

## MASTER

### Servitization in SMEs

capabilities and conditions to transition towards offering advanced product-service systems

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EINDHOVEN UNIVERSITY OF TECHNOLOGY

Department of Industrial Engineering and Innovation Sciences

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## **MASTER THESIS**

*Servitization in SMEs: capabilities and conditions to transition  
towards offering advanced product-service systems*

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## Management summary

### Research context

This research aims to understand how small and medium-sized enterprises (SMEs) can successfully make the transition towards offering advanced product-service systems (PSS). Because SMEs face different conditions and challenges than larger firms, it requires them to focus on other capabilities and conditions to make the transition (Gebauer et al., 2010; Kowalkowski et al., 2013).

Research shows that usually, SMEs can provide basic PSS (i.e., product and spare part provision) without the involvement of other actors (Gebauer et al., 2010), but to provide more complex PSS (i.e., preventive maintenance), SMEs need a network of partners (i.e. ecosystem) to acquire the necessary resources and capabilities that large firms occupy, to provide a wide range of services (Kowalkowski et al., 2013). SMEs will need network capabilities, to initiate, maintain, and utilize relationships with various actors in a network (Kowalkowski et al., 2013). However, cooperation with other actors in a network is more challenging when actors are asymmetrical in firm size and management style, which is generally the case for an SME network (Brouthers et al., 1995). Moreover, the perceived legitimacy for SMEs to take a leading role in an ecosystem is lower than for large firms (Brouthers et al., 1995).

Providing more complex PSS does not only require SMEs to involve other actors and prioritize their ecosystem but it may also require them to exploit digitalization to enable the transition because digitalization can achieve higher service levels by facilitating different types of service innovation and it can reduce servitization barriers for SMEs (Coreynen et al., 2017; Gago & Rubalcaba, 2007). To effectively manage digital business transformations, such as digitalization, SMEs could need a superior digital business capability (DBC) (Wielgos et al., 2021). However, especially SMEs often lack a digitalization strategy, making digitalization in SMEs' transition towards advanced PSS underexplored (Kohtamäki et al., 2020).

This research aims to understand the role of network capabilities, ecosystem conditions and capabilities, and digital business capabilities in SMEs' transition towards advanced PSS. This leads to the following generalized research question:

*What capabilities and ecosystem conditions are necessary for SMEs to transition towards advanced PSS?*

To answer the main research question, the following sub-questions should be answered:

1. *What is the role of network capabilities in the transition towards advanced PSS?*
2. *What is the effect of ecosystem asymmetry and competitiveness on SMEs' transition towards advanced PSS?*

3. *What is the role of ecosystem priority in the transition towards advanced PSS?*
4. *What is the role of digital business capabilities in the transition towards advanced PSS?*

## Method

This study employed an exploratory and qualitative multiple case study (Yin, 2014) of SMEs in the manufacturing industry that were involved in development of their PSS. To recreate a longitudinal study, this study focused on nine SMEs in different stages of the servitization process. For this study, the primary data source was in-depth semi-structured interviews with a key decision-maker from nine manufacturing SMEs who were involved in PSS development. Transcripts were coded axially with the support of a coding template. In total 281 relevant quotations were identified.

After coding, first, a within-case analysis was performed which depicts the PSS development transition of each SME with their corresponding challenges, capabilities, and ecosystem conditions. Next, a cross-case analysis was made using a pattern-matching logic (Yin, 2014). The pattern matching logic was supported by the template analysis. The transition of PSS advancement was divided in three stages; basic PSS, intermediate PSS, and advanced PSS. Last, a maturity model was developed that depicts the necessary conditions and capabilities that are needed to transition towards different stages of PSS advancement.

## Results

Results show that in the transition towards advanced PSS, the need for a partner network increases. Firms offering base and intermediate PSS required hardly any service partners for the development or delivery of the PSS. However, as the complexity of the PSS increased, the firms needed more resources and capabilities such as knowledge, budget, and data analytics capabilities. Consequently, all firms offering advanced PSS required service partners to enable the transition towards advanced PSS. Second, in the transition from basic to advanced PSS, the level of network capabilities that is required increased. As firms in this study produced customized engineered equipment or had to integrate their offering into customers' production lines, they had to communicate, discuss, and solve problems with customers regularly, which required firms to have a high amount of partner information and a high level of relational skills. However, in the transition from intermediate to advanced PSS, it was required to have additional network capabilities, as the firms with advanced PSS needed to be better informed about competitors and customers and needed to communicate this information frequently throughout the organization. Third, the level of ecosystem competitiveness did not differ in the transition from basic to advanced PSS. Firms indicated that the ecosystem competitiveness did not hinder their servitization efforts. However, all firms in this study operated in ecosystems where market demand was high. Thus, firms did not have to compete for market share. Fourth, all SMEs operated in an asymmetric ecosystem. The asymmetry had effect on

the collaboration process with large firms as it was more time-consuming and formal than the collaboration with similar firms in terms of firm size and management style. However, the effect of an asymmetric ecosystem was present in every stage of the transition and it did not hinder the development of their PSS. Fifth, the results showed that in the transition from basic to advanced PSS the need for an ecosystem priority increased. Firms with an advanced PSS had an ecosystem priority, whereas firms with intermediate and base PSS did not. For firms to transition towards advanced PSS they needed to attract additional resources such as funds, capabilities, and knowledge. Firms that transitioned towards advanced PSS did this by forming ecosystem relationships and looking for opportunities in other industries. In order to form and maintain these relationships it required the firms with advanced PSS to have a high level of network capabilities. Sixth, the results showed that digitalization and DBC played an important role in the transition towards advanced PSS. SMEs providing basic PSS had a low level of DBC and digitalization which meant that most of their service processes were documented on paper and service mechanics had to travel to customers abroad for every malfunction. This caused service processes to be time-intensive and mechanics had to waste time travelling, which was challenging for the SMEs because they were already experiencing a lack of resources. Therefore it hindered the transition towards intermediate PSS. Firms with a medium level of DBC were able to transition towards intermediate PSS by digitalizing on the front-end with the option to remotely monitor their equipment. This did not only give the SMEs the ability to provide service globally, but the service processes were also more efficient because the firms were able to solve 80 to 90 per cent of the malfunctions remotely by accessing the equipment and changing or resetting settings. Firms that transitioned towards advanced PSS had a high level of digitalization of their PSS and a had a medium to high level of DBC. The firms offering advanced PSS developed their PSS by digitalizing their PSS on the front-end and the back-end which created value for the firm and their partners. Due to the high level of digitalization, the firms were able to provide most of their services globally without the need to set up local service organizations. All firms offering advanced PSS had a digital strategy that aimed to continuously deliver digital product and service innovations. Moreover, the digital strategy was evaluated regularly and was an important part of the business plan which they evaluated regularly. Therefore, the level of DBC was crucial in digitalizing the firms' PSS which enabled the transition from intermediate to advanced PSS.

The results are summarized in a servitization maturity model for SMEs (Table 6). The maturity model can be used to, assess the current capabilities of a firm, identify desirable maturity levels and provide improvement measures, and benchmark internally and externally (de Bruin et al., 2005).

Table 1 SME servitization maturity model

	PSS level		
	Basic	Intermediate	Advanced
Type of services	Corrective maintenance, spare parts	Preventive maintenance, remote monitoring	Proactive maintenance, optimization, system integration
Service strategy	No deliberate service strategy	Service as value-added	Service as a differentiator
Series of critical requirements that characterize...	... network capabilities		
Coordination	✓	✓	✓
Relational skills	✓	✓	✓
Internal communication	✓	✓	✓
Partner knowledge			✓
Series of critical requirements that characterize...	...ecosystem priority		
Building ecosystems in proximal and distal networks			✓
Fostering integrated ecosystems			✓
Series of critical requirements that characterize	...digital business capabilities		
Digital strategy		✓	✓

Digital integration			✓
Digital control			✓



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# 1. Introduction: The transition from basic to advanced PSS as an SME

## 1.1. Research context & gap

This research aims to understand how small and medium-sized enterprises (SMEs) can successfully make the transition towards offering advanced product-service systems (PSS). This transition requires firms to develop themselves through ‘servitization’ (Vandermerwe & Rada, 1988), which can be defined as *“the innovation of an organisation's capabilities and processes to better create mutual value through a shift from selling product to selling product-service systems (PSS)”* (Baines et al., 2009). PSS can range from basic PSS that are product-oriented and focus on product provision (i.e. installation and spare parts) to advanced PSS that are customer-oriented and focus on product performance (i.e. optimization and system integration) (Baines & Lightfoot, 2014). The more advanced the PSS is, the more it requires firms to develop their capabilities and processes (Baines & Lightfoot, 2014).

Motives for servitization are especially relevant for SMEs, which are often more vulnerable to price-based competition than larger firms due to a lack of financial resources and economies of scale (Man et al., 2002). By adding services to their core product offering, SMEs can obtain financial, strategic, and marketing benefits (Baines et al., 2009; Gebauer & Fleisch, 2007; Mathieu, 2001; Oliva & Kallenberg, 2003). Servitization can increase profit margins and income stability (Sawhney et al., 2004), and can mitigate price-based competition by using service elements to differentiate manufacturing offerings from competitors (Gebauer & Fleisch, 2007; Malleret, 2006). Additionally, services help firms to create customer loyalty by increasing switching costs, customer satisfaction, and customer relationships (Blut et al., 2014; Coelho & Henseler, 2012). These motives draw increased attention to servitization efforts among SMEs (Gebauer et al., 2010; Lay et al., 2010).

Prior research mainly focused on the transition to advanced PSS in large firms (Cenamor et al., 2017; Coreynen et al., 2017; Matthyssens & Vandenbempt, 2008). However, SMEs cannot transition in the same way larger firms do (Gebauer et al., 2010). First, SMEs are generally younger and have had less time to develop service capabilities (Gebauer et al., 2010; Helfat & Peteraf, 2003). Second, SMEs are not as likely to set up a separate service organization or local service units, as most large firms do, and they have fewer internal resources such as employees and financing to develop new offerings or to invest in new equipment (Storey & Greene, 2010). Third, as opposed to large firms, SMEs may not always be able to serve an installed base directly, since SMEs often deliver through system integrators and installers or sell to distributors (Oliva & Kallenberg, 2003). Fourth, SMEs generally occupy different value chain positions than large firms as SMEs are often suppliers of sub-systems

and components which makes it difficult to move downstream in the value chain because of competition with other actors (Gebauer et al., 2010). Last, for large firms, there are predefined transition paths and business models for servitization with frameworks that include multiple stages and require different activities a firm must perform to servitize (Matthyssens & Vandenbempt, 2008; Oliva & Kallenberg, 2003; Penttinen & Palmer, 2007). However, due to their limitations, SMEs are more dependent on other actors (e.g., suppliers, distributors, customers) in their business network than larger firms, since they are not as likely to have the necessary resources and capabilities to deliver an advanced service proposition by themselves (Gebauer et al., 2010). Thus, SMEs must adapt their servitization process to a greater extent to fit with their network of partners and customers and are therefore not as likely to follow a predefined servitization path (Kowalkowski et al., 2013). These differences between SMEs and large firms require SMEs to focus on different capabilities and conditions than larger firms (Kowalkowski et al., 2013).

Research shows that usually, SMEs can provide basic PSS (i.e., product and spare part provision) directly to their customers, without the involvement of other actors (Gebauer et al., 2010), but to provide more complex PSS (i.e., preventive maintenance), SMEs construct different partner networks to acquire the necessary resources and capabilities, whereas large firms can do this almost independently (Kowalkowski et al., 2013). These partner networks are integrated structures of direct relationships with suppliers, SMEs, competitors, and customers (Normann & Ramírez, 1993). The success of a partner network depends largely on the firm's network capability, to initiate, maintain, and utilize relationships with various actors (Kowalkowski et al., 2013). What remains unclear is how SMEs construct these networks and what level of network capabilities are required for delivering advanced PSS.

In addition to the necessary network capabilities, if SMEs want to take a leading role in their network, other actors need to cooperate by sharing information, competences, and resources (Kamalaldin et al., 2021). Moreover, other actors will need to accept a follower role and accept the leader, as the leading firm often sets and enforces governance rules, determines the timing of activities, and reaps the major share of ecosystem value that is created (Adner, 2017). However, cooperation with other actors is more challenging when actors are asymmetrical in firm size and management style, which is generally the case for an SME network (Brouthers et al., 1995). Additionally, the perceived legitimacy for SMEs to take a leading role in an ecosystem is lower than for large firms (Brouthers et al., 1995). Therefore, the role of ecosystem cooperativeness and symmetry in SMEs' servitization efforts requires more attention.

Besides having the right ecosystem conditions, research suggests that SMEs can influence and shape their ecosystems by forming systems of relationships within and outside the supply chain (i.e.,

vertical and horizontal relationships), and beyond the firm's horizon, to create new opportunities unrelated to the current business (Homburg et al., 2020). SMEs can do this by focussing on two main activities; building ecosystems in proximal and distal networks, and fostering integrated ecosystems (Homburg et al., 2020). These activities can be defined as 'ecosystem priority' (Homburg et al., 2020). However, in contrast to large firms, SMEs generally have limited competencies and legitimacy to form ecosystem relationships (Senik et al., 2011; Su et al., 2020). Therefore, the question remains if SMEs can always shape their ecosystem to take a leading role in their business ecosystem or if SMEs can provide advanced services without a leading role.

Providing more complex PSS does not only require SMEs to involve other actors and shape their ecosystem but it may also require them to exploit digitalization as a servitization enabler because digitalization can achieve higher service levels by facilitating different types of service innovation (Coreynen et al., 2017; Gago & Rubalcaba, 2007). Digitalization could be especially important for SMEs since it can enable cost-effective and scalable services with monitoring, optimization, and autonomous functions (Kohtamäki et al., 2019). Recent research suggests that firms can effectively manage digital business transformations, such as digitalization, due to a superior digital business capability (DBC) (Wielgos et al., 2021). However, SMEs often lack a comprehensive digitalization strategy (Schröder, 2016), which makes the role of digital business capabilities in enabling SMEs' transition towards advanced PSS still underexplored.

In summary, not enough is known at this point about what capabilities and conditions are needed for SMEs to effectively make the transition towards advanced PSS. This research aims to understand the role of network capabilities, ecosystem conditions and capabilities, and digital business capabilities in SMEs' transition towards advanced PSS. A multiple-case study is used to illustrate the transition towards advanced PSS followed by servitizing SMEs from the manufacturing industry.

