (2013), and a slightly adapted version is used in this research study. They provide guidelines and it consists of five stages. The approach they describe starts with stage one; defining the inclusion/exclusion criteria, determining the appropriate databases, and deciding on specific keywords. Then in the second stage, the databases are searched. In the third stage, the sample is refined. Stage four analyses the sample and finally in the last stage the outcome is presented. In Figure 2.1 this approach is portrayed, also showing the amount of analyzed articles in the described stages.

2.1.1 Literature collection strategy

2.1.1.1 Search engines

The goal of this literature review was to define digital servitization, and how it can impact a manufacturing firm's operations and performance. Ultimately, main challenges and success factors could be determined. To achieve this goal, multiple search engines were consulted. The search engines used are all accessible using the university's network. Moreover, the search engines have a focus in the field of engineering. Multiple (complementary) search engines were used to ensure a slimmer chance of missing research papers, as well as encountering more conference proceedings. The used search engines are shown in Table 2.1.

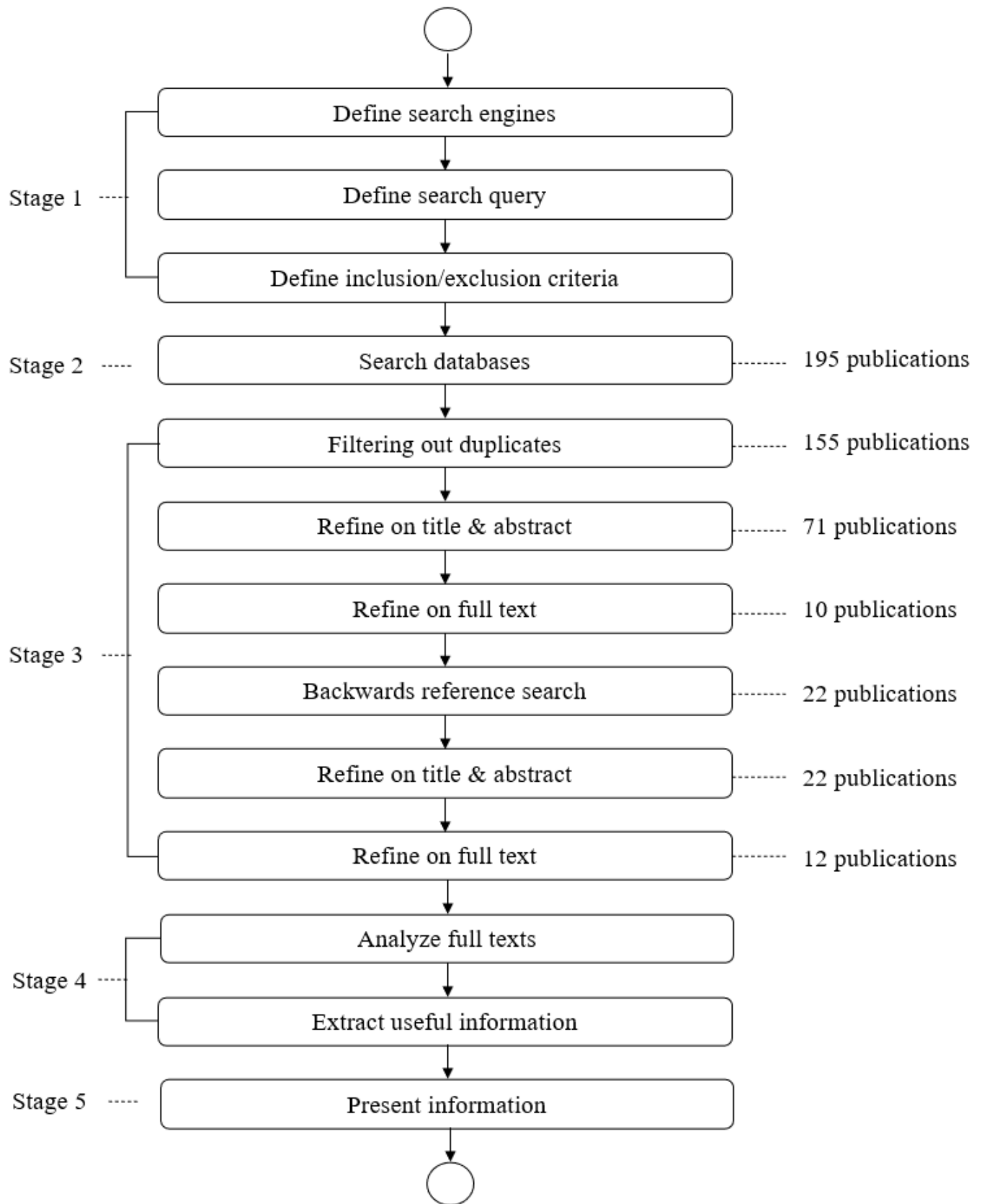


Figure 2.1: Systematic Literature Review stages (based on Wolfswinkel et al., 2013)

Table 2.1: Search engines used

Search engine	Knowledge domain	Description
Scopus	All	Citing Elsevier (2021): “Scopus uniquely combines a comprehensive, expertly curated abstract and citation database with enriched data and linked scholarly literature across a wide variety of disciplines.”
Web of Science	All	Citing Clarivate (2021): “We provide data, analytics and insights, as well as workflow tools and bespoke professional services to researchers and the entire research community that underpins research – universities and research institutions, national and local governments, private and public research funding organizations, publishers and research-intensive corporations, across the world.”
IEEE Xplore	All	Citing ProQuest (2021): “Developed for teaching and research success across the curriculum, ProQuest’s expertly curated DEI collections offer authentic, diverse perspectives spanning books, video, scholarly journals, primary sources and more.”

2.1.1.2 Search terms

Based on the formulated research question and the goal to obtain information on the relationship between servitization and Industry 4.0, the search terms could be derived. This is presented in Table 2.2. The used keywords, with synonyms and variants are displayed here also. Baines et al. (2009) noticed that servitization scholars use different terminology for manufacturing firms moving towards services. Therefore, this research decided to use search strings constructed by Lightfoot, Baines & Smart (2013) for the concept of servitization. The same reasoning was followed for the construction of Industry 4.0 related search words. Again, variants are used in literature, since there is no clear standardized terminology yet agreed on in research (Hofmann & Rüsck, 2017). Therefore, for “Industry 4.0” the synonyms "the fourth industrial revolution" and "the 4th industrial revolution" are used.

The search terms were used as input for the search engines, and certain search queries were constructed. The title, abstract, and keywords of the search engines’ database were searched. This resulted in the following search query:

TITLE-ABS-KEY ("servitization" OR "product-service system" OR "product-service continuum" OR "product-service offering" OR "product-service bundle" OR "service innovation" OR "hybrid offering" OR "service transition" OR "service infusion") AND TITLE-ABS-KEY ("the fourth industrial revolution" OR "the 4th industrial revolution" OR "Industry 4.0")

Finally, some inclusion criteria were used on the found literature. Inclusion criteria are:

- Articles are written in English
- Articles describe servitization in combination with Industry 4.0 related technologies

Table 2.2: Keywords used for the first systematic literature review

Term type 1	Term type 2
"servitization" OR "product-service system" OR "product-service continuum" OR "product-service offering" OR "product-service bundle" OR "service innovation" OR "hybrid offering" OR "service transition" OR "service infusion"	AND "the fourth industrial revolution" OR "the 4th industrial revolution" OR "Industry 4.0"

2.1.1.3 Systematic literature review results

The results of the described search of section 2.2.2.1 are shown in Table 2.3 for each of the search engines.

Table 2.3: Number of publication per search engine

Search engine	# of publications
Scopus	141
Web of Science	41
ProQuest	13
Total	195

The search of the three databases using the mentioned search query resulted in a total of 195 publications. After removing duplicates, 155 publications remained. Thereafter, of these publications the title and abstract was read. Many articles mentioned “servitization” just as to why firms are digitalizing their business, but did not discuss the relationship (i.e. Oluwafemi & Laseinde, 2020; Sala et al., 2019). Other articles were dismissed for discussing a single technology thoroughly (i.e. Liu & Xu, 2017; Marini & Bianchini, 2016) or focusing on a niche industry (i.e. Aiello et al., 2020; Corradi et al., 2018). Thus, a list of 71 publications remained. These were all fully read and filtered on the full text, and determined if they were applicable and useful for answering the research questions. Some articles were excluded due to being too technical, focused on a single technology, or industry specific (i.e. Stark et al., 2014; Bagozi, 2019; Arifiani, 2019). Other articles were disregarded as they only focused on Industry 4.0 (i.e. Bellavista et al., 2019). The eventual number of articles was a total of 10 which added to the purpose of answering the research questions. Using the technique of snowballing (Wohlin, 2014) on these articles resulted in an addition of 12 articles. Again, the title and abstract and full text were read, and 2 articles were added to the final result of the systematic literature review. Thus, a final of 12 articles was the outcome of using the search engines.

The systematic literature review thus resulted in 12 articles. These were used to define servitization in the context of Industry 4.0, and to identify what drives servitization, and how the servitization process is characterized. This is explained in section 2.1.2.

2.1.2 Digital Servitization Literature Result

2.1.2.1 Defining servitization

Vandermerwe & Rada (1988) introduced the term “servitization”, which refers to the shift firms make when value is added to the core of their offerings by bundling it with services. Since its introduction, scholars have tried to provide a definition for the concept. Baines et al. (2009) constructed a definition scholars tend to agree on: “Servitization is the innovation of an organisations capabilities and processes to better create mutual value through a shift from selling product to selling PSS.” (p. 555). What this definition shows is that a firm has to reconsider the way it operates, both on employee level, as well as on an organization level. Both the required capabilities change, as well as the firm’s processes. Therefore, this definition fits this research, since it focuses on how a firm internally has to change in order to recreate value. Furthermore, “product-service systems” (PSS) is mentioned in the definition. PSS is closely related to servitization (Tukker & Tischner, 2006), and much of the principles are identical. Baines et al. (2007) describe PSS as the integration of product and services offerings by a firm that delivers value to the user. In this research, servitization is more focused on the process of shifting from a product-centric company to a service-oriented company, whereas PSS emphasizes the result of that shift. Both servitization and PSS enrich value for the user of the product. Since the value proposition is a crucial part of the business model (Chesbrough, 2010), this affects how a business operates.

2.1.1.2 Drivers of servitization

Oliva and Kallenberg (2003) identified three major drivers of servitization: financial drivers, strategic drivers, and marketing drivers. Matthyssens and Vandenbempt (2008) add avoiding commoditization as a reason to pursue servitization. Finally, digitalization is mentioned as a driver of servitization (Coreynen et al., 2017; Ardolino et al., 2018). These drivers are discussed one by one.

Financial incentives mentioned in literature are higher margins, and a more stable, continuous stream of revenue (Davies, 2004). Especially in the manufacturing industry, where firms tend to have a large installed base at customers, services as an add-on are from a business model standpoint an appealing way to generate more revenue on sold products (Davies, 2004).

Strategic drivers focus on new ways to innovate a product (Carlborg, Kindström & Kowalowski, 2013). Servitization can be used as a way to differentiate a firm from its competitors, by creating new service bundles or delivering services better than competitors. Moreover, this hampers competitors from imitating the firm’s products, due to the intangible nature of services (Vandermerwe & Rada, 1988). Moreover, Vendrell-Herrero et al. (2017) point out servitization differentiates manufacturing firms from downstream (in the supply chain) players, which can become empowered by the digitalization process. Commoditized products are products sold by competitors that are almost identical. Typical commodity type products are sand, or nails (Robinson, Clark-Hille & Clarkson, 2002). Servitization can act as a way to differentiate from a competitor’s identical product and bind the customer to the manufacturing firm.

Marketing drivers are drivers of servitization specifically focused on increasing the firm-customer relationship (Tukker, 2004). When the customer relies more heavily on the firm’s services, these relationships tend to become more loyal, establishing longer relationships

between the firm and customer. With these strengthened and longer lasting relationships firm and customer are able to create new opportunities, and ultimately co-creation of value can appear among them (Baines et al., 2007).

Industry 4.0, and digitalization in general, is considered a driver of servitization (Ardolino et al., 2018). Specifically, digital technologies facilitate the service offerings of manufacturing firms (Kindström & Kowalkowski, 2009; Coreynen, Matthyssens & Van Bockhaven, 2017) by enabling new services (i.e. remote monitoring) and reinventing the manufacturing industry (Porter & Heppelmann, 2014). Moreover, digital technologies have changed the interaction between firm and customer before, during, and after purchase (Paschou et al., 2017). Digital technologies also enable firms to develop customized value propositions, and research considers them crucial for manufacturing firms to even move towards PSS (Ardolino et al., 2018; Paschou et al., 2017).

2.1.1.3 Digital servitization

Digital servitization is about servitization driven by digital technologies. The phenomenon of Industry 4.0, which is considered a new industrial scenario with convergence of different emerging technologies, is characterized by the Internet of Things (IoT). IoT results in cyber-physical systems and intelligent systems in general (Frank et al., 2019; Liao et al., 2017). What the industrial internet offers, are connectivity platforms. On these platforms, machines, devices and products can be interconnected and adapt themselves, or be flexible using smart digital technologies. A key factor for IoT to work, is the interplay of sensors and the development of the Internet supporting those sensors: IoT enables data gathering from the sensors on the smart products, which has to be converted to information in order to be used as strategic information (Grandinetti et al., 2020; Santos et al., 2017). Data gathering is thus not enough, the firm has to have the right internal infrastructure to be able to analyse it and act upon it.

Digital servitization can be implemented on different levels. Paiola & Gebauer (2020) describe three different levels of digital servitization: product-oriented digital servitization, process-oriented digital servitization, and outcome-oriented digital servitization. Product-oriented digital servitization refers to services oriented to the manufacturing firm's products by using IoT technologies. These are also known as Product Life-Cycle Services (Oliva & Kallenberg, 2003). These services revolve around the functioning of the product during its life-cycle, from the deliverance of the product, installing it, calibration, basic maintenance and overhaul, and spare parts services. The relationship between manufacturing firm and customer often is purely transactional. Process-oriented digital servitization refers to services oriented to increase efficiency of customer's products and processes by using IoT technologies. These services aim to improve the customer's processes by assisting, auditing and consulting. Uluga and Reinartz (2011) explain the customer benefits from these services in achieving productivity gains. Service examples are process-oriented training, remote condition monitoring and preventive maintenance. The manufacturing firm and customer's relationship strengthens, as it, compared to a lower level of digital servitization, evolves from a transactional to a more relationship-based attitude (Oliva & Kallenberg, 2003; Paiola & Gebauer, 2020). Finally, Paiola and Gebauer (2020) describe outcome-based digital servitization, which refers to securing a certain business outcome for the customer's processes by the manufacturing firm by using IoT technologies. Moreover, the manufacturing firm may provide resources (e.g. service personnel) and capabilities to ensure the agreed outcome is met. Performance contracts are a typical example of these types of digital servitization levels. Here, the manufacturing firm and customer tend to have close relationships, with high sharing of information. What all these

levels of digital servitization have in common, is that a certain level of data sharing is required. When data is shared, the involved parties can act and react to the knowledge that is being generated from that data and – if preferred – higher levels of digital servitization can be reached.

Other researchers recognize these levels of digital servitization. However, they choose to include more intermediate levels of digital servitization. For example, Neff et al. (2020) choose five service levels, ranging from basic spare part services, to reactive maintenance services, predictive maintenance services, performance contracting services, and ultimately managing the customer’s operations. The choice of distinguishing three or five levels comes down to taste: both approaches recognize the same trend in how these levels are constructed, with higher levels using more data and the supporting digital technologies, and essentially taking away as much of the customer’s attention to the processes involved with the acquired product. Urmetzer, Neely and Martinez (2016) discuss different service provisions levels and present it in the form of a service staircase (adapted from Turunen, 2012). A low to a high level of service provision is concurrently described as: manufacturing, after sales, maintenance, solutions and process outsourcing. With higher service provision levels, comes a closer relationship with the customer due to higher complexity of service provision. This service staircase is shown in Figure 2.2. Furthermore, the levels are interdependent, meaning to progress to a higher staircase, the lower service provisions should be already present. This reveals that the servitization process is tedious, and steps should be carefully taken.

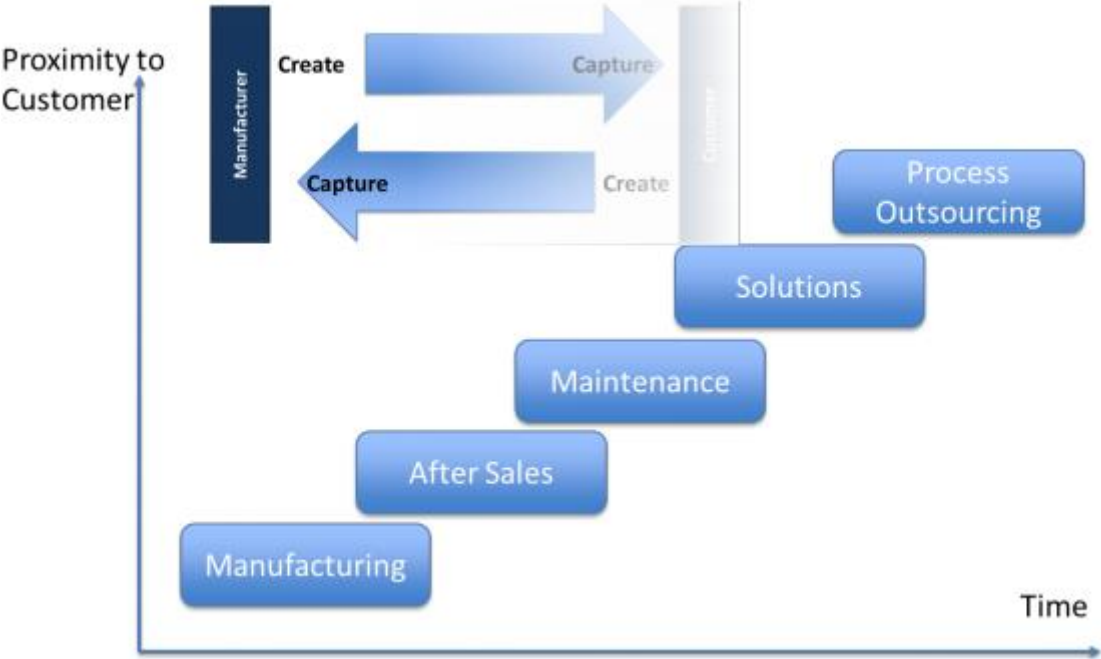


Figure 2.2: The service staircase, focused on value for the manufacturer (Urmetzer, Neely & Martinez, 2016)

2.1.1.4 Digital servitization process

This literature review has established why manufacturing firms pursue digital servitization, how digital technologies enable digital servitization, and the types of service offerings related to digital servitization. This section described how manufacturing firms have to (re)arrange their internal business to adhere to the shift of transitioning from a product-centric to a service-oriented firm. Oliva and Kallenberg (2003) regard this shift as a transformation along a

continuum, with on the one hand being a product-provider, and on the other hand being a service-provider. This is shown in Figure 2.3.

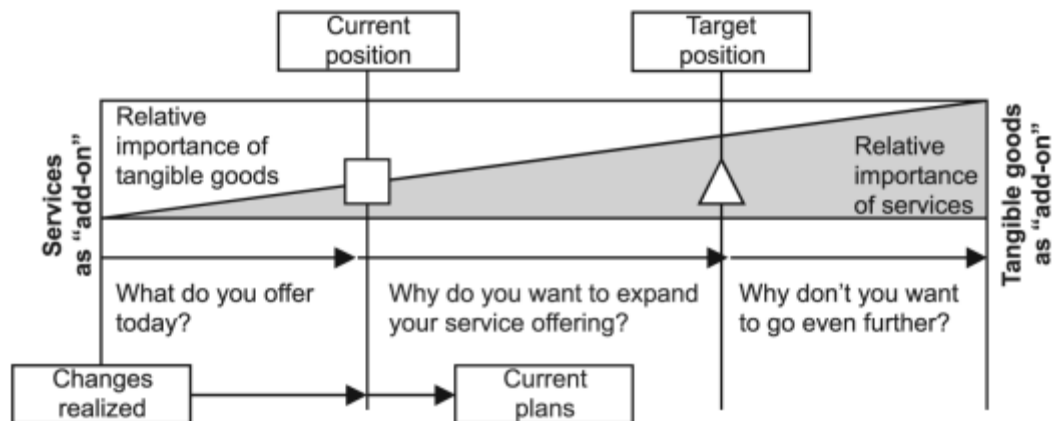


Figure 2.3: Product-service continuum (Oliva & Kallenberg, 2003)

When manufacturing firms pursue (digital) servitization, they move through the model from left to right, and the manufactured goods shift from being the core focus to “add-on” to the service. Despite acknowledging this transition, Belvedere et al. (2013) note that defining how digital servitization changes a firm’s strategy, culture and processes remains unexplored. Baines and Lightfoot (2014) aim to establish critical requirements affected by pursuing a digital servitization strategy, and how it relates to other chain elements. These elements include customers, competitors, partners, and internal relationships. Following this reasoning, Paschou et al. (2019) establish four business areas impacted by a digital servitization transition: strategy, customer experience, business processes, and organization and culture. Other research chooses a business model innovation perspective (Frank et al., 2019), since servitization directly refers to a change in the business model’s value proposition, the value deliverance and value capturing mechanisms need to be aligned. These alignments take place by internally changing the business. Externally, the manufacturer has to change as well: the strategy should be aligned with the customer, and the service network (Alghisi & Saccani, 2015). Therefore, servitization is an organization-wide change process.

The transition of becoming a service-provider by changing gradually is called the incremental transition (Perona, Saccani & Bacchetti, 2017). Perona et al. (2017) argue this is the most frequent mentioned transition process in literature, and also most cases of firms ‘servitizing’ take this approach. It is the most natural way of changing, taking it step-by-step. Moreover, literature mentions a more radical transition as opposed to this incremental one. This approach is much less discussed in literature, but can sometimes occur in case studies (Perona et al., 2017). Since the incremental transition occurs most frequently, this is the focus of the digital servitization process discussed in this research.

Either regarding the approach of Oliva and Kallenberg (2003), the way Tukker (2004) describes the servitization process, the service provision staircase of Urmetzer, Neely and Martinez (2016); they all assume a gradual, incremental servitization process, in which the organization has to change the way it operates. At each level of servitization the business needs to be aligned with the strategy and the business model, both internally and externally. To achieve this, certain challenges have to be overcome for the company to adapt to that new service provision level. Some researchers aimed to collect these challenges, by providing structured insights (Martinez

et al., 2010; Alghisi & Saccani, 2015); Zhang & Banerji, 2017). Table 2.4 grants an overview of the found challenges.

Table 2.4: Challenges when pursuing servitization

Authors	Identified challenges
Martinez et al. (2010)	<ol style="list-style-type: none"> 1. Strategic alignment 2. Internal processes and capabilities 3. Embedded product-service culture 4. Delivery of integrated offering 5. Supplier relationships
Alghisi & Saccani (2015)	<ol style="list-style-type: none"> 1. Company strategy for service 2. Internal organization 3. Customers 4. Service offerings portfolio 5. Service network
Zhang & Banerji (2017)	<ol style="list-style-type: none"> 1. Business model 2. Organizational structure 3. Customer management 4. Development process 5. Risk management

The challenges found have some similarities. For example, manufacturing firms are challenged with their new service strategy, and aligning it internally with their business model. Oliva and Kallenberg (2003) recognized that manufacturers sometimes have no clear sense of what direction they are heading in. Alghasi and Saccani (2015) note that when a strategy is present, still difficulties arise in their internal organization. The strategy has to be incorporated throughout the entire business, including the business processes and capabilities that come with this strategy. Consequently, new processes and capabilities have to be developed (Alghasi & Saccani, 2015), considering delivering services is different to solely selling goods. This also requires an internal organizational change of culture (Martinez et al., 2010; Alghisi & Banerji, 2015). A real change in mindset is needed, however it remains a challenge for the manufacturing firm to establish this change company-wide. This cultural misalignment can really hamper the manufacturing firm in transitioning to their desired servitization level. Firms have to adopt the mindset of thinking like the end-user (Martinez et al., 2010). The relationships with the customer changes as well, as described before, and this needs to be managed well by the manufacturing firm. With closer relationships, different expectations arise, and going from a purely transactional to a relationship-based relation can be challenging for the manufacturer.

Finally, Martinez et al. (2016) constructed seven critical success factors for servitization. These are:

1. Assess the market and internal readiness
2. Create the right strategic and cultural context
3. Build the structures and governance for services
4. Dedicate the resources for creating and delivering new services
5. Proactively manage engagement and trust
6. Develop and embed service processes
7. Optimize services and communicate best practices

The challenges described and the success factors outlined give an overview of how manufacturing firms have to adapt in general when pursuing a digital servitization strategy. Of course every industry has their specific difficulties to transition to a service-provider, making servitization a complicated topic to deal with in practice.

2.2 Systematic Literature Review: Servitization Maturity Models

Besides the first literature review, a second one was executed on mapping what servitization maturity models have been developed in research. This review followed the same procedure as the review on digital servitization (Wolfswinkel et al., 2013). This is shown in Figure 2.4.

