Improving services within a manufacturing firm through servitization
a design science approach

Lewis, R.M.

Award date:
2021

MASTER THESIS

Improving services within a manufacturing firm through servitization: a design science approach

By
R.M. (Rick) Lewis
Student number: 1241281

Eindhoven, April 6, 2021

In partial fulfillment of the requirements for the degree of

Master of Science in
Innovation Management

1st supervisor TU/e	Dr. D. Keskin
2nd supervisor TU/e	Dr. A.G.L. Romme
3rd supervisor TU/e	Dr. A. Markus
Company supervisor	Ir. J.M. Kolp

Department of Industrial Engineering and Innovation Sciences
Sub-department of Innovation Technology Entrepreneurship & Marketing
Eindhoven University of Technology

Department of Industrial Engineering and Innovation Sciences
Series Master Thesis Innovation Management

Keywords: servitization, maturity, product-service continuum, servitization transition, servitization barriers & challenges, product manufacturer, design science

Preface

By writing this thesis, I conclude the scholarly chapter of my life and begin writing a new chapter in the professional world. From an early age onwards, I knew that I wanted to combine my interest in technology and business innovation. Not only by achieving a bachelor's degree in mechatronics but also by following my heart in wanting to get a master's degree from the Eindhoven University of Technology. My time at the university has brought me great joy and satisfaction. My time during the pre-master and master broadened my horizon on a personal and professional level, where I can say that I really met some wonderful people. I am especially grateful to have had the opportunity to study for half a year at the National Tsing Hua University in Taiwan. Words cannot describe how much I enjoyed this chapter in my life.

Firstly, I want to express my gratitude and appreciation towards my company supervisor, Jeroen Kolp. Thanks to him, I got the opportunity to execute the research as is presented here. Thank you Jeroen for guiding me during this process and challenging me without explicitly stating the obvious. Moreover, I want to thank Erik Zeegers for seeing the potential in me and trusting me along the way. Lastly, I want to express my appreciation for Ralph Stassen. Without your guidance at the beginning of the endeavor, I wouldn't have been where I am now.

I also would like to thank my supervisors from the University. Firstly, my first supervisor, Duygu Keskin. For giving me the freedom to pursue my interest in the research direction and by challenging me during the process while providing detailed feedback. Your guidance has helped me to improve my thesis which unquestionably led to better results. Also, I have really appreciated the kind interaction and personal communication we had, thank you. Secondly, I would like to thank my second supervisor, Sjoerd Romme. During the process, your feedback helped me make important decisions regarding the methodology, persist with the research, and dive deeper into specific topics.

During the execution of my thesis I met many inspirational, hard-working, and supporting people at PT. I am very grateful to have met these people within many different parts of the company. Many thanks to the people who have participated in my research. Although I will not name people specifically (because that would make this too large), you know who you are.

Lastly, I would like to thank my family and friends who have supported me during this challenging endeavor. Especially my parents and brother, who have supported me along the way during the highs and lows. Without your support, I wouldn't have made it.

Rick Lewis

Eindhoven, April 6, 2021

"Not I, nor anyone else can travel that road for you. You must travel it by yourself" – Walt Whitman

Management summary

There is an increasing movement of manufacturing companies who initially considered themselves to be in goods and then moved to offer goods combined with closely related services, and eventually to a position where the firm offers bundles consisting of customer-focused combinations of goods and services (Vandermerwe & Rada, 1988). This so-called servitization transition is executed along a product-service continuum and raises significant challenges to a goods-centered manufacturer to organize and provide services, which is the main topic of this research.

This servitization transition can challenge a firm's management regarding how far to go, what services to choose, and when more services are too much (Vandermerwe & Rada, 1988). It presents challenges for managers in successfully integrating services into the firm's overall strategy and portfolio (Vandermerwe & Rada, 1988). Furthermore, literature is sparse in describing how the integration of services under servitization could be carried out and in detailing the challenges and barriers inherent to the transition towards extending the service business (Oliva & Kallenberg, 2003). Conclusively, there is an increasing need for the research community to engage prescriptively in the change process by engineering the tools and techniques needed by practitioners (Baines et al., 2009).

This research is conducted within the empirical context of a global fast-growing high-tech manufacturing firm named PT. PT's corporate objectives are to grow sustainably by increasing revenue and productivity. PT is originally a product manufacturer with little emphasis on value-added services; therefore, services have a limited role within the firm's offering. PT has ambitions to extend the service business (i.e. servitization) but faces several problems to achieve this. First, PT has a low organizational maturity regarding services. Second, there is a lack of knowledge regarding the barriers and challenges of servitization among managers. And third, there is a risk of no uniformity within the firm on how to organize services. Due to this, the firm's current services are unprofitable, and other services' potential is unexploited. These problems led to the following research question:

How can PT transition along the product-service continuum to better provide diverse services to customers across their strategic business units?