## 1.2. Organizational context: SME Canline

The study is performed at the request of a small to medium-sized enterprise (SME) interested in transforming its PSS from product provision to an integrated product-service solution partner, that shares the same challenges as other SMEs. In this section, the organizational context and challenges are described.

Canline is an international specialist in the design and installation of complete turnkey projects in transport and handling systems for the metal and aluminium can-making industry with offices in the Netherlands and the United States of America. The firm has around 52 FTE and had an annual turnover of € 13.524.272 in 2020 and thus can be considered an SME. Since 2015, Canline is part of the XANO Group, which consists of entrepreneurial companies with a high level of expertise in niche markets such as industrial products and automation equipment. With Canline's technology of magnetism,

vacuum, and air they are a successful supplier of transport systems with magnetic components. Figure 1 shows the manufacturing diagram of beverage cans of a customer of Canline. Canline connects all the numbered machines and places with their transport and handling systems.

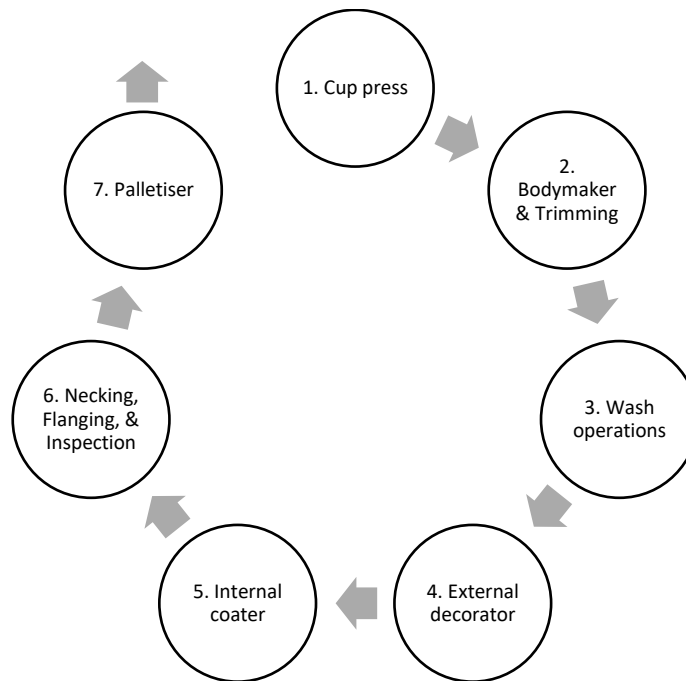


Figure 1 General beverage can manufacturing diagram of one of Canline's customers

Canline's company mission is to offer the best conveying and handling solutions for the metal and aluminium can-making industry to enable efficient and fast handling systems. To do so, Canline continues to innovate by having a high customer focus to explore new ways to design, develop and implement their systems and to look for new solutions that can improve and accelerate the production process of their customers.

### 1.2.1. Problem description for Canline

Currently, the sale of services is only responsible for a minor part of the company turnover as most turnover comes from turnkey projects that are priced at cost-plus. For Canline it is not a viable strategy to keep competing on price, as larger competitors can offer lower prices or can capture higher profit margins. Therefore, Canline wants to differentiate itself from the competition and capture more value by developing and commercializing a new, more advanced service proposition, by leveraging its knowledge and expertise. From January 1<sup>st</sup> 2021, Canline started developing its service proposition by offering simple preventive and reactive maintenance contracts to key accounts. Although this might be challenging for Canline internally, it does not require a high level of adaptation of customers as it does not change their business processes significantly. However, in the future, Canline likes to explore a new mission and strategy aiming to be the solution partner in managing and optimizing can production lines.

Canline seeks to be more focused on customer processes such as proactive maintenance and process optimization of entire manufacturing lines which can be accompanied by performance contracts such that it benefits from the higher performance of the can manufacturing lines. However, the manufacturing lines consist of multiple machines (see Figure 1), typically, from different suppliers, which affect the performance of the line. In addition, the composition of the manufacturing line is either managed by a *systems integrator* (generally for larger projects), who brings together subsystems into a whole, or directly by the customer. Therefore, if Canline wants to deliver advanced services such as system integration with outcome-based contracts, it will need to change existing roles in the network (e.g. it takes over the role of system integrator), create new relationships with suppliers of subsystems, convince customers the solution adds value, and develop new capabilities. If Canline wants to deliver a hybrid solution where it is responsible for the performance of the can manufacturing line, other actors will need to share knowledge, product-related information, and capabilities, and accept Canline as the leader in the service proposition. However, current customers see the conveyor and handling systems as the last piece to connect all the equipment in the manufacturing line and therefore as less significant. Moreover, for Canline it is difficult to get in contact with decision-makers of large customers, making the transition towards advanced services difficult. Additionally, Canline does not yet make use of digital tools to support its offerings which makes it difficult to optimize its products based on data. Therefore, the question for Canline remains, what capabilities should be developed, which actors to cooperate with, and to who the value proposition should be directed.

### 1.3. Problem statement and research questions

Canline experiences similar problems as other SMEs. Therefore, based on the problem description for Canline and the research context, the problem statement can be generalized such that it applies to other SMEs. Thus, the following problem statement is formulated:

*To ensure firm survival, SMEs want to move away from the price-based competition by developing advanced service propositions. However, the transition will fail if it is unclear what capabilities should be developed, and what ecosystem conditions are required to successfully make this transition.*

This leads to the following generalized research question:

*What capabilities and ecosystem conditions are necessary for SMEs to transition towards advanced PSS?*

To answer the research question several sub-questions should be answered:

1. *What is the role of network capabilities in the transition towards advanced PSS?*



2. *What is the effect of ecosystem asymmetry and competitiveness on SMEs' transition towards advanced PSS?*
3. *What is the role of ecosystem priority in the transition towards advanced PSS?*
4. *What is the role of digital business capabilities in the transition towards advanced PSS?*

#### 1.4. Managerial relevance

The managerial relevance of this research is as follows. First, servitization is new for many SMEs and their employees, and therefore this research will contribute to a better understanding of servitization in general. Second, this research will present a maturity model with possibilities of which capabilities to develop to commercialize advanced service propositions. Therefore, SMEs will be able to identify a possible gap in required capabilities. Developing these capabilities will help to transition towards offering advanced PSS which will differentiate SMEs from their competitors. Last, this study will discover the effect of ecosystem characteristics on the servitization process of SMEs. Recognizing the characteristics of the ecosystem will help SMEs to decide whether it can pursue a servitization strategy or if ecosystem conditions will hinder the transition towards advanced PSS.

#### 1.5. Research outline

To answer the research questions, this study contains several steps (see Figure 2). In chapter 1, the research context and questions were introduced. The following chapter (Chapter 2) encompasses a literature review to develop extensive knowledge on servitization in SMEs which will result in several theoretical propositions that will serve as a basis for the development of an interview guide. Chapter 3 presents the methodology used for conducting the study and it includes the research method, the development of an interview guide, case selection, and method of data collection and analysis. Chapter 4 discusses the obtained results by presenting the cases within- and cross-case, which concludes with a maturity model. Last, chapter 5 entails the discussion of the results and provides answers to the research question. The chapter includes managerial and theoretical implications, as well as the limitations of the study and directions for future research.

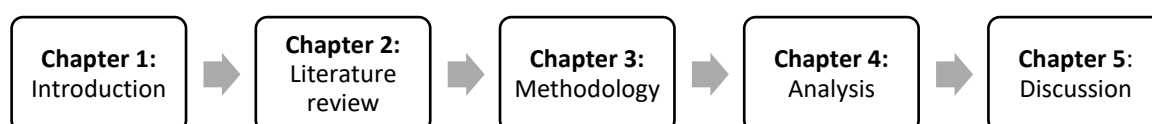


Figure 2 Research steps

## 2. Literature review

The literature search was performed using several databases such as ProQuest, Scopus and Google Scholar. The first section explains the servitization process, its different stages, and its barriers and required capabilities and conditions. The second section discusses the specific capabilities and conditions, that were introduced in the research context (i.e. network capabilities, digital business capability, and ecosystem priority and conditions), that this study deems important for SMEs' servitization efforts. The capabilities and conditions will conclude with theoretical propositions derived from literature, that will be examined in the multiple case study.

### 2.1. Theoretical background

#### 2.1.1. Servitization

The term "servitization" was first introduced by Vandermerwe & Rada, (1988) and refers to firms adding services to their core product offerings to create additional customer value. Interest in this topic is still increasing (Raddats et al., 2019) and similar concepts, such as 'integrated solutions', 'product-service systems', 'service infusion', and multiple other definitions of servitization arose. This study uses a more recent and extensive definition of servitization defined by Baines et al. (2009) as: *"The innovation of an organisation's capabilities and processes to better create mutual value through a shift from selling product to selling product-service systems (PSS)"*.

Baines & Lightfoot (2014) classified the services of PSS into base, intermediate, and advanced services. Base services are focused on provisions such as product and spare part provision, and warranty. Intermediate services focus on the maintenance of product condition such as preventive maintenance, customer support, remote monitoring and operator training. Advanced services focus on capabilities that are delivered through the performance of the product such as system integration, optimization, risk and reward sharing, and revenue-through-use contracts. This study will focus on the transition towards these complex and advanced services that are mainly outcome-based and customer-oriented. The advanced PSS are characterized by performance incentives, long-term agreements, and payments structured around product usage (Baines & Lightfoot, 2014). An overview of the differences between base and advanced services can be seen in Table 2.

Table 2 Comparison between base and advanced services (based on Sousa & da Silveira (2017))

<b>Dimension</b>	<b>Base services</b>	<b>Advanced services</b>
Business model	Product-centered (product provision and maintenance)	Service-centered (co-creation, focus on solutions)
Contractual relationship	Transactional (selling products)	Relational (selling solutions through long-term relationships)
Added customer value	Low-medium	High
Extent of customer process takeover by provider	Low	Medium-high
Nature of the service processes	Simple, low contact, standardized	Professional, complex, high contact, customized
Degree of customer interaction, involvement and co-creation	Low	High
Competitive strategy	No deliberate service strategy	Service as differential strategy

PSS can be further categorized into six categories based on the value proposition (input, performance, and result) and the focus of the service (product-oriented, and customer process-oriented) (Coreynen et al., 2017; Kindström & Kowalkowski, 2014; Ulaga & Reinartz, 2011). The resulting categories can be seen in Figure 3. Going from the bottom left of the figure (product lifecycle) to the top right (hybrid customer solution), the complexity of the PSS increases as the service provider will need to take over customer processes and the reliance on the product as the core component decreases (Tukker, 2004). The increase in complexity requires an increase in capabilities (Tukker, 2004).

<b>Value proposition</b>	<b>Result</b>	Product result (e.g. energy/waste reduction)	Hybrid customer solution (e.g. outcome-based contracts, system integration)
	<b>Performance</b>	Product performance (e.g. preventive maintenance, remote monitoring)	Process delegation (e.g. fleet management, supply chain management)
	<b>Input</b>	Product lifecycle (e.g. spare parts, repair)	Process support (e.g. training, consulting, simulation)
		<b>Product-oriented</b>	<b>Customer process-oriented</b>
<b>Service focus</b>			

Figure 3 Service categories based on Coreynen et al. (2017, p. 43); Kindström & Kowalkowski (2014, p. 102); Ulaga & Reinartz (2011, p.17)

#### 2.1.1.1. Servitization barriers

The transformation of a firm from a product- to a service-centric approach is challenging and comes with uncertainty caused by factors such as a change in corporate culture, strategic focus, internal conflict, and the development of new capabilities (Nordin & Kowalkowski, 2010). Hou & Neely (2013) identified seven barriers to servitization: First, it is difficult to get cooperation and coordination from competitors, suppliers, and partners (Mont, 2002). Second, there are environmental barriers, such as a lack of policy and infrastructure support (Mont, 2002). A third barrier is a lack of customer trust in added value and a lack of control over customer behavior (Heiskanen & Jalas, 2003). Fourth, there can be a lack of financial resources and pricing strategy to integrate products and services (Mont, 2002). Fifth, there is usually a lack of knowledge and information about services and innovation, and information management (Vandermerwe, 1994). Sixth, it is difficult to design service packages and measure services (White et al., 1999). Last, the organizational structure and culture require a change to transform the organizational structure and culture to support the development and sales of services (Vandermerwe, 1994; Vandermerwe & Rada, 1988; White et al., 1999). The more advanced the service is, the higher the barriers will be since advanced services require more co-creation, long-term relationships, service customization, customer involvement and interaction, and resources (Queiroz et al., 2020).

#### 2.1.1.2. Servitization capabilities and conditions

To overcome the servitization barriers, firms should have the following capabilities and conditions: First, firms should have the capability to design products for serviceability (Kindström &

Kowalkowski, 2009; Ulaga & Reinartz, 2011). Second, servitization requires firms to design and manage service processes, which are more people-intensive and require more customer interactions compared to manufacturing processes (Kindström & Kowalkowski, 2009). Third, the provision of services should be backed up by a service organization which could involve the creation of a separate service unit, training of service-centred employees, and changing incentive and control systems for PSS performance (Baines & Lightfoot, 2014; Oliva & Kallenberg, 2003).

Regarding the differences between base and advanced services, for advanced services in particular, literature identified six additional capabilities and conditions that are crucial for the delivery of advanced services. According to Baines & Lightfoot (2014), to deliver advanced services, first, firms are required to have performance measures and customer value demonstrations to reflect the outcomes required by the customer and reassure an efficient contract fulfilment. Second, service providers should be co-located and distributed throughout their customer's operations either physically or virtually, to ensure responsive and reliable maintenance. Third, service providers should be integrated forwards to adopt customer activities, and integrated backwards to retain production and design capabilities for complex subsystems. Fourth, firms should use ICT, for remote monitoring of product location, and condition, and to enable responsive actions to manage maintenance, repairs, and improvements. Fifth, service providers should train or hire people in front-line that are skilled in flexibility, relationship building, customer sensing, and service-centricity to sustain positive customer relationships. Last, firms should integrate in customer touchpoints so that they can proactively manage people, information, and facilities to maintain the condition of the product.

#### 2.1.2. Servitization capabilities and conditions for SMEs

The aforementioned barriers and required capabilities in chapters 2.1.1.1 and 2.1.1.2 are generic and also hold for SMEs. However, as mentioned in the research context, SMEs experience additional barriers and conditions and will therefore need additional capabilities (Gebauer et al., 2010; Kowalkowski et al., 2013). Thus, this study, as discussed in the research context, will focus on ecosystem conditions and priority, network capabilities, and digitalization and digital business capabilities. This study deems these specific capabilities and conditions important for SMEs' transition towards advanced PSS.