2.2.1 Literature collection strategy

To achieve the goal of mapping the servitization maturity models, the same search engines were used: Scopus, Web of Science, and ProQuest. The search terms were derived from the work of Adrodegari and Sacconi (2020). They constructed synonyms and variants for the term “maturity model”, and they proved useful for this research also. Variants are "capability model", "process improvement model", "assessment model" and "maturity grid". These were combined with the earlier established variants for the term “servitization” (Lightfoot et al., 213). The search terms are shown in Table 2.5.

Table 2.5: Search terms used

Term type 1	Term type 2
("maturity model" OR "capability model" OR "process improvement model" OR "assessment model" OR "maturity grid")	AND ("servitization" OR "product-service system" OR "product-service continuum" OR "product-service offering" OR "product-service bundle" OR "service innovation" OR "hybrid offering" OR "service transition" OR "service infusion")

Combining the search terms resulted in the following search query:

TITLE-ABS-KEY ("maturity model" OR "capability model" OR "process improvement model" OR "assessment model" OR "maturity grid") AND TITLE-ABS-KEY ("servitization" OR "product-service system" OR "product-service continuum" OR "product-service offering" OR "product-service bundle" OR "service innovation" OR "hybrid offering" OR "service transition" OR "service infusion ")

The reason why Industry 4.0 was not incorporated in the search query, is to extend the outputted amount of publications. The research stream of digital servitization is emerging, so it would have been too exclusive to refine on these search terms also.

2.2.2 Systematic Literature Review results

The results of the in section 2.2.1 described search query are shown in Table 2.6.

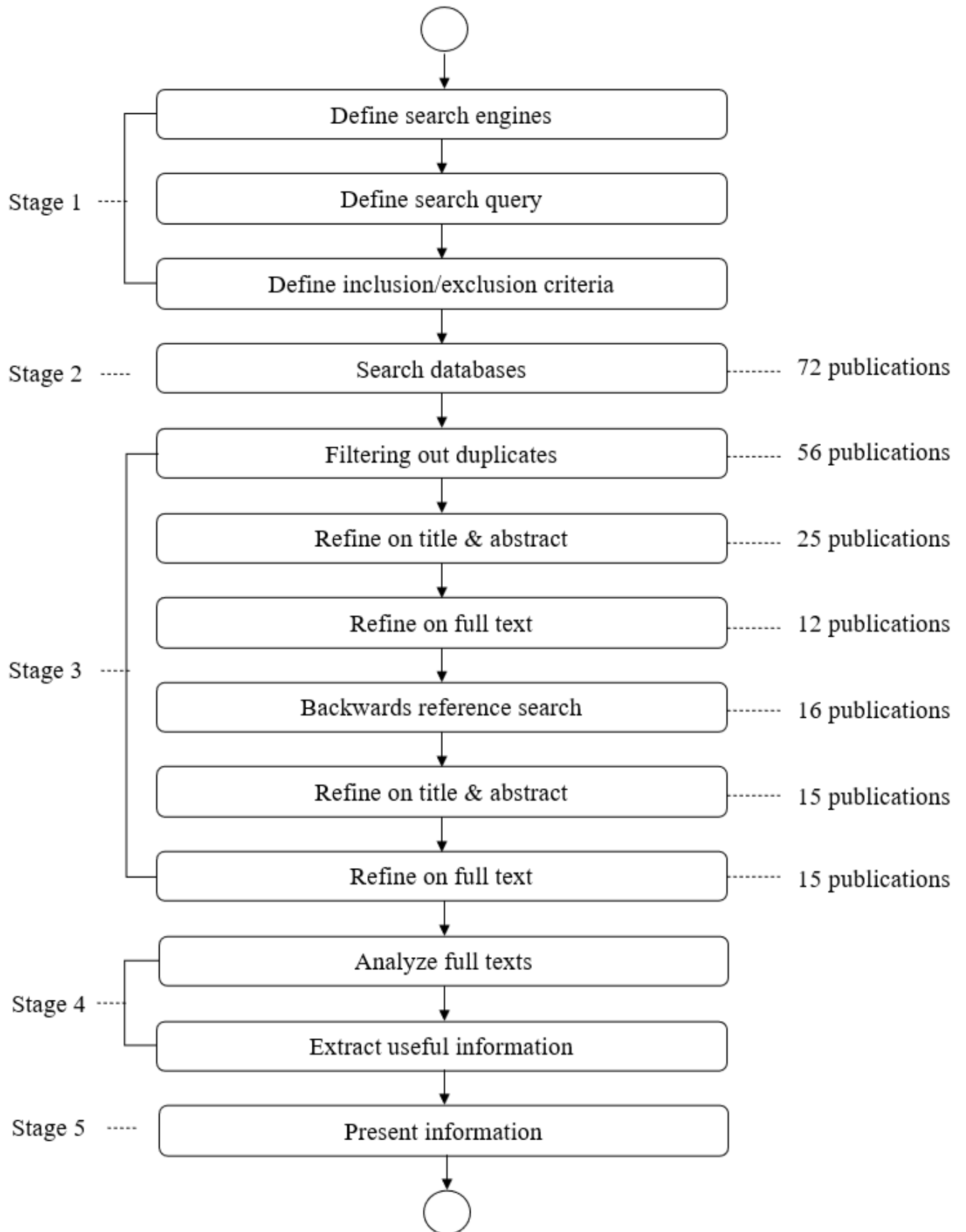


Figure 2.4: Systematic Literature Review stages (based on Wolfswinkel et al., 2013)

Table 2.6: Number of publication per search engine

Search engine	# of publications
Scopus	47
Web of Science	20
ProQuest	5
Total	72

The search of the three databases using the mentioned search query resulted in a total of 72 publications. After removing duplicates, 56 publications remained. These publications were then assessed on their the title and abstract. Some articles were dismissed as they did not discuss servitization maturity (i.e. Medini et al., 2021). Many conference proceedings were unavailable and could therefore not be accessed. A list of 25 publications remained. These were all fully read and filtered on the full text, and determined if they were applicable and useful for the creation of the maturity model. Dismissed articles did not present a model (i.e. Cao & Jiang, 2013; Vasantha et al., 2012), or were focused on one topic (i.e. sustainability (Xing et al., 2013)) The eventual number of articles was a total of 12 in which some sort of servitization maturity model was discussed. Using the technique of snowballing (Wohlin, 2014) on these articles resulted in an addition of 4 articles. Again, the title, abstract and full text were read, and 3 articles were added to the final result of the systematic literature review. Thus, a final of 15 articles was the outcome of using the search engines.

2.2.3 Servitization Maturity Model Literature Result

What became evident from the first systematic literature review, is the breadth of challenges a manufacturing firm is faced with when pursuing a servitization strategy. As a result, to face these challenges, firms have to adapt to servitization by changing organization-wide. The dimensions of how servitization affect the manufacturer are aimed to be grasped by the maturity models, which were the result of the literature search. These models all have slightly different goals, and all approach servitization differently. An overview of the found maturity models and what dimensions they consider are shown in Table 2.7. For each of the models the authors, topic, maturity description, maturity dimensions, number of levels, and level of analysis have been specified. Wikström et al. (2009) focus on changes in project-based firms as they move from equipment-suppliers to also being service-providers. Rapaccini et al. (2013) suggest a new service development (NSD) maturity model for product-centric manufacturers. The model is built upon four dimensions: the management of processes and projects; the use of specific resources; customer, supplier and stakeholder involvement; and the adoption of performance management systems. Jin et al. (2014) have a similar NSD focus and define a set of success factors and group these into four dimensions: strategy management, process formalization, knowledge management, and customer involvement. Li et al. (2014) designed a service maturity model for product-centric firms, created based on four dimensions: sales profit source, service business composition, service process quality, and service infrastructure. Alvarez et al. (2015) base servitization on the relationship among players in the value chain, and analyzes four dimensions: market, network, customer, and internal. Pigosso and McAloone (2016) developed a maturity model when transitioning to sustainable PSS. Sousa et al. (2017) designed a model of capability antecedents and performance outcomes of servitization strategies, based on two types of services (basic and advanced). Exner et al. (2018) created a PSS self-assessment tool, with four distinct dimensions, which are each further divided into two sub-dimensions: value proposition (degree of individualisation, service degree), business processes (PSS management, PSS orientation), customer (customer demands, customer integration), and

sustainability (sustainable management, end-of-life responsibility). Cui et al. (2019) produced a servitization related decision-making maturity model, to determine how decisions change as servitization matures. This is structured around four business model components: value proposition, organizational structure, governance, and revenue and profit model. Paschou et al. (2019) created a digital servitization maturity model, based on four dimensions, each with their own sub-dimensions: strategy (strategic orientation, business model, digital service offering, digital service ecosystem), customer experience (customer centricity, customer trust), business processes (production, marketing, human resources), and organization and culture (digital service mindset, governance and leadership, organization design and talent management, competences). Babaei and Aghdassi (2020) built a model measuring the quality of service innovation, with the four maturity dimensions they took from Jin et al. (2014). Andersen et al. (2020) built a servitization maturity model with six dimensions: organizational governance, strategic management, value function activities, market reach, digital integration, and service integration. Neff et al. (2020) developed a maturity model for service systems, and divided it into three dimensions with sub-dimensions: strategy (performance measurement), environment and organization (installed base management), and IT artefact (mobile support for service workforce, integration of service and product data, data quality assurance). Lexutt et al. (2020) created servitization maturity based on the outcome of the service offerings. Finally, Adrodegari et al. (2020) built a servitization maturity model which builds on successfully deploying a servitized business model by assessing five dimensions: capabilities, process management, tools, organizational approach, and performance management. Each of the dimensions is then compared to each of the business model components.

Table 2.7: Overview of servitization maturity models

Author	Topic	Maturity Description	Maturity dimensions and components	# of levels	Level of analysis
Adrodegari et al. (2020)	Servitization maturity model	Assessing and positioning companies in the servitization journey	Five dimensions: <ol style="list-style-type: none"> 1. Capabilities 2. Process management 3. Tools 4. Organizational approach 5. Performance management 	5	Firm level
Lexutt et al. (2020)	Key factors for servitization success	Maturity of servitization is captured in the offering as the outcome of implementing service	Three dimensions: <ol style="list-style-type: none"> 1. Configurations sufficient for financial success 2. Configurations sufficient for non-financial success 3. Configurations sufficient for overall success. 	N/A	Firm level
Neff et al. (2020)	Information system for PSS	Maturity model for service systems	Three dimensions: <ol style="list-style-type: none"> 1. Strategy 2. Environment and organization 3. IT artefact 	5	Firm level and process level
Andersen et al. (2020)	Assessment of maturity in servitization process	Three levels of maturity assigned to combinations of dimensions	Six dimensions: <ol style="list-style-type: none"> 1. Organizational governance 2. Strategic management 3. Value function activities 4. Market reach 5. Digital integration 6. Service integration 	3	Firm level
Babaei and Aghdassi (2020)	Measurement of quality in service innovation	Facilitating evolution of NSD capabilities and process improvement direction	Four dimensions: <ol style="list-style-type: none"> 1. Strategy management 2. Process formalization 3. Knowledge management 4. Customer involvement 	4	Firm level and process level

Paschou et al. (2019)	Digital servitization maturity model	Assessing and positioning companies in their digital servitization journey	Four dimensions: 1. Strategy 2. Customer experience 3. Business processes 4. Organization and culture	3	Firm level
Cui et al. (2019)	Decision making logics in servitization transformation process	From basic services to performance-based solutions	Business model components: 1. Value proposition 2. Organizational structure 3. Governance 4. Revenue and profit model	4	Process level
Exner et al. (2018)	Self-assessment tool for PSS	Five maturity levels of maturity for PSS	Four dimensions: 1. Value proposition 2. Business processes 3. Customer 4. Sustainability	5	Firm level
Sousa et al. (2017)	Servitization strategies	Business model alignment with service provisions	Seven dimensions: 1. Business model 2. Predominant contractual relationship 3. Value added to customer through services 4. Extent to which manufacturer takes over customer processes 5. Nature of service processes 6. Degree of customer interaction and co-creation 7. Competitive positioning	2	Firm level
Pigosso and McAloone (2016)	Sustainable PSS	Eco-design maturity model to support PSS	Six steps to support maturity profile of firms 1. Diagnosis of current maturity profile 2. Definition of desired maturity 3. Deployment of a strategic roadmap for eco-design implementation 4. Planning of improved projects 5. Implementation and change management 6. Monitoring and evaluation	5	Firm level

Alvarez et al. (2015)	Servitization process maturity model	Shift from product-centric to service-oriented firm	Four dimensions: 1. Market 2. Network 3. Customer 4. Internal	5	Process level
Jin et al. (2014)	Assessment tool for NSD maturity model	Facilitating evolution of NSD capabilities and process improvement direction	Four dimensions: 1. Strategy management 2. Process formalization 3. Knowledge management 4. Customer involvement	5	Firm level and process level
Li et al. (2014)	Service management	Four stage service model determined by added value of service	Four dimensions: 1. Sales profit source 2. Service business composition 3. Service process quality 4. Service infrastructure	4	Firm level
Rapaccini et al. (2013)	NSD	Roadmaps for assessing firm capabilities	Four dimensions: 1. Organizational approach 2. Resources 3. Customers, suppliers and other stakeholders 4. Performance management	5	Firm level
Wikström et al. (2009)	Service provision	Firm's maturity in service deliverance	Eleven dimensions: 1. Goal 2. Value create route 3. Mental process 4. Organizational concept 5. Key process 6. Measures 7. Culture 8. Priority-setting bases 9. Main offering 10. Approach to personnel 11. Sales bias	3	Firm level

2.3 Theoretical framework of DSMM

The previous section provided an overview of the available servitization maturity models. Only one of the models specifically focused on digital servitization (Paschou et al., 2019). This model however is purely conceptual and has not yet been tested. The need for an empirically tested digital servitization maturity model can thus be discovered. Another shortcoming of the different models, is the (lack of) implementation of digitalization. Some models (Neff et al., 2020; Andersen et al., 2020) have implemented some sort of IT technology maturity, and only Paschou et al. (2019) have integrated digitalization maturity with all maturity dimensions. However, this research aims to develop an integrated digitalization – servitization model, therefore this remains a shortcoming in the found maturity models.

As a result, only some of the found models have been considered as input for the development of the DSMM also and their results were used to design the initial version of the DSMM of this research study.

Moreover, the mentioned models do not share a similar setup in terms of how the models were designed. Since the goal of the DSMM is for manufacturers to assess their digital servitization level, De Bruijn et al. (2005) classify such models as a descriptive model. Fraser et al. (2002) note that to achieve the descriptive model purpose, the model should have a number of components:

- A number of dimensions;
- A number of levels;
- A descriptor for each level;
- A generic description of each level as a whole;
- A description of each level per dimension.

The dimensions and levels are described in the next two sections.

2.3.1 Dimensions

The number of dimensions per model ranged from a minimum of three dimensions, to a maximum of eleven dimensions. The average amount of dimensions is 4.87 dimensions. In Figure 2.5 an overview of the frequencies per dimensions is portrayed. It can be noticed that the amount of dimensions which is mostly used is four dimensions, with a total of eight times out of the fifteen found models. This does not restrict the DSMM to consist of exactly four dimensions, but it gives an idea on the general trend in these models.

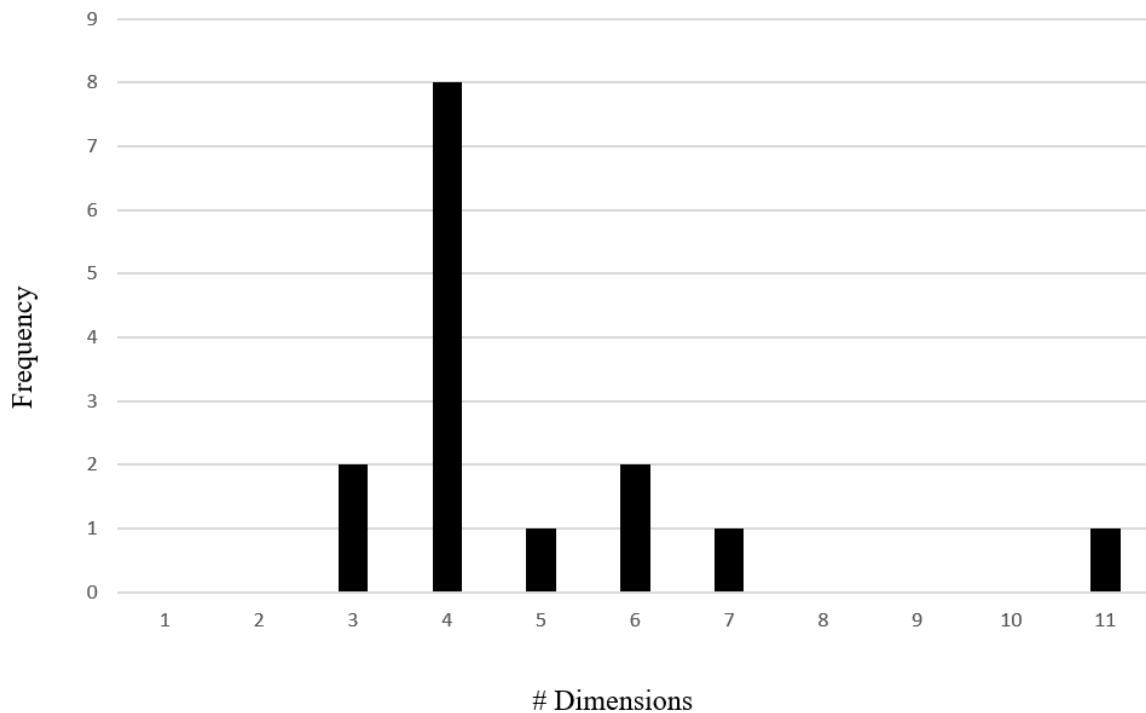


Figure 2.5: Frequency of dimensions in found maturity models

According to De Bruijne et al. (2005) identifying dimensions can be achieved through executing an extensive literature review. The initial version of the DSMM is thus built up from the found dimensions from Table 2.7. The first step in the model development was to screen the models on their goal, and for the models which share the same research goal as this research study more information was gathered.

Only some of the mentioned models bear resemblance with the objective of this research study: to design a digital servitization maturity model, by structuring the key dimensions for firms pursuing such a strategy. These are the models of Adrodegari et al. (2020), Neff et al. (2020), Andersen et al. (2020), Paschou et al. (2019), Exner et al. (2018), Alvarez et al. (2015), and to some extent Rapaccini et al. (2013) and Wikström et al. (2009). However, they all have some inconsistencies with the research aim of this study. Adrodegari et al. (2020) take a business model approach, while not considering as much the organizational change aspects. Neff et al. (2020) focus mostly on the service systems outcome, rather than approaching servitization as a process or even a journey. The work of Andersen et al. (2020) provides good basis for further research, however the model is not empirically tested, nor is it clear how their model has been developed, rather than descriptive statements on how their work has been conducted. The maturity model developed by Paschou et al. (2019) comes closest to this research study, by delivering a digital servitization maturity model. However, their model is purely conceptual as well, and written for a conference proceeding, which has hampered their abilities to exhaustively describe their taken research steps. Alvarez et al. (2015) designed a model which focuses on organizational elements needed to provide certain service levels. What they failed to describe is maturity levels for each service level, but more so created a checklist what is needed at each service level per organizational element. Difficulties arise to use the model for prescriptive purposes. Rapaccini et al.'s model (2013) is not purely focused on servitization, but an interplay between NSD and servitization exists. Furthermore, descriptive practices are in place, which echoes with the research goal of this study. Finally, Wikström et al. (2009)

provides a model with results focused on service deliverance, not so much of the organization supporting the service deliverance.

Moreover, De Bruijne et al. (2005) argue that the identification of sub-dimensions is recommended for complex domains, enabling a more thorough analysis of maturity results. Although this could be difficult to populate, in the development of the DSMM dimensions are divided into sub-dimensions. The initial version of the dimensions of the DSMM is presented in Table 2.8. This is used as the basis for further development of the model and used as input for the focus group research (section 3.2). Moreover, to mitigate the risk of missing (sub-)dimensions, the focus groups were also asked their expert opinion on completeness of the DSMM.

Table 2.8: Initial dimension overview of DSMM based on the systematic literature review

(Sub-)dimension	Authors
<i>Customer</i>	
Systemic integration with the customer	Alvarez et al. (2015)
Knowledge of customer's installed base	Alvarez et al. (2015); Babaei & Aghdassi (2020); Neff et al. (2020)
Contact with potential customers	Alvarez et al. (2015)
Knowledge of solution criticality	Alvarez et al. (2015)
Tests of new technologies with the customer	Alvarez et al. (2015)
Evaluation of customer satisfaction and customer service operations	Alvarez et al. (2015); Babaei & Aghdassi (2020); Paschou et al. (2019); Rapaccini et al. (2013)
Customer training	Alvarez et al. (2015)
<i>Strategy</i>	
A business model is in place supporting the digital service offerings	Paschou et al. (2019)
Servitization specific analytical performance objectives (KPIs) are in place	Neff et al. (2020); Rapaccini et al. (2013)
Existence of a digital servitization strategy, aimed at developing digital service offerings	Paschou et al. (2019); Rapaccini et al. (2013); Babaei & Aghdassi (2020); Wikström et al. (2009)
<i>Organization & culture</i>	
Governance and leadership: decision making processes concerning digital servitization projects	Paschou et al. (2019); Rapaccini et al. (2013)
Competences and knowledge development of employees of digital technologies	Paschou et al. (2019)
Digital service mindset	Paschou et al. (2019)
Change of firm's culture from product provider to customer-centric approach	Wikström et al. (2009)
<i>Process and project management</i>	
Procedures for managing projects are in place	Rapaccini et al. (2013)
Usage of interdisciplinary teams for digital servitization	Babaei & Aghdassi (2020);

Extent to which company takes over processes of customers	Rapaccini et al. (2013) Sousa et al. (2017)
Production; the amount of traceability and customization in the production process	Paschou et al. (2019)
Performance management systems (feedback, KPIs) are in place for service projects	Rapaccini et al. (2013)
<i>Market</i>	
Identifying competitors	Alvarez et al. (2015); Babaei & Aghdassi (2020)
Analyzing market and industry trends	Paschou et al. (2019)
Solution availability already on market	Alvarez et al. (2015)
Marketing: analytical studies carried out to determine (product and dynamic) pricing	Babaei & Aghdassi (2020); Paschou et al. (2019)
<i>HRM</i>	
Firm's focus on hiring service-oriented personnel	Rapaccini et al. (2013)
Supporting employees' development in the service transition	Paschou et al. (2019); Rapaccini et al. (2013)
<i>Network</i>	
Involving the upstream supply chain in new service development	Rapaccini et al. (2013)
Company repositioning in the value chain	Alvarez et al. (2015)
Digital service ecosystem presence with partners/stakeholders	Paschou et al. (2019)

2.3.2 Levels

To complete the initial version of the DSMM, the maturity levels must be added to the discussed dimensions and their respective sub-dimensions. In Table 2.7 the number of levels per maturity model are shown. Table 2.9 shows how the maturity models which resulted from the literature review designed the maturity levels.

Table 2.9: Maturity levels of models from literature review

Author	Level 1	Level 2	Level 3	Level 4	Level 5
Adrodegari et al. (2020)	Level 1	Level 2	Level 3	Level 4	Level 5
Lexutt et al. (2020)	N/A				
Neff et al. (2020)	Rudimentary spare parts service	Reactive maintenance service	Predictive maintenance service	Performance contracting service	Managing the customer's operations
Andersen et al. (2020)	Low	Medium	High		
Babaei and Aghdassi (2020)	Incapable	Struggling	Truncated	Exhaustive	
Paschou et al. (2019)	Beginner	Experienced	Leader		

Cui et al. (2019)	Products plus after sales services	Products plus extension services	Integrated solution	Performance based solution	
Exner et al. (2018)	Novice	Beginner	Advanced	Experienced	Expert
Sousa et al. (2017)	Basic services	Advanced services			
Pigosso and McAloone (2016)	Level 1	Level 2	Level 3	Level 4	Level 5
Alvarez et al. (2015)	Initial	Repeatable	Defined	Managed	Optimizing
Jin et al. (2014)	Initial	Financial	Forecast-based	Externally oriented	Strategic management
	Initial	Managed	Defined	Quantitatively managed	Optimizing
	Initial	Intuiting	Interpreting	Integrating	Institutionalizing
	No involvement	Observation	Advice	Doing	Strong control
Li et al. (2014)	Basic services	Initial stage	Growth stage	Maturity stage	
Rapaccini et al. (2013)	Initial stage	Repeatable	Defined	Managed	Optimized
Wikstrom et al. (2009)	Goods-dominant	Customer-centric	Business-dominant		

Lexutt et al. (2020) did not specify maturity levels. Some of the models have maturity levels inspired on the service provisions (Neff et al., 2020; Cui et al., 2019; Sousa et al., 2017; Li et al., 2014; Wikström et al., 2009). Babaei and Aghdassi (2020) chose maturity levels based on service innovation performance. Other maturity models chose maturity levels from a simplicity standpoint (Adrodegari et al., 2020; Andersen et al., 2020; Paschou et al., 2020; Exner et al., 2018; Pigosso and McAloone, 2016). This can be a way to decrease the complexity of the maturity model. Jin et al. (2014) chose a mix of maturity levels based on the different dimensions. Finally, Alvarez et al. (2015) and Rapaccini et al. (2013) based their maturity levels on the capability maturity model integration (CMMI) for services (CMMI Product Team, 2010), and then specifically the ‘staged’ representation.