Methodology

A design science methodology (DSM) is utilized to provide an answer to the above question. DSM links practice and science by designing a solution using scientific knowledge (Romme & Endenburg, 2006). Based on a theoretical and empirical analysis, synthesized CAMO principles were derived grounded in both theory and practice. While the empirical analysis led to design requirements, the direction and scope of the design were influenced by both empirical and theoretical findings. The empirical analysis consisted of 22 interviews within the case company with candidates with varying functions and one interview with an external expert on servitization. The designed solution was iterated through three semi-structured evaluation sessions leading to the improvement and formative evaluation of the solution design. A summative evaluation was used to evaluate the final solution design through a focus group and six semi-structured interviews. Whereafter a conclusion to the research question is elaborated, and findings are discussed.

Theoretical analysis

Within the literature, three servitization perspectives are found: (i) an internal perspective, (ii) an external perspective, and (iii) a technological perspective (Vandermerwede & Rada, 1988). The external perspective groups barriers under competitors, suppliers, & partners, and customers. The internal perspective groups barriers under financial, knowledge & information, activities & processes, organizational structure, culture, and cognitive phenomena of managers. Within the literature, a non-holistic approach is often applied to investigate specific barriers or transition actions and mechanisms;

while at the same time, these specific approaches alone are not sufficient to guide firms in the servitization transition (Spring and Araujo, 2013; Ulaga and Reinartz, 2011). Due to this, a holistic approach was incorporated discovering the actions and mechanisms manufacturing firms can utilize to transition successfully along the product service continuum. The theoretical analysis resulted in the following transition components under which various actions and mechanisms are grouped; these are: service strategy, business model, firm culture & cognitive phenomena managers, organizational structure, activities & processes, and resources & capabilities.

Empirical analysis

The empirical analysis revealed several barriers related to the external environment, such as the type of product and position in the value chain, the customer's voice, market considerations, and the customer's perceptions of the supplier's service capabilities. The empirical analysis also revealed mainly internal barriers such as strategic arguments not to extend the service business, the type of distribution model and place in the value chain as inhibiting factor, a lack of emphasis on value selling, and a product-focused firm culture and cognitive phenomena among managers inhibiting the transition. No significant technology-related barriers were discovered. Moreover, the empirical analysis revealed a substantial gap between two stakeholder groups: being the (managers of the) strategic business units and the support organization (represented by the COO). On the one hand, an inadequate emphasis is placed on services within the strategic plans, the subsequent missing of a service strategy. And on the other hand, insufficient internal support is provided proactively. Conclusively, the most significant internal servitization barrier found within the empirical analysis is related to the firm's organizational structure, highlighting that necessary adjustments need to be made accordingly.

Design

Based on the CAMO principles synthesized from both the theoretical and empirical analysis, a solution design being a transition framework is developed.. Through a holistic approach, the transition framework guides manufacturing firms in successfully making the servitization transition, incorporating concrete actions manufacturing firms should implement. As the empirical analysis revealed two stakeholder groups, two more detailed solutions were designed specifically for each stakeholder group. Although the main barriers were found to be in the firm's culture and organizational structure, the transition process starts with a clear service strategy based on external factors (i.e. market, competitors, and customers). A servitization maturity overview is presented for the strategic business unit managers, including the various services and business models applicable within each maturity level. Alongside this, an eight-step process is designed to empower these managers to incorporate a service orientation within their strategic plans. Although a complete organizational structure change was deemed unnecessary, as the empirical analysis revealed that the process-based organizational structure is suitable to support the servitization transition, various organizational improvements were formulated.

Conclusion and discussion

This research discovered various internal and external servitization barriers, contributing to the current body of literature. Furthermore, this research integrated earlier works into a servitization framework and described the servitization journey as a holistic approach covering various components which all have to be considered by manufacturing firms wishing to successfully transition in servitization. Moreover, through this transition framework, PT has insight into the types of services that can be offered and the potential of extending the service business on the current business models, where the potential is most applicable for original equipment. The designed solution supports SBU managers in developing a service-oriented strategy and details the necessary organizational changes that need to be implemented to facilitate the servitization transition. Through this research, PT has the knowledge and guidelines available to embark on their servitization journey.