The following sections will elaborate on these capabilities and conditions.

##### 2.1.2.1. Ecosystem priority and conditions

Over the past 25 years, there is an increasing interest in ecosystems, and it has become common in discussions of strategy, including servitization (Adner, 2017; Jacobides et al., 2018). However, with increasing interest, multiple definitions and notions of ecosystems emerged. This study will look at

ecosystems from an ecosystem-as-structure perspective defined by Adner (2017). The ecosystem-as-structure perspective defines an ecosystem as: “The alignment structure of the multilateral set of partners that need to interact for a focal value proposition to materialize” (Adner, 2017). Therefore an ecosystem can be compared to the network of partners that SMEs require to offer advanced PSS. The ecosystem-as-structure perspective contains four basic elements: activities, actors, positions, and links. Taken together, the ecosystem begins with a value proposition and considers discrete actions (activities), undertaken by actors, for the proposition to materialize (Adner, 2017). The actors have specified locations in the flow of activities and transfer resources (e.g. information, competencies) across positions. Moreover, the perspective includes activities and actors with whom they have no direct contact or over which they have no control. When innovation in the ecosystem occurs (e.g., a new service proposition), changes in the configuration of the basic elements are required. Therefore, a thorough understanding of the ecosystem dynamics is crucial for implementing a service strategy (Adner, 2017).

In contrast to large firms, SMEs have limited access to resources, capabilities and expertise required for providing advanced services, and they need to look for partners to fill their gaps to make up for these shortcomings in the servitization process (Kamalaldin et al., 2021; Kohtamäki et al., 2020; Kowalkowski et al., 2013). Thus, there is a need to align and collaborate with other partners including suppliers, competitors, and customers, to deliver advanced service propositions (Kohtamäki et al., 2020). Especially emerging digital solutions require extensive collaborations between actors within an organization as well as external actors, as these intelligent and smart solutions generally have to be designed to be compatible with those from other manufacturers, customers, and the rest of the ecosystem actors who are involved in the service (Kohtamäki et al., 2019). However, prior research found that SMEs generally have limited competencies and legitimacy to form ecosystem relationships (Senik et al., 2011; Su et al., 2020). Therefore, it is of great interest to investigate how SMEs shape the ecosystem collaboration process to deliver advanced services.

If SMEs want to offer advanced PSS in an ecosystem, competing actors need to cooperate to achieve the common goal of the customer. For instance, SMEs and their partners need to cooperate to integrate equipment and systems into the customer’s processes by sharing capabilities and knowledge. However, when engaging in a new value proposition, each actor seeks to maximize their value, and actors consider their capabilities and knowledge as competitive resources (Molm, 2003). Consequently, actors are unwilling to share their resources unless it favours them (Kamalaldin et al., 2021). If firms in an SME partner network are over cooperative, they may not capture enough value to survive, but if firms are over-competitive, the value proposition may not work out (Ozcan & Santos,

2015). A situation where actors are simultaneously balancing cooperation and competition is referred to as 'coopetition' (Bengtsson & Kock, 2000), which this study proposes as a requirement for the introduction of an advanced service proposition by SMEs.

However, the success of a service proposition is not only dependent on the cooperativeness of other actors in the ecosystem but also on the willingness to accept another firm taking the lead and their respective role as a follower. Research indicates that a leadership role in a service ecosystem should be subject to having the necessary capabilities such as service routines, customer knowledge and relationships, and service employees to enable the implementation (Kamalaldin et al., 2021). If SMEs have the necessary capabilities and resources, other ecosystem actors tend to accept and trust the leadership of the SME, even more so if they have existing relationships (Kamalaldin et al., 2021). Although existing relationships can help in taking a leading role, it is not a necessary condition, as it can be compensated by outstanding network capabilities to convince other actors of its leading capabilities (Kamalaldin et al., 2021). The roles and bargaining power of the actors in the ecosystem seem to be independent of the ability to capture value in the ecosystem which gives SMEs, with generally lower bargaining power, the same ability to capture value as larger firms (Adner & Kapoor, 2010). However, research has shown that cooperation with actors in the ecosystem is more difficult when actors are asymmetrical in firm size, financial resources, internal working environment, and complementary management styles (Brouthers et al., 1995). This makes it harder for SMEs to take a leading role in advanced servitization efforts since they generally are not symmetrical with other actors in their network regarding their size and financial resources (Gebauer et al., 2010).

Recent research suggests that prioritizing the ecosystem as part of the business strategy is a key factor in achieving organic growth. Firms can prioritize their marketing ecosystem by focussing on two main activities; building ecosystems in proximal and distal networks, and fostering integrated ecosystems (Homburg et al., 2020). Firms can build ecosystems by forming systems of relationships within and outside the supply chain (i.e., vertical and horizontal relationships), and beyond the firm's horizon to create new opportunities unrelated to the current business (Homburg et al., 2020). Fostering integrated ecosystems includes all activities related to steering, guiding, and connecting the firm's systems of relationships such as the development of organizational governance units (Homburg et al., 2020). By prioritizing the ecosystem, SMEs can shape their ecosystem and therefore, acquire resources, new opportunities for partners, and steer ecosystem relationships for the provision of advanced PSS.

In conclusion, actors in SME networks are likely to be asymmetrical regarding firm size and management goals. An ecosystem that is characterized by cooperation will ease the transition towards

advanced PSS since it can allow SMEs to take a leading role in service provision. Moreover, SMEs that prioritize their ecosystem by, building proximal and distal networks, and fostering integrated ecosystems will be more capable of building relationships with possible service partners for the provision or development of advanced PSS.

Therefore, this study proposes the following theoretical propositions:

*TP1: An ecosystem that is symmetrical will ease the transition towards advanced PSS for SMEs.*

*TP2: An ecosystem that is characterized by coopetition will ease the transition towards advanced PSS for SMEs.*

*TP3: SMEs will need to prioritize their ecosystem to acquire necessary resources and steer ecosystem relationships to transition towards advanced PSS.*

#### 2.1.2.2. Network capabilities

This study will adopt the view of Walter et al. (2006), who defined the construct of network capabilities as “a firm’s ability to initiate, maintain, and utilize relationships with various external partners”. Additionally, the construct encompasses the following dimensions: coordination, relational skills, partner knowledge, and internal communication. This definition is consistent and all-inclusive with the literature on network capabilities, network competence, alliance capability, alliance competence, and other related constructs (Kohtamäki et al., 2013).

As SMEs have limited competencies and legitimacy to form ecosystem relationships (Senik et al., 2011; Su et al., 2020), network capabilities will be crucial for SMEs to acquire the much-required external resources in exchange relationships by facilitating access to a larger resource network (Ritter & Gemünden, 2003). Moreover, a higher level of network capabilities will improve the firms’ position in the network, and it provides a superior ability to manage key relationships (Ritter & Gemünden, 2003). This is important for SMEs since smaller firms generally possess lower levels of perceived legitimacy than larger firms, making it harder to secure a strategic position in the business network that provides opportunities for complex service offerings (Stuart, 2000). Network capabilities are less important for large firms as they are generally not relying on external resources such as finance and capabilities since they are able to set up separate service organisations and develop capabilities in-house (Baines et al., 2009; Baines & Lightfoot, 2014).

The level of network capabilities that SMEs require depends on the complexity of exchange processes (Windahl & Lakemond, 2006). Offering simple services, where the exchange process is relatively



straightforward and external partners are not needed, does not require the same level of network capabilities as more complex services where services and products are bundled as integrated solutions and require external partners with reciprocal adaptation (Kohtamäki et al., 2013). Yet, prior research (e.g. Kowalkowski et al. (2013)) did not focus on the levels of network capabilities that are needed for SMEs, and only reported cases with moderate levels of service complexity.

Network capabilities, however, consist of four dimensions (coordination, relational skills, partner knowledge, and internal communication) (Kandemir et al., 2006; Wales et al., 2013). Each dimension will play a different role in the service exchange process and therefore will require different levels based on the PSS and customer expectations. The dimensions are discussed below.

Coordination refers to boundary-spanning activities which connect firms to other firms and connects different individual relationships into a network of mutually supportive interactions (Walter et al., 2006). As SMEs transition from basic to advanced PSS the amount of external resources that are required increases (Kowalkowski et al., 2013). Therefore, SMEs will need a higher level of coordination to connect to partners if they want to advance their PSS level. Coordination facilitates knowledge sharing that reduces knowledge asymmetries which enables the firm to determine the needs of their partners and influence their loyalty, commitment, and value experience (Kohtamäki et al., 2013). When service exchanges are simple, knowledge symmetries are smaller and less likely and therefore coordination is less required. When service exchanges are complex a higher need exists for coordination.

Relational skills encompass the ability to respond to a broad range of information and social stimuli from inside and outside the organization and it included skills such as conflict management, communication, extraversion, self-reflection, and cooperativeness (Marshall et al., 2003). For SMEs, relational skills are required to manage the extensive amount of cooperation and information exchange with partners that are needed to provide advanced PSS. A high level of relational skills will enable SMEs to develop close relationships with customers and partners, better understand their requirements through open dialogues and increase trust, commitment, and loyalty, which are critical factors to customer value creation in complex service offerings (Kohtamäki et al., 2013).

Partner knowledge is organized and structured information about an organization's upstream and downstream partners (e.g. suppliers and customers) and competitors. As SMEs require a network of partners to provide more complex PSS, a high level of partner knowledge enables SMEs to shape appropriate exchange routines and governance structures to avoid and handle instabilities in their partnerships (Das & Teng, 2000). Moreover, partner knowledge increases the lower position of SMEs

in the value chain by reducing transaction control costs and improving solution-oriented conflict management (Kohtamäki et al., 2013).

*Internal communication* is the assimilating and disseminating of up-to-date information on partners, their resources, and agreements with them to all involved departments (Walter et al., 2006). It helps to avoid miscommunication and redundant processes as well as improve the detection of synergies between partners (Cohen & Levinthal, 1990). Partner knowledge about SMEs' network of partners must be communicated within the firm to stimulate innovation, and to enable the co-production of service and solution offerings (Kohtamäki et al., 2013).

To conclude, SMEs need a high level of network capabilities, to facilitate the offering of complex services and products as integrated solutions, to co-design and integrate customer resources, to select and manage their required network of partners, and to ensure the service corresponds to customer needs (Kohtamäki et al., 2013). Moreover, SMEs with sufficient network capabilities will continually monitor customer needs and competitor actions, while disseminating this knowledge throughout the organization and within the supplier network which can exert a positive non-linear effect on sales and service growth (Kohtamäki et al., 2013). With a high level of network capabilities SMEs can acquire access to a larger resource network (Ritter & Gemünden, 2003) which is needed for advanced PSS.

Therefore this study proposes the following theoretical proposition:

*TP4: To successfully transition towards advanced PSS, SMEs need a high level of network capabilities across all its dimensions to gain access to a larger resource network and to maintain and utilize the partner network to facilitate the offering of complex services and products as integrated solutions.*

#### 2.1.2.3. Digitalization and digital business capabilities

In recent years, the notion of digitalization has become a priority for the majority of firms across industries (Kane et al., 2018). Digitalization can be defined as: *"the use of digital technologies to change a business model and provide new revenue and value-producing opportunities"* (Gartner, 2021).

The combination of digitalization and servitization presents SMEs with new opportunities for advanced service offerings as it can enable services like remote monitoring of assets, automation of production, design activities, information and communication technologies (ICTs) for customer relations management, and data communication (Coreynen et al., 2017; Grubic, 2018). A recent digital technology that is considered a key element of digitalization in manufacturing is called the industrial internet of things (IIoT). IIoT can be described as the concept of connecting any industrial device to the internet and to other devices to create a network of connected things and people

which collect and share data about their environment and usage (IBM, 2016). IIoT allows SMEs to gain knowledge about how customers are using their products as a massive amount of data can be generated by relatively inexpensive sensors and actuators, and can be stored, accessed, and analysed easily due to cloud computing technologies (Hashem et al., 2015). With this information, it is possible to monitor, optimize and automatize products remotely and globally (Porter & Heppelmann, 2014), and it gives SMEs the option to offer effective preventive and proactive maintenance (Suppatvech et al., 2019).

Digitalization is especially important for SMEs that want to deliver advanced services since the costs of scaling and producing digital services are relatively small, and remote monitoring and maintenance removes the need to set up service units in different countries (Suppatvech et al., 2019). Moreover, digitalization offers SMEs the ability to achieve closer and better proximity to their customers and therefore reshaping their value chains, increasing the relative dependence of upstream firms on downstream firms, giving more power to SMEs (Vendrell-Herrero et al., 2017). Therefore, digitalization can remove barriers in SMEs' servitization transition, levelling the playing field between SMEs and large firms. By using digitally enabled service propositions, SMEs can reduce operating costs, maintain long-term relationships with customers, extend current business, gain global presence, improve PSS, and gain a competitive advantage (Suppatvech et al., 2019).

Although digitalization can present enormous advantages for SMEs in advanced service offerings and the design of innovative PSS, it can radically affect the value proposition, up-and downstream relationships, and the business model (Laudien & Daxböck, 2016). Consequently, the implementation of digitalization is challenging, as more than 80% of digital business transformations result in losses or fail to provide the expected performance (Deakin et al., 2019). Digitalization of manufacturing requires close collaboration with different stakeholders, new ways of customer interaction and the ability to leverage data created by IIoT (Suppatvech et al., 2019; Urbinati et al., 2019). Evidence suggests that many companies lack the capabilities to utilize and capitalize on the collected market data (Ehret & Wirtz, 2017). Especially SMEs generally lack a comprehensive digitalization strategy (Schröder, 2016), have a lack of understanding of the value of digital technologies and the effect on their business performance (Cenamor et al., 2019), and are dependent on external digital competence (Wang & Rusu, 2018). Therefore, the question remains if SMEs are capable of pursuing a digital servitization strategy to transition towards advanced PSS.

If SMEs want to effectively manage digital business transformations, such as digitalization, they will need a superior digital business capability (DBC) (Wielgos et al., 2021). DBC comprises three complementary capabilities: digital strategy, digital integration, and digital control. This study argues

that the ability to integrate digitalization and servitization should be related to a firm's digital business capability since it gives firms the ability to effectively manage digital business transformations (Wielgos et al., 2021). In addition, a superior DBC is more valuable in organizations with fluid and non-routinized processes (Wielgos et al., 2021), such as SMEs.