In the design of the DSMM, the CMMI staged maturity representation is used as well. CMMI aims to give a simplified representation of the real world. CMMI contains the essential elements of an organization’s processes. CMMI is intended for organizations to improve their organization company-wide. As established in the literature review, servitization affects a firm across the entire organization, thus CMMI is in line with the goal of this research. The staged representation reflects maturity levels consisting of related specific and generic practices for the predefined dimensions. The dimensions should improve the organization’s overall performance, when progressing through the maturity levels, and the progressing maturity levels require increasing sophistication. The staged process focuses thus on the entire organization, and organizational process improvements (CMMI Product Team, 2010).

The five maturity levels are:

1. Initial
2. Managed
3. Defined
4. Quantitatively managed
5. Optimizing

Alvarez et al. (2015) adapted an overview of the CMMI staged representation, which is shown in Figure 2.6.

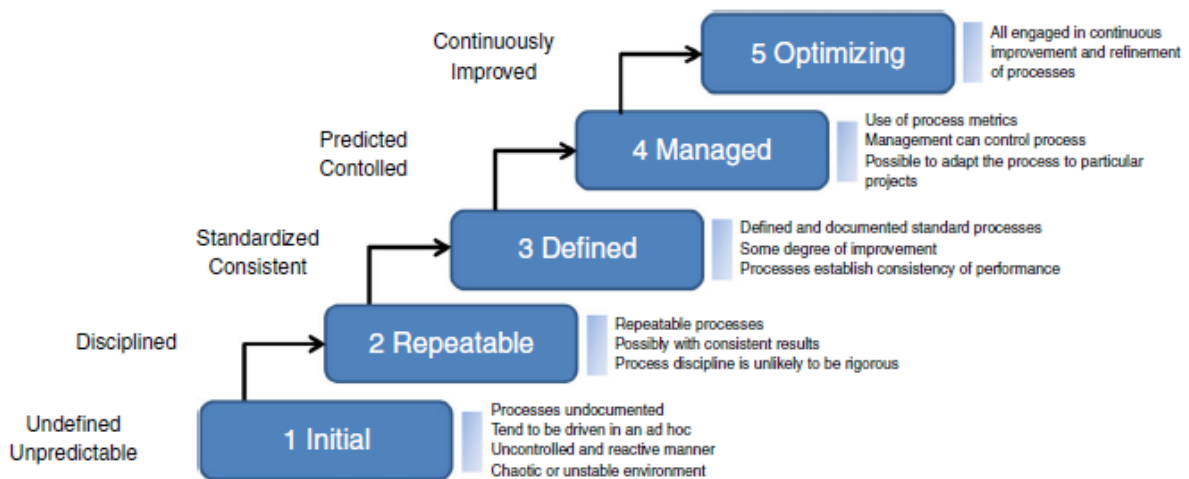


Figure 2.6: Staged representation of maturity levels (Alvarez et al., 2017; adapted from Paulk et al., 1993)

Finally, to distinguish the DSMM from the servitization models, and to adhere to the need of focusing on the “digital” part of the DSMM, the DIKW framework is incorporated in the maturity levels. As explained in the first literature review, especially IoT can generate excessive amounts of data. The more mature a company is in digital servitization, the more it is able to make sense of this data and transform it into information, knowledge, and wisdom. This is explained by the Data, Information, Knowledge, Wisdom (DIKW) hierarchy (Rowley, 2007). The higher the level of maturity, the better the data can be transformed into information and knowledge and the better the manufacturer can act upon this knowledge. Wisdom is yet a bridge too far for digital technologies, as this requires personal judgements (Ardolino et al., 2017). However, the trend of progressing from data to knowledge is captured in the maturity levels.

2.3.3 Initial blueprint DSMM

Finally, by combining the dimensions, sub-dimensions and levels, the blueprint of the DSMM was created. Figure 2.7 shows this blueprint. Note, for visibility the blueprint does not show the exact sub-dimensions as mentioned in Table 2.8.

Dimension	Sub dimension	Initial Undefined Unpredictable	Repeatable Disciplined	Defined Standardized Consistent	Managed Predicted Controlled	Optimizing Continuously improved
Strategy	...					
	...					
	...					
Customer	...					
	...					
	...					
Market	...					
	...					
	...					
Network	...					
	...					
	...					
Organization & culture	...					
	...					
	...					
HRM	...					
	...					
	...					
Process & project management	...					
	...					
	...					

Figure 2.7: Blueprint of DSMM

2.4 Conclusion

In section 2.2, the systematic literature review on digital servitization was described. Digital servitization, its relation to Industry 4.0 and digitalization, and challenges were identified. What became evident is that to adopt a digital servitization strategy, the manufacturing firm has to implement changes company-wide. It is not enough to for example adapt just the product, or just the strategy. The entire business has to change the way it operates, both internally and externally to its partners and most importantly the way they cooperate with their customers.

Section 2.3 provided an overview of the servitization maturity models found in the literature review. These models share the subject servitization, but serve different purposes. Therefore, not all models were useful in the initial construction of the DSMM. This resulted in an assessment of which of the models do evaluate the manufacturer’s internal and external organization facilitating the servitization journey, and choosing the (sub-)dimensions accordingly. Moreover, the way the servitization maturity models are structured varied also. The CMMI staged representation (CMMI Product Team, 2010) for maturity levels was considered the best option, due to its organizational focus. This was then combined with the DIKW hierarchy (Rowley, 2007) to include the “digital” in “digital servitization”, which resulted in the DSMM blueprint. The next chapter elaborates on the method used in this research to further develop the model.

Chapter 3

Research Methodology

This chapter describes the methodology this research followed. For this research the Design Science Research (DSR) paradigm as described by Hevner et al. (2004) was used. This is described in the first section. Then, the Design Science Research Process (DSRP) as described by Peffers et al. (2006) is explained.

3.1 Design Science Research

The research paradigm used is Design Science Research (DSR). DSR can be defined as “a family of approaches to research that are driven by field problems, use a participant-observer instead of the independent observer perspective, and pursue a solution orientation”, and is a well-known paradigm in Information Systems research (Van Aken & Romme, 2012, p. 3). Since the research goal is to develop a solution artefact for a real-life field problem, the approach of Design Science is very much applicable. DSR is fundamentally a problem-solving paradigm (Hevner et al., 2004). The DSR framework, shown in Figure 3.1, presents how the research revolves around both relevance and rigor. Hevner et al. (2004) explain the components of the framework. “Environment” describes the problem space, which is composed of the organization as well as technologies involved. Combined, it forms the problem this research aims to solve. As explained in the introduction, this is how Atos perceives the challenges manufacturing firms face when dealing with digital servitization. The “knowledge base” is composed of relevant literature and models to the environment the research is in. In this study specifically, the literature review as performed in chapter 2 is what the knowledge base consists of. DSR combines both the environment and knowledge base in the development of the solution artefact. In this research specifically the artefact developed will be the Digital Servitization Maturity Model, aiming to help solving the business need, and add to the knowledge base. Evaluation of the DSMM will take place via a multiple case study. The firms cooperating in the multiple case study are presented a survey for evaluation purposes also, following the Technology Acceptance Model (TAM) (Davis, 1989).

Following Hevner et al.’s work from 2004, Gregor and Hevner (2013) extended the DSR with a knowledge contribution framework, as can be seen in Figure 3.2. This framework aims to position the solution artefact based on two scales: Solution Maturity and Application Domain Maturity. Using this framework to place the solution artefact of this study, the “improvement” quadrant is most applicable. The solution artefact is low in terms of Solution Maturity, meaning it is a new solution in terms of the focus it has compared to other servitization maturity models. The solution this study posits is aimed to be a better solution than what is already available for the specific problem context it is in. The Application Domain Maturity is high, i.e. the environment in which the problem occurs and the problem itself is rather defined and well-known.

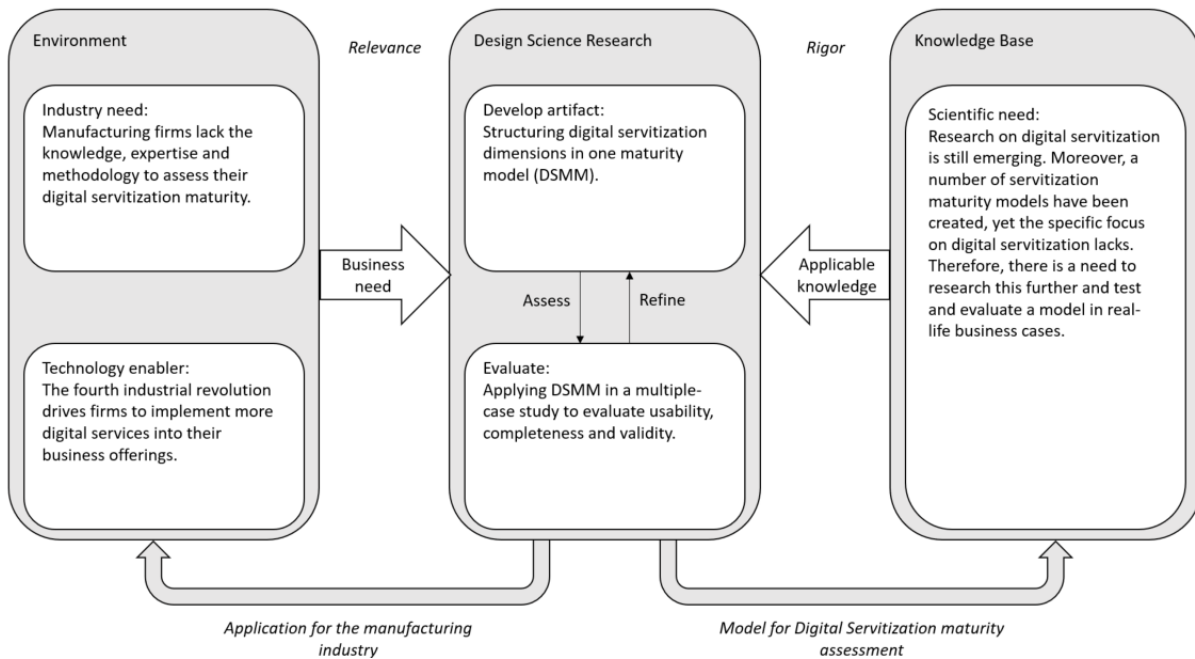


Figure 3.1: DSR framework (adapted from Hevner et al., 2004)

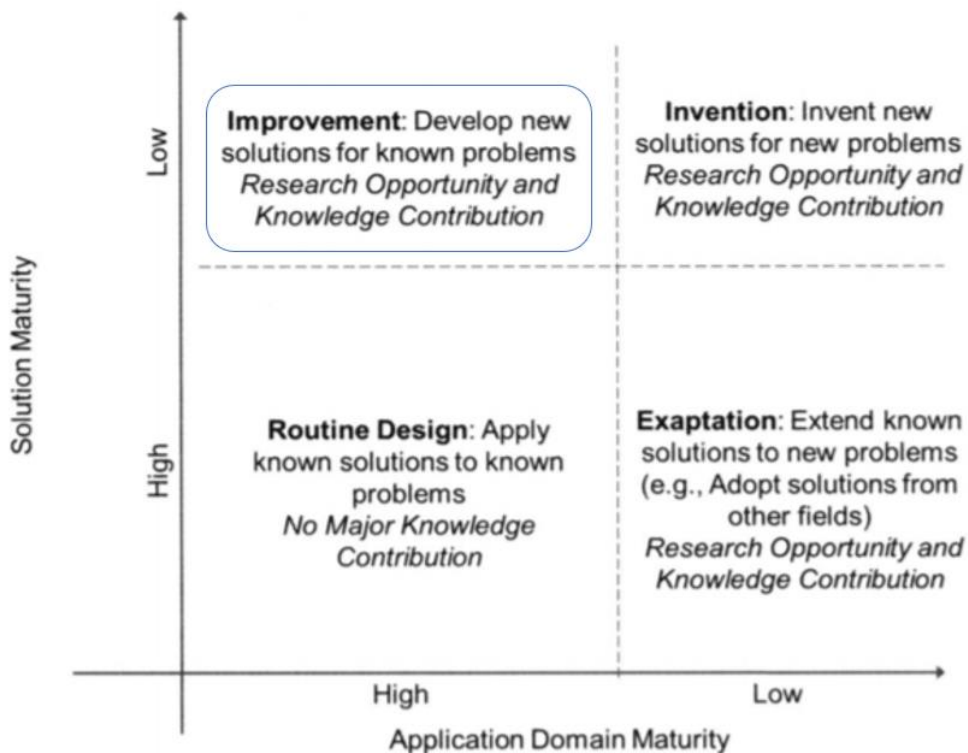


Figure 3.2: Knowledge contribution framework (adapted from Gregor & Hevner, 2013)

Besides the knowledge contribution framework, Gregor and Hevner (2013) describe three levels of maturity of knowledge. At level 1, artefacts are developed for specific applications, level 2 describes knowledge as operational principals and level 3 consists of well-developed design theories. In this study the solution artefact is a more abstract, general contribution,

applicable to an industry rather than a specific situation. It is therefore a level 2 contribution: a nascent design theory.

3.2 Design Science Research Process

The process of executing DSR is explained by Peffers et al. (2006) and is called the Design Science Research Process (DSRP). The DSRP model is depicted in Figure 3.3. The process they describe allows the researcher to execute DSR by the following six activities:

1. Problem identification & motivation
2. Objectives of a solution
3. Design & development
4. Demonstration
5. Evaluation
6. Communication

The problem identification and motivation of step 1 were established in consultation with Atos, and some initial research on servitization was conducted. Step 2 aims to fill the found research gap, as well as establishing what is required to solve the problem. Step 3 of the DSRP specifies the artefact's design and how it is developed. In this research, the initial version of the DSMM that combined the results of the literature reviews and was proposed in section 2.3.3 was the initial artefact. Following this initial model, it was used as a base model to further develop using the Atos experts in the focus group research. In the concurrent step 4 the artefact was demonstrated with case studies. This step included testing if the model helped to solve the problems manufacturers face. In step 5 the results of the multiple case-study were evaluated based on completeness, validity and usability. Finally, step 6 bundled all the outcomes and communicated it in this master thesis, following the publication schema of Gregor and Hevner (2013) as discussed in section 1.6.

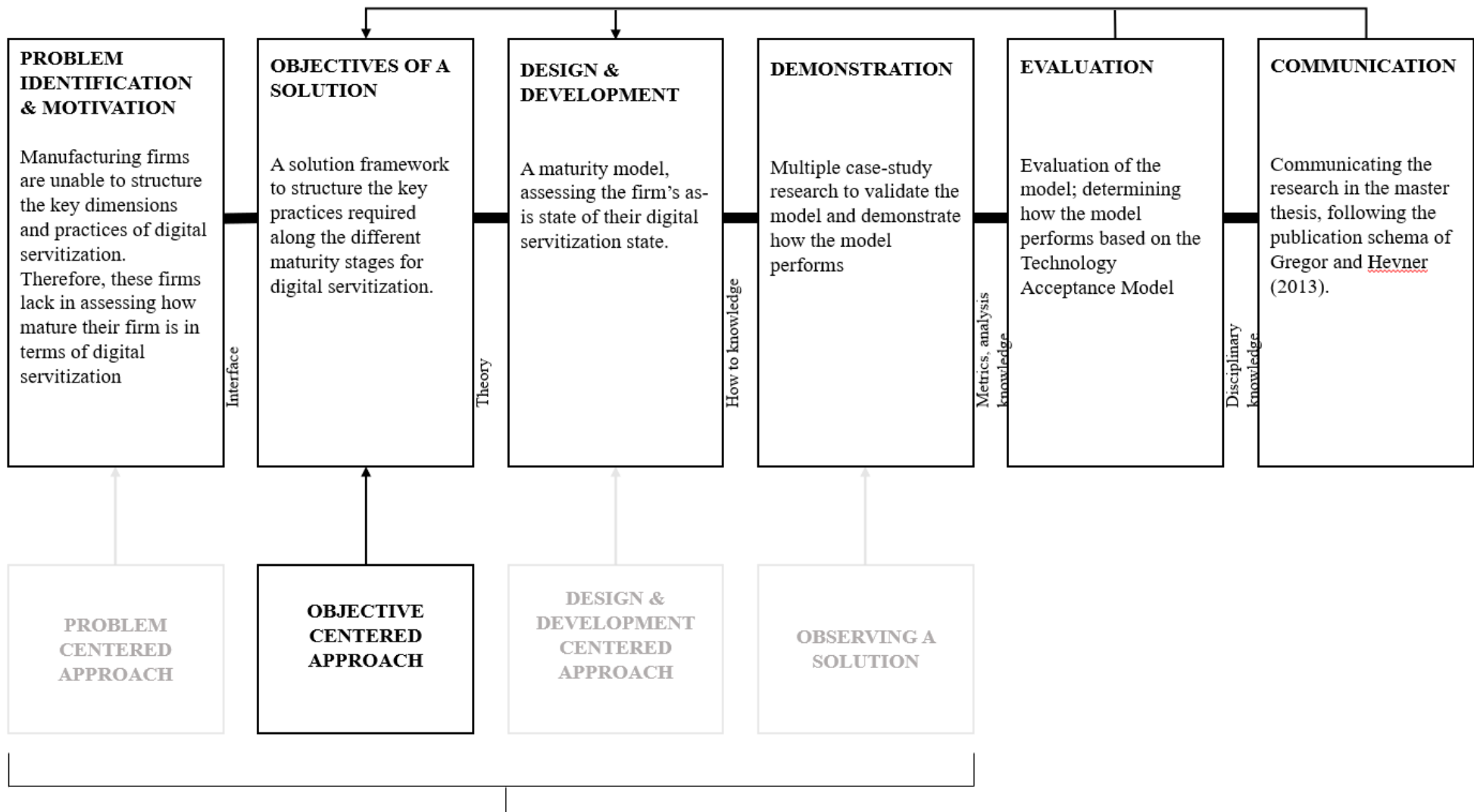


Figure 3.3: Design Science Research Process, adapted from Peffers et al. (2006)

Chapter 4

DSMM Description

This chapter presents the final DSMM. First, the focus group research is explained, resulting in the dimensions of the model. Then, the level descriptions are presented, which are refined and validated by the second part of the focus group research. This chapter concludes with the final version of the DSMM, presented dimension by dimension.

4.1 Model refinement via Focus Group Study

In section 2.3.3 the initial blueprint of the DSMM was proposed. This blueprint was created based on the results of the literature reviews, and consisted of seven dimensions, with each their specific sub-dimensions, and five maturity levels: initial, repeatable, defined, managed, and optimizing. This blueprint was used as input for the focus group research, which further developed the model. De Bruin et al. (2005) discuss the possibilities of focus group and recommend it as an exploratory research method to identify and verify (sub-)dimensions of a maturity model. Other research methods may also be applicable, i.e. the Delphi technique, Nominal Group technique, or case study interviews. The focus group research is not a standalone research, but has to be incorporated with other methods. In this research study in particular, the initial version of the DSMM was based on the extensive literature review. Focus group has some (dis)advantages over the other mentioned research methods (De Bruin et al., 2005). Disadvantages are:

1. No anonymity, which can hamper the panel in creative outcomes
2. Issues inherent to face-to-face meetings, such as dominant personalities, or group pressure
3. Geographic boundaries and associated travel factors
4. Higher cost of study

However, in this research study the first and second disadvantages were minimized by adding a preliminary survey which was filled out by a number of Atos experts. The survey setup is explained in section 4.1.1. The result of this survey was used as input to spark group discussion. This ensured the panel was well-prepared, and acted as a guideline for discussion. Moreover, discussing an outcome of opinions is different from discussing “the truth”. Besides, the culture of the focus group promoted whatever input and experiences. However, this research acknowledges that with a different research method the outcome could have been slightly different. The third and fourth disadvantage were no issue in the focus group research, since focus groups were online, and the panel expert consisted of Atos employees. Focus group research also has some advantages (De Bruin et al., 2005):

1. It has a flexible nature
2. Discussion course is determined in the moment, rather than fully set beforehand
3. Accuracy and validity of outcomes is high

4.1.1 Focus group setup

The focus group research consisted of two rounds with four servitization domain experts to gather information, and use that information to develop the DSMM, evaluate the initial findings, and to finalize the DSMM. The domain experts were formed as the focus group panel. The focus group research consisted of two rounds. In the first round, the panel was asked to evaluate the initial (sub-)dimensions on their completeness and relevance. After evaluation, the researcher could specify for the established (sub-)dimensions the maturity level labels. Thereafter, the second round was used to evaluate the specified labels mainly on their correctness and completeness.

- Round 1: DSMM dimensions
- Round 2: DSMM labels

As input for the first round, Atos experts on the topic of servitization were asked to fill out an initial evaluation on the formed dimensions, their sub-dimensions, if (sub-)dimensions were missing, and a ranking on what dimensions were deemed most important for assessing digital servitization for manufacturing firms. Microsoft Forms was used as the online survey tool. For each of the sub-dimensions, the experts could specify how important the particular sub-dimension was to the dimension, by grading it on a five-point Likert scale. This scale ranged from 1: not important, i.e. this sub-dimension is not important for digital servitization and should not be included in the model – slightly important – moderately important – important – to 5: very important, i.e. this sub-dimension is very important to digital servitization and should remain in the model. Besides grading, the experts could propose new sub-dimensions and dimensions in general. The last question asked the experts to provide a ranking on the dimensions in term of importance, meaning the highest ranked dimension should definitely remain in the model, and the lowest ranked dimension could possibly be removed from the model. An overview of the Microsoft Forms form is given in Appendix A.1. The results from the forms were not definitive, yet mainly used as input for the focus group session itself. After the eight experts approached had filled out the form, the results were consolidated, and anonymized for further research.

Before the beginning of the first round, a kick-off meeting was held to inform potential participants about the research and how the research was setup. At the beginning of the first focus group round, the researcher explained the goal of the session once more: to assess the model's correctness and completeness on the identified (sub-)dimensions. Thereafter, the researcher presented some simple rules to ensure a smooth discussion, to promote discussion, and to respect the other experts involved. Then, the results of the survey were discussed dimension by dimension, and a discussion was started on the presented results.

The second round of the focus group started again with specifying the goal of that session: to assess the labels on their completeness and correctness. The same rules as in the first round applied, and it was emphasized to have an open discussion, especially since no Microsoft Forms results were used for the second round.

In between the first and the second round, the researcher specified the labels for the (sub-)dimensions which resulted from the first round of the focus group.

The first focus group round was exploratory in nature, meaning the expert panel was explicitly asked to suggest new (sub-)dimensions, or changing how the sub-dimensions were formulated.

The second focus group round was a little less exploratory in nature, since no new (sub-)dimensions could be proposed. There certainly was a degree of freedom for the panel to alter the level descriptions of the sub-dimensions. To summarize, Figure 4.1 portrays how the focus group research is conducted and its position with regards to the literature review and case study research.

4.1.2 Panel selection

The participants of the focus group sessions were grouped in a panel. The panel was formed based on availability of the experts, their experience with servitization, and their involvement in this research project. For the goal of the focus group session, experts on servitization were required, preferably with knowledge on maturity models also. Especially their experience with projects at real companies dealing with servitization challenges proved to be invaluable. The experts had the ability to match the literature with their experiences, and therefore obtained a deeper understanding of the aspects of the organization manufacturers have to evolve when actually transitioning to servitized businesses. To ensure the panel was involved in the research project, a kick-off meeting was held. In this meeting the potential participants were introduced to this research and its importance, and the focus group research was outlined to them as well. During this meeting it became apparent the potential candidates were eager to cooperate and participate depending on their schedule. During the kick-off meeting eight persons were present, of which eventually four persons were able to participate in the focus group session. All persons were able to fill out the survey on the dimensions though, which added more reliability to the outcome of this survey. Hennink (2007) writes that focus groups tend to be comprised of six to ten participants, however smaller groups could work too. Smaller groups may be more suitable when the participants have significant knowledge, experience and motivation on the research topic, as it is anticipated that their contribution is higher. For this particular focus group setup, the panel adhered to these requirements. Table 4.1 presents an overview of the composition of the expert panel.