Contents

List of abbreviations

Abbreviation	Explanation
AGV	Automated guided vehicle
CAMO	Context, Action, Mechanism, Outcome
CCO	Chief Commercial Officer
CEO	Chief Executive Officer
COO	Chief Operations Officer
DSM	Design science methodology
ETO	Engineered to order
LCM	Lifecycle management
NPD	New product development
OEM	Original Equipment Manufacturer
OTS	Off the shelve
PMP	PT Motion Platform
PSS	Product-service system
QLTCS	Quality Logistics Technology Cost Sustainability
RMA	Return material authorization
SBU	Strategic business unit
SLA	Service-level agreement
SMM	Service Maturity Model
TI	Technology-intensive
VAR	Value-added reseller

List of Figures

List of Tables

1. Introduction

Traditionally, the tendency for firms has been to view services merely as a necessary component in the context of marketing strategies, where the primary value is considered to originate from the physical goods involved (Baines et al., 2009). There is an increasing movement of companies who initially considered themselves to be in goods and then moved to offer goods combined with closely related services, and eventually to a position where the firm offers bundles consisting of customer-focused combinations of goods and services (Vandermerwe & Rada, 1988). This so-called servitization transition raises significant challenges for a goods-centered manufacturer to organize and provide services, which is the main topic of this research.

This servitization transition can challenge a firm's management regarding how far to go, what services to choose, and when more services are too much (Vandermerwe & Rada, 1988). It presents challenges for managers to successfully integrate services into the firm's overall strategy and portfolio (Vandermerwe & Rada, 1988). Moreover, literature is sparse in describing how the integration of services under servitization could be carried out, and in detailing the challenges and barriers inherent to the transition towards extending the service business (Oliva &Kallenberg, 2003). Manufacturing firms that venture into servitization can experience barriers and challenges in extending the service business and adding product-service combinations to their portfolio (Coreynen et al., 2018). Albeit manufacturers acknowledge the importance of moving into services, many are unable to exploit its full potential (Eggert et al., 2014). Furthermore, there is an increasing need for the research community to engage prescriptively in the change process by engineering the tools and techniques needed by practitioners (Baines et al., 2009).

This master thesis project is executed at the firm PT, which is concerned with the challenges of extending the service business. It follows a design science methodology that is grounded in practice and science and takes a practical business problem as a foundation for the research. This research focuses on investigating the company's current portfolio and future ambitions concerning providing different product-service combinations. What prevents the company from offering different types of product-service combinations, and how the company can improve its service offering by dealing with the barriers and challenges of providing different product-service combinations. Moreover, how these different types of services are provided to customers within the firm, considering the differences of the various strategic business units and their portfolio and the firm's process-oriented organizational structure.

The setting of the research is detailed by firstly introducing the case company in the next section. This is followed by an analysis of the firm's business problem and context, subsequently leading to a formal problem statement and research question(s). Chapter 2 explains the methodology used within this research consisting of an iterative design approach between theory and practice. The literature review is elaborated in Chapter 3. The empirical analysis is discussed in Chapter 4. As per the chosen methodology, Chapter 5 details the synthesis step in which both the theoretical and empirical analysis are used as input. Chapter 6 discusses the steps towards a solution design and elaborates on the designed solution and evaluation hereof. Lastly, in Chapter 7, the research outcome is discussed, and a conclusion is presented to answer the research question.

1.1 Company background

A passion for technology, sustainable growth, and refined process control. This vision is important for the firm PT. PT was founded in 1993 in Eindhoven and currently has more than 1300 full-time employees. The firm's headquarter is based in the Netherlands with additional offices in the USA, Germany, Israel, China, and Japan. PT has a global presence and operates in diverse business-to-business markets

worldwide. These markets can be considered technology-intensive (TI) markets, which are markets in which technology has a central role (John et al., 1999). PT develops and manufactures products, software, and complex systems. The mission of PT is to create meaningful technologies that make the world work. To pursue this mission, PT invents, designs, manufactures, and supports customers. PT is aiming to grow sustainably and to achieve the best possible solutions for their customers.

Within PT, technologies are clustered within strategic business units (SBUs). These are vision & sensing, embedded computing systems, industrial automation, contract manufacturing services, power conversion, and motion & mechatronics (see Figure 1). These SBUs are very similar to traditional stand-alone Business Units, which act as independent organizations; however, with the exception that processes and activities are managed company-wide (across the business units). Moreover, PT follows a process-based organizational structure. A process-based organizational structure is designed around the end-to-end flow of different processes. Examples of centralized activities are support processes (e.g. manufacturing, purchase, human resources) and account management. Decentralized activities are specific for each business unit such as sales and R&D. For example, after product development led by R&D and specific to a single SBU, products are manufactured according to a centralized manufacturing process for each manufacturing step performed. The reason for these centralized