The three complementary factors (i.e., digital strategy, digital integration, and digital control) that compromise DBC are discussed below.

Digital strategy can be defined as *'the degree to which a firm aims to create new forms of value for itself, its customers and its partners through combinations of digital technologies'* (Wielgos et al., 2021). An excellent digital strategy should encompass the following elements: First, digital strategy should be regarded as a stand-alone firm-level strategy that encompasses multiple business functions such as marketing, sales and IT (Yeow et al., 2018). Second, a digital strategy should be market-based with a primary focus on the customer (Chanas et al., 2019). Third, a digital strategy should combine digital technologies to create new types of value such as digital services or products (Bharadwaj et al., 2013).

Digital integration: can be defined as: *'the degree to which a firm establishes linkages that coordinate organizational processes within and across its boundaries to deliver new forms of value through combinations of digital technologies'* (Wielgos et al., 2021). Firms should digitally integrate their internal business processes such as product and service development, customer relationship management, and supply chain management, to be able to serve customers in a more individual way (Srivastava et al., 1999). Moreover, firms should interconnect digitally with customers, partners, and suppliers by engaging in value networks such as digital platforms to deliver new forms of value (Rangaswamy et al., 2020).

Digital control: can be defined as: *'the degree to which a firm specifies, monitors, and evaluates formal procedures and systems that use information to maintain or alter patterns in organizational activity to appropriate new forms of value through combinations of digital technologies'* (Wielgos et al., 2021). First, firms should establish a few key performance indicators (KPIs) which are aligned with the firm's digital strategy and are shared within multiple functions of the organization to assess how well the firm creates value through digital business changes. Second, control systems should be used to sense and respond to changing market requirements to ultimately gain performance (Verhoef et al., 2021).

In summary, digitalization present SMEs with new opportunities to provide advanced PSS (Grubic, 2018). These digital technologies are globally scalable, relatively inexpensive, and give direct access to customers' equipment (Hashem et al., 2015; Porter & Heppelmann, 2014). Therefore, it gives SMEs, the opportunity to be present on a global scale without the need for large capital investments, and increase their position in the value chain by removing the need for intermediaries (Laudien & Daxböck, 2016; Suppatvech et al., 2019; Vendrell-Herrero et al., 2017). This allows SMEs to provide advanced PSS. However, digitalization is challenging and only SMEs with a superior DBC will be able to integrate these digital technologies in advanced PSS.

Therefore, this study proposes the following theoretical proposition:

*TP5: Digitalization of the PSS removes barriers for SMEs to transition towards offering advanced PSS. To successfully manage the digitalization of their PSS, SMEs need a superior DBC.*

To conclude on this theoretical background, the theoretical propositions are shown in Table 3. The theoretical propositions will form the basis of the case studies.

*Table 3 Theoretical propositions*

Theme	Theoretical Proposition
Ecosystem symmetry	<i>TP1: An ecosystem that is symmetrical will ease the transition towards advanced PSS for SMEs.</i>
Ecosystem competitiveness	<i>TP2: An ecosystem that is characterized by cooptation will ease the transition towards advanced PSS for SMEs.</i>
Ecosystem priority	<i>TP3: SMEs will need to prioritize their ecosystem to acquire resources and steer ecosystem relationships to transition towards advanced PSS.</i>
Network capabilities	<i>TP4: To successfully transition towards advanced PSS, SMEs need a high level of network capabilities across all its dimensions to gain access to a larger resource network and to maintain and utilize the partner network to facilitate the offering of complex services and products as integrated solutions.</i>

Digital business capabilities

*TP5: Digitalization of the PSS removes barriers for SMEs to transition towards offering advanced PSS. To successfully manage the digitalization of their PSS, SMEs need a superior DBC.*

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### 3. Methodology

#### 3.1. Research method and case selection

This study employed an exploratory and qualitative multiple case study (Yin, 2014) of SMEs in the manufacturing industry that were involved in servitization transitions. In particular, the study aimed to investigate how SMEs transition from basic to advanced PSS and how they utilize their network, ecosystem, and digitalization capabilities, and what the role of the ecosystem conditions is in this transition. This approach was used because relevant behaviour cannot be manipulated and the boundaries between the phenomenon of interest and the context are not clear (Yin, 2014). Because it was not possible to conduct a longitudinal study due to the limited time frame, this study tried to replicate the longitudinal effect by adopting a multiple-case study approach with SMEs in different stages of the transition towards advanced PSS. Through this approach the study will be able to draw evidence from more than one unit of analysis to add both breadth and depth to data collection (Yin, 2014).

The study made use of a convenience sample as the case selection criteria were based on the study's research question, their convenient accessibility, and proximity to the researcher (Mason, 2017). Correspondingly, the case selection criteria were as follows: First, SMEs were classified as SMEs if they employed less than 250 full-time-equivalent (FTE). Second, case selection was based on theoretical sampling (Eisenhardt & Graebner, 2007) such that there was manufacturing SMEs that offered different levels of PSS complexity and thus were in different stages of the transition towards offering advanced PSS. Third, all the selected SMEs were engaged in an ecosystem of multiple actors, including other suppliers, competitors, and customers, that were collaborating in service initiatives.

After confirming their eligibility to be included in the study and their interest to participate, the study focused on ten case companies, in line with the recommendation of four to ten cases for multiple case studies (Eisenhardt, 1989). One of the case companies (Firm I) was found to be ineligible as an SME due to a communication error but was analysed nonetheless for contrasting purposes. The profiles of the case companies can be seen in Table 4.

Table 4 Profiles of case companies

Firm	Employees	Industry/business focus	PSS services	Interviewee function	Other consulted information
A	135-162	Package handling solutions	Remote monitoring, AR/VR support, proactive maintenance, optimization, system integration	After-sales manager	a, c,
B	63- 75	End handling equipment for metal cans	OEE system, remote monitoring, consulting, proactive maintenance, system integration	After-sales manager	a, c,
C	60-72	Packaging equipment	Spare parts, preventive maintenance, automatization	Manager service & maintenance	a, c
D	130 - 156	Dosing & Weighing systems for animal feed industry	Preventive maintenance, spare parts, optimization	Service coordination manager	a
E	35 - 45	Product handling systems	Preventive maintenance, spare parts	Service manager	a
F	55 - 66	Case packing systems	Preventive maintenance, remote monitoring	Service manager	a, c
G	80 - 96	Baling equipment	Preventive maintenance, remote monitoring	Service manager	a
H	100 - 120	Product transport & handling equipment	Corrective maintenance, spare parts	After-sales representative	a
I	>250	Industrial robot supplier and manufacturer	Connected services, consulting	Sales & Marketing manager	a, b, c
J	52 - 63	Conveying and handling solutions	Corrective maintenance, spare parts	Service Sales manager	a

Other: a) official websites including presentations and promotion material, b) online news articles, and c) online media



### 3.2. Data collection

For this study, the primary data source was ten in-depth semi-structured interviews, that lasted between one and two hours, with key decision-makers from nine manufacturing SMEs who were involved in servitization. Informants were either directly involved in the development and delivery of the service offering; decision-makers involved with servitization strategies or experienced in key service-supporting functions (e.g. marketing, sales), such that they had profound knowledge about the servitization process.

Informants were asked open-ended questions with the support of an interview guide which was based on the theoretical propositions (see Table 8 in appendix A). In-depth and open-ended interviews are effective as it enables interviewees to integrate individualized knowledge and background in the interview (Wagner et al., 2010). To increase independent scrutiny the interview guide was discussed with an independent researcher. Moreover, interviewees were ensured confidentiality to improve the accuracy of their answers. All interviews were recorded and transcribed, and interview transcripts were used as the main basis for data analysis. The interviews were transcribed intelligently such that it excludes pauses and cleans up grammar.

During the interviews, data on the study variables (servitization transition, PSS level, network capabilities, ecosystem capabilities and conditions, and digitalization and digital business capabilities) was collected. With support from online media (see Table 4) the study used different data sources that allowed for triangulation for internal validity (Yin, 2014). Before the interviews, each case was familiarized by studying the firm's website and consulting online media featuring the firm in question.

### 3.3. Data analysis

Each interview was audio-recorded, transcribed, and coded using NVivo (QSR International) software. Transcripts were coded axially with the support of a coding template. The coding template is part of the template analysis. The template analysis consisted of developing an initial coding template which summarizes important 'a priori' themes derived from the theoretical background (King et al., 2018). The initial coding template can be seen in Table 5. After every interview, preliminary findings were weighed against existing theories on servitization, digitalization, network capabilities, and ecosystems, to systematically find any deviations from the proposed study variables (Dubois & Gadde, 2002). Therefore, the analysis is iterative, such that the initial coding scheme can be adapted during the analysis if necessary. Once a final coding scheme was defined, all transcripts were coded to it, and the template served as a basis for the interpretation of the findings (King et al., 2018). The iterative deductive and inductive approach was chosen to increase reliability and validity.

The final coding scheme can be found in Appendix B. In total 281 relevant quotations were identified.

After coding, first, a within-case analysis was performed to get in-depth knowledge of each case before identifying common themes among the cases. The within-case analysis depicts the servitization process of each SME with their corresponding challenges, capabilities, and ecosystem conditions. The analyses were given to the case respondents to ensure the accuracy and validity of the findings. Next, a cross-case analysis was made using a pattern-matching logic (Yin, 2014). Such logic compares the pattern based on the findings with the pattern that was suggested in the literature review. If empirical and predicted patterns appeared to be similar, the results help to strengthen their internal validity (Yin, 2014). The pattern matching logic was supported by the template analysis. Last, to conclude and summarize on the cross-case analysis, this research presents a servitization maturity model for SMEs. The maturity model represents a theory of how SMEs can evolve in a stage-by-stage manner along a logical path (Röglinger et al., 2012). Especially SMEs can benefit from an assessment of their current capabilities and emergent gaps that can be provided by maturity models due to their limited experience and resources (Mittal et al., 2018). The maturity model was divided in three stages in the transition towards advanced PSS; basic PSS, intermediate PSS, and advanced PSS. The level of advancement is defined by the services included in the PSS. Basic PSS are PSS with base services, intermediate PSS are PSS with intermediate services, and advanced PSS are PSS with advanced services. The cases will be classified according to the highest level of service they offer. The level of service is based on the classification in the coding scheme (see Table 5).

*Table 5 Initial coding template*

<b>First-order category</b>	<b>Second-order category</b>	<b>Third-order category</b>
PSS level	Basic services	Repair, corrective & preventive maintenance, spare parts
	Intermediate services	Remote monitoring, help desk, training
	Advanced services	Optimization, consulting, proactive maintenance, system integration

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Servitization transition challenges	Internal challenges  External challenges	Lack of resources Lack of capabilities Lack of organizational commitment Customer value Data security Customer trust Perceived legitimacy Intermediaries
Network capabilities	Coordination Relational skills Partner knowledge Internal communication	
Digitalization	Digital business capability  IIoT	Digital strategy Digital integration Digital control Remote monitoring Global scalability Traceability
Ecosystem conditions	Ecosystem symmetry Ecosystem cooperativeness	Asymmetry effect Competition Cooperation Coopetition
Ecosystem priority	Building ecosystems in proximal and distal networks  Fostering integrated ecosystems	

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#### 4. Analysis and results

In order to depict the transition from basic to advanced PSS in SMEs and what is needed for SMEs to advance their PSS, the results are grouped on the level of PSS advancement.

First, the within-case results are described for cases with basic, intermediate, and advanced PSS. The within-results depict the servitization transition of the cases with the corresponding challenges, capabilities, and conditions. Specifically, the results will focus on network capabilities, ecosystem priority and conditions, digital business capabilities, and the effect on the servitization transition within the SMEs.

Second, the cross-case results will conclude on the results of the within-case by summarizing the level of capabilities and conditions during the transition in PSS advancement. The level of capabilities (i.e., low, medium, high) is determined by the number of statements that hold for the researched constructs: network capability (Walter et al., 2006), ecosystem priority (Homburg et al., 2020) and digital business capability (Wielgos et al., 2021). If less than a third of the statements hold, the capability level will be scored as low. If at least a third and not more than two-thirds of the statements hold, the level will be scored as medium. If more than two-thirds of the statements hold, the level will be scored as high. The statements of the constructs can be seen in Appendix C.

Third, the servitization maturity model for SMEs is presented. Based on the cross-case analysis, the model shows which capabilities are needed for SMEs to transition to a certain level of PSS advancement.

The one case (I) that was found to be ineligible cannot be compared to other cases in the study. Despite this, the case was analysed and results were taken into consideration for the cross-case analysis.

## 4.1. Within-case analysis

### 4.1.1. Basic PSS

#### *Firm E*

Firm E produced transport and product handling equipment, such as conveyors. The firm offered spare parts and preventive and corrective maintenance on their equipment. However, this was still reactive and on request. Thus, firm E did not offer service contracts to their customers. The firm was developing its basic PSS by transitioning from reactive maintenance to preventive maintenance, which was necessary for their customers, as customers of firm E produce 24/7 and the equipment of firm E is critical in the production process of its customers. The equipment of firm E is complex due to the amount of software, settings, and parameters. This led to, customers of firm E not being able to solve a breakdown by themselves which led to downtime of the whole production process. Therefore, an adequate service solution was necessary to support their customers. Firm E hired a service manager to set up a service department within the firm. The service manager was mainly concerned with contract management, to make sure customer needs are met and employees of firm

E are available when the customers need them. To do this, the service manager created new employee functions and tried to set up communication protocols between departments.