Table 4.1: Focus group panel

Index	Function	Work experience with servitization
1	I4.0-PLM-Business consultant	2-4 years
2	Digital configuration management business consultant	4-8 years
3	Business management consultant	2-4 years
4	I4.0-PLM-MES business consultant	> 8 years

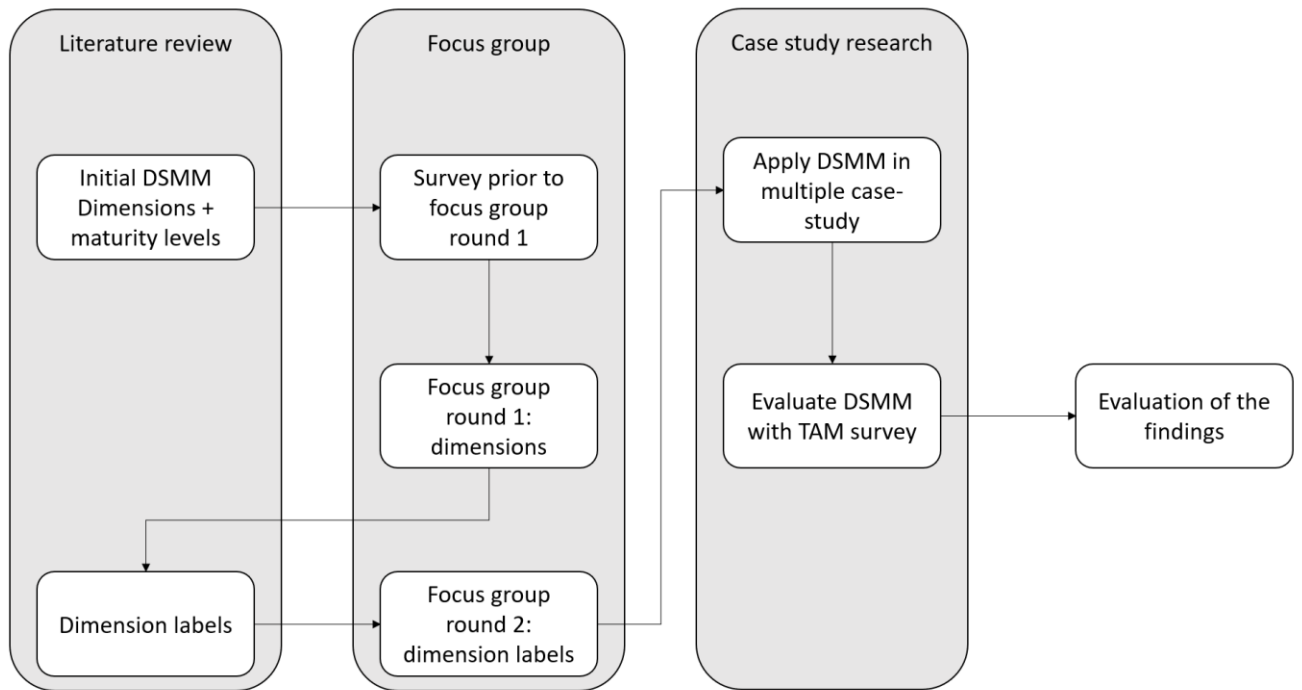


Figure 4.1: Focus group research position in the research study

4.1.2 Focus group first round

4.1.2.1 Survey result

The goal of the first round of the focus group was to evaluate the dimensions formulated in the initial version of the DSMM, as proposed in Table 2.8, specifically on their completeness, correctness and relevance. In the survey conducted prior to the focus group session, the experts were asked to evaluate on these aspects, and during the first focus group the result of this survey were discussed in an open discussion format. The results of the survey are outlined in Appendix A.2. These results show there was agreement on the importance of many of the (sub-)dimensions (for example on the importance of “knowledge of customer’s installed base”, “knowledge of solution criticality” and “Evaluation of customer satisfaction and customer service operations”) and also agreement that some (sub-)dimensions were not important (i.e. “Firm’s focus on hiring service-oriented personnel”). For some sub-dimensions the survey did not yield in agreements on importance. A summary of the results are shown in Table 4.2. The column “no agreement” means the outcome of the survey for that particular sub-dimension was deemed important by some, and not important by others. The table also hints that discussion is needed to further clarify the used terminology and reach more agreements.

Table 4.2: Survey results per dimension and its sub-dimensions

Dimension	Important	Not important	No agreement
Customer	Knowledge of solution criticality Evaluation of customer satisfaction Customer training Tests of new technology with customer		Systemic integration with customer Knowledge of installed base Contact with potential customer

Strategy	All sub-dimensions	
Organization & culture	All sub-dimensions	
Process & project management	Taking over customer processes	All sub-dimensions
Market	All sub-dimensions	
HRM	Supporting employee's development	Focus on hiring service oriented personnel
Network	Involving supply chain Digital service ecosystem presence	Repositioning in value chain

The ranking results showed how the experts considered the dimensions based on importance:

1. Strategy
2. Customer
3. Market
4. Network
5. Organization & culture
6. Process and project management
7. HRM

In Appendix A.2, Table A.1 the remarks made per dimension are collected. What became evident based on the comments, is that not all experts always understood the meaning of the sub-dimensions. Specifically, “Knowledge of customer’s installed base”, “Test of new technologies with the customer”, “Evaluation of customer service operations”, and “Customer training” were not well described in the survey, which led to troubles in understanding. Some dimensions were considered irrelevant for servitization by some experts, specifically “Extent to which company takes over processes of customer”, “Production: traceability and customization in the production process”, “Firm’s focus on hiring service-oriented personnel”, the entire dimension “Process and project management”, and “Company repositioning in the value chain”. Finally, remarks on the correctness of descriptions were made, specifically on “customer involvement in the manufacturing firm’s production process”.

In Appendix A.2, Table A.2 the suggestions for adding dimensions are shown. These have been discussed in the focus group round one, if relevant. For example, the suggestions “Service offerings”, “Technologies”, and “Sales” were already incorporated in the initial DSMM and were therefore not considered as new dimensions.

4.1.2.2 Focus group result

The first focus group session was fully recorded, for transcription purposes. The anonymized results are shown in Appendix A.3. Based on the feedback, some changes were made to the model. Table 4.3 gives a summarized overview of the comments made by the participants of the focus group on the discussed (sub-)dimensions, and the corrective actions taken because of the discussions. Then, some more context is given on why these actions were taken, to clarify the summarized results. Also, some of the sub-dimensions were renamed or described slightly differently due to the discussion, which is not depicted in Table 4.3 for readability purposes.

Table 4.3: Focus group participant sub-dimension creation comments and outcome per dimension

	Participant 1	Participant 2	Participant 3	Participant 4	Outcome
Strategy	What are the <i>KPIs</i> ? <i>Business model</i> is a valid sub-dimension.		Should there be differentiated between internal and external factors for <i>Strategy</i> ?		Nothing was changed.
Customer	<i>Installed base</i> and <i>Evaluation of customer satisfaction</i> are very important, <i>Contact with potential customers</i> is more a sales dimension, <i>Solution criticality</i> is a given and thus important. <i>Customer training</i> is less important for servitization.	<i>Systemic integration</i> is important, otherwise you cannot progress to higher service levels. This dimension should describe how linked the customer and manufacturer are.	The definition of <i>Customer</i> should be reconstructed. Production process is not relevant for customer. <i>Test of new technologies with the customer</i> is not important for servitization	Agrees with the other participants.	<i>Contact with potential customer</i> , <i>Test of new technologies with the customer</i> and <i>Customer training</i> removed.
Market	Should be more focus on servitization in these sub-dimensions. <i>Pricing</i> could be defined differently.	Is it really necessary to include <i>Identify competitors</i> ?	<i>Analyzing market and industry trends</i> is very important for servitization. <i>Marketing/pricing</i> is linked with this sub-dimension and thus irrelevant/could be combined.		<i>Solution availability already on market and Marketing</i> ; <i>analytical studies carried out to determine (product and dynamic) pricing</i> combined.
Network	<i>Repositioning in value chain</i> is a strategic shift. Could be a conclusion of the model, not a variable. <i>Supply chain</i> could also be partners of the firm.		Strategic partnerships should be included.	<i>Ecosystems</i> are very important, also for servitization.	<i>Company repositioning in the value chain</i> and <i>Involving the upstream supply chain in new</i>

				<i>service development removed..</i>
Organization & culture	<i>Digital service mindset</i> has to be present. <i>Change of firm's culture</i> is the outcome of the dimension, not a variable.	Not everyone in the firm should have all service related <i>competences</i> . <i>Digital service mindset</i> is important for servitization.	<i>Culture</i> is a specific capability. Having a <i>service mindset</i> does not mean the firm knows how to do servitization. Therefore, <i>Competences development</i> important.	<i>Change of firm's culture</i> and <i>Digital service mindset</i> combined.
Process and project management	<i>Procedures for managing projects</i> is not servitization specific, should be removed. <i>Interdisciplinary teams</i> are also used always, not for servitization per se. Entire dimension should be removed, as it is too focused on service execution rather than servitization maturity.	<i>Procedures for managing projects</i> should be removed, as these are always present. <i>Extent to which company takes over processes of customer</i> is too dependent on service type. <i>Traceability</i> is not important for servitization.	Agrees with the other participants.	Entire dimension <i>Process and project management</i> removed.
HRM		<i>Hiring service oriented personnel</i> can be removed.	<i>Hiring service oriented personnel</i> is already incorporated in <i>Competences</i> sub-dimension.	<i>Firm's focus on hiring service-oriented personnel</i> removed.

The outcomes of Table 4.3 are further discussed with more context per dimension below.

- Sub-dimensions “Contact with potential customer”, “Test of new technologies with the customer” and “Customer training” were removed from dimension “Customer”.

The sub-dimension “Contact with potential customer” is not the core focus of the dimension “Customer”. This dimension is focused on ensuring the integration/interlinking of the manufacturer and the customer, and acting on the knowledge generated from that relationship. Therefore, the manufacturer has to know how a product is used by a single customer, how critical the service is to the customer, and how all the installed base is performing. Moreover, evaluation of the customer has to be considered and acted upon. “Customer training” is less relevant, as servitization essentially is about ‘unburdening’ the customer.

- “Solution availability already on market” and “Marketing; analytical studies carried out to determine (product and dynamic) pricing” are merged in dimension “Market”.

For the dimension “Market” the two mentioned sub-dimensions are merged, as they somewhat represent the same concept.

- “Company repositioning in the value chain” and “Involving the upstream supply chain in new service development” have been removed from the dimension “Network”.

“Company repositioning in the value chain” is a strategic consideration, since moving up or down in the value chain is a fundamental change in the business model and strategy. As a variable for measuring servitization maturity it was considered not suitable. “Involving the upstream supply chain in new service development” was removed also, since these could be considered regular partners as described by “Digital service ecosystem presence with partners/stakeholders” in the same dimension “Network”.

- “Change of firm’s culture from product-provider to customer-centric approach” was merged with “Digital service mindset” in dimension “Organization & culture”.

The two sub-dimensions were merged, incorporating the cultural aspect in the firm’s mindset.

- Removed dimension “Process and project management”.

The dimension “Process and project management” was removed from the model. From the ranking this dimension scored just higher than the lowest ranked dimension “HRM”, but only by a margin. Furthermore, it was discussed if service projects are managed differently than regular projects. During the focus group it became evident this was not the case, based on the experiences of the experts and the consecutive discussion. Also, the sub-dimensions were not deemed relevant for servitization: “Procedures for managing projects are in place” was not considered servitization specific. “Usage of interdisciplinary teams for digital servitization” was not considered a unique, distinctive servitization characteristic, “Production” was not seemed as a necessary servitization sub-dimension, and “Performance management systems (feedback, KPIs) are in place for service projects was not regarded distinct enough for servitization.

- “Firm’s focus on hiring service-oriented personnel” was removed from “HRM”.

During the focus group session, it remained unclear what service-oriented personnel exactly is, and how they differ from ‘regular’ personnel. Moreover, a similar focus of this sub-dimension, was already described in “Competences and knowledge development of employees of digital technologies”.

Moreover, some descriptions of the dimensions were altered slightly, to improve their understandability and clarity. This resulted in the following blueprint, as shown in Figure 4.2.

Dimension	Sub dimension	Initial Undefined Unpredictable	Repeatable Disciplined	Defined Standardized Consistent	Managed Predicted Controlled	Optimizing Continuously improved
Strategy	Business model					
	KPIs					
	Digital service offerings					
Customer	Systemic integration with the customer					
	Installed customer's base management					
	Service criticality					
	Customer evaluation					
Market	Identifying competitors					
	Analyzing market and industry trends					
	Marketing					
Network	Digital service ecosystem					
Organization & culture	Governance & leadership					
	Competences and knowledge development					
	Digital service mindset & culture					
HRM	Employee development					

Figure 4.2: Focus group-revised blueprint of the DSMM

4.2 Level descriptions

In section 4.1 the dimensions and sub-dimensions, which were identified in the literature review, were evaluated and validated via the first focus group session. This section describes how the level descriptions were formed, based on the literature review.

Synthesizing maturity level descriptions for each of the specified sub-dimension from Figure 4.2 was done by returning to how the sub-dimensions were constructed in the first place: the maturity models identified in Table 2.7. Each sub-dimension had some basis in these models. Some sub-dimensions have been adapted, combined with other sub-dimensions or evolved altogether, so the maturity descriptions given in the original publication were not directly usable either. Moreover, those models have different representations of maturity, and may contain different amount of levels. Therefore, some results from those models were combined (in the case when multiple models were used to describe a single sub-dimension), maturity descriptions could have been extrapolated (in the case when other maturity models used less than the five maturity levels as specified in Figure 2.6), or some maturity level descriptions were changed by the researcher to better serve this research study and digital servitization in particular. In the case the researcher changed the maturity descriptions, this was done with a goal: to incorporate the trend the DIKW hierarchy (Rowley, 2007) described. In the lowest level of maturity

(initial), data collection is limited, and the manufacturer is unable to analyse the data properly and create value from it. As the maturity levels get higher, not only more data is collected, but the manufacturer has the capabilities and digital technologies to turn data into information, and eventually with the highest levels of maturity generate knowledge out of the information. Appendix A.4 shows the full maturity level descriptions for each dimension, what sources were used, and when the researcher adapted the descriptions.

An example of how the labels for dimensions “Network”, sub-dimension “Digital service ecosystem” is explained. Figure 4.3 shows the resulting label from literature and some additions from the researcher. Paschou et al. (2019) describe how the presence of a digital service ecosystem matures as servitization matures. Moreover, Alvarez et al. (2015) also describe strategic partners in their model. Paschou et al. (2019) only has three maturity levels. Level 1 describes: company has few partnerships, with low collaboration, with no additional integration. Level 2 describes: company has partnerships with some stakeholders, with medium collaboration, and a moderate level of collaboration. Level 3 describes: a fully digitized, integrated partner ecosystem. Alvarez et al. (2015) describe that with higher servitization maturity more integration occurs with partners, and data sharing becomes more symmetric. These descriptions of Paschou et al. (2019) and Alvarez et al. (2015) are then transformed into five levels, using mostly the same terminology, but changing some parameters to better fit five levels. Moreover, how data is collected and how it is used is incorporated to some extent. Combined, Figure 4.3 is the result.

Network	Digital service ecosystem	Firm and business partners ecosystem aimed at gaining access to resources to increase the firm's ability to improve, innovate and grow.	Firm has no partnerships.	Firm has partnerships with few stakeholders; low level collaboration. Little to no integration is present.	Firm has partnerships with some stakeholders; medium level of collaboration. There is some integration and data sharing on a platform, yet information is asymmetric.	Firm has partnerships with many stakeholders, in a fully digitized, integrated partner ecosystem. Platform is an open system, with a flexible architecture. Information can be accessed freely on this platform.	Firm has partnerships with many stakeholders, in a fully digitized, integrated partner ecosystem. Platform is an open system, with a flexible architecture. Information sharing is symmetric. Customer input can be accessed by all partners.
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Figure 4.3: Example of Digital service ecosystem label description

For each of the sub-dimensions a description was constructed in a similar fashion. Table 4.4 outlines what maturity models were taken as input. Note that although the names of the sub-dimensions have been developed, yet this information still is grounded in Table 2.8 from the literature review. Besides the maturity models, some additions to the level descriptions were made by the researcher. These additions were primarily focused on the DIKW hierarchy, by including collection and usage of data in the level descriptions. Appendix A.4 provides a complete overview of the level descriptions based on the literature and researcher’s additions.

Table 4.4: Level description sources and researcher’s additions

	Descriptions used from	Additions
<i>Strategy</i>		
Business model	Paschou et al. (2019)	-
KPIs	Neff et al. (2020); Rapaccini et al. (2013)	-
Digital service offerings	Paschou et al. (2019); Neff et al. (2020)	-
<i>Customer</i>		
Systemic integration with the customer	Alvarez et al. (2015)	-

Installed customer's base management	Neff et al. (2020)	-
Service criticality	Alvarez et al. (2015)	-
Customer evaluation	Paschou et al. (2019); Rapaccini et al. (2013)	-
<i>Market</i>		
Identifying competitors	Alvarez et al. (2015); Babaei & Aghdassi (2020); Rapaccini et al. (2013); Paschou et al. (2019)	DIKW progression
Analysing market and industry trends	Babaei & Aghdassi (2020); Rapaccini et al. (2013); Paschou et al. (2019)	DIKW progression
Marketing	Paschou et al. (2019)	Customer involvement
<i>Network</i>		
Digital service ecosystem	Alvarez et al. (2015); Paschou et al. (2019)	DIKW progression and data accessibility
<i>Organization & culture</i>		
Governance and leadership	Paschou et al. (2019); Rapaccini et al. (2013)	-
Competences and knowledge development	Paschou et al. (2019)	DIKW progression
Digital service mindset	Paschou et al. (2019)	DIKW progression
<i>HRM</i>		
Employee development	Paschou et al. (2019); Rapaccini et al. (2013)	-

Not for all sub-dimensions the literature models and the researcher's interpretation resulted in fully developed level descriptions, as can be seen in Appendix A.4. For four sub-dimensions not all descriptions were created. Those few lacking descriptions were aimed to be resolved with the second round of the focus group, in conjunction with the evaluation and validation of the created descriptions.

4.3 Level description refinement via Focus Group Study

To conclude the model, the second round of the focus group was deployed. The goal of this focus group study was to evaluate the maturity level descriptions on their correctness, completeness and understandability. The same expert panel as in the first round was used, as well as a similar set of rules and approach. This focus group session was also recorded for transcription purpose, and its anonymized transcribed results are shown in Appendix A.5. In Table 4.5 a summarized overview of comments made by the focus group is showcased. Also, the outcome of the discussion on each of the dimensions is described.

Table 4.5: Focus group participant level description comments and outcome per dimension

	Participant 1	Participant 2	Participant 3	Participant 4	Outcome
Strategy	<i>Business model</i> level 3 and 4: focus on add-on and solution-oriented business models.		Change lowest level of <i>Business model</i> to product business model only.		Level descriptions added for <i>Business model</i>
Customer	Considering servitization, important what is done with the data.	Explains difference between <i>Installed base</i> and <i>Systemic integration</i> .	Highest level of <i>Systemic integration</i> means information is real-time shared with manufacturer, manufacturer can access machine. Provides description for <i>solution criticality</i> . The lower the maturity, the lower the criticality of the service.		Level descriptions added for <i>Systemic integration with customer</i> and <i>Knowledge of solution criticality</i> .
Market	This dimension is dependent on the type of market.	This dimension and analysis is dependent on the market position of the firm. Market needs might be missing.			Descriptions are not changed.
Network			The link with servitization is missing from the description. Level 1 is wrong, firms always have some partners.		Add clear link with servitization, change level 1. Level 3 and 4 should describe the platform differently.

			Level 3 and 4 should describe the platform clearer.	
Organization & culture	Wonders if recruitment should be in this dimension.			Descriptions are not changed.
HRM			For level 3: standardized competence development and learning programs. For level 4: structured competence development and learning programs.	Descriptions for level 3 and level 4 are added.
General comments	Quantifying model is hard, model is more qualitative.	Quantify the measures were possible; avoid statements like “few”. Instead of full sentences, use bullet points.	Add typical services at the top of the model for level 1 to level 5.	Bullet points are used throughout the final model.

Following the experts knowledge on the level descriptions, improvements to the DSMM were deployed. This was already shown in Table 4.5 but is shortly summarized:

- Sub-dimension “business model” level 1 description was changed to “no product model for services”. Level 3 and 4 descriptions were added.
- Level descriptions for “Systemic integration with the customer” and “Service criticality” were identified.
- “Installed customer’s base management” level 4 and 5 were slightly adapted, to allow for real-time data availability in lower maturity levels.
- “Governance & leadership” level descriptions were all changed to decision making instead of project management, the previous was inconsistent.
- “Employee development” level 3 and 4 descriptions were discussed, and level descriptions were added for these two.

Besides these structural comments, some general notions on the DSMM labels were expressed in the focus group research:

- Instead of long descriptions, using sentences, bullet points were recommended for readability;
- Avoid statements like “few” and “some”, since they are hard to interpretate by the user of the model.
- Addition of typical services belonging to the specific levels 1 to 5.

The first recommendation was followed, and the level descriptions for each sub-dimension were expressed bulleted, avoiding full sentences. The second recommendations was ignored, as this was chosen deliberately by the researcher to describe in general terms how the organization is arranged at certain maturity levels. Also, the last recommendation was dismissed, as the model’s design remained true to the CMMI logic.

Overall, the second round of focus group improved the DSMM considerably, especially on validity, readability and understandability. Moreover, it helped settling four incomplete sub-dimension maturity descriptions, and removed multiple errors.

4.4 Final DSMM

This section presents the final DSMM which resulted from the focus group research. First, the structure will be briefly elaborated on, followed by a presentation of the different dimensions, sub-dimensions and their maturity level descriptions. Finally, it is explained how the model can be utilized in practice to assess the digital servitization maturity.

4.4.1 Structure and dimensions

The DSMM assesses six dimensions: strategy, customer, market, network, organization & culture, and HRM. Each dimension is divided into, ranging from one to four, sub-dimensions, to enable a better representation, and thus a better assessment, of the corresponding maturity. The fact that some dimensions consist of more sub-dimensions than others, does not imply these dimensions have greater importance. The DSMM does not prioritize any of the dimensions, it is eventually up to the manufacturer to decide their desired improvement path based on the assessment.

Each sub-dimension is provided with a description, to guide the user in how the sub-dimension is defined. Moreover, five maturity levels exist. This means for every sub-dimension five descriptions corresponding to the five maturity levels are present. Each dimension and its maturity level descriptions is portrayed in the following subsections.