However, to transition to preventive maintenance, several challenges would need to be dealt with. First, the roles and responsibilities were not clear and departments within the organisation were not collaborating adequately to provide service. The information flows between departments were not set up accordingly and there were no systems in place to facilitate these information flows. Second, the firm was struggling with the availability of personnel, as the service manager said:

*'You need to organise and facilitate for providing services, but you also need the people that execute it. There lies a great challenge to strengthen our team. Now you just have to see who is available and it is by luck if someone wants to work during the weekend. You could coordinate this. To build a service department you need to right people that are passionate about further developing it. That means we need to drop other work, or we need to recruit new persons that fill in that gap.'*

Third, firm E was still lacking efficient service processes as service engineers were still doing their work on paper which would need to be passed on through the whole organisation. Fourth, employees of firm E were lacking the necessary capabilities and knowledge to provide PSS. The knowledge about the equipment was concentrated among a few employees and they were lacking time to spread this knowledge throughout the organisation. Furthermore, firm E had difficulties managing relationships with customers since they did not inform them promptly about service issues and proper agreements were not in place, which caused regular discussions with customers. Since firm E was mainly doing business with large multinationals which accounted for a major part of their revenue, it was of great importance to build trust and manage these relationships according to the service manager:

*'If you sold to a big firm, you could see it at multinational X; doors open, that is the effect you get. If you say that is easy; no, that is hard work because trust is hard to earn but easy to lose. So, if you do not fulfill your agreement, which can happen with engineering, you need to make sure you manage and solve the issue as quickly as possible. If you do not, it has a big impact on other customers if one large firm labelled you as unreliable.'*

For the offered basic PSS, no external partners were required. However, the service manager of firm E expected to need external partners if the firm wanted to offer intermediate PSS. First, the service manager of firm E expected to need IT partners to develop their EPR system to use it more efficiently. Second, he expected to need a partner to construct a vehicle fleet for their service engineers. Third, the service manager would need large customers to sign long-term contracts, so

the firm had enough resources to set up the service organisation. Fourth, firm E is looking into acquiring consultancy by graduates to improve their knowledge of processes such as digitalization.

Regarding its capabilities and conditions, Firm E possessed a low level of network capabilities as the firm lacked boundary-spanning activities that connected the firm to other firms. Furthermore, internal communication was still an issue within the organization and the service manager was not informed about partners. Because the firm's service department was not yet developed they had difficulties solving problems with their partners and could not build good personal relationships with business partners because there was no time available within the organization. Therefore, the low level of network capabilities hindered the transition towards intermediate PSS.

Firm E's ecosystem could be characterized as asymmetric as the firm's customers were mostly large multinationals. Firm E sold their equipment either directly to these large multinationals or to system integrators who would integrate their equipment at the end-user. The sales of their services were more difficult when their equipment would be sold through system integrators because the firm did not have an influence on what the system integrator would sell to the end-user. Moreover, firm E's ecosystem was competitive and there was no cooperation possible between competitors. However, the service manager indicated that the asymmetry and competitiveness this was not hindering the provision or development of the PSS. Furthermore, the firm did not have an ecosystem priority as they did not create new proximal and distal networks and they did not try to foster integrated networks, although they were in the process of prioritizing their ecosystem.

Firm E's digital business capability was low since there was no digital strategy and there was a lack of digital tools that created value for the service provision. Moreover, the firm was not digitally connected to partners or platforms and there was no digital monitoring of service performance.

#### *Firm H*

Firm H produced transport and handling equipment, like firm E. Firm H offered corrective and preventive maintenance and spare parts of their equipment. However, contracts were only offered on request and the firm is not planning to expand the service organisation and proactively offer service contracts. For the current services, no external partners are needed. Firm H developed their service by structuring internal processes and transforming analogue into digital processes. However, the level of digitalization is still low, as a large part of the service is still documented on paper, which was challenging during the COVID pandemic according to the after-sales representative:

*'From the past, it remains difficult to find certain product drawings. We come across items that have not been replaced for a long time, so the drawing is still on paper. Therefore, we cannot work from home during the COVID pandemic because we need our paper archive. However, those are things*

*that do not happen that frequently that it requires us to transform these items to 3D drawings, and there is also no time for this, unfortunately.'*

Firm H kept focusing on internal process improvements and the sales of projects. The sales of services would remain reactive and only on request. Therefore, firm H did not have specific servitization challenges.

Regarding the firm's capabilities and conditions, firm H had a moderate level of network capabilities as the firm had good relational skills with strong relationships and the ability to solve problems effectively. However, the firm was not informed about competitors and information was not exchanged adequately throughout the firm.

Firm H's ecosystem could be described as cooperative, as firm H collaborated with competitors regularly by working together on projects and providing spare parts when required by a competitor. The firm's ecosystem was asymmetric because it had large multinationals as customers as well as local craftsmen as suppliers. However, this did not affect their service development or provision other than that they had to adapt their relational approach with different customers and suppliers. The firm had no ecosystem priority as they did not create distal and proximal networks.

Firm H's digital business capability was low since they did not make use of digital tools to create value for their customers and there was no digital strategy in place. In addition, most internal processes were not digitalized and the firm was not digitally connected to partners.

#### *Firm J*

Firm J produced transport and product handling equipment, such as conveyors, for the can manufacturing industry. Firm J is offering corrective maintenance and spare parts of their equipment and wants to transition towards intermediate PSS in the short-term and advanced PSS in the long-term. The transition towards intermediate PSS is initiated by both the firm as well as customers that ask for preventive service contracts. For the provision of the current services, no external partners were required as it was relatively basic. However, the transition towards intermediate PSS is challenging for firm J as they have limited resources according to the service sales manager:

*'If we want to offer these preventive maintenance contracts, we need an x amount of service engineers so you can draw from a pool of service engineers of which you can say: 'Ok tomorrow you need to go there and there'. You always need to have someone available when necessary. That is our biggest challenge now. We have too few service engineers. Another thing is knowledge. For everyone this is a new approach so you will need to grow. The knowledge about the equipment is there but we*

*do not have the knowledge to put it into the market. We need to retrieve and exploit that knowledge out of people that have experience with this transition.'*

Moreover, for firm J it is difficult to offer service globally since the lack of global presence on a physical and digital level makes it that the firm will need to travel and accommodate for every service visit which is expensive for their customers. Therefore, distant customers of firm J are inclined to hire local service firms. The service sales manager at Firm J expressed the need for expansion of the service department. However, the priority of the firm was on bringing in and maintaining important key customers and bringing in large projects from those key customers, instead of focusing on the service department. Firm J wanted to servitize to capture more value and differentiate themselves from competition. However, for firm J it is challenging to prioritize servitization due to the market circumstances, according to the sales manager:

*'There is a big demand for new projects. The number of firms that are capable to fulfil the demand is smaller than the total demand. There are more projects than suppliers so at this moment it is not a problem there are competitors, but everyone has the same issue, that is delivery time. None of the suppliers can meet the delivery time because they are occupied with projects so the customers will need to be patient.'*

Regarding firm J's capabilities and conditions, the firm had a moderate level of network capabilities since they had good relationships with customers and suppliers and were able to solve problems and discussions adequately. In addition, firm J was informed about partners, although this was not being discussed and communicated internally. Moreover, internal communication protocols between departments were not set up which resulted in miscommunication and mistakes in the engineering process.

Firm J's ecosystem could be described as co-competitive since competitors of firm J could also be partners in several projects. Therefore, there was a need to cooperate and collaborate with competitors. The firm's ecosystem was asymmetrical as customers ranged from local craftsmen to large multinationals. The ecosystem competitiveness and asymmetry did not affect their service provision or transition. Firm J had to adapt their relational approach with large customers but the demand was high so they were still able to deliver its services without any difficulties. The firm did not prioritize its ecosystem although it had a network of sister companies that could provide them with the necessary knowledge and capabilities in service provision or development.

Firm J's digital business capability was low since they did not make use of any digital tools to support their service provision or development and there was no digital strategy to further digitalize the



firm. Furthermore, the firm had no digital control over its performance and the digital tools were not interconnected throughout the firm. For firm J the low level of DBC was hindering the transition towards intermediate PSS as the firm's service processes were inefficient and time-consuming because there were no digital systems in place.

#### 4.1.2. Intermediate PSS

##### *Firm C*

Firm C produced packing systems and offered corrective and preventive maintenance, spare parts, a 24/7 hotline, and automation of their equipment in production lines. The firm transitioned towards intermediate PSS due to demand from large customers. To keep large customers satisfied and to meet the market demand, they extended their PSS by developing a 24/7 hotline. Firm C was transitioning towards advanced PSS with predictive maintenance, enabled by the IIoT. However, due to the rapid growth of the firm, it was challenging to remain organized. Therefore, the firm was in the process of evaluating its internal processes, mainly the use of its digital systems and coordination of information flows, and the selection of new suppliers and partners for their systems, as Firm C had many systems in place that were not integrated adequately throughout the firm according to the service manager:

*'Currently, we are busy keeping up with the growth and organizing it adequately. Last and this year we are focusing on this because we grew very rapidly, so now we are busy reviewing what systems we are working with and how to coordinate all the data and calls that come in, and how to utilize this.'*

Another challenge for firm C was the knowledge of their service employees. Because firm C had a wide variety of equipment, all service employees were required to know the full range of machinery. Educating all the service employees was challenging and time-consuming, especially because there was a large influx of new employees due to the growth of the company. Additionally, the COVID pandemic caused that service engineers were not able to be trained at the customers' site with operational equipment. Therefore, experienced engineers had to train new employees which resulted in a larger lack of resources. Moreover, due to the wide range of equipment firm C was selling, they needed spare parts from many suppliers, and for some parts the delivery time was high. Thus, there was a logistical challenge to get the right parts at the right location at the right time. Since customers of firm C were producing 24/7, it was harder to plan preventive maintenance because customers wanted to minimize downtime of their production. Therefore, firm C had to plan preventive maintenance far in advance and mostly at weekends, which not every service engineer wanted. To provide more efficient service, firm C started developing predictive maintenance services with IIoT techniques. Together with a key customer, firm C was developing predictive maintenance

services by analysing and exploiting data of their equipment, which already resulted in a decrease in malfunctions and higher customer satisfaction. To develop and execute the offered services, firm C required several partners. First, firm C required sister companies, that delivered sub-systems for their equipment, to provide them with the right drawings and spare parts. Second, the firm was relying on system integrators to integrate their equipment into customers' production lines and to sell their service offerings. Third, firm C outsourced a part of their IT capacity for the supply and maintenance of its ERP and digital service system, despite the firm having its own IT department. The digital service systems were crucial in delivering the current PSS of firm C as the service manager said:

*'Without our systems, it is almost impossible. Even with these systems it is hard to control. Information enters the firm through random employees whereby you need to know what others are doing and what has been agreed upon. At the moment, you record the information and made agreements, it has to be findable for others. To control that is difficult.'*

Firm C possessed a high level of network capabilities. The firm had good relationships with partners and the partners were selected based on selection criteria which were evaluated regularly. Firm C was able to constructively solve problems and discussions and was informed about customers and competitors. Information from competitors and customers was collected in different departments which would be communicated internally. Firm C utilized their network capabilities to enable the transition to intermediate PSS by creating, maintaining and utilizing a partner network to fill in the lack of resources and capabilities.

Firm C's ecosystem was competitive and competitors did not cooperate or collaborate. This meant that firm C's service level had to meet or exceed the level of its competitors to lock in customers. However, the service manager indicated that the firm had a leading position compared to competitors. Moreover, the firm's ecosystem was asymmetrical since more than three-quarters of its customers were bigger. Firm C did not experience difficulties with their ecosystem asymmetry and even found it easier to deliver services to larger firms, as they work structured, make long-term plannings, and have dedicated budgets for services. The effect of this was that the firm prioritized large customers over smaller customers when they needed service, as larger firms brought in more revenue. Last, although the firm was connected with several sister companies and ICT partners to deliver their PSS, the firm did not create any distal networks and did not foster an integrated ecosystem and therefore did not prioritize their ecosystem.

Firm C had a medium level of digital business capability. The firm had several digital tools that created value for its customers and the firm internally. However, not all tools were interconnected

throughout the firm as departments had different tools that could not be integrated into one tool. Moreover, the firm was not able to connect to partners on a digital level. The firm had a digital strategy to further digitalize the firm's processes and evaluate whether the current digital tools should be replaced by a tool that could be used by all departments. Further, the firm digitally controlled its service performance with several KPIs. Due to the medium level of DBC, firm C was able to create digital systems that enabled the services for the intermediate PSS. However, the firm did not have the data analytics capabilities that were necessary to transition towards advanced PSS.

#### *Firm F*

Firm F produced end-of-line packing systems and offered installation, preventive maintenance, spare parts, and remote monitoring of their equipment. The development of the PSS started 20 years ago by digitalizing its PSS with remote access to their equipment by installing PCs in the control units. With a modem connection the firm was able to access the programmable logic controller (PLC) of the equipment through a telephone line, which gave the firm the option to control the equipment. However, this type of connection was slow and cumbersome. With the technological developments, the firm was able to advance its connections by first using ADSL connections and later VPN connections. With the ability to operate their equipment remotely, the firm was able to solve between 70 to 85 per cent of all malfunctions without having to travel. This was important for firm F since they did not have a global presence and especially during the COVID pandemic, the ability to remotely operate was crucial in delivering their service. The firm wanted to transition towards more advanced PSS with predictive maintenance offerings. Yet, the firm was struggling with the amount of resources to meet customer demands before advancing their service offering according to the service manager:

*'Our customers are struggling to recruit employees for their technical service. Therefore, they outsource more, which we can see in the number of service requests from customers that we have not heard from for years. Moreover, customers are demanding more retrofits to increase their efficiency. You notice that service is becoming increasingly important, and I think it is important to gain control over the customer demand before expanding to something that will bring even more work in.'*

The biggest challenge for firm F to gain control over the customer demand was a lack of personnel. The firm tried to deploy its employees flexibly and tried to fill the gaps with hired workers. This was sufficient to cover the amount of work but was not enough to develop the service department as the service manager said:

*'I think we could double our revenue if we had twice the amount of employees. You can work flexibly within the company but finding people for field service remains a problem. This will remain a challenge for the coming years, knowing that it is hard to find technical employees and to motivate people to work here for those kinds of tasks.'*

Another challenge for firm F was the COVID pandemic since it was harder for employees to travel to customers and the delivery time on spare parts almost doubled which meant that it was harder to plan preventive maintenance. However, these challenges were minor compared to the lack of personnel. For the delivery of the current services, firm F required external service engineers to carry out maintenance on site.

Firm F had a high level of network capabilities. The firm had good and long-lasting relationships with suppliers and customers. Moreover, Firm F prioritized the solving of customer problems in a transparent way. The firm tried to keep customers up to date and involved with developments while solving the problem. In addition, Firm F tried to monitor and analyse competitor information and discuss implications with several departments. Therefore, if firm F discovered improvements in competitors' equipment, they would look for improvements within their concept. Due to firm's high level of network capabilities the firm was able to co-develop their PSS with customers which made the transition from basic to intermediate PSS possible.