4.4.1.1 Strategy

Dimension	Sub dimension	Description	Initial Undefined Unpredictable	Repeatable Disciplined	Defined Standardized Consistent	Managed Predicted Controlled	Optimizing Continuously improved
Strategy	Business model	A business model is in place supporting the digital service offerings	<ul style="list-style-type: none"> -No business model for services -Services are ad-hoc -Little to no data is collected on the basic services 	<ul style="list-style-type: none"> -Add-on business models for services -Services are add-on for existing physical product -Basic DTs (ICT, IoT) support data collection on services 	<ul style="list-style-type: none"> -Add-on and usage-based business models for services -Personalized services and product usages are measured -Pay-per-use -DTs (ICT, IoT, cloud computing, big data) support data usage 	<ul style="list-style-type: none"> -Usage-based and solution-oriented business models -Pay-per-use, subscription services and customization available -DTs (ICT, IoT, cloud computing, big data) generate knowledge from data 	<ul style="list-style-type: none"> -Solution-oriented business models with subscription options -IoT technology enables customized, integrated solutions for customers -DTs (ICT, IoT, cloud computing, big data, AI) used for real time data and knowledge
	KPIs	Digital servitization specific analytical performance objectives (KPIs) are in place	<ul style="list-style-type: none"> -No servitization specific KPIs are in place 	<ul style="list-style-type: none"> -Only few KPIs servitization specific -Financially oriented -Mainly related to cost and productivity 	<ul style="list-style-type: none"> -Servitization and product KPIs balanced -Non-financial KPIs added (e.g. remaining product lifetime, machine failure rate). 	<ul style="list-style-type: none"> -Mainly servitization KPIs -Financial and non-financial KPIs are balanced, -Internal, external, customer and financial orientation (e.g. equipment reliability measures, production up times) 	<ul style="list-style-type: none"> -Mainly servitization KPIs, -Internal, external, customer and financial orientation -KPIs are regularly adjusted to customer needs
	Digital service offerings	The type of service offerings and the strategy supporting them.	<ul style="list-style-type: none"> -Basic services (installation, spare parts) -Some ad hoc data on these services is collected -Basic ICT, data not really used 	<ul style="list-style-type: none"> -Reactive maintenance services (e.g. installation or maintenance and repair) -Data is manually entered -Basic ICT 	<ul style="list-style-type: none"> -Remote monitoring and predictive maintenance services -Data collection is partially automated and used to evaluate services -DTs are used to deliver service 	<ul style="list-style-type: none"> -Performance contracting services -Data collection is fully automated and integrated across entire business -High usage of DTs to deliver service 	<ul style="list-style-type: none"> - Performance contracting services/managing customer's operations - Data is automatically integrated on a real-time basis - High usage of DTs provides value for both firm and customer

4.4.1.2 Customer

Dimension	Sub dimension	Description	Initial Undefined Unpredictable	Repeatable Disciplined	Defined Standardized Consistent	Managed Predicted Controlled	Optimizing Continuously improved
Customer	Systemic integration with the customer	Integration of customer and firm and ensuring all parts have the same level of information	-No systemic integration is present -No data is shared between customer and firm	-Little systemic integration -Data between customer and firm is shared on request	-Moderate systemic integration -Manual released reports and automatically shared data	-High systemic integration -Data is automatically shared and real-time available -Firm and customer periodically generate knowledge from data	-Full systemic integration -Firm has real-time knowledge of customer's processes -Firm and customer co-create value continuously
	Installed customer's base management	Knowledge of what customers are using of firm's products and services	-No DTs (sensors) are present -No coordinated interaction is present.	-Basic electronic reports are manually released and exchanged by customers -Low level DTs (e.g. sensors) are present	-Manually released reports by customers and real-time data available for firm -Moderate usage level of DTs (e.g. sensors, remote calls)	-Real-time data available on installed base for firm -High usage of DTs (e.g. sensors, IoT)	-Real-time data available on installed base for firm -High usage of DTs (e.g. sensors, IoT, Big Data, machine learning)
	Service criticality	The impact of the services on the customer's business processes	-Services do not impact customer's business processes	-Services have low impact on customer's business processes	-Some services are critical for customer's business processes -Service level agreements on these services	-Services are critical for customer's business processes -High service level agreements on these services	-Services are critical for customer business processes -High service level agreements on these services -Customer can continuously update service level agreements
	Customer evaluation	Evaluating how well the delivered service is perceived by the customer and acting upon this knowledge.	-No feedbacks are collected -Corrective actions are ad-hoc and subjective -Interaction between firm/customer is non-existent.	-Some data is collected, feedbacks are poorly used -Corrective and preventive actions are performed according to internal procedures -Customer preferences and needs are discussed after service deliverance.	-Feedbacks are standard obtained and discussed, after technical assistance -Consistent use of monitoring systems -Generating knowledge from data lacking, decisions always disputable	-Feedback systematically used to identify weaknesses -Improvements and innovations are performed in a systematic way -Corrective actions are always objective	-Formal procedures drive customer preferences/needs and future strategical decision -Customer/interaction data are collected through different channels -Feedbacks always discussed with customer and used in the continuous improvement process by creating common platforms

4.4.1.3 Market

Dimension	Sub dimension	Description	Initial Undefined Unpredictable	Repeatable Disciplined	Defined Standardized Consistent	Managed Predicted Controlled	Optimizing Continuously improved
Market	Identifying competitors	Evaluating your competitor's services and their strengths and weaknesses.	-No analytical studies are conducted to identify competitors	-Ad hoc analytical studies to identify direct competitors's service offerings. -Data somewhat used in establishing firm's service offerings.	-Regular analytical studies to determine competitors' services offerings -Data is used to expand service offerings.	-Continuously conducted analytical studies to determine competitors' service offerings -Data used to evaluate own service offerings -Customers are sometimes involved in evaluation of competitors' offerings	-Continuously conducted analytical studies to determine competitors' service offerings -Customers are continuously involved and engaged in what competitors do offer
	Analyzing market and industry trends	Evaluating and understanding industry trends and how the market is developing.	-No analytical studies are conducted to understand market development	-Ad hoc analytical studies are conducted to understand market development -Data somewhat used in firm's service offerings.	-Regular analytical studies for industry trends/market development -Data used to expand service offerings.	-Continuously conducted analytical studies for industry trends/market development -Data used to evaluate firm's service offerings -Customers are sometimes involved	-Continuously conducted analytical studies for industry trends/market development -Customers are continuously involved and engaged (e.g. new DTs/innovations)
	Marketing	Analytical studies carried out to determine pricing and pricing options	-No analytical studies are conducted to determine pricing	-Ad hoc analytical studies are conducted to determine pricing -Data is used but only ad hoc.	-Regular analytical studies to determine pricing -The customer has little control over pricing and how service bundles are constructed.	-Analytical studies are continuously conducted to determine pricing -Customer has some control over the pricing and how service bundles are constructed -Payments based on performance	-Analytical studies are continuously conducted to determine pricing -Customer has full control over service bundles and can negotiate on pricing -Gain-loss agreements

4.4.1.4 Network

Dimension	Sub dimension	Description	Initial Undefined Unpredictable	Repeatable Disciplined	Defined Standardized Consistent	Managed Predicted Controlled	Optimizing Continuously improved
Network	Digital service ecosystem	Firm and business partners ecosystem aimed at gaining access to resources to deliver services to the customer	<ul style="list-style-type: none"> -Firm has partnerships with few stakeholders -Low level collaboration in service delivery -Little to no integration is present. 	<ul style="list-style-type: none"> -Firm has partnerships with some stakeholders -Low to medium collaboration in service delivery -Some integration is present -Resources and knowledge sharing lacking 	<ul style="list-style-type: none"> -Firm has partnerships with some stakeholders -Medium level of collaboration in service delivery -There is some integration and data sharing on a standardized platform -Information is assymetric 	<ul style="list-style-type: none"> -Firm has partnerships with many stakeholders, in a fully digitized, integrated partner ecosystem -High level of collaboration in service delivery -Standardized open platform, with a flexible architecture -Information sharing is symmetric 	<ul style="list-style-type: none"> -Firm has partnerships with many stakeholders in a digitized, integrated partner ecosystem -Platform is a standardized open system, with a flexible architecture -Information sharing is symmetric -Resources and competences sharing occurs continuously

4.4.1.5 Organization & culture

Dimension	Sub dimension	Description	Initial Undefined Unpredictable	Repeatable Disciplined	Defined Standardized Consistent	Managed Predicted Controlled	Optimizing Continuously improved
Organization & culture	Governance & leadership	The decision making processes which define the expectations, systems and management of digital servitization projects.	-No decision making processes in place for service projects. No data is used in these processes	-Basic decision making processes for service projects -Low quality/availability/accuracy of data used for decision making processes.	-Advanced decision making processes for service projects -Moderate quality/availability/accuracy of data used for decision making processes and expectation management	-Moderate to high quality/availability/accuracy of data used for decision making processes and expectation management	-High quality/availability/accuracy of data used for decision making processes and expectation management
	Competences and knowledge development	Competences and knowledge for firm's resources	-Little competences and few resources for digital services in firm -Few "heroes" only	-Only technology focused areas has employees with digital skills -Not involved in service projects, only service deliverance	-Mostly technology focused areas, but also service business units have employees with digital skills. -Standard employee allocation to specific digital service projects -Data can be interpreted by most project teams.	-All across the firm digital skills have been developed -These resources are allocated to specific digital servitization projects -Knowledge to take data-driven decisions.	-All across the firm, fully developed digital and analytical skills are common and continuously challenged -Specific digital servitization projects have knowledge to take data-driven decisions and interpret customer needs.
	Digital service mindset & culture	Change of company mindset to view digital service offering as a business logic and perspective on value creation	-No digital service mindset in firm -Firm focuses solely on delivering product	-Low attitude towards digital servitization -Project evaluation lacks -Customer involvement in service offerings not promoted -Little data sharing across firm	-Moderate attitude towards digital servitization -Service projects and digital competences are evaluated, customer involvement in service offerings is somewhat promoted -Data sharing encouraged across firm, but systems are unstructured	-Digital servitization is promoted in firm, vision is present -Digital competences are critical and projects always evaluated following procedures -Customer involvement for improvements is stimulated -Knowledge is shared internally and cross-functional collaborations	-Digital servitization vision is promoted -Besides structural evaluation of projects, digital competences are critical -Continuously involve customer in service offerings -High level of knowledge sharing and cross-company collaboration and value creation networks.

4.4.1.6 HRM

Dimension	Sub dimension	Description	Initial Undefined Unpredictable	Repeatable Disciplined	Defined Standardized Consistent	Managed Predicted Controlled	Optimizing Continuously improved
HRM	Employee development	Supporting employees to develop knowledge and expertise with DTs in the deliverance of services	-Little to no digital servitization competences and knowledge development available for employees	-Ad hoc digital servitization competences and knowledge development is available -Structured programs are unresent	-Standardized digital servitization competence development and learning programs	-Structured digital servitization competence and development management to all the relevant roles in the service processes	-Continuous structured development programs for employees -Employees can request outside firm knowledge development programs -Customer can request employees to follow critical programs

4.4.2 Using the DSMM

The DSMM is specifically designed for manufacturing firms. These organizations can use the DSMM to self-assess their digital servitization maturity. Based on this assessment, improvement opportunities can be identified. Moreover, this tool can be deployed in collaboration with their partners, if they have more experience and knowledge of digital servitization practices. This last strategy could be especially useful for manufacturers new to digital servitization, but willing to explore the possibilities. Of course, this tool is developed with Atos, and Atos could be that partner for manufacturers to explore their possibilities.

When using the DSMM, the researcher recommends to either choose a person with business-wide knowledge, or to have a small group of persons representing different functions of the business. This, due to the nature of the DSMM; it is developed to assess a company-wide maturity, therefore company-wide knowledge has to be present for the user(s).

When the assessment does not take place internally, but for example a consultancy firm approaches a manufacturer, it is recommended to introduce the participants of the manufacturer beforehand. A certain ground of shared language has to be established in order to move forward smoothly. This could be done by incorporating it in a workshop, or via a presentation before going to work with the DSMM. The information shared should be documented, for the participants to go easily over the notes if needed. If a group of participants uses the DSMM, it would be best to let each participant make its own assessment. Then, several as-is states are the result, and these can then be discussed. It would be wise to document the findings, this could be done by creating an online tool for the DSMM to quickly share the results after completion, but can also be done manually. Thereafter, each participant could go over the model once more, but this time assigning the appropriate level for the ambition of the company in given years. After discussing these results, the group can decide on what would be logical improvement steps, based on the gap between the as-is state and the to-be state.

Lastly, benchmarking can be an outcome of the DSMM. Results of the DSMM can be collected and firms can compare their organization with the industry benchmark.

Chapter 5

Evaluation

This chapter presents the evaluation of the DSMM. As the DSR specifies, the created artefact has to be evaluated in a real business context (Hevner et al., 2004). The evaluation has been performed using a multiple case study, with the goal to test the model on *completeness*, *validity* and *usability* (Yin, 2017). Moreover, a survey adapted from the Technology Acceptance Model (TAM) (Davis, 1989) was carried out. This chapter starts with the evaluation approach, followed by the case studies, the cross-case analysis and the results of the TAM survey.

5.1 Evaluation approach

When doing case study research, the researcher has a choice between a single and a multiple case study. Yin (2017) advocates for the use of a multiple case study, as more cases result in better results. The evidence is clearer, conclusions can be more easily drawn to multiple sources and the overall results are just more convincing. Yin (2017) describes how evaluation is done using a multiple case study. In order to properly execute such a study, a case study protocol was defined. A case study protocol consists of a set of questions used to collect the results from the case study and it ensures a procedure is specified beforehand to be followed during the evaluation. The protocol consists of:

- Selecting the cases
- Data collection
- Evaluation questions

The case companies selected had to be firms active in the manufacturing industry. The organizations were chosen from different industries. Since the first literature review showed generic servitization challenges, the DSMM usability was also tested with respect to firms from different industries. The case studies were performed with a single representative of a company. This representative of each company was deemed knowledgeable and experienced enough in the company to be able to make a sufficient assessment of the firm's digital servitization maturity. The participant of the case study was asked to fill out the model and make an assessment of the firm. The focus for the researcher was in determining the completeness, validity and usability of the DSMM. The case study sessions were scheduled online, with a duration ranging from 1 to 1.5 hours.

First the researcher introduced the topic, the performed research and presented the model (0.4 hours). Then, the participant was asked to start the assessment. During this assessment, the participant was asked to share their screen, so the researcher could determine what the status of the participant was. The researcher observed the participant, aiming to evaluate the reactions on completeness, validity and usability of the model. Moreover, the participant was asked to elaborate on these three constructs answering the evaluation questions:

Completeness

Are all organizational dimensions covered in the DSMM for assessing digital servitization maturity, or are there (sub-)dimensions missing?

Validity

Are the model and its descriptions valid?

Usability

Is it clear how to use the DSMM, and is it understandable?

Besides the assessment of the as-is state, the participant was also asked to fill out the DSMM for the desired ambition level. The reasoning behind this, was to provide the participant afterwards with a conclusive report, also stating some improvement steps the company could consider. The researcher believed this would persuade the participants to take the time for the case study research.

After the assessment for the as-is state and ambition level were completed, the participant was asked to fill out a survey of just ten questions. These questions were based on the TAM, adapted from Davis (1989). The goal of this survey was to determine three constructs:

- Perceived usefulness
- Perceived ease-of-use
- Intention-to-use

The three constructs were measured by using multiple indicators, based on Davis (1989). Perceived usefulness and perceived ease-of-use consisted of four questions, while intention-to-use consisted of two questions. Each question's answering option was based on a five-point Likert scale, ranging from strongly disagree to strongly agree. The results are shown in section 5.4.

5.2 Multiple case study

The cases were carefully selected, to ensure both similar results were predicted, as well as contrasting results (Yin, 2017). The similar results were to be obtained by the fact that one organization was willing to provide three different participants, who could all be present at individual moments. The contrasting results were ensured by choosing entirely different organizations, operating in different industries.

The first firm (case A) is headquartered in Europe and employs over 300 people. Its products are employed globally, but mainly in Europe. The company designs and manufactures amusement rides and rollercoasters. The second firm (case B) is headquartered in Europe and employs over 28000 employees. The company designs and manufactures lithography machines. The third firm (case C) is headquartered in Europe and employs over 7000 employees. The company designs and manufactures food processing machinery. The last firm (case D) is headquartered in Europe and employs over 1600 employees. It provides production machinery. Table 5.1 summarizes the overview of the case firms.

Table 5.1: Case study characteristics

Case	Industry	Region	Headquarter	# employees
A	Amusement parks	Global	Europe	300
B	High tech manufacturing	Global	Europe	28 000
C	Food processing machinery	Global	Europe	7000
D	Production machinery	Global	Europe	1600

Table 5.2 provides an answer to the evaluation questions on completeness, validity and usability. Unfortunately, the results were not as conclusive as anticipated. The participants – perhaps due to making an assessment alone – had troubles to answering the questions for each dimension. Therefore, all results are shown in the one table.

Conclusions per case are drawn in the following sections, including usability statements and possible additions to the DSMM.

5.2.1 Case A

5.2.1.1 Participant 1

The first participant of case A was a unit manager field service and has worked for over 20 years at the company. Due to this long experience in the firm, the participant has a good understanding of how the company operates and where the company is heading.

Concluding remarks

The participant considered the DSMM as an extensive model, which takes effort to complete. Moreover, the participant admitted that the choice for a certain level was not always based on the actual level description, but could be based on a ‘gut-feeling’. The somewhat ‘expert’ terminology could sometimes hamper the usability of the model. The level descriptions (initial – optimizing) could be more descriptive. The participant stated that the model could be a useful tool. It could be difficult at first glance, and certain knowledge is needed to understand the described concepts. Once the assessment is started it gets easier as progressed further. Furthermore participant adds firm A is concerned with circular economy, and this could be a useful addition.

Figure 5.1 presents the result for this case study. Note, the sub-dimension maturity scores where averaged to assign a single score for a dimension. This makes it easier to visualize. The full outcome is shared with the participant in an additional report.

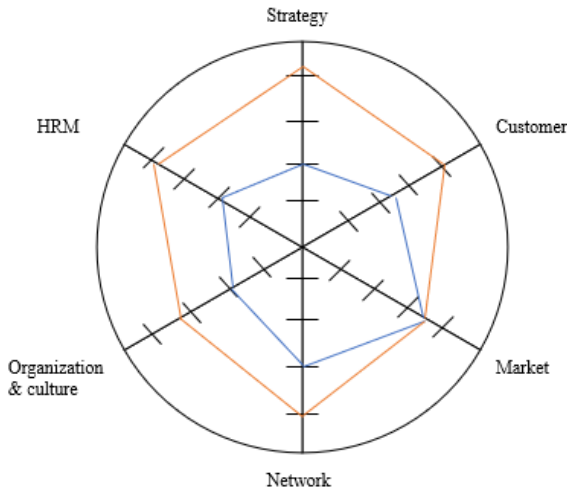


Figure 5.1: Results of DSMM, in blue as-is and in red ambition level for case A, 1

Table 5.2: Case study results on completeness, validity and usability

	Participant 1	Case A Participant 2	Participant 3	Case B	Case C	Case D
Strategy				On <i>Digital service offerings</i> , participant worries real-time data is not always what the customer wants to share.	On <i>Digital service offerings</i> , data can already be real-time on level 4.	
Customer	Unclear what was meant with <i>Customer's installed base</i>		Due to data security with customer, not all level descriptions applicable.	Customer intimacy should be included in <i>Customer evaluation</i> .		
Market	Participant had trouble assessing maturity, since firm is market leader. When market leader, hard to learn from competitors.	Participant had trouble assessing maturity, since firm is market leader.	Continuous analysis at level 4 of <i>Analysing market and industry trends</i> is too much.	As a market leader, firm cannot learn much from competition.	Participant had trouble assessing maturity, since firm is market leader.	Participant believes competition is not important for firm, as firm is market leader. On <i>Marketing</i> , at level 4 customer has control over pricing; remove payments based on performance.

Network	Supply chain is missing in <i>Network</i> .	Level 2: change resource and knowledge sharing to basic sharing. Instead of many partnerships, focus on the depth of the partnerships.
Organization & culture	On <i>Governance & leadership</i> participant was partly assessed on level 2 and partly on level 4.	
HRM		

5.2.1.2 Participant 2

The second participant of case A also was a unit manager field service. This participant was a very experienced employee to case A as well. This participant had but few comments on the model, which were mainly related to clarification requests on terms. No overall usability comments were made.

Concluding remarks

The participant found the model useful, but sometimes difficult to use due to the used terms. Moreover, assigning market did not correspond well with the way the business is situated. Figure 5.2 shows the assessment result.

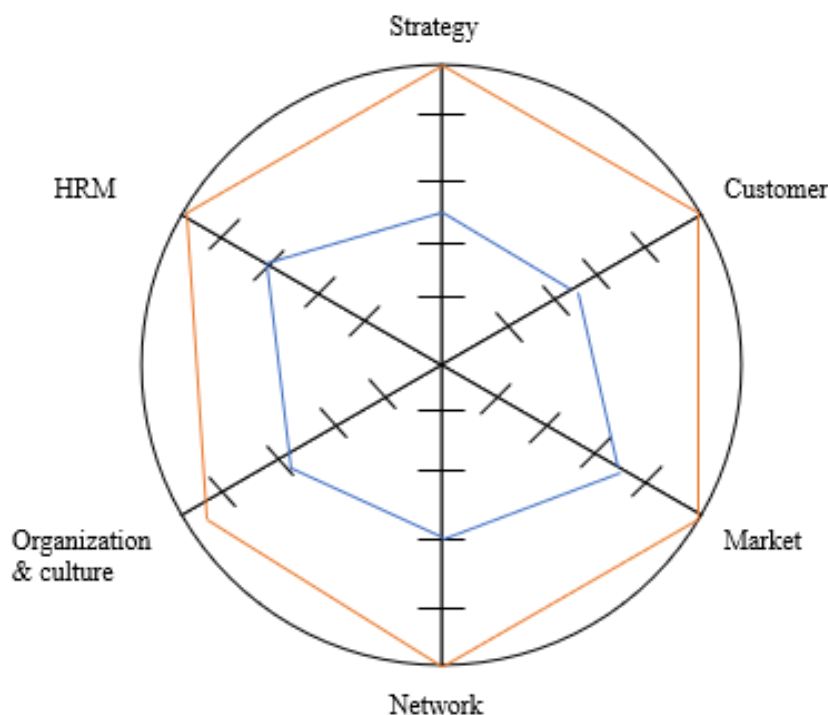


Figure 5.2: Results of DSMM, in blue as-is and in red ambition level for case A, 2

5.2.1.3 Participant 3

The third participant of case A was a unit manager engineering. This participant worked for a shorter time at case A, about six years.

Concluding remarks

Participant noted that not all descriptions were always immediately clear. Often participant had to take some time to grasp what was described and then translate it to the business. Moreover, participant struggled with the different products case A employs. For different products, different services exist, so the participant had to – in his mind – try to focus on one type of product and assess the business based on this product. Moreover, participant had some troubles when dealing with descriptions which were partly true. Participant wondered if that means to go for that level anyway, or then choose a lower maturity level. Furthermore, it was noticed that the DSMM regarded dimensions the participant had not yet considered for servitization. In

terms of usability, participant stated some prior information is definitely required to understand the DSMM better. The participant liked the breadth of the model, which forced new insights. Moreover, creating a visual representation of how a company scores is useful to start a dialogue inside a firm, using the same scientific language. Figure 5.3 shows the assessment result.

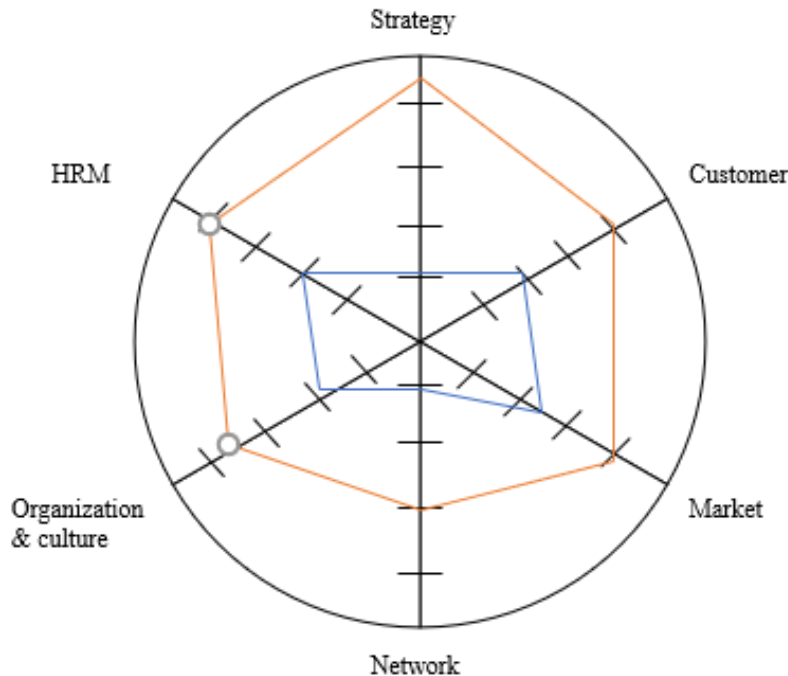


Figure 5.3: Results of DSMM, in blue as-is and in red ambition level for case A, 3

5.2.1.4 Case A conclusions

The fact that the DSMM has been used on three different occasions for the same case, makes it interesting to compare the results. What can be determined from Figures 5.1, 5.2 and 5.3 is the overall low servitization maturity. This is constant across all three assessments. Differences in assigned maturities could have many reasons, like personal judgements or different interpretations of the maturity descriptions. Moreover, all ambition levels in the figures are higher than the current level of the business. This suggests the participants share the same vision of where the company should be heading. Before innovating the business entirely, it is recommended to start defining a clear strategy, and promote this vision throughout the firm. Then, each of the corresponding business processes can be defined, based on the strategy, and the rest of the firm can adhere to that.

5.2.2 Case B

The participant of case B has worked at case B since the early days of the company, in different divisions of the business.

Concluding remarks

The structure of the DSMM is overall very clear and comprehensible to the participant. Also, the terminology is completely understandable. The participant found the given descriptions very much applicable to case B. Besides some small improvements, this model proved a useful

way to assess digital servitization. Moreover, an addition could be made on network, involving the supply chain. Figure 5.4 shows the result of the assessment.

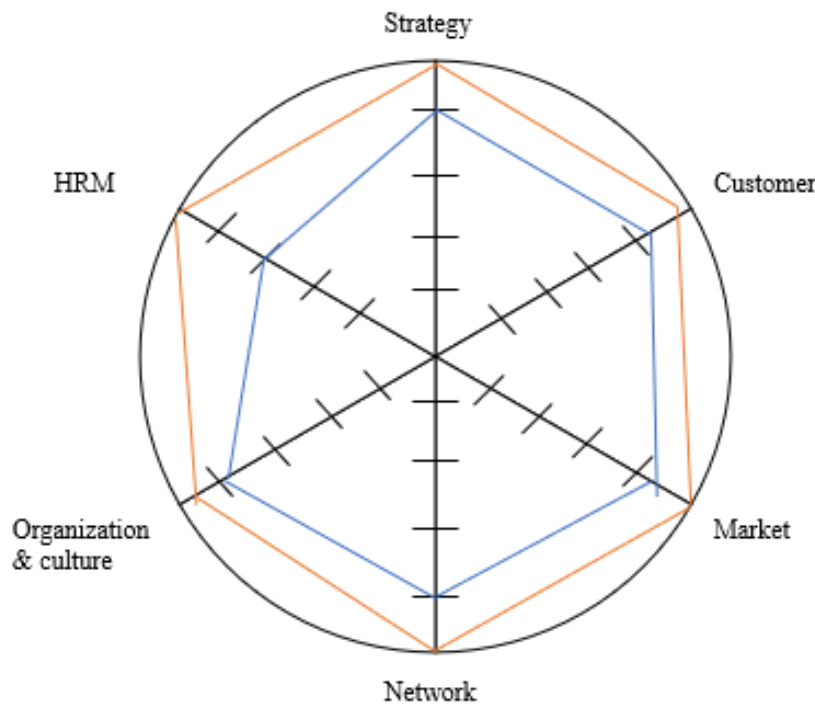


Figure 5.4: Results of DSMM, in blue as-is and in red ambition level for case B

Considering the difference in ambition and current state, improvement steps are in the HRM dimension. More servitization specific training programs could push the firm further in the servitization journey.

5.2.3 Case C

The participant of case C worked for over 15 years at case C, currently in the service business unit. The participant did not really provide much feedback on completeness, validity or usefulness. Only some comments were made.

Concluding remarks

Participant had some troubles sometimes with the readability of the presented DSMM. Moreover, some terms needed more explanations. Participant had some troubles with filling out the DSMM individually. However, with the help of the researcher, the participant was able to perform the assessment. Participant stated a DSMM specific ‘dictionary’ could be a useful addition. Figure 5.5 portrays the DSMM assessment result.

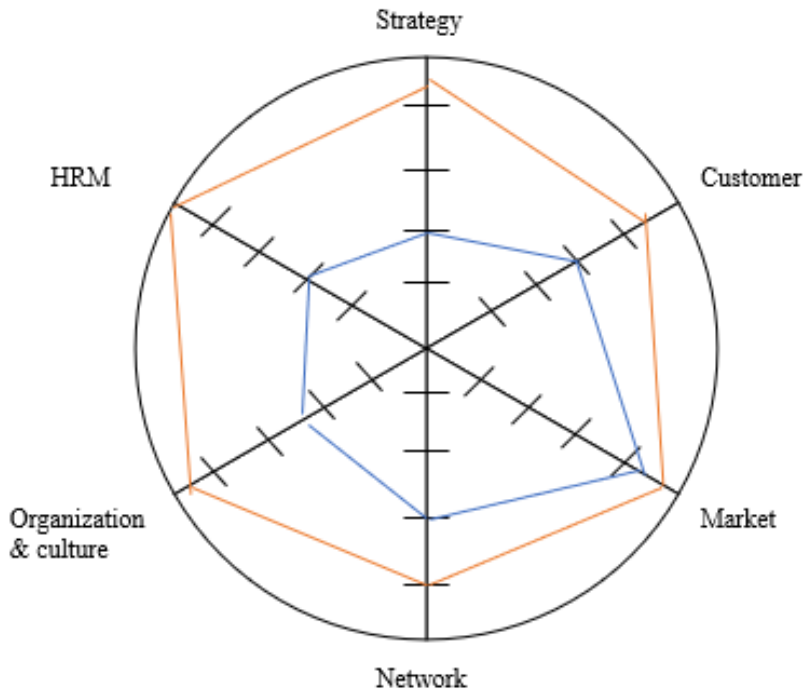


Figure 5.5: Results of DSMM, in blue as-is and in red ambition level for case C

Looking at the results in Figure 5.5 it becomes evident a more developed strategy on servitization would be a good start point for improvements. With a defined strategy this can be translated into a vision, adding to cultural changes inside firm. With these changes, HRM could develop to a higher maturity to support the transition.

5.2.4 Case D

Participant has many years of experience with servitization. In case D participant has been working for about ten years.

Concluding remarks

By using the DSMM, the participant tried to create an image by the maturity descriptions. Then, the case D was tried to fit that image. The general context of the DSMM could make it hard to apply to case D for the participant. Participant further remarked the DSMM provided a useful starting point for discussion. However, since the model is created so general, not all descriptions made sense for all businesses. Moreover, some improvements were coined. The results of the assessment is shown in Figure 5.6.

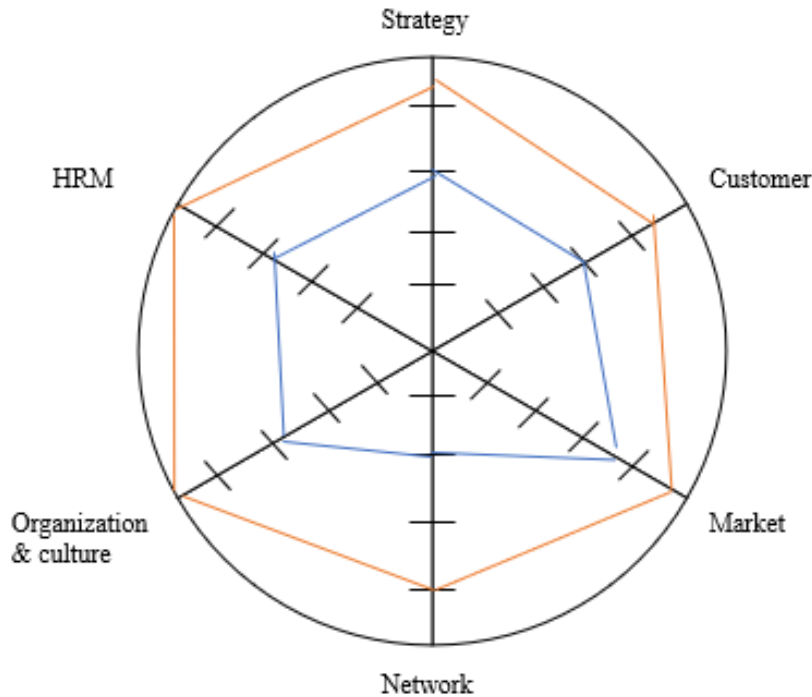


Figure 5.6: Results of DSMM, in blue as-is and in red ambition level for case D

Case D has constructed a future strategy on servitization, and could improve on the network strengthening this strategy. Identifying the partners which add value to the firm and developing deep value relations could push their servitization further.

5.3 Cross-case conclusions

Comparing all the assessment results from the cases, the internal assessment of case A was quite similar. This suggests for this case specifically the DSMM provided quite reliable results. Comparing the different cases, case B trumps the other cases in terms of their digital servitization maturity. The industry case B operates in, the highly complex technological industry, demands firms to go beyond delivering products as the sold machines are highly complex. This could explain some of the differences. It would be useful to compare similar industry business cases to test that hypothesis. One important finding was that the dimension “Market” was not really useful in determining the digital servitization maturity, especially when the firm using the DSMM is market leader. Judging from the information provided by the case firms, all were market leader, so that could explain the similar feeling towards “Market”. It would be useful to test whether this dimension can help firms who are not leading their specific market. Table 5.3 aims to capture critique on completeness, validity and usefulness.

Table 5.3: Multiple case study critiques

	Completeness	Validity	Usability
Case A	Circular/sustainability aspect DSMM needs explanation when a maturity score can be assigned	<i>Market</i> seems not valid for market leaders Continuous <i>market research studies</i> is too much	Complex terminology <i>Systemic integration</i> not fully understood
Case B	Customer intimacy should be included in <i>customer evaluation</i> ; Supply chain addition to network	Is real-time data applicable for <i>digital service offerings</i>	
Case C	A DSMM specific terminology list with definitions	<i>Market</i> difficult to assess for market leaders	Complex terminology
Case D		On <i>Network</i> do not mature with more partners, but with deeper relationship partners Change level 2 <i>network</i> to basic sharing instead of sharing is lacking On <i>marketing</i> , level 4 customer should have control over pricing	General character of DSMM makes it difficult to apply to case D

5.4 TAM survey

The TAM survey was shared with the participants immediately after the assessment ended. Figure 5.7 shows the outcome of the TAM survey. This result underscores that maturity represented in the DSMM can be difficult to understand at first (Q1) however the DSMM is considered useful by the participants. This could suggest the information session before using the model is necessary for the DSMM to be deemed useful.

			Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Perceived usefulness	Q1	Maturity represented in the DSMM is difficult to understand *			4	2	
	Q2	I think the DSMM provides an effective solution for assessing Digital Servitization maturity				6	
	Q3	Using the DSMM would make it difficult to communicate Digital Servitization maturity *				6	
	Q4	Overall, I found the DSMM in this case study useful				6	
Perceived ease-of-use	Q5	Learning to use the DSMM for assessing maturity would be difficult for me*		1		4	1
	Q6	The way maturity is represented is difficult and unclear to me*			1	4	1
	Q7	Becoming experienced in using the DSMM to assess digital servitization maturity is easy for me				4	2
	Q8	Overall, I found the DSMM easy to use				5	1
Intention to use	Q9	I would prefer to use the DSMM to assess digital servitization maturity in the future			3	2	1
	Q10	I would definitely not use the DSMM to assess digital servitization*				4	2

Figure 5.7: TAM survey results, question with an * are reversed due to negative forms

The figure shows perceived ease-of-use scores high. Most of the users score a 4 (agree) on all the sub-questions. This means that the way the maturity model is constructed is rather clear. From the case studies it became apparent that usability issues exist though. However, it is interesting to note that learning to use the DSMM would not be difficult for most of the participants, neither would it to comprehend the outcome of the model. Finally, intention-to-use scores high on the last questions, meaning participants would like to use the model in practice.

Chapter 6

Conclusions

This final chapter describes the conclusion of this research study. Following the DSR (Hevner et al., 2014) and the publication schema (Gregor and Hevner, 2013) the contribution to the knowledge base and to the environment should be outlined.

This research was set out to answer the main research question: “What practices are deployed at the different stages of maturity for manufacturing firms pursuing a digital servitization strategy?”. The answer to this question was given in the form of the Digital Servitization Maturity Model. Pursuing a digital servitization strategy consists of many practices a firm has to consider. This research tackled this question by structuring an organization’s processes, strategy, and culture. For each of the identified dimensions this research was able to identify practices and describe these practices at five different levels. With these level descriptions - ranging from an initial level of servitization to an optimizing level of servitization – manufacturing firms are able to assess their own business, based on their own operations. This gives these firms to some extent the knowledge and helps them get experienced with digital servitization. Ultimately, it can set them on the way to reach their desired state and reap some of the promised benefits servitization has to offer. In the very least the DSMM provides firms with a clear assessment of what parts of the business should attain attention next.

Creating the DSMM was done by performing two systematic literature reviews: one on digital servitization, and one on servitization maturity models. Synthesizing these findings, resulted in an initial blueprint of the DSMM. Using the knowledge and expertise of Atos experts in focus group research enabled the model to further develop to the final DSMM. This model was then further validated in a multiple case study research. This business environment amplified the model’s strengths (for example its practical applicability) and showed some of its weaknesses (for example the difficult terminology). Overall, the TAM survey showed that the participants of the case study research considered the model useful, easy-to-use and with relatively high intention-to-use. This means the model’s acceptance is rather high. Still, several improvements to the model were suggested, which are discussed in this chapter as well.

6.1 Contribution to Knowledge Base

This research extended the work of Paschou et al. (2019) and their endeavours to create an empirical tested digital servitization maturity model. It therefore addresses the research gap as described by Paschou et al. (2019), by creating new tools for practitioners to use. Moreover, their recommendation to test new models in a business environment was answered also. Besides, this research added a digital servitization maturity model to the already existing body of maturity models on servitization. What sets the DSMM apart from the other developed maturity models is the explicit focus on *digital* servitization. As manufacturing firms generally are slow to implement Internet of Things applications (Ezell et al., 2018), researchers must pave the way for firms willing to make the transition.

The converging of the two research streams Industry 4.0 and servitization is still a hypothesized relationship, under development (i.e. Frank & et al., 2019). This research adds to the understanding of how these two streams are intertwining, by specifically focusing on maturity

of servitization with regards to the DIKW hierarchy. It thus indirectly discusses the question raised by Kamp and Parry (2017), as to how digital technologies enable servitization practices. The DSMM both assumed and discovered that indeed data collection and usage is needed to foster digital technologies, which on its turn enables the servitization maturity of the manufacturing industry substantially.

Besides the development of the model, this research study conducted a systematic literature review on the developed servitization maturity models. This can serve as input for other researchers aiming to develop an assessment model for digital servitization with a slightly different focus. Many of the identified models did not provide multiple case study evidence, which the DSMM has done.

6.2 Contributions to Environment

The industrial need to provide structure in the broad concept of servitization was answered by the development of the DSMM. The way firms have to change both internally and externally to adapt their strategy and business model to servitization have been outlined in this research study, dimension by dimension, and sub-dimension by sub-dimension. Moreover, this research helps generate knowledge on servitization, giving confidence to firms to take a leap of fate and jump into the deep.

Manufacturing firms currently struggling with what improvement to consider, and where to invest their resources on, can use the DSMM to take a step back from their current transitioning efforts. By assessing the as-is state of their business, organizations can easier define their ambition. This may prevent quitting when challenges arise, as these challenges are easier known beforehand. Moreover, the gap analysis which results from their as-is and ambition state forces firms to do their research on servitization.

6.3 Limitations and Future Research

As with any research, it is bound to limitations. It is important to recognize them, describe them so they can be addressed in future research. These limitations are presented and ideas for future research are described.

The first limitation deals with the systematic literature review, and then the second one specifically. In this literature review, servitization maturity models were identified, analysed, and useful results were extracted from them. This collection of articles formed the base of the initial version of the DSMM. Although the literature was collected in a structured and systematic way, chances remain articles were missed. These articles could comprise crucial information. The first recommendation is thus to redo the literature search to mitigate this risk, while using different search engines also.

The second limitation deals with the focus group research, and then the panel size specifically. Hennink (2007) writes that focus groups tend to be comprised of six to ten participants. Moreover, the author states smaller groups could work too if the participants have sufficient knowledge and expertise. Since digital servitization is a relatively new topic, it could be their experience and knowledge was insufficient, yielding different results if performed with more people. Furthermore, the second focus group session resulted in very limited input from one of the participants, decreasing the panel size effectively even more. Future research should thus ensure a large enough focus group size.

The next limitation is in the validity of the DSMM. In the validation sessions with the case studies, more emphasis could have been put on the validation of the model. The sessions tended to fixate on the result of the model for the cases, rather than on the performance of the model. This was amplified by discussing the model with only one representative of the firm, which forced them to really focus on the content and linking that with their business case. For future research it would be wise to do the case study research with a small group of people to stimulate discussion on validity of the model.

The following limitation lies in the usability of the model. During the case studies, some participants required much time to comprehend the level descriptions fully. This sometimes resulted in participants following their gut feeling, rather than assessing their maturity based on the actual situation of the firm. A recommendation to improve this situation would be to have a short workshop before using the model. Then, when the model is in action, the host should ensure to have a list of definitions of predicted hard to understand terms.

Finally, the case studies itself have its own limitations. First of all, the number of cases researched. Although four companies is a good score, more companies would have yielded additional results and insights. A larger sample size could also force companies of the same industry in the sample. This would test the model on its benchmarking abilities, if the similar companies were willing to be transparent and honest to the researcher. It is thus recommended to find a large as possible sample size to validate the model, and if possible add some companies from the same industry in the mix.

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Appendix A

A.1 Microsoft Forms: dimension evaluation

Digital Servitization Maturity Model (DSMM)

Thank you for participating in this Focus Group research. Your input will be of particular value and interest in the development of the Digital Servitization Maturity Model. This new conceptual model will yield better understanding in assessing the Digital Servitization maturity for manufacturing firms. These insights can guide firms in their servitization journey.

The content of this form will be treated with high confidentiality. For any questions about the procedure, please contact me:

Pedro Németh
<mailto:pedro.nemeth@atos.net>

Hallo Pedro, als u dit formulier verzendt, kan de eigenaar uw naam en e-mailadres zien.

* Vereist

Introduction

Before starting the first round, I would like to ask two profiling questions. Note that all your answers will be anonymized.

1. What is your position/function/role within Atos? *

Voer uw antwoord in

2. Please indicate your working experience in the domain of Servitization. *

- < 2 years
- 2 - 4 years
- 4 - 8 years
- >8 years

Volgende

Digital Servitization Maturity Model (DSMM)

* Vereist

Round 1: Dimensions

Before this Focus Group research, a systematic literature review has been conducted. Its goal was to obtain an overview of existing Servitization models, and gain insight in the intersection of Industry 4.0 and Servitization. Where I4.0 and Servitization research collide, it is referred to as "Digital Servitization".

From these insights, the Digital Servitization Maturity Model is developed, however your input is needed to determine which dimensions are most important, and how the dimension can be best constructed. Other servitization maturity models typically have around five dimensions, so that is the aim of this model also.

Note, the presence of IT supporting the digital servitization journey will not be a separate dimension, but will be incorporated in each maturity level descriptions explicitly.

The following dimensions are considered:

1. Customer
2. Strategy
3. Organization & culture
4. Process and project management
5. Market
6. HRM
7. Network

Please indicate for each dimension the importance of each sub-dimension. Furthermore, if you feel like there is missing a sub-dimension or there are unclearities, please describe this in the follow-up question.

3. Customer: The extent to which customers are involved in the manufacturing firm's production process *

	Not important	Slightly important	Moderately important	Important	Vary important
Systemic integration with the customer	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Knowledge of customer's installed base	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Contact with potential customers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Knowledge of solution criticality	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Tests of new technologies with the customer	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Evaluation of customer satisfaction and customer service operations	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Customer training	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

4. Would you like to add sub-dimensions to "Customer"? Any other remarks? *

Voer uw antwoord in

5. Strategy: the strategic focus of the firm on digital servitization *

	Not important	Slightly important	Moderately important	Important	Very important
A business model is in place supporting the digital service offerings	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Servitization specific analytical performance objectives (KPIs) are in place	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Existence of a digital servitization strategy, aimed at developing digital service offerings	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

6. Would you like to add sub-dimensions to "Strategy"? Any other remarks? *

Voer uw antwoord in

7. Organization & culture: firm's ability to build and align the transformational properties towards digital servitization *

	Not important	Slightly important	Moderately important	Important	Very important
Governance and leadership: decision making processes concerning digital servitization projects	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Competences and knowledge development of employees of digital technologies	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Digital service mindset	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Change of firm's culture from product provider to customer-centric approach	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

8. Would you like to add sub-dimensions to "Organization & culture"? Any other remarks? *

Voer uw antwoord in

7. Organization & culture: firm's ability to build and align the transformational properties towards digital servitization *

	Not important	Slightly important	Moderately important	Important	Very important
Governance and leadership: decision making processes concerning digital servitization projects	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Competences and knowledge development of employees of digital technologies	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Digital service mindset	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Change of firm's culture from product provider to customer-centric approach	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

8. Would you like to add sub-dimensions to "Organization & culture"? Any other remarks? *

Voer uw antwoord in

9. Process and project management *

	Not important	Slightly important	Moderately important	Important	Very important
Procedures for managing projects are in place	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Usage of interdisciplinary teams for digital servitization	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Extent to which company takes over processes of customer	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Production: the amount of traceability and customization in the production process	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Performance management systems (feedback, KPIs) are in place for service	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

projects

10. Would you like to add sub-dimensions to "Process and project management"? Any other remarks? *

Voer uw antwoord in

11. Market: firm's knowledge of market *

	Not important	Slightly important	Moderately important	Important	Vary important
Identifying competitors	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Analyzing market and industry trends	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Solution availability already on market	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Marketing: analytical studies carried out to determine (product and dynamic) pricing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

12. Would you like to add sub-dimensions to "Market"? Any other remarks? *

13. HRM: firm's focus on service-oriented personnel *

	Not important	Slightly important	Moderately important	Important	Vary important
Firm's focus on hiring service-oriented personnel	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Supporting employee's development in the service transition	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

14. Would you like to add sub-dimensions to "HRM"? Any other remarks? *

15. Network: Firm's role in the value chain *

	Not important	Slightly important	Moderately important	Important	Vary important
Involving the upstream supply chain in new service development	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Company repositioning in the value chain	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Digital service ecosystem presence with partners/stakeholders	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

16. Would you like to add sub-dimensions to "Network"? Any other remarks? *

17. Did I miss any dimensions, or other remarks? Please describe what you would add to the model. *

18. Please rank the dimensions based on importance for manufacturing firms pursuing digital servitization. *

- Customer
- Strategy
- Organization & culture
- Process and project management
- Market
- HRM
- Network
- Your 1st added dimension
- Your 2nd added dimension

A.2 Survey results

2. Please indicate your working experience in the domain of Servitization.

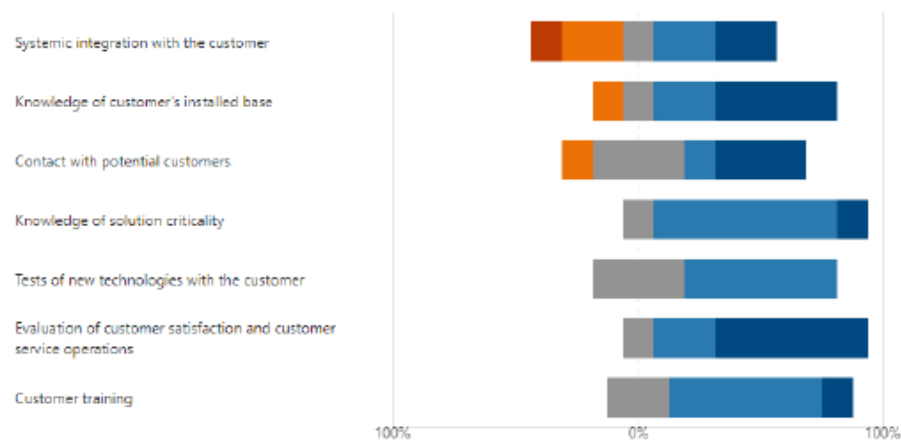
[Meer details](#)



3. Customer: The extent to which customers are involved in the manufacturing firm's production process

[Meer details](#)

Not important Slightly important Moderately important Important Very important



5. Strategy: the strategic focus of the firm on digital servitization

[Meer details](#)

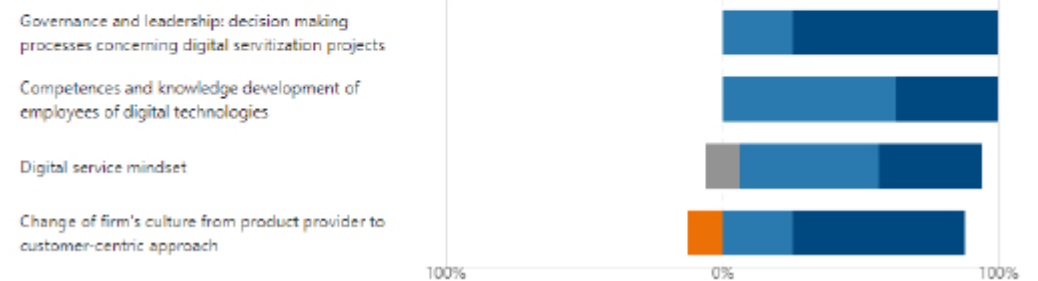
Not important Slightly important Moderately important Important Very important



7. Organization & culture: firm's ability to build and align the transformational properties towards digital servitization

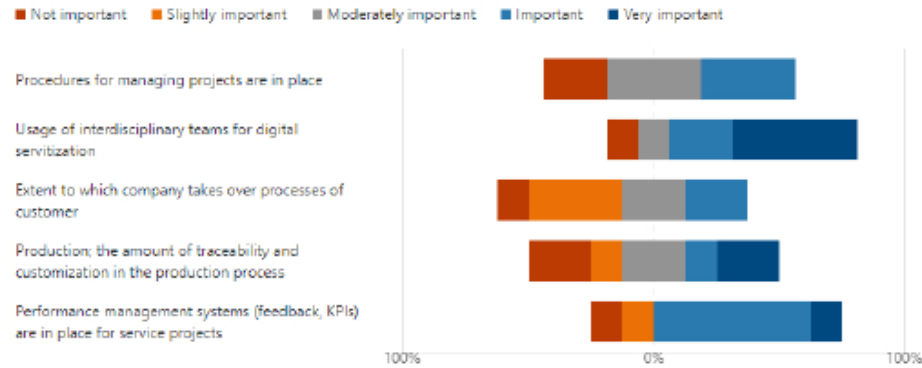
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Not important Slightly important Moderately important Important Very important

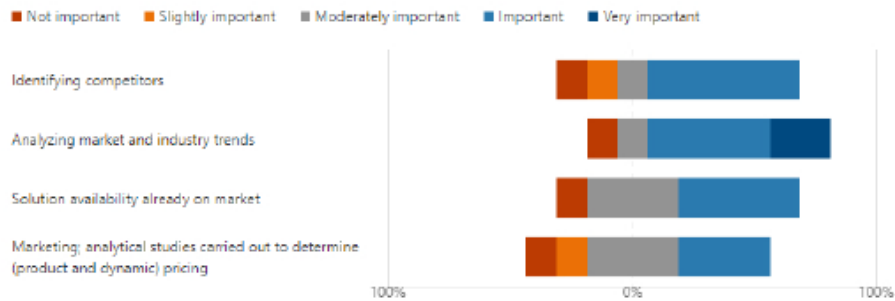


9. Process and project management

[Meer details](#)