Firm F's ecosystem was asymmetrical as its customers differed from small local companies to large multinationals. The asymmetry did not have a large effect on the collaboration process, other than that the firm needed to change its relational approach since larger firms were more formal and were more focussed on financial metrics. Furthermore, Firm F's ecosystem was competitive. There was no collaboration possible with competitors because in the past competitors tried to copy firm F's equipment and spread false rumours about the firm to gain customers. However, the competitiveness did not hinder their servitization process, because Firm F believed to be a market leader in service quality as they said they were quicker, better, and more flexible in offering solutions, especially for older equipment. Firm F tried to build proximal and distal networks by joining different industry platforms. However, this was only on a sales level and the service department was not involved in this. Therefore, the firm did not foster its ecosystem.

Firm F possessed a medium level of DBC. The firm digitalised most front-end processes, such as the remote monitoring service. However, several back-end processes were still documented on paper which prevented the firm to transition towards advanced PSS due to a lack of process efficiency. The remote monitoring service caused some challenges for firm F as some large customers were not accepting other firms to access their network connections. The firm tried to pressure large

customers to let them connect to their network but some of these customers declined. A solution firm F offered was placing SIM cards in their equipment so they would not need the customers' network. However, this was less effective and costly. The firm was in the process of switching to a new digital system where all information flows would be integrated digitally. The firm wanted to develop a digitalization strategy after implementing the new digital systems. With the current systems, firm F was not able to monitor the performance of its services because a lot of processes were still manual. Therefore, firm F could only guess how their service was performing. Additionally, digital information about their equipment was not proactively spread throughout the firm and they did not act upon it. The level of DBC enabled the transition towards intermediate PSS because the firm was able to integrate digital tools in its PSS. However, the lack of digital strategy and digital integration of tools prevented the firm to transition towards advanced PSS.

#### *Firm G*

Firm G produced baling equipment and offered corrective and preventive maintenance, spare parts, remote monitoring, and operator training, for their equipment. Because their equipment was customized for every customer, firm G avoided standard service contracts since every project had different service requirements. Therefore, firm G remotely monitored the number of goods produced by their equipment and tried to predict the wear of the parts. Despite this, customers were approaching the firm to execute service instead of the firm contacting their customers, because firm G was experiencing a lack of personnel. Due to the lack of personnel, the firm was only able to proactively reach out to customers 35 to 40 per cent of the time. Firm G started by offering corrective and preventive maintenance and spare parts, which was coordinated by the sales department. Due to an increase in service demand, the firm set up a service department 18 years ago with 1 person responsible for the coordination of the service activities. During the years the service department expanded from 1 to 4 persons and the PSS was extended with remote monitoring and after-sales training. Especially the administrative part of the service department was improved over those years. Firm G wanted to digitalize their service department and activities to increase work efficiency and improve its service offering. The biggest servitization challenge for firm G was attracting capable service personnel according to the service manager:

*'At the moment we have 8 mechanics that are deployed within the whole company, but we want specific service mechanics. On the one hand, it is challenging to find personnel. On the other hand, it is hard to educate service mechanics because we produce customer-specific equipment. That is a disadvantage of our company. We make so much different machinery that it is challenging to get the right mechanic for the right customer. We have excellent mechanics for machine A, that know nothing about machine B.'*

Because firm G was experiencing a lack of employees it was also hard to provide service globally since the firm had customers all over the world. Moreover, service mechanics did not have time to receive education about new equipment because they were at a customer site most of the time. Therefore, training about new equipment was mostly done over the phone.

Another challenge for firm G was to show customers the value of their service as the firm could not express how much money a customer could save by buying their service. Therefore, multiple customers saw the acquisition of service visits as a necessary evil and some customers even refused the service offering of firm G. Despite customers of firm G not seeing the value of the service provided, the firm did not try to convince customers either, as the demand for new equipment and service was still higher than their capacity.

For the development or delivery of their service offering, Firm G only required partners for the supply of software for their remote monitoring solution.

Firm G possessed a medium level of network capabilities. The firm had good and long-lasting relationships with suppliers and customers and was able to constructively solve problems with them. Moreover, suppliers of firm G were selected on quality as the firm is committed to delivering the best equipment in the market. This meant that firm G was providing equipment for a niche market with customers that wanted to pay more for quality. The firm was reasonably informed about its partners but the information that was collected about its partners was not communicated internally frequently.

Firm G's ecosystem was asymmetrical but that did not hinder their servitization transition. The collaboration process was more formal and impersonal with large firms than with SMEs but larger firms were less restricted in paying for the services offered by firm G. Firm G's ecosystem could be described as cooptation as equipment of firm G could be integrated with competitor's equipment. However, service activities were separated from competition as each firm had its own specialized equipment. In addition, as firm G was producing equipment for a niche market, they were not concerned about competition as market demand was high. Firm G did not prioritize their ecosystem as they did not build and foster distal and proximal networks.

Firm G had a low level of DBC. Firm G digitalized on the front-end with digital tools such as remote monitoring and automation of production lines. However, digitalization on the back-end was still in its infancy, as many of the administrative processes were still on paper. Therefore, digital tools were not interconnected within the firm. The service manager was pushing for further digitalization of the back-end processes and camera systems for their equipment but management did not want to

invest in this. There was no digital strategy and digitalization was also not pushed within the firm. Firm G did not monitor their service performance and was therefore not able to provide customers with service guarantees. The low level of DBC was hindering the development of the firm's PSS as the firm was not able to show the value of its services due to a lack of digital control. In addition, the lack of digitalization caused that it was hard to have global presence and it was difficult stay informed about preventive maintenance.

#### 4.1.3. Advanced PSS

##### *Firm A*

Firm A produced filling and handling packaging equipment for different industries such as infant formula and pet food. Firm A provided training, optimization, spare parts, remote support by phone and by HoloLens, and corrective and predictive maintenance. The services are combined in their 'line care' concept, where customers can buy different levels of 'line care' with different price levels according to how much is included. Firm A developed its PSS because it recognized the limitations of an SME, as the service manager said:

*'Being an SME, you are not able to have local departments or local entities all over the world. However, we do have customers all over the world and we cannot always be there in let's say 12 hours if we have to go there physically. So, we needed a concept that was really strong on remote support. Normally what I tell our customers is, that even though you have a local service provider in the neighbourhood, it will take a couple of hours, or at least 3 or 4 hours before he can be on-site and we can be there within 2 minutes via HoloLens or phone call. That is the competitive part of the service organization.'*

The development of firm A's PSS started in 2017 when the firm created the 'line care' concept. The firm was able to provide training, maintenance and customer support for a while but it was always on request of the customer. With a shift in strategic focus, the firm started developing the line care concept to proactively address customer needs. The concept started with training, maintenance, emergency response, and optimization. Later the firm builds on top of that with the introduction of the HoloLens, remote support and data analysis. The firm was in the process of improving its data analysis capabilities to increase its ability to optimize the efficiency of its equipment and ability to predict the wear of parts. Firm A recognized the importance of PSS as a differentiator, as the firm cannot compete on price as an SME, according to the service manager:

*'It has moved to be a really really big part of the competitive side, especially in terms of cost. We are a European country, and looking worldwide, we are not the cheapest on the market. So we also need*

*something else to bring to the table that is more difficult to buy, and service is a great way to do that.'*

During the servitization process, the firm encountered several challenges. First, firm A had to change its strategic focus and company culture to accommodate for servitization. After proving that the firm could earn a considerable amount of money on services, the strategic view of the firm changed. The service manager tried to change the company culture by showing employees that their work gets easier and more efficient by having a service view combined with a service department.

A second challenge for firm A was the lack of resources and capabilities in the development of the PSS. In the beginning the firm did not have dedicated service employees which meant that they had to work flexibly with employees from other departments to provide the required services.

For the development of the PSS, the firm executed several external development projects funded by the government. The first project was a servitization project where the firm got help from a couple of consultancy companies for 8 months to set up the desired PSS. Another project, also funded by the government, was called 'digital reality', which focussed on the development of the firm's remote support solution. The development projects were also executed with collaborations with key customers with who they could test and improve their solutions.

For the delivery of their services, firm A was dependent on robot suppliers that deliver sub-systems of their equipment. Since the robot suppliers had all the knowledge and expertise about the robots, they had to be involved in the delivery of the service. Therefore, firm A had close collaborations with these suppliers. Moreover, the firm is dependent on software from large industrial software suppliers. However, the software suppliers are not actively involved in the delivery of the PSS.

Firm A had a high level of network capabilities. The firm had good relationships with suppliers and customers and they worked together closely to develop new solutions that could benefit all partners. Customers were involved in an early stage of the manufacturing process and the firm was able to constructively solve problems and discussions. Firm A is informed about partners and communicates this information regularly within the organization. The firm has local agents that were informed about the market and who visited customers regularly. The local agents collected information about partners that was analysed by the business developer of firm A. The high level of network capabilities helped in the transition from basic PSS to advanced PSS by creating a partner network with suppliers and customers that gave access to resources and capabilities that were needed to develop its PSS.



Firm A's ecosystem was asymmetric as 75% of its suppliers and customers are bigger than the firm. On the supplier side, the service manager indicated this was not an issue since the firm was still able to negotiate prices and general terms because they buy a lot of products from these suppliers. On the customer side, their negotiation position is weaker and they need to devote more time and energy to these relationships. However, the firm gains a large part of its revenue in return. Firm A's ecosystem could be described as cooperative as the firm had to collaborate with competitors regularly as the service manager described:

*'We have good cooperation with these competitors and as soon as we have the same agenda, we want to help the customer. We might disagree or we might be in a competitive position but we normally put that behind us, close our eyes, help the customer, support the customer, solve the issue, and then all the discussions can start afterwards.'*

The firm had an ecosystem priority as they build proximal and distal networks and try to foster these integrated networks. The firm continues to build networks in new segments and industries to see if the technology of the firm is applicable in other segments and industries. Additionally, the firm continued to search for externally funded development projects and attracts graduates to do research within the firm.

Firm A had a high level of DBC. The firm had a digital strategy that was part of its business plan which was evaluated regularly. The firm created value internally and externally with new digital technologies such as the HoloLens and remote access to its equipment. In addition, firm A was able to transition towards advanced PSS because the digitalization of their PSS made it able to solve problems more efficiently and on a global scale. The digital tools were interconnected throughout the firm and were interconnected with customers and suppliers. Firm A regularly evaluates its digitalization progress and measures its service performance with several KPIs that are based on digital information from its equipment.

#### *Firm B*

Firm B designed, developed, and manufactured automation equipment for the metal packaging industry. The firm offered a 'support package' to their customers that included several services. First, the support package included a service where firm B collected equipment data and analysed the overall equipment efficiency (OEE) of their machines. With the data, the firm could build a report that was discussed with the customer to optimize their OEE. Second, the support package contained remote support where the firm could connect to the machine and operate and analyse it remotely. Third, the package consisted of a camera solution that could record alarms and malfunctions of the equipment. Fourth, another service included was a module overview that monitored the

performance of the production lines in real-time. Fifth, the package included a traceability system that kept track of and stored data of the can ends manufacturing process such that all products could be tracked. Last, the support package included preventive maintenance and inspection.

The development of the PSS started in 2000 by moving from corrective maintenance to preventive maintenance. Later, in 2008, the firm developed a remote access system to support its customers remotely. After, in 2013, the firm started to focus on digitalization to develop new services and improve the offered services, which led to the introduction of the OEE system. The latest development, which was still in progress, was a digital customer portal to enhance customer relationships.

During the servitization process, the firm encountered several challenges. First, firm B had a lack of knowledge and personnel to develop the new digital service concepts as there were no IT employees within the firm. Second, because the firm had a lack of knowledge about digitalization it was difficult for the firm to run the development projects as they had difficulties making an accurate budget and planning. Third, after introducing the new digital service concepts such as remote access, the firm had difficulties connecting with customers' internet networks as customers were reluctant to let outsiders connect to their networks because of data privacy concerns.

To overcome the lack of knowledge and personnel, firm B required external partners to bring in the necessary knowledge and capacity. This resulted in the firm outsourcing its IT capacity to a great extent. The external partners knew how to develop and maintain the digital service offerings for firm B.

To overcome the data privacy concerns, the firm developed a solution together with their IT partners where customers would store the data produced by firm B's equipment on a local server that could be disconnected at any time. Moreover, the network that was used for remote access was an encrypted connection. Firm B tried to convince customers of the value of their services by comparing the value of the increase in OEE due to their service offerings to the cost of these services as the service manager explained:

*'If you have an OEE of 85% that is world-class, but if we can improve that with 1%, that means a lot more produced products. All the products that these customers produce, they can sell. That consists of a value of course. We tell our customers that if we, with our support services and continuous improvements, can increase their OEE by 1%, they will earn 10x more or 20x more than the costs. Then some customers accept this without any discussion.'*

Firm B had a high level of network capabilities. The firm had good and long-lasting relationships with suppliers, customers, and IT partners, with whom they could constructively discuss and solve problems. The firm was informed about their customers and suppliers and tried to collect data about their competitors by analysing online media and exhibitions. Partner information was analysed as part of the firm's business plan, which was updated yearly. Due to the high level of network capabilities, firm B was able to create a partner network that included key customers and an IT partner to gain access to the necessary resources to transition from intermediate to advanced PSS.

Firm B's ecosystem could be described as asymmetric as most of the firm's customers were bigger than them and most of the suppliers were smaller companies. The ecosystem asymmetry did not have any effect on the collaboration process with suppliers and customers because there is not much competition in the industry and the demand of customers is larger than the firm's capacity. The firm's ecosystem was competitive and there was no collaboration with competitors possible since one of their competitors tried to copy their equipment in the past. However, due to the limited amount of competitors and the large industry demand, the competitiveness did not affect the servitization process of the firm. Firm B had an ecosystem priority as the firm built proximal and distal networks by building partnerships with technology partners and by exploring new industries such as the automotive industry.

Firm B had a medium level of DBC. The firm used multiple tools that created value for their employees and their customers, such as the OEE system and a digital customer portal where all information about the customer and the equipment is stored. However, most of the DBCs come from external partners who are responsible for the development and maintenance of the digital service offerings for firm B. The digital tools were interconnected within the firm in a way that different departments used information that was collected by the digital PSS. Although digitalization was a focus area for the firm, a digital strategy was still in development.

#### *Firm D*

Firm D produced dosing, weighing, and transportation equipment for the animal nutrition and pet food industry. The firm provided a 24/7 helpdesk, remote monitoring, preventive maintenance, and optimization of their equipment. The services were combined in a service level agreement (SLA), in which you could choose different 'levels' according to the needs of the customer.