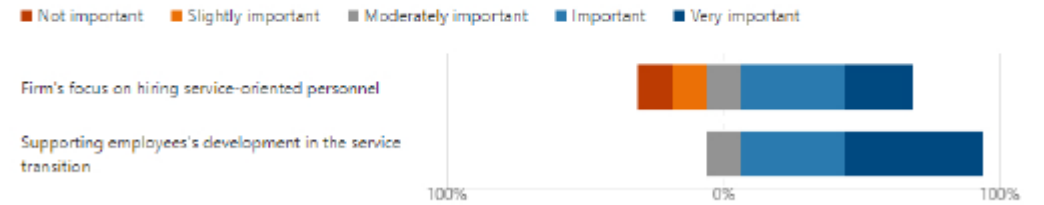


11. Market: firm's knowledge of market



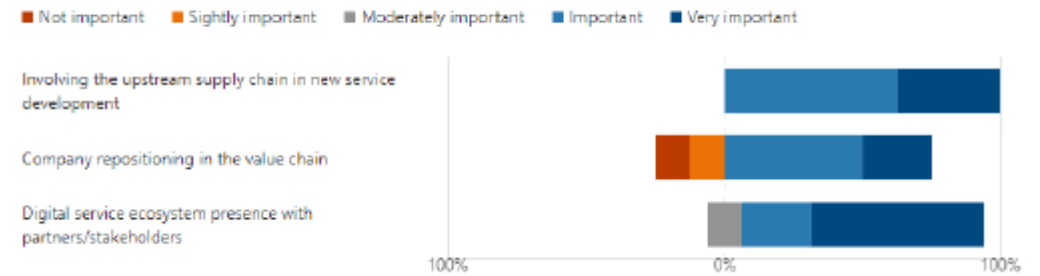
13. HRM: firm's focus on service-oriented personnel

[Meer details](#)



15. Network: Firm's role in the value chain

[Meer details](#)



18. Please rank the dimensions based on importance for manufacturing firms pursuing digital servitization.

[Meer details](#)

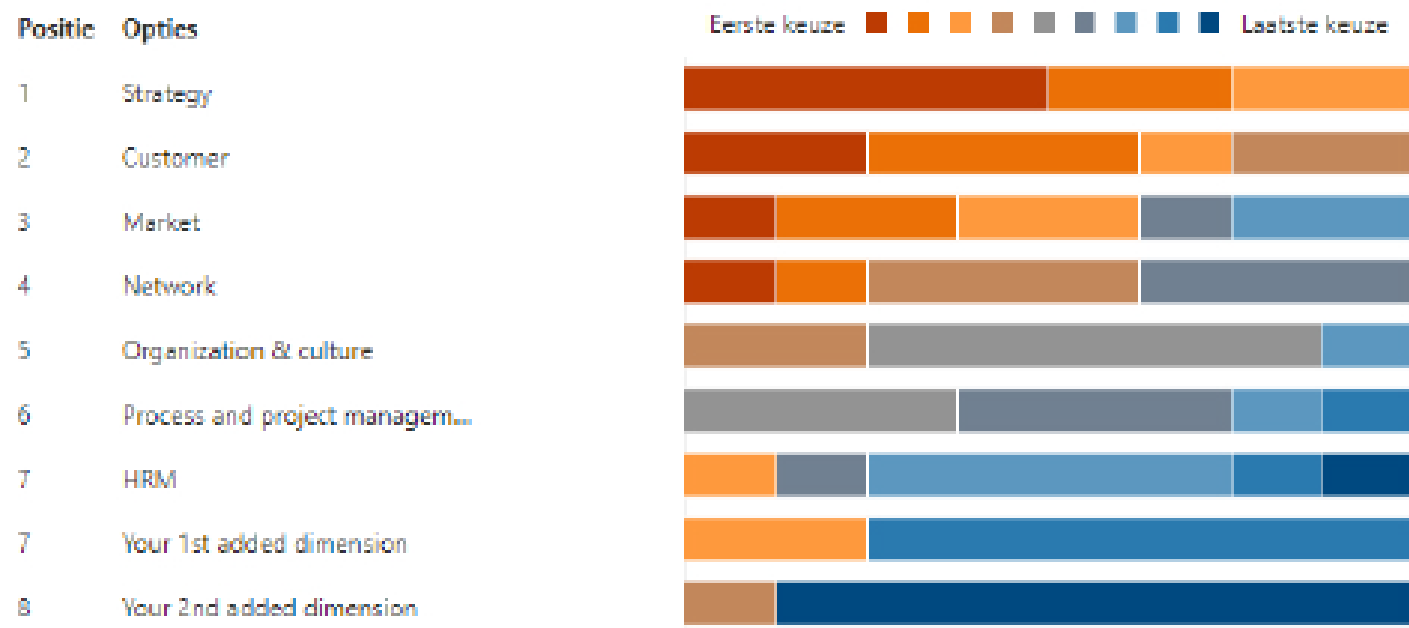


Table A.1: Remarks on the dimensions

Dimension	Remarks
Customer	Not all sub-dimensions were understood; Definition of customer is perhaps flawed; Link with product definition & development process; Add sub-dimension: user experience; integration and calibration; Depends on the customer.
Strategy	Perhaps a link between strategy – tactic – operational; Proposition to add service level agreements.
Organization & culture	Ability to move to a model where “service is the business”.
Process and project management	Extent to company takes over processes of customer: is this really a servitization characteristic?; Is traceability important for servitization?; This entire dimension is irrelevant, as it is not specific, unique distinction for servitization; Agile project management; This is strongly related with the type of customer and product.
Market	Focus more on what of the current products can be transformed into services; What services do we not yet offer (to stay competitive); This depends a lot what position the manufacturer has in the market.
HRM	What is service-oriented personnel?; What skillset does new personnel need for servitization?; Training.
Network	Why company repositioning in the value chain: this is the result of strategic orientation; Data sharing with the network;

Table A.2: Suggested dimension additions

Dimension	Remarks
Sales dimension	Perhaps a dimension on sales focus, service contracts could be a useful addition.
Service offerings	The service offerings the company wants to offer.
Technologies	Investments, data standards, data transfer, digital twin technology etc.
Product complexity	Depending on the complexity of the product, different servitization.
Product importance	Depending on the importance of the product, different servitization.

A.3 Transcription of first round focus group

Focus group session 1

Thursday 20-05-2021

Present: 1 host, 4 attendees: speaker 1, speaker 2, speaker 3, speaker 4.

Welcome

Host welcomes the present attendees. Host presents the agenda: first a short *introduction* is given, then the *dimensions* will be discussed one by one, and the meeting will be concluded with some *closing remarks*.

Introduction

Host: The host introduces himself, that he is writing his master thesis for his master Innovation Management, and is developing a Digital Servitization Maturity Model. The goal of the focus group session is outlined: to find out if the dimensions are complete, and well-constructed. This is done by evaluating the sub-dimensions, and determining whether the sub-dimensions grasp the dimension or if there are parts missing.

Next, some rules are presented. Firstly, there are no wrong answers, everyone has their experiences with servitization depending on their clients. It is encouraged to mention relevant working experience related to servitization, but is asked to stray away from long anecdotes due to time constraints. However, relevant experiences may add to quality and practicability of the host's report, so could be useful as well. Moreover, the attendees are asked to discuss among each other their experiences, as it may result in new insights.

Speaker 3: Speaker 3 adds that the host is the first student to manage the audience in such nice manner, and encourages the host to let the attendees follow these rules, as the input for the host is most important.

Dimensions

Ranking

Host: The host depicts the ranking outcome of dimensions as outlined to the participants of the Microsoft forms. The dimension *HRM* is ranked the lowest. This is in line with the opinion of the host. Therefore, the host has decided to remove said dimension from the list and the remaining six dimensions will be discussed one by one. After each dimension has been discussed, remaining comments on the Microsoft forms will be elaborated on.

Speaker 3: Speaker 3 adds that recklessly crossing off dimensions may be unwise. Especially a subject revolving around people change management is important, and if not taken into account in this model, should be included as a point of future research. Moreover, there actually is a student aiming to write a thesis on the subject of people change management for business dealing with new Industry 4.0 technologies, exemplary of its importance. Therefore, speaker 3 would not just remove this dimension, but highlight that this dimension is considered in initial research, but for reasons is excluded. The other attendees nod in agreement.

Strategy

Host: The host starts the list of dimensions with *strategy*. It is noted that alongside the presentation slides a description is given, outlining comments of the MS forms participants as well as working definitions of used terms in the presentation slide. Strategy – how the firm has arranged its strategy concerning digital servitization – is ranked with highest importance by the participants. However, some comments were made, and therefore host would like to know if there are questions or parts missing constructing the strategy dimension.

Speaker 1: Speaker 1 kicks off the discussion by stating that indeed, a strategy is required. This strategy should be documented and supported by the firm. It is questioned on the sub-dimension “*Servitization specific analytical performance objectives (KPIs) are in place*”, what these KPIs are? Because some concrete examples are needed to make it useful in a model. Speaker 1 continues by stating that this sentence is too generic, and as a consultant using this model to assess if a firm is ready for servitization two or three specific examples of KPIs are more useful. If yes: check, if no: the consultant can comment that the firm is not fully ready. As the sub-dimension stands now, it is too difficult to grant a score for this sub-dimension if there are no KPIs mentioned.

Host: The host to some extent agrees, but notes that the description of the (sub-)dimensions is not yet part of this focus group session, but of the upcoming one. Some examples of KPIs however are given, like machine failure rate, product lifetime for non-financial KPIs, and the proportion of service revenue for financial KPIs.

Speaker 1: Speaker 1 continues this thread and mentions the two different dimensions of KPIs. One is the percentage of revenue coming from services, which could be a KPI used to assess if a firm is “doing servitization”, whereas machine failure rate is a KPI of one particular service hosted by this firm. This second one does not help assessing how well a firm is doing in servitization.

Speaker 3: Speaker 3 agrees and continues if the distinction can be made concerning *strategy* between internal and external factors. Internal factors could as stated being internal performance of production activities, whereas there also should be a market of customers willing to work with this firm. Thus, if there is “*a business model in place*”, can be regarded from the internal perspective as well as the external perspective. For instance maybe a total new group of customers should be approached as an example.

Speaker 1: Speaker 1 comments on speaker 3 that this statement is the second phase, after the model has been applied. The first phase is to determine how well prepared a firm is on servitization and digitalization thereof, and in this light the sub-dimension “*a business model is in place supporting the digital service offerings*” is a fine definition. Because indeed, you regard the model as if you are the firm. This then maybe should be a working assumption supporting the model, that the usage of this model should be done as if the firm is determining how it is positioned concerning servitization. This then covers that indeed these internal factors are meant by *strategy*.

Speaker 3: Speaker 3 agrees, and states that these external factors are out of scope of this model. However, the minimum expectations internally are not just that there is a business plan for the firm’s activities, but also a marketing plan to throw at your customers.

Speaker 1: Speaker 1 comments on what was said by speaker 3, that a marketing plan is part of a strategy. So there is a business model, which either follows from the strategy or supports the strategy, but for example the question if other customers should be approached is part of the strategic analysis of the firm. So is there a strategy in place? The answer to this question is what is it the firms wants to do, and how is it going to accomplish this.

Speaker 3 asks the host whether this discussion was useful. The host answers that he is satisfied, and together they decide to move to the next dimension.

Customer

Host: The host introduces the next dimension: *customer*. The customer being the one served by the firm's product/service and the extent to which the customer is involved.

Speaker 1: Speaker 1 notes that this dimension is interesting, especially if you consider servitization as it is talked about recently. Everyone then speaks about "unburdening" the customer. Its implication is that the customer is not at all interested in how the firm "does" its service. The service is delivered, it is judged on its result, i.e. downtime is less than two percent, and how that is accomplished is not relevant for the customer.

Speaker 2: Speaker 2 comments, except when the customer has to invest in the service.

Speaker 1: Speaker 1 comments, that then it is not a service.

Speaker 2: Speaker 2 begins discussing the first sub-dimension "*Systemic integration with the customer*". An example is given of a printer which notifies the user it is almost out of ink. Then, the customer also has to perform actions. The customer has to ensure a connection between the printer and his PC. This could cost the customer as well.

Speaker 1: Speaker 1 agrees to an extent, that indeed a certain level of integration of infrastructure between the firm and the customer is needed to deliver the service. However, one should note that the customer should not have to invest greatly to be able to use the service. That is the underlying idea, when the customer takes out a subscription. The trick is to incrementally add services so the customer increases their payments to the firm. The initial investment is something to overcome, so be aware that the investment for systemic integration is minimized. For example a firm as firm A, which works with complex products and requirements, wants to know how the customer or supplier works to secure the requirements are met.

Speaker 3: Speaker 3 continues discussion on *customer* and remarks that the definition of *customer*: the extent to which customers are involved in the manufacturing firm's production process may be flawed. Everything discussed is not about the production process, but about the usage of the product in the field/dealing with the service delivered to the customer. The question is raised if this definition is chosen deliberately.

Host: The host agrees that indeed this definition may be wrongly constructed.

Speaker 1: Speaker 1 gives his thoughts on the definition and would construct it differently: the extent to which the firm and customers are integrated/interlinked in their processes. That would be a bit more generic. This is also reflected in the answers of importance on each of the

sub-dimensions. “*Knowledge of customer’s installed base*”, “*Evaluation of customer satisfaction and customer service operations*” are very important. “*Contact with potential customers*” is more a sales-dimension. “*Knowledge of solution criticality*” is sort of an open-door. Speaker 1 thinks that taking “*Systemic integration with the customer*”, “*Knowledge of customer’s installed base*”, “*Knowledge of solution criticality*”, and “*Evaluation of customer satisfaction and customer service operations*” would reflect the dimension *customer*, with the altered definition well.

Speaker 3: Speaker 3 agrees with speaker 1 on this point

Speaker 2: Speaker 2 had not noticed the definition of *customer* and wonders if this was the same on the questionnaire. After confirming this was the case, speaker 2 explains that this may explain the choice for less importance on the sub-dimensions “*Systemic integration with the customer*” and “*Knowledge of customer’s installed base*”.

Speaker 1: Speaker 1 agrees and explains that because of this definition the choice for lower importance on “*Systemic integration with the customer*” was made. Again, when talking about services it does not matter how it is done, but that it is done.

Host: Host wants to know if the definition was as agreed upon, would that have changed the answer on importance of “*Systemic integration with the customer*”?

Speaker 1: Speaker 1 agrees and “*Systemic integration with the customer*” would have been more important, because then the process is regarded. The example of HP earlier is recalled, then indeed some data link with the customer is required.

Speaker 2: Speaker 2 gives another example of firm B, where they work with connected trucks, a wireless connection is in place. With firm B, the firm has more control and the cost of the system is not settled with the customer.

Speaker 3: Speaker 3 concludes that with these examples there are different levels of integration with the customer.

Speaker 2: Speaker 2 believes that this systemic integration should be very important, how else can you serve the customer without knowing a lot?

Market

Host: Host introduces the next dimension: *market*. Host remarks that the outcome was somewhat odd, as *market* is ranked third highest, but the sub-dimensions’ importance differs a lot. Therefore, host believes that these sub-dimensions can perhaps be improved.

Speaker 2: Speaker 2 believes that in serviceability it is important the firm knows what can be offered to a customer, and it should be market-compliant or better. To service a customer, is it really necessary to “*Identifying competitors*”? Speaker 2 comments this is only useful to generate ideas. This may explain the variety in answers. Moreover it is questioned if the firm needs to know the market to service a customer. However, if by not knowing the market a customer is lost because competitors give better service, then it is applicable.

Speaker 1: Speaker 1 continues that when talking about transitioning from a product-centric firm to a service-delivering firm, this service delivery should be included in the dimension. Specifically, the sub-dimensions should include this service focus. Is the firm “*Analyzing market and industry trends*” with regards to servicing? “*Solution availability already on market*” with regards to servicing? And then the third or fourth sub-dimension can be removed, because that is the general market analysis the firm does when investigating what types of services will be offered.

Speaker 2: Speaker 2 agrees and adds, is it there on the market? Can we do it better and cheaper? Moreover, certain technologies can help to make it cheaper. An example is given from the firm C lamps which can be controlled by phone. Previously the firm C lamps used a more expensive but very good performing system to control the light, but in a different country competitors had cheaper Bluetooth systems. There the firm had to adapt to the market and also become cheaper to not lose the market.

Speaker 3: Speaker 3 adds that with the MS forms as well as the discussion confirms “*Analyzing market and industry trends*” is one of the more important sub-dimensions of *market*. Pricing the service relating to “*Marketing: analytical studies carries out to determine (product and dynamic) pricing*” is completely linked with “*Analyzing market and industry trends*”.

Speaker 1: Speaker 1 poses that dynamic pricing may not be the correct terminology. The pricing of services can vary depending on what type of market the firm is in. If a service is in play guaranteeing a certain outcome, then the pricing could be a percentage of money saved due to no standstill. Other services like at firm C, where there can be subscribed to various levels of detail of data coming out of reports differ. A standard vs advanced vs premium subscription of pricing.

Speaker 2: Speaker 2 wonders if that then is dynamic pricing?

Speaker 1: Speaker 1 comments that is the risk of using the wording ‘dynamic pricing’, it can be interpreted as pricing can be volatile during the year. This could be done, for example on the volume of data that is used, or the volume of ink that is used, then indeed dynamic pricing is applied. Moreover, firms in general are keen on predictability, without surprises, and introducing dynamic pricing hinders planning.

Speaker 2: Speaker 2 agrees, and adds the customer does want a choice in the amount of service they buy.

Speaker 3: Speaker 3 proposes that ‘dynamic pricing’ could be changed to ‘flexible’.

Speaker 2: Speaker 2 believes that everyone agrees that the customer wants the freedom to choose their preferred level of service, and agree upon the price of this service. More service means more money.

Speaker 3: Speaker 3 concludes that with better terminology for ‘dynamic’ the attendees come to an agreement.

Host: Host agrees and will also merge the sub-dimension “*Solution availability on market*” and “*Marketing: analytical studies carries out to determine (product and dynamic) pricing*”.

Network

Host: Host introduces next dimension: *network*. The firm's role in the value chain is discussed in this dimension. Moreover host depicts experience input would be useful to more understand how servitization influences *network*.

Speaker 1: Speaker 1 starts with "*Company repositioning in the value chain*". It is noted that would be a major strategic shift for a firm, because it effectively means they have to vertically integrate either up or down the value chain. This is a fundamental change in the business model and strategy the firm has. Speaker 1 wonders if this sub-dimension is relevant to a servitization maturity model. Theoretically maybe, in practice maybe less. Speaker 1 continues that this sub-dimension could be a conclusion from the model instead of a variable in the model. In comparison to strategy and the business model, *customer* and *market*: those are dimensions that can be measured/observed. A conclusion from those dimension could be that the firm is not in the correct position in the value chain, or that it misses some dimensions in the value chain. A conclusion could then thus be to move up or down, or integrate up or down.

Host: Host understands these suggestions.

Speaker 1: Speaker 1 continues that the other two sub-dimensions "*Involving the upstream supply chain in new service development*" and "*Digital service ecosystem presence with partners/stakeholders*" are valid.

Host: Host wonders if there are things missing to *network*.

Speaker 3: Speaker 3 posits that if the firm has strategic partnerships, or partnerships in general, in the value chain that can support the servitization movement would be a valuable addition.

Host: Host moves discussion to sub-dimension "*Digital service ecosystem presence with partners/stakeholders*" and wonders if this sub-dimension is complete.

Speaker 4: Speaker 4 argues that ecosystems are important for firms generally, not only for servitization.

Speaker 1: Speaker 1 reminds speaker 4 that the focus right now is on servitization, but agrees that ecosystems generally are important.

Organization & culture

Host: Host introduces next dimension: *organization & culture*, which is about the firm's ability to build and align the transformational properties towards digital servitization.

Speaker 2: Speaker 2 kicks off by stating the first sub-dimension "*Governance and leadership: decision making processes concerning digital servitization projects*" is more about leadership and convincing employees in the firm that service/digital servitization is important. Moreover, speaker 2 argues that on "*Competences and knowledge development of employees of digital technologies*" not everyone in the firm has to know everything about servitization, since the product itself has to be created as well. About a "*Digital service mindset*", the people

that are working in that part of the firm need to think how they can serve the customer better in a digital way.

Speaker 1: Speaker 1 discusses that if the maturity model is to be used to assess if a company is ready to go into servitization, having a “*Digital service mindset*” is important. Speaker 1 agrees with speaker 2 that not a hundred percent of the employees need to have this mindset, but the ones involved do.

Host: Host posits that a “*Digital service mindset*” and “*Change of firm’s culture from product provider to customer-centric approach*” then have similarities.

Speaker 3: Speaker 3 argues that “*Change of firm’s culture from product provider to customer-centric approach*” is a specific one about the change capabilities, whereas “*Competences and knowledge development of employees of digital technologies*” and “*Digital service mindset*” are more linked. Having a mindset does not mean you know how to do it.

Speaker 1: Speaker 1 analyses that “*Governance and leadership: decision making processes concerning digital servitization projects*” is about does the firm want it (documented in strategy and business plan), “*Competences and knowledge development of employees of digital technologies*” is about how is the firm going to achieve it, “*Digital service mindset*” is an extension on the second, and as a result “*Change of firm’s culture from product provider to customer-centric approach*” is the outcome for that part of the business concerned with servitization.

Speaker 2: Speaker 2 states that “*Governance and leadership: decision making processes concerning digital servitization projects*” is more for the management, whereas “*Digital service mindset*” is also for the people working in the company. In that case, at least the management should have this mindset, but not everyone working for the firm. Speaker 2 suggests it may be good to rephrase this sub-dimension to more management specific.

Host: Host refers to firm B example and concludes that the production team care less about servitization than the management team for example, and speakers agree.

Speaker 1: Speaker 1 agrees and reminds audience that the product still has to be created and manufacturing plant is still there, regardless of shift towards servitization.

Host: Host wonders if the group would hold on the last sub-dimension “*Change of firm’s culture from product provider to customer-centric approach*”, since it is somewhat the outcome of the first three sub-dimensions.

Speaker 3: Speaker 3 believes that it is still valid, yet a slightly different topic.

Host: Host posits the question if the dimension *organization & culture* is complete.

Speaker 3: Speaker 3 discusses that shifting the business towards servitization requires new resources, for example hiring new young employees with such mindset. Speaker 3 wonders if the word resources can be included in one of these sub-dimensions.

Speaker 1: Speaker 1 believes this is already covered by the second sub-dimension “*Competences and knowledge development of employees of digital technologies*”, by changing employees to resources.

Process and Project management

Host: Host introduces the next dimension *process and project management*, and thinks that it is up for debate.

Speaker 2: Speaker 2 mentions the first sub-dimension “*Procedures for managing project are in place*” and wonders if it is applicable for digital servitization.

Speaker 1: Speaker 1 agrees and thinks this sub-dimension should be removed.

Speaker 2: Speaker 2 questions if projects are managed differently if it regards servitization.

Speaker 1: Speaker 1 does not believe this is the case.

Speaker 3: Neither does speaker 3.

Speaker 2: Speaker 2 continues with “*Usage of interdisciplinary teams for digital servitization*” and thinks there is almost always usage of these teams, regardless of digital servitization.

Host: Host wonders if this does not depend on servitization.

Speaker 2: Speaker 2 does not believe it does, and moves on with “*Extent to which company takes over processes of customer*”, and thinks it depends on the type of service. Considering the printer example, the firm takes over the process of the customer obtaining the ink. However, it could differ per service, so this sub-dimension is very dependent on the type of business/product. Consider a firm B machine, the customer may want good service because the machine is so complex.

Speaker 3: Speaker 3 notes this comes down to the level of service the firm and customer agree upon.

Speaker 1: Speaker 1 believes that it may be wise to scratch the entire dimension *process and project management* and include *HRM* as a dimension. Speaker 1 has the opinion, looking at “*Performance management systems (feedback, KPIs) are in place for service projects*”, this sub-dimension is one of the basic ideas of servitization. Firm-customer agree on a service contract level and as a result the firm has to adapt its own internal organization to facilitate this. Then, that is the process and HR impact in the firm which is relevant. However, “*Extent to which company takes over processes of customer*”: no, this is not servitization but ‘old-school outsourcing’, “*Production; the amount of traceability in the production process*”: completely irrelevant, “*Performance management systems (feedback, KPIs) are in place for service projects*”: they are not relevant for service projects, but for service execution. So most of these sub-dimensions fall out of the maturity model.

Speaker 2: Speaker 2 comments on “*Production; the amount of traceability in the production process*” and wonders if that really is not important. Speaker 2 thinks of business like aviation, or food industry and believes they want to know where stuff comes from.

Speaker 1: Speaker 1 says this generic statement of speaker 2 is completely true, however this sub-dimension “*Production; the amount of traceability in the production process*” in the context of making a model to analyze whether a firm is prepared to move into servitization.

Host: Host adds the model will also be used to determine how well the company is doing servitization already.

Speaker 1: Speaker 1 continues thought and explains in that context traceability in the production process is not that relevant. What could be stated is end-to-end traceability in general is very important.

Speaker 2: Speaker 2 agrees and adds that traceability in production is only important for the firm itself. Maybe with a service with guaranteed uptime, and something goes wrong, the firm needs to be able to explain the customer what the root cause of this failed uptime was. Then, traceability is needed, otherwise the customer will not be pleased.

Speaker 3: Speaker 3 adds that a lot of these thoughts touch upon the business model that is chosen by the firm. Speaker 3 wonders if the existence of a customer service organization within the organization would reflect something about the process in *process and project management*. Regarding the customer service organization, there may be different processes to deal with servitization. Perhaps that could be a substitute for the sub-dimension about project management.

Host: Host tries to link this suggestion with the possible addition of a dimension *sales*.