The firm needed to servitize to match the customer needs according to the service manager:

*'The developments you see during the last years is that our equipment becomes more complex, which means that we get more calls from customers for problems they cannot solve. The second thing we see is that our customers are less knowledgeable, operators are poorly educated, and customers cut*

*back on their technical service. Therefore, they can solve fewer problems independently and they need our services.'*

Firm D started as an automation software company for the animal nutrition and pet food industry and later acquired a firm that made dosing, weighing, and transportation equipment for that industry because the owners of firm D recognized that the equipment could be made 'smarter, better, and faster'. From that point, the firm combined new service concepts with the equipment from the firm they acquired.

The servitization process was difficult for firm D and it was still struggling with the knowledge and capacity of its service employees according to the service manager:

*'We have equipment in the field that is up and running for over 25 years. However, that equipment uses a vastly different technology than the equipment of today. The service engineers need to be familiar with all these technologies but we see that it is almost impossible to unite this knowledge in 1 person. This means that we need to look at different working methods to keep serving all those customers. We are looking to train our service employees in certain specializations so employees have more focused knowledge but that means we need more capacity to cover all specialities we offer. However, as an SME we cannot afford capacity that is not utilized all the time so it remains challenging to organize this.'*

Another challenge for firm D was the COVID pandemic because it was not always possible to send field service engineers to customers. Firm D reacted to this challenge by developing augmented and virtual reality solutions to be able to serve their customers on a global scale without a local presence.

The last challenge in firm D's servitization process was the demands about data security when firm D would have remote access to their equipment. Customers are more demanding in what way a connection would be made with their networks according to the service manager:

*'In the past, we delivered our equipment from A to Z, so we also installed our own software and we made our own connections. Currently, you often see that automation systems are connected to the customer's network which is maintained by their own IT department who make the demands on the type of connection that is allowed.'*

To deliver their PSS, firm D only required a few hardware suppliers but they did not play an active role in the delivery of the service. Because the firm started as an automation software company it had its own IT department with expertise in digital PSS and the firm was able to make its own software that was compatible with every customer's network.

Firm D had a medium level of network capabilities. The firm had good and close relationships with most of its suppliers and customers. However, with some suppliers of sub-systems they had to collaborate and communicate closely, which did not always happen and resulted in fierce discussions which hindered the development of their PSS. However, the firm was able to solve most problems and discussions adequately. The firm was not informed about competitors although the service manager said there was no direct competition as firm D was the only firm that could offer complete equipment with automation solutions.

Firm D's ecosystem was asymmetric. The firm's suppliers were mostly local and small but their customers ranged from local farmers to large multinationals. The collaboration process with large customers was more formal and time-consuming but it was easier to sell PSS to these customers as they had dedicated budgets for it. Firm D's ecosystem was cooperative as competitors could be partners as well and there was a need to collaborate closely with these competitors. Due to the cooperation firm D occasionally had difficulties keeping responsibilities separated between the partners that had to collaborate in the project when mistakes were made. Firm D prioritized their ecosystem by building and fostering networks with other industries, schools, and universities. By opening their firm for students and graduates the firm tried to bring in knowledge and specific capabilities, such as data analytics, that were needed to develop and maintain their PSS.

The firm had a high level of DBC. As firm D started as a software company it had all the necessary expertise in digital business transformations. After the equipment manufacturer was acquired the firm transitioned from basic to advanced digital PSS that created value for their customers and employees. The digital tools were interconnected and used throughout the firm and there was a clear digital strategy in place. The firm used several KPIs to digitally monitor the service performance.

#### 4.2. Cross-case analysis

Table 6 shows the cross-case results with the multiple cases and their respective characteristics in different phases of the transition towards advanced PSS. The scoring of capabilities was based on the statements of the capabilities that held, as explained at the beginning of this chapter.

First, it can be seen that in the transition towards advanced PSS, the need for a partner network increases. Firms offering base and intermediate PSS required hardly any service partners for the development or delivery of the PSS. However, as the complexity of the PSS increased, the firms needed more resources and capabilities such as knowledge, budget, and data analytics capabilities. Consequently, all firms offering advanced PSS required service partners to enable the transition towards advanced PSS.

Second, in the transition from basic to advanced PSS, the level of network capabilities that is required increased. However, besides firm E, all other firms offering basic PSS had at least a medium level of network capabilities. As firms in this study produced customized engineered equipment or had to integrate their offering into customers' production lines, they had to communicate, discuss, and solve problems with customers regularly, which required firms to have a high amount of partner information and a high level of relational skills. However, in the transition from intermediate to advanced PSS, it was required to have a high level of network capabilities, as the firms with advanced PSS needed to be better informed about competitors and customers and needed to communicate this information frequently throughout the organization. This caused their PSS were more focused on creating value for their customers and outperforming competitors. Therefore, the firms offering advanced PSS were able to offer solutions that corresponded with the needs of their customers.

Third, the level of ecosystem competitiveness did not differ in the transition from basic to advanced PSS. Firms indicated that the ecosystem competitiveness did not hinder their servitization efforts. However, all firms in this study operated in ecosystems where market demand was high. Thus, firms did not have to compete for market share.

Fourth, every SME indicated they operated in an asymmetric ecosystem. The asymmetry had effect on the collaboration process with large firms as it was more time-consuming and formal than the collaboration with similar firms in terms of firm size and management style. However, the effect of an asymmetric ecosystem was present in every stage of the transition and it did not hinder the development of their PSS.

Fifth, the results showed that in the transition from basic to advanced PSS the need for an ecosystem priority increased. Firms with an advanced PSS had an ecosystem priority, whereas firms with intermediate and base PSS did not. For firms to transition towards advanced PSS they needed to attract additional resources such as funds, capabilities, and knowledge. Firms that transitioned towards advanced PSS did this by forming ecosystem relationships and looking for opportunities in other industries. Firms with advanced PSS shaped their ecosystem by searching for development projects, industry platforms, technology partners, and education networks. In order to form and maintain these relationships it required the firms with advanced PSS to have a high level of network capabilities.

Sixth, the results show that digitalization and DBC played an important role in the transition towards advanced PSS. SMEs providing basic PSS had a low level of DBC and digitalization which meant that most of their service processes were documented on paper and service mechanics had to travel to

customers abroad for every malfunction. This caused service processes to be time-intensive and mechanics had to waste time travelling, which was challenging for the SMEs because they were already experiencing a lack of resources. Therefore it hindered the transition towards intermediate PSS, as the resource requirements would increase even more. Due to the low level of DBC, the firms were not able to create and integrate digital tools with their equipment and did not have a strategy to do so in place. Firms with a medium level of DBC were able to transition towards intermediate PSS by digitalizing on the front-end with the option to remotely monitor their equipment. This did not only give the SMEs the ability to provide service globally, but the service processes were also more efficient because the firms were able to solve 80 to 90 per cent of the malfunctions remotely by accessing the equipment and changing or resetting settings. Firms C and F, with intermediate PSS, wanted to extend their service offering by further digitalizing their service offering by transitioning toward predictive maintenance. However, both these firms did not have any form of digital integration of in PSS and no digital control over their PSS. Therefore, the firms were not able to interconnect digitally with partners in their network and they did not have a digital strategy or a roadmap to do so. Due to a lack of digital integration and control the firms had difficulties transition towards advanced PSS. Firms that transitioned towards advanced PSS had a high level of digitalization of their PSS and a had a medium to high level of DBC. The firms offering advanced PSS developed their PSS by digitalizing their PSS on the front-end and the back-end which created value for the firm and their partners. Due to the high level of digitalization, the firms were able to provide most of their services globally without the need to set up local service organizations. All firms offering advanced PSS had a digital strategy that aimed to continuously deliver digital product and service innovations. Moreover, the digital strategy was evaluated regularly and was an important part of the business plan which they evaluated regularly. Therefore, the level of DBC was crucial in digitalizing the firms' PSS which enabled the transition from intermediate to advanced PSS.

Table 6 Cross-case results of SMEs

Company	PSS advancement	Required service partners	Network capabilities	Ecosystem competitiveness	Ecosystem symmetry	Ecosystem priority	DBC
A	Advanced	External development projects, Robot suppliers	High	Coopetition	Asymmetry	Yes	High
B	Advanced	IT partner	High	Competition	Asymmetry	Yes	Medium*
D	Advanced	Hardware suppliers	Medium	Coopetition	Asymmetry	Yes	High
<i>I**</i>	<i>Advanced</i>	<i>None</i>	<i>High</i>	<i>Competition</i>	<i>Asymmetry</i>	<i>Yes</i>	<i>High</i>
C	Intermediate	Sister companies, Key customer, IT partner	High	Competition	Asymmetry	No	Medium
F	Intermediate	External service engineers	High	Competition	Asymmetry	No	Medium
G	Intermediate	None	Medium	Coopetition	Asymmetry	No	Low
E	Basic	None	Low	Coopetition	Asymmetry	No	Low
H	Basic	None	Medium	Coopetition	Asymmetry	No	Low
J	Basic	None	Medium	Coopetition	Asymmetry	No	Low

\*Outsourced most IT capabilities.

\*\*Results not taken into account (does not meet SME criterium)



### 4.3. SME servitization maturity model

To conclude and summarize on the cross-case analysis, this research presents a servitization maturity model for SMEs. Based on the cross-case analysis, the model shows which capabilities are needed for SMEs to transition to a certain level of PSS advancement. The maturity model can be used to, assess the current capabilities of a firm, identify desirable maturity levels and provide improvement measures, and benchmark internally and externally (de Bruin et al., 2005). The model can be seen in Table 7.

Table 7 SME servitization maturity model

	PSS level		
	Basic	Intermediate	Advanced
Type of services	Corrective maintenance, spare parts	Preventive maintenance, remote monitoring	Proactive maintenance, optimization, system integration
Service strategy	No deliberate service strategy	Service as value-added	Service as a differentiator
Series of critical requirements that characterize...	... network capabilities		
Coordination	✓	✓	✓
Relational skills	✓	✓	✓
Internal communication	✓	✓	✓
Partner knowledge			✓
Series of critical requirements that characterize...	...ecosystem priority		

Building ecosystems in proximal and distal networks			✓
Fostering integrated ecosystems			✓
Series of critical requirements that characterize	...digital business capabilities		
Digital strategy		✓	✓
Digital integration			✓
Digital control			✓

## 5. Discussion

### 5.1. Conclusion

In the search for greater competitive advantage and to move away from price-based competition, SMEs are transitioning from product to PSS providers. However, this transition is challenging. If SMEs want to develop and offer advanced PSS they need to develop new capabilities and should be aware of their ecosystem conditions (Kowalkowski et al., 2013; Valtakoski & Witell, 2018). Since SMEs generally have limited resources in the form of time and budget, they need to decide what should be developed and focused on. The SME Canline finds itself in a similar situation, where they want to transition towards offering advanced PSS but they are uncertain which capabilities to develop and which ecosystem conditions should be taken into account.

Since prior research did not focus on specific capabilities and conditions needed for SMEs to provide advanced PSS, a multiple case study was carried out to answer the following question:

*What capabilities and ecosystem conditions are necessary for SMEs to transition towards advanced PSS?*

The first sub-question of this study aimed at analyzing the role of network capabilities in the transition toward advanced PSS. To answer this question, theoretical proposition 1 served as a guideline. The role and level of network capabilities were investigated for each case. The results

show that SMEs the level of network capabilities that is required increases when transitioning from basic to advanced PSS. In particular, to transition from intermediate to advanced PSS, SMEs need a high level of network capabilities to be better informed about competitors and customers and to communicate this information frequently throughout the organization to ensure their PSS meets customer needs. Therefore, theoretical proposition 1 holds.

The second sub-question of this study focused on analyzing the effect of ecosystem conditions (ecosystem symmetry and competitiveness) on SMEs' servitization transition. To answer this question theoretical propositions 2 and 3 served as a guideline. First, the firms in this study all operated in ecosystems that were asymmetrical. The ecosystems of the SMEs were mostly asymmetrical on the customer side as they all had customers ranging from local small firms to large multinationals. Although the collaboration process with large customers was more formal and time-consuming, the large customers acknowledged the value of the PSS and had dedicated budgets to acquire services. Thus, theoretical proposition 2 is rejected. Second, the cases in this study operated in ecosystems with different levels of competitiveness and the interviewees indicated that the level of competitiveness did not hinder or ease the transition towards advanced PSS. Therefore theoretical proposition 3 is rejected. A reason why the level of ecosystem competitiveness did not affect the servitization process of the SMEs was that all the firms in this study operated in industries with high demand and a low amount of supply. Moreover, most firms in the study produced at their maximal capacity. Thus, even if the ecosystem was competitive, the firms did not have to compete for their market share and it was not necessary to transition towards an advanced PSS to attract customers or to differentiate from competition.

The third sub-question aimed at identifying the role of ecosystem priority in the transition towards advanced PSS. To answer this question theoretical proposition 4 served as a guideline. The results showed that only the firms that offered advanced PSS had an ecosystem priority whereas the other firms did not. The firms that had an ecosystem priority indicated that they needed to attract additional resources to transition from intermediate to advanced PSS. Firms acquired the necessary resources and capabilities by forming proximal and distal networks. The networks they formed differed from government-funded development projects to university networks, to industry platforms, to collaboration with key customers. Therefore theoretical proposition 4 holds.

The fourth sub-question focused on analysing the role of digital business capabilities in the transition towards advanced PSS. To answer this question theoretical proposition 5 served as a guideline. From the results, it can be seen that firms offering basic PSS did not possess any DBC. When firms transition towards intermediate PSS, they used their DBC to digitalize either the front- or back-end

of their service processes and therefore created value for themselves and their customers by creating more efficient work processes and global presence by enabling remote access to their equipment. However, the firms offering intermediate PSS did not monitor and control the digital business transformation with KPIs and most digital tools were not interconnected throughout the firm. To make the transition towards advanced PSS, SMEs digitalized both the front- and back-end of their PSS, which gave them the option to monitor, automate, and optimize their equipment remotely and globally. The SMEs were able to digitalize their PSS due to a superior DBC as the firms had a digital strategy which was an important part of the business plan, the firms had digital control over their PSS which was measured with several KPIs, and the firms used several digital tools that were interconnected throughout the firm and were connected with partners. Therefore theoretical proposition 5 holds.

## 5.2. Managerial implications

From a managerial perspective, this study presents managers the fact that SMEs can offer advanced PSS regardless of their ecosystem conditions. This implies that the ability to transition towards advanced PSS is mainly dependent on the firm's capabilities.

The results of this research can be used by SMEs to identify which capabilities a firm should develop and which capabilities are already developed. This study offers a maturity model for managers who seek to develop their level of PSS advancement. First, this study defined levels of PSS advancement by categorizing the service complexity that accompanies the product. This offers managers a way to pinpoint and interpret their current PSS, explore future directions for PSS development and consider potential capability barriers along the way.

Second, this study offers insight into how different networks of partners can supply the resources that SMEs need to initiate and further develop their PSS. SMEs that want to develop and offer advanced PSS can form distal networks to access external resources that are not present in the firm. To do this, SMEs should prioritize their ecosystem and invest in their network capabilities to form, maintain, and utilize the required relationships.

## 5.3. Theoretical implications

Prior research on servitization primarily focused on capabilities that large companies need when transitioning from product to PSS provider (Adrodegari et al., 2017; de Jesus Pacheco et al., 2019; Kowalkowski et al., 2013). However, research on servitization capabilities that SMEs need to advance their PSS was lacking. This study is among the first to gather insight into the use of specific capabilities and the effect of ecosystem conditions on the servitization transition of SMEs that want to offer advanced PSS.

This study provides three theoretical propositions to guide the development of advanced PSS in SMEs in the form of a maturity model. The theoretical propositions concern the role and level of network capabilities, the need for an ecosystem priority, and the role and level of DBC. These theoretical propositions are an addition to the existing servitization literature as they can contribute to the development of guidelines and tools that SMEs can apply to support their servitization efforts. Future research can use these theoretical propositions to explore the effect in a quantitative study.

Furthermore, this research complements prior research on servitization in SMEs. First, this study complements Kowalkowski et al. (2013) by not only examining network capabilities as a single capability but also examining the four dimensions of network capabilities and the role they play in the development of advanced PSS. Moreover, this study also examined the effect of ecosystem conditions on the development of partner networks that are needed for SMEs to offer advanced PSS. Second, this study complements Coreynen et al. (2017) by examining the level of DBC to pursue a servitization strategy led by digitalizing the back- and front-end of the PSS. The results show that firms need a high level of DBC to successfully integrate digital tools to develop advanced PSS. In addition, this research adds to the understanding of how IIoT and servitization are intertwined, a relationship that is still being researched heavily (Frank et al., 2019). This study shows that the use of IIoT technologies can decrease servitization barriers for SMEs and enable advanced PSS.

#### 5.4. Limitations and future research

Beyond the contribution to existing literature, several limitations can be noted that call for further research.

First, the objective of this research was to study the transition of SMEs towards advanced PSS. However, the research method was not longitudinal and did not follow the cases over time. Although this research tried to replicate the longitudinal effect by selecting cases in different stages of the transition towards advanced PSS, results could differ in a longitudinal study as it can better establish the real sequence of events and it eliminates the risk of recall bias, allowing more insight in the effect of capabilities and conditions in the servitization transition of SMEs.

Second, the capabilities and conditions examined in this research were not meant to be exhaustive. This study is mostly exploratory and influenced by Coreynen et al. (2017), Gebauer et al., (2010) and Kowalkowski et al. (2013). Therefore, other capabilities and conditions could play a role in SME servitization efforts that have not been addressed in this research. Further research is needed on the importance of other capabilities and conditions compared to the ones investigated in this study.

Third, the firm interviews included only one key informant per firm, mainly because only a few people are responsible for service development in SMEs. Further investigation might include several

layers of management to clarify the role of capabilities and conditions at a tactical, strategic, and operational level.

Fourth, the collection and coding of the data were conducted by a single person. This could be subject to recall bias. Higher reliability and rigidity of this study could be realized if two researchers independently coded the transcripts because this results in higher objectivity of each coding category and it could achieve complementary insights (Eisenhardt, 1989; Yin, 2014).

Fifth, one needs to be cautious when generalizing these results. Despite all cases being SMEs, some of the SMEs were part of a corporate group which could restrain financial barriers and present those SMEs with investment opportunities that other SMEs cannot get. The effect of this was not taken into account. Moreover, all of the cases were B2B OEMs operating in markets with high demand and only a few suppliers. SMEs with different market conditions might need other capabilities and conditions. In addition, the capabilities and conditions investigated in this study can certainly be found in other industries as well, including the chemical and medical industries. However, investigating other industries could also lead to different capabilities and conditions being discovered.

Last, there was no measure of servitization success and the time of existence of SMEs was not considered. SMEs with a longer life could potentially solve more servitization challenges by developing their firm over time. Further research could investigate the servitization process over time and measure the servitization success of SMEs.

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## Appendix A

### Interview guide

The interview guide was used as a road map for the interviewer, providing instructions about what to do and what to say during the interview, ensuring standardisation of the interviews (Emans, 2004). The questions are based on the identified themes in the theoretical background. The structure of the interview guide is based on the four-stage funnel approach (Roller & Lavrakas, 2015). The first stage entails the introduction of the research, the researcher, the interviewee and the protocol. The second stage is used to define the background, context, and service context of the case. In the third stage the, interview starts to focus on the transition path from products to PSS and the accompanying challenges. Finally, in the fourth stage, the interview gained depth about the capabilities and environment that were needed to enable advanced PSS for SMEs. Capabilities discussed in this stage were network and digital business capabilities. The environment focussed on the ecosystem characteristics and ecosystem priority. The used interview guide can be seen in Table 8.

### Interview protocol

#### **Interview instructions**

Two days before the interview, the respondent will have received a confirmatory letter containing the message summarised below:

- Goal of the research: Study on the transition toward advanced services in SMEs
- Questions to be asked
- Organisation responsible: University of Technology Eindhoven & Canline
- Time needed: 1-2 hour(s)
- Study outcomes: will be published within six months from now
- Audio recording: for use by interviewer only
- Anonymity guaranteed

#### **Instructions for the interviewer:**

- Keep to the order of questions as they appear in this interview guide
- Text that is printed *in italics* must be read verbatim; in a calm manner
- Check before beginning the interview whether the audio equipment works
- Note the time directly before asking the first question.

Begin the interview by introducing yourself. Refer to the letter of announcement that was sent to the interviewee. Bring the following points to the attention of the interviewee before asking the first question:

- *The organisation responsible for the research project is the University of Technology Eindhoven.*

- *The project is done in collaboration with Canline (Eersel), which is interested in the topic to be discussed.*
- *The purpose of the research project is to help small and medium-sized enterprises (SMEs) (such as Canline) to successfully make the transition towards advanced service propositions*
- *The questions in the interview deal primarily with past actions undertaken by the firm, and opinions you have about these and similar activities.*
- *The research report will be sent to the University of Technology Eindhoven for the completion of my Master degree in Innovation Management*
- *The final report will be delivered within six months*
- *It is important that the interview will be audio-recorded for transcription purposes. The transcription will be handled in such a way that the interviewee cannot be identified. Only supervisors from the university will have access to it.*
- *The information obtained in the interview will be processed anonymously. Confidentiality is guaranteed. No other members of your firm will ever see the direct answers of the interview.*

*The interview will take approximately 1-2 hours*

*Do you have any questions? (If not, begin the interview)*

Name interviewer:.....

Name interviewee:.....

Date of interview:..... Time (start).....

Interview location:.....

*I will start the audio recording now.*

*Table 8 Interview guide*

<b>Service-related questions:</b>
<i>I will first ask questions about the services that are offered by the company.</i>
1. <i>What services are currently provided by the company?</i>
<i>(Let the interviewee give as many answers as possible. If needed ask about unclear services. Try to categorize them according to the service categories)</i>
2. <i>What did the transition path of the service offerings look like? With what service did it begin, where is it now, and is this the end?</i>
<i>(Probe for transition path)</i>
3. <i>Was it necessary to have a specific service before introducing the other?</i>
4. <i>What initiated the transition from selling products to selling product-service systems? (Was it pushed from within the company or was it demanded from the market?)</i>

<p>5. <i>As an SME, what difficulties within the company did you experience when implementing the different services?</i></p> <p>(Probe for organizational commitment, resources, capabilities)</p>
<p>6. <i>What enablers/solutions did the company find to overcome these difficulties?</i></p>
<p>7. <i>What difficulties outside the company did you experience when implementing the different services?</i></p> <p>(Probe for customer acceptance, competition, lack of customer value, no installed base)</p>
<p>8. <i>What enablers/solutions did the company find to overcome these barriers?</i></p>
<p><b>Network capability questions: Partners (customers, suppliers, technology partners) (FOCUS ADVANCED SERVICES)</b></p> <p><i>I will now ask some questions about specific capabilities that are of interest to this study. In these questions, I refer to partners. Partners can be customers, suppliers, or technology partners. For these questions I am particularly interested in advanced services.</i></p>
<p>9. <i>In terms of partners, were any needed to develop the current service offerings? What did they bring to the table?</i></p>
<p>10. <i>What did you do to select your current and future partners?</i></p>
<p>11. <i>How do you experience the current relationships with your partners? Did you ever experience discussions or problems? How did you manage?</i></p> <p>(Probe for partner discussions, problem-solving, escalation)</p>
<p>12. <i>Are you informed about your competitors? If so, what information do you collect about your competitors and how do you put it to use?</i></p>
<p><b>Digitalization questions:</b></p> <p><i>I will now ask some questions about digitalization within the company, especially related to the services offered.</i></p>
<p>13. <i>What digital technologies do you need for your services? and how do they create value?</i></p>
<p>14. <i>Are you able to deliver your services without these digital tools?</i></p>
<p>15. <i>Is there a clear digitalization strategy within the company? If so, what is it and how do you experience it in the firm?</i></p>
<p>16. <i>When implementing these digital tools within the service, did you experience any problems or barriers? (e.g. data privacy, competitor data)</i></p>
<p>17. <i>What enablers/solutions did the company find to overcome these barriers?</i></p>
<p>18. <i>Are the digital tools interconnected throughout the firm such that it is spread across different functional areas? If so, can you give examples of how they are interconnected?</i></p>



19. Does the firm regularly monitor and analyse some sort of performance metrics for the services delivered?
<b>Business ecosystem:</b>
<i>I will now ask some questions about the business ecosystem. (This concerns the alignment structure of multiple partners that are needed for a value proposition to materialize)</i>
20. Think about the partners (customers, suppliers, technology partners) that were needed to deliver the service propositions, how do they compare to the firm in terms of firm size, amount of resources and management style?
21. Did you experience any effect of the differences of partners in the collaboration process?
22. How would you describe the level of competitiveness in your current business network? Are partners and competitors willing to cooperate, or it is dominated by competition? Could you give some examples of competition or cooperation? How does it affect the delivery of your services?
23. Does the firm expand activities and contacts beyond its own industry? (e.g. partnerships, strategic alliances, collaboration, platforms) Did this influence the servitization process?

- Besides the themes that we just focussed on, are there any other factors that you experienced as crucial in enabling advanced PSS?
- Conclusion
- Thanks
- Any comments?

## Appendix B

### Final coding scheme

Table 9 Final coding scheme

PSS level	Basic services	Repair, corrective & preventive maintenance, spare parts, installation
	Intermediate services	Remote monitoring, help desk, training, automation
	Advanced services	Optimization, consulting, proactive maintenance, system integration, predictive maintenance
Servitization challenges	Internal challenges	Lack of resources Lack of capabilities Lack of organizational commitment Equipment complexity
	External challenges	Customer value Data security Customer trust Perceived legitimacy Intermediaries Covid pandemic Supply chain
Network capabilities	Coordination Relational skills Partner knowledge Internal communication	
Digitalization	Digital business capability	Digital strategy Digital integration Digital control

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	IloT	Remote monitoring Global scalability Traceability
	Digitalization challenges	Data security Connection strength Data analytics
Ecosystem conditions	Ecosystem symmetry Ecosystem cooperativeness	Asymmetry effect Competition Cooperation Coopetition
	Market circumstances	Market leader Market demand
Ecosystem priority	Building ecosystems in proximal and distal networks Fostering integrated ecosystems	

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## Appendix C

### Capability statements

#### Network capabilities

##### **Network capability** (Walter et al., 2006)

###### **Coordination:**

- We analyze what we would like and desire to achieve with which partner.
- We match the use of resources (e.g., personnel, finances) to the individual relationship.
- We inform ourselves of our partners' goals, potentials and strategies.
- We judge in advance which possible partners to talk to about building up relationships.
- We appoint coordinators who are responsible for the relationships with our partners.
- We discuss regularly with our partners how we can support each other in our success.

###### **Relational skills:**

- We have the ability to build good personal relationships with business partners.
- We can put ourselves in our partners' position.
- We can deal flexibly with our partners.
- We almost always solve problems constructively with our partners.

###### **Partner knowledge:**

- We know our partners' markets.
- We know our partners' products/procedures/services.
- We know our partners' strengths and weaknesses.
- We know our competitors' potentials and strategies.

###### **Internal communication:**

- In our organization, we have regular meetings for every project.
- In our organization, employees develop informal contacts among themselves.
- In our organization, communication is often across projects and subject areas.
- In our organization, managers and employees do give intensive feedback on each other.
- In our organization, information is often spontaneously exchanged.

#### Ecosystem priority

##### **Ecosystem priority** (Homburg et al., 2020)

###### **Building ecosystems in proximal and distal networks:**

- In our organization we use expand activities and contacts beyond our own industry.
- In our organization we incorporate multiple partners in value creation.
- In our organization we enable partners throughout the network.
- In our organization we share knowledge within and beyond the firm's own industry.

- In our organization we build and shape platforms with multiple stakeholders, including competitors.

**Fostering integrated ecosystems:**

- In our organization we implement connecting hubs.
- In our organization we harmonize and align work streams.
- In our organization we develop integrated offerings.
- In our organization we use modular team structures.

Digital business capability

**Digital business capability** (Wielgos et al., 2021)

**Digital strategy:**

- Our digital strategy opens up entirely new opportunities to create value for our customers.
- Our digital strategy opens up entirely new opportunities to create value for our SBU/firm and its partners.
- Our digital strategy aims to continuously deliver digital product and service innovations.

**Digital integration:**

- Our SBU/firm is increasingly digitally interconnected with customers, suppliers, and partners.
- Digital business transformation increasingly pervades and interconnects all areas of our SBU/firm.
- Our business processes along the entire value chain are increasingly digitally interconnected.
- Our SBU/firm is increasingly digitally interconnected via digital platforms.

**Digital control:**

- Our SBU/firm has concrete specifications for the implementation of digital business transformation
- Our SBU/firm systematically and regularly monitors the progress of its digital business transformation
- Our SBU/firm systematically and regularly analyzes performance metrics to inspect its digital business transformation