Speaker 3: Speaker 3 reminds audience of mentioned SLA: service level agreement and shares experiences from firm B. There, customer support struggles with different levels of service they provide. There, the old-fashioned processes are mastered, but when new skills are required like data analytics or awareness of closed loop activities it gets difficult. Assessing whether these processes are done by the firm could be useful.

Host: Host suggests to go over *HRM*, and everyone agrees.

HRM

Host: Host introduces last dimension: *HRM*.

Speaker 3: Speaker 3 argues that “*Firm’s focus on hiring service-oriented personnel*” is already mentioned in “*Competences and knowledge development of employees of digital technologies*”.

Speaker 2: Speaker 2 agrees.

Speaker 1: Speaker 1 continues and argues that “*Supporting employee’s development in the service transition*” to availability of training programs for services. It becomes more practical by measuring/asking what training programs are in place at the firm.

Host: Host answers that this would be the measurement of this particular sub-dimension. For instance at the lowest level there would be no training programs, whereas at the highest level there is continuous development to get a service oriented mindset.

Speaker 1: Speaker 1 agrees with host.

Host: Host wonders whether “*Usage of interdisciplinary teams for digital servitization*” would be useful in this dimension.

Speaker 1: Speaker 1 states that from an HRM perspective hiring people who are capable in working in interdisciplinary teams – although there is a challenge to make this specific.

Host: Host wonders if there could be added more, or if having capable, trained employees working with services is most important.

All agree that is most important.

Speaker 2: Speaker 2 thinks that training can be divided into two areas, one being starting with a job, and the other being continuously updating them.

Closing remarks

Host: Host thanks the audience for their participation.

A.4 Label development

Dimension	Sub dimension	Description	Initial Undefined Unpredictable	Repeatable Disciplined	Defined Standardized Consistent	Managed Predicted Controlled	Optimizing Continuously improved	Authors
Strategy	Business model	A business model is in place supporting the digital service offerings	There is no business model supporting services. Services delivered are ad-hoc. Some data is collected.	Add-on business models use DTs (ICT) to enable additional functions or adding personalized services. Data is collected for some services, but not always used for new business models.			Solution-oriented business models use DTs (IoT, AI) to enable the provision of solutions to customers. Through IoT technology, firm is able to offer integrated solutions to customer's needs (subscription availability).	Paschou et al. (2016)
	KPIs	Digital servitization specific analytical performance objectives (KPIs) are in place	No servitization specific KPIs are in place.	Few and ad hoc financially oriented KPIs are in place, mainly related to costs and productivity, to point out cost-savings opportunities.	Standard KPIs dashboard, with also non-financial KPIs added (e.g. remaining product lifetime, machine failure rate).	Financial and non-financial KPIs are balanced, considering internal, external, customer and financial orientation (e.g. equipment reliability measures, production up times).	Balanced KPIs for new services, considering internal, external, customer and financial orientation. These KPIs are regularly adjusted to customer needs.	Rapaccini et al. (2013); Neff et al. (2020); researcher
	Digital service offerings	The type of service offerings and the strategy supporting them.	No DTs are used in the deliverance of basic services (installation, spare parts). Some ad hoc data on these services is collected.	Low usage level of DTs (ICT) is used to provide obligatory reactive maintenance services, such as installation or maintenance and repair. Data is manually entered.	Moderate usage level of DTs is used to provide intermediate services, e.g. remote monitoring and predictive maintenance. Data collection is automated.	Higher usage level of remote monitoring DTs to deliver performance contracting services. Data collection is fully automated and integrated across all business units.	High usage level of DTs provides value for both firm and customer in the deliverance of performance contract services or even managing customer's operations. Data is automatically integrated on a real-time basis.	Paschou et al. (2016); Neff et al. (2020)

Dimension	Sub dimension	Description	Initial	Repeatable	Defined	Managed	Optimizing	Authors
			Undefined Unpredictable	Disciplined	Standardized Consistent	Predicted Controlled	Continuously improved	
Customer	Systemic integration with the customer	Integration of customer and firm and ensuring all parts have the same level of information	No systemic integration is present.					Alvarez et al. (2015)
	Installed customer's base management	Knowledge of what customers are using of firm's products and services	No DTs (sensors) are present. Therefore, no coordinated interaction is present.	Basic electronic reports are manually released and exchanged by customer.	Moderate usage level of DTs (sensors) providing data on installed base. Data is periodically updated.	Higher level usage of DTs (sensors, IoT) provide continuous data on installed base.	High usage level of DTs (sensors, IoT, Big Data) ensures continuous, real-time data is collected on installed base.	Neff et al. (2020)
	Knowledge of solution criticality	Knowing how important the offered solution is to the customer and its operations.	?					Alvarez et al. (2015)
	Evaluation of customer satisfaction and customer service operations	Evaluating how well the delivered service is perceived by the customer and acting upon this knowledge.	No feedbacks are collected; corrective actions are ad-hoc and subjective rather than based on objective data analysis. Interaction between firm/customer is non-existent.	Some data is collected, yet feedbacks are poorly used. Corrective and preventive actions are performed according to internal procedures rather than being totally aware of the reported issues. Customer preferences and needs are discussed after service deliverance.	Feedbacks are achieved and discussed. Due to the poor understanding of the field/customer phenomena, feedback-based decisions are always disputable. Nevertheless, there is consistent use of monitoring systems for assessing the new services.	Feedbacks are systematically used to identify the weaknesses of the services, in order to make robust the design of service contents and delivery processes. Improvements and innovations are performed in a systematic way	Formal procedures and rules drive customer preferences and needs, used for future strategical decision. Customer and interaction data are collected through different channels. Feedbacks are discussed with the customer and are explicitly considered in the continuous improvement process by creating common platforms.	Rapaccini et al. (2013); Paschou et al. (2019)

Dimension	Sub dimension	Description	Initial	Repeatable	Defined	Managed	Optimizing	Authors
			Undefined Unpredictable	Disciplined	Standardized Consistent	Predicted Controlled	Continuously improved	
Market	Identifying competitors	Evaluating your competitor's services and their strengths and weaknesses.	No analytical studies are conducted to identify competitors.	Ad hoc analytical studies are conducted to identify direct competitors's service offerings. This data mostly remains unused in establishing firm's service offerings.	Regular analytical studies are conducted to determine competitors' services offerings. This data is used to expand service offerings.	Analytical studies are continuously conducted to determine competitors' service offerings. This data is used to evaluate own service offerings. Customers are sometimes involved in evaluation of competitors' offerings.	Analytical studies are continuously conducted to determine competitors' service offerings. Customers are continuously involved in expressing latent needs competitors do offer.	Babaei & Aghdassi (2020); Rapaccini et al. (2013); Alvarez et al. (2015); Paschou et al. (2019); researcher
	Analyzing market and industry trends	Carrying out research studies to understand how the market and industry is developing.	No analytical studies are conducted to understand market development.	Ad hoc analytical studies are conducted to understand market development. Data remains mostly unused in firm's service offerings.	Regular analytical studies are conducted to understand market development. Data is used to expand service offerings.	Analytical studies are continuously conducted to understand market development. Data is used to evaluate firm's service offerings. Customers are sometimes involved in evaluating industry.	Analytical studies are continuously conducted to understand market trends. Customers are continuously involved in expressing latent needs (new DTs/innovations) firm could integrate.	Babaei & Aghdassi (2020); Rapaccini et al. (2013); Paschou et al. (2019); researcher
	Marketing	Analytical studies carried out to determine pricing.	No analytical studies are conducted to determine pricing.	Ad hoc analytical studies are conducted to determine pricing. Data is used but only ad hoc.	Regular analytical studies are conducted to determine pricing. The customer has little control over pricing and how service bundles are constructed.	Analytical studies are continuously conducted to determine pricing. Customer has some control over the pricing and how service bundles are constructed.	Analytical studies are continuously conducted to determine pricing. Customer has full control over service bundles and can negotiate on pricing.	Paschou et al. (2019); researcher

Dimension	Sub dimension	Description	Initial Undefined Unpredictable	Repeatable Disciplined	Defined Standardized Consistent	Managed Predicted Controlled	Optimizing Continuously improved	Authors
Network	Digital service ecosystem	Firm and business partners ecosystem aimed at gaining access to resources to increase the firm's ability to improve, innovate and grow.	Firm has no partnerships.	Firm has partnerships with few stakeholders; low level collaboration. Little to no integration is present.	Firm has partnerships with some stakeholders; medium level of collaboration. There is some integration and data sharing on a platform, yet information is asymmetric.	Firm has partnerships with many stakeholders, in a fully digitized, integrated partner ecosystem. Platform is an open system, with a flexible architecture. Information can be accessed freely on this platform.	Firm has partnerships with many stakeholders, in a fully digitized, integrated partner ecosystem. Platform is an open system, with a flexible architecture. Information sharing is symmetric. Customer input can be accessed by all partners.	Alvarez et al. (2015); Paschou et al. (2019); researcher
Organization & culture	Governance & leadership	The decision making processes which define the expectations, systems and management of digital servitization projects.	No decision making processes in place for service projects. No data is used in these processes.	Basic project management for service projects. Low quality/availability/accuracy of data used for decision making processes.	Advanced project management for service projects. Moderate quality/availability/accuracy of data used for decision making processes.	Moderate to high quality/availability/accuracy of data used for decision making processes.	High quality/availability/accuracy of data used for decision making processes.	Rapaccini et al. (2013); Paschou et al. (2019)
	Competences and knowledge development	Competences and knowledge for firm's resources	No competences and resources for digital services in firm.	Only technology focused areas has employees with digital skills, yet not involved in service projects.	Mostly technology focused areas, but also service business units have employees with digital skills. Sometimes they are allocated to specific digital service projects. Data can be interpreted by most project teams.	All across the firm digital skills have been developed. These are allocated to specific digital servitization projects, with knowledge to take data-driven decisions.	All across the firm, fully developed digital and analytical skills are common and continuously challenged. Specific digital servitization projects have knowledge to take data-driven decisions and interpret customer needs.	Paschou et al. (2019); researcher
	Digital service mindset & culture	Change of company mindset to view digital service offering as a business logic and perspective on value creation	There is no digital service mindset in firm. Firm focuses solely on delivering product.	Low attitude towards digital servitization. (Failed) project evaluation lacks, customer involvement in service offerings not promoted. No data sharing across firm.	Attitude towards digital servitization is moderate. Service projects and digital competences are evaluated, customer involvement in service offerings is somewhat promoted. Some data sharing is encouraged across firm, but systems are unstructured.	Digital servitization is promoted in firm. A vision is present. Digital competences are critical and projects always evaluated following procedures. Customer involvement for improvements is stimulated. Knowledge is shared internally and cross-functional collaborations are preferred.	Digital servitization vision is promoted. Besides structural evaluation of projects, digital competences are critical. Firm aims to continuously involve customer in service offerings. High level of knowledge sharing and cross-company collaboration and value creation networks.	Paschou et al. (2019); researcher
HRM	Development of employees	Supporting employees to develop knowledge and expertise with DTs in the deliverance of services	No digital servitization competences and knowledge development available for employees.	Ad hoc digital servitization competences and knowledge development is available, yet structured programs are unrepresent.			Continuous development programs for employees are integrated by firm and employees are required to follow specifically chosen programs. Employees can request outside firm knowledge development programs. Customer can request employees to follow critical programs.	Rapaccini et al. (2013); Paschou et al. (2019)

A.5 Transcription of second round focus group

Focus group session 2

Tuesday 22-06-2021

Present: 1 host, 4 attendees: speaker 1, speaker 2, speaker 3, speaker 4.

Welcome

Host welcomes the attendees Host presents the agenda: first a short *introduction* is given, then the *levels* will be discussed one by one, and the meeting will be concluded with some *closing remarks*.

Introduction

Host: Host presents some rules. Firstly, there are no wrong answers, everyone has their experiences with servitization depending on their clients. It is encouraged to mention relevant working experience related to servitization, but is asked to stray away from long anecdotes due to time constraints. However, relevant experiences may add to quality and practicability of the host's report, so could be useful as well. Moreover, the attendees are asked to discuss among each other their experiences, as it may result in new insights.

Furthermore, host outlines the goal of this session. That is to validate if the level descriptions are complete and well-constructed. Moreover, host wants to find out if there are more digital-related practicalities which could be added, and if the descriptions make sense. Moreover, four sub-dimensions lack (some) level descriptions, so the attendees are asked to help paint a picture of what could be filled out.

Levels

Level typology

Host: Host lays out the way the maturity of each dimension is built up. The lowest level – level 1 – means there is no servitization happening yet in the firm. The highest level – level 5 – means servitization is happening and the firm is fully mature, and the processes inside the firm are continuously improved and updated. This is stage-wise depicted, from 1) initial – 2) repeatable – 3) defined – 4) managed – 5) optimizing.

Strategy

Host: Host starts the discussion with strategy. Strategy is divided into three sub-dimensions: *Business model*, *KPIs*, and *Digital service offerings*. For *Business model*, two of the five level descriptions are still lacking and the attendees are asked to give input.

Speaker 1: Speaker 1 is confused about what sub-dimension is being discussed.

Host: Host explains *Business model* is being regarded first. This sub-dimension shows how mature the firm has developed a business model supporting the digital service offerings. At the lowest maturity level there is no business model supporting the services. Some services are delivered, yet it is not described how the firm makes its money on this. In the highest level

of maturity solution-oriented business models are in place, supported by the right amount of digital technologies.

Speaker 1: Speaker 1 understands that two of the five descriptions are lacking.

Host: Host wonders if the attendees understand what is meant with the given level descriptions of this sub-dimension.

Speaker 1: Speaker 1 did not get the abbreviation “DT”.

Host: Host explains this stands for “Digital technologies” and continues that at the lowest level some data is collected from the services, however not really used, at the second level there is some ICT supporting the services, while at the highest level data is continually being collected and services are tailored to customer needs.

Speaker 2: Speaker 2 has a suggestion on the wording “data is collected for some services”. Start with level 1 as 0%, level 2 25% and so on to 100% of the services data is collected on, and wonders if that would be an option.

Host: Host agrees it could be an option.

Speaker 1: Speaker 1 agrees with speaker 2, and adds that this would also work for the KPIs as a checklist. Moreover, speaker 2 wonders if the typology of the levels could be used in the description of the levels. For example level 2 repeatable is characterized as “disciplined”, which suggests a certain routine is in place to collect data to for example do predictive maintenance and reach servitization. This could also be used for level 3 and level 4 of the descriptions, standardized/consistent and predicted/controlled respectively. So incorporating those terms in the description with a similar fashion could be a solution.

Speaker 2: Speaker 2 agrees and a description of how to get from level 2 to level 3 would be useful also. What should the firm do extra to get there.

Speaker 1: Speaker 1 tries to give a description of level 3: data is collected from a defined set of services and is at least consistently used for new business models. Speaker 1 believes much more is not really needed, but this shows the difference between the levels well. Moreover, for measurability, those percentages could be incorporated, with the step-wise addition of 25%.

Host: Host explains that the original literature differentiates between add-on, usage-based, and solution-oriented business models, usage-based not yet being mentioned in the description could be used also.

Speaker 2: Speaker 2 suggests to instead of having full sentences in the level descriptions, to use bullet points. This can help in evaluating more quickly what the differences are between the different levels of each dimension, and helps in what has to be done extra to go from level x to level y.

Host: Host agrees and will incorporate this change into the model.

Speaker 2: Speaker 2 would change “There is no business model supporting services”.

Speaker 3: Speaker 3 suggests to change it to “product business model only”.

Host: Host thanks attendees for input, and believes that *KPIs* and *Digital service offerings* are constructed well. Host gives a short overview of these two sub-dimensions.

Speaker 2: Speaker 2 comments that words like “few” and “some” are somewhat useless words, because they are not explicit. For example, if a firm has 4 KPIs and 2 of these are servitization specific, what does then a few mean? Speaker 2 would rather see a percentage, instead of using these words. A few could for example be less than 25%, and most could be more than 75%. This increases the accuracy without changing the description that much.

Host: Host warns the attendees that these type of descriptions are used throughout the model often, for the purpose of generalization.

Speaker 1&2: Speakers 1 & 2 together agree.

Speaker 1: Speaker 1 adds that quantifying the model would be great, but in general the model is more qualitative.

Speaker 3: Speaker 3 comments that saying “few” or less than 10% is similar, since “less than 10%” suggests accuracy, which in reality there is no reality either.

Speaker 1: Speaker 1 adds that creating a model like this always involves some informed guessing. It is more about a general indication, whether the firm is on the level of “repeatable”, or is the firm on “Defined”.

Speaker 2: Speaker 2 agrees and adds this gives some room of interpretation for the analyst.

Host: Host continues with *Digital service offerings*, and the maturity is built up from spare parts services, to reactive maintenance, to predictive maintenance, to performance contracting services and finally managing the customer’s operations.

Customer

Host: Host introduces customer, and points out *Systemic integration with the customer* and *Knowledge of solution criticality* are not yet filled out in the model. Host reminds attendees of first focus group session’s discussion on *Systemic integration with customer* to start a discussion.

Speaker 3: Speaker 3 asks host what definition of *Systemic integration with the customer* is.

Host: Host explains that information sharing has to occur for systemic integration, and perhaps a platform is necessary for this to happen.

Speaker 2: Speaker 2 refers to an example of an ASML machine, and names some properties which could be measured, like the amount of wafers per hour or other basic things.

Speaker 3: Speaker 3 explains that these are two different things: on the one hand there is the information coming from the machine. In the initial situation (level 1) there is no systemic integration and the customer has to share this information with the firm. On level 5 this information is real-time being shared with the firm, without the customer interfering. Then, the firm has access to the machine, or the machine shares the data with the firm automatically.

Host: Host wonders how this compares to the second sub-dimension *Installed customer's base management*.

Speaker 2: Speaker 2 disagrees.

Speaker 3: Speaker 3 also disagrees and explains that *Installed customer's base management* is different. Speaker 3 suggests that these two sub-dimensions could be merged.

Speaker 2: Speaker 2 disagrees with speaker 3.

Speaker 1: Speaker 1 explains that *Installed customer's base management* tells the firm something about all products in the field at different customers. For example the firm delivers coffee machines, then the firm knows something about all coffee machines around the world and can analyse if something is happening with all machines around the globe. *Systemic integration with the customer* is more about the direct performance of a single product at a single customer.

Host: Host agrees and wonders if the two sub-dimensions have overlap then.

Speaker 1: Speaker 1 agrees there is overlap, however the difference is in that *Systemic integration with the customer* aims to focus on a single customer and *Installed customer's base management* aims to see patterns across all customers.

Host: Host wonders if the description for *Systemic integration with the customer* should then focus on a single customer and the systems supporting this information sharing.

Speaker 1: Speaker 1 explains this is the interpretation of speaker 1, but is not fully sure whether this is correct.

Speaker 2: Speaker 2 believes that the explanation for *Installed customer's base management* is correct, however *Systemic integration with the customer* should more focus on what, how much and how specific the information is what is being shared by the customer. For example when driving a truck, the amount of kilometres driven is basic information, but the average speed could be more detailed, the location even more, the altitude even more. This results in the customer opening-up more.

Speaker 1: Speaker 1 remarks that considering servitization, it is more about what is done with the collected data. The goal then is twofold, one to help the customer (maintenance) and one to help the firm.

Speaker 3: Speaker 3 continues that the difference between the two sub-dimensions is interesting. For speaker 3 *Systemic integration with the customer* implies integration of the business process with the customer. So yes, information sharing is needed, and for the firm to

advise the customer more maturity is needed and finally the firm can real-time watch along with the customer.

Host: Host thanks the attendees for this fruitful discussion.

Speaker 2: Speaker 2 enjoys this discussion and explains that clients have the same issues when dealing with servitization.

Host: Host laughs and states he should take extra care of this dimension then.

Speaker 3: Speaker 3 continues that a quick Google search on “business model and servitization” shows that it is about a move from product with some maintenance, to predictive maintenance, and ultimately to solutions. The added value there with those solutions is about guaranteeing business outcomes. That could take form as a certain yield on a machine, versus guaranteeing the machine has a 99% uptime. These types of solutions are typical for high levels of servitization maturity, since it requires the firm to have high maturity on the dimensions portrayed in this model. So then indeed, full maturity on *Systemic integration with the customer* is required. Then the information should be frequent, real-life and in the right format received by the firm, and transformed into advices also to guarantee those outcomes. *Installed customer’s base management* is then also needed, because the information has to be shared, and should be accurate and up-to-date, because otherwise wrong actions could be taken. About *Knowledge of solution criticality* speaker 3 continues, is indeed relevant, since based on this criticality for example certain performance criteria are constructed. Without knowing how critical certain services are for the customer coming to service level agreements is very difficult. Based on these sub-dimensions good judgements can be made.

Host: Host wonders if it would be wise to add in the level typologies the trend of going from spare parts services to selling solutions.

Speaker 3: Speaker 3 agrees and explains it as selling business outcomes.

Host: Host wonders how *Knowledge of solution criticality* could be built up in terms of level descriptions.

Speaker 3: Speaker 3 remarks that *Knowledge of solution criticality* is a given.

Speaker 2: Speaker 2 believes this sub-dimension is more about being able to tell what processes/services are more important than others and prioritizing them, as well as distinguishing in the offers of these services as a firm. So for example the customer may want full advice on critical processes, however the less critical ones less advice would also be fine.

Speaker 3: Speaker 3 believes descriptions in terms of what the impact of the services are on the customer’s operations will help.

Host: Host understands suggestion.

Speaker 3: Speaker 3 suggests in level 1 the service does not impact the customer’s operations, and with higher levels of maturity this impact increases.

Speaker 2: Speaker 2 remarks that removing “knowledge” from *Knowledge of solution criticality* would also help in defining this sub-dimension.

Host: Host explains the last sub-dimension *Evaluation of customer satisfaction and customer service operations* and no further remarks are made.

Market

Host: Host introduces next dimension market and explains it is about *Identifying competitors, Analysing market and industry trends* and *Marketing*, and how the customer is involved in these processes. Host further elaborates that a market analysis always is comprised of these three parts, and whether the attendees have opinions about the level descriptions.

Speaker 2: Speaker 2 comments that this dimension is dependent on the market position of the firm. When firm is market leader, its analyses will be different.

Speaker 1: Speaker 1 believes that it also depends heavily on the type of market a firm is in, either consumer-market with high volumes or a niche market where a firm only produces 100 products yearly.

Speaker 2: Speaker 2 agrees and explains that these types of markets have their own market analyses.

Speaker 1: Speaker 1 continues and wonders how these different types of firms in different markets relate to servitization. For these market leader types of firms, it is questionable how much they care about their competitors.

Host: Host wonders if the attendees agree that with higher levels of maturity the customer is more involved and has more saying in what the firm should offer, depending on what the market has to offer.

Speaker 1: Speaker 1 states that this dimension about the market, and how the market develops, movements in pricing systems; these are focused on the market position the firm has.

Speaker 2: Speaker 2 comments the market needs are perhaps missing in this dimension.

Speaker 1: Speaker 1 explains a firm is continuously analysing market developments, since the ecosystem in which the firm operates continuously changes as well. Moreover, speaker 1 believes that with the descriptions given in the DSMM the market aspect has been covered. At least, it paints a picture of what to consider when doing servitization.

Network

Host: Host introduces network, and more specifically *Digital service ecosystem* and remarks that *Strategic partnerships* are already incorporated in *Digital service ecosystem*. However, host believes that some improvements can be made regarding the level description.

Speaker 3: Speaker 3 misses the link with servitization, especially regarding *Strategic partnerships*, since this is a too generic statement firms always do. Moreover, speaker 3 adds level 1 of *Digital service ecosystem* is wrong, firms always have some partnerships. The

increment between level 1 and level 2 is too high. Moreover, the service aspects should be more highlighted.

Host: Host follows this line of reasoning.

Speaker 3: Speaker 3 continues and elaborates firms have partnerships for specific competences or knowledge to deliver some services to the customer, competences or knowledge the firm does not own itself. The customer does not have to know or be involved with these partnerships, it just receives the service.

Host: Host agrees and will incorporate changes.

Speaker 3: Speaker 3 remarks that a platform is mentioned in the level description, and wonders if that is a prerequisite for an ecosystem.

Host: Host explains that a platform is mentioned to enable streamlining of data and better data sharing among partners.

Speaker 3: Speaker 3 understands this reasoning but notes this should then be described more clearly in the level description. Of level 3 and level 4 of *Digital service ecosystem*.

Organization & culture

Host: Host introduces organization & culture. Host explains this dimension is about *Governance & leadership, Competences and knowledge development, and Digital service mindset & culture* and how this related to digital servitization.

Speaker 1: Speaker 1 wonders if recruitment is incorporated here.

Host: Host explains this is more HRM related, but is not really involved in the model.

Speaker 3: Speaker 3 notices *Governance & leadership* level descriptions are not fully consistent, and proposes some changes to level 2 and level 3. Do not write about project management, but about decision making.

HRM

Host: Host introduces last dimension: HRM, and specifically *Development of employees*. The trend in this dimension is that with higher level of maturity more learning is possible and regularly occurs within the firm.

Speaker 3: Speaker 3 suggests for level 3 of *Development of employees* standardized competence development and learning programs, and for level 4 structured competence development and learning programs managed for all the relevant roles in the service processes.

Closing remarks

Host: Host thanks the audience for their participation and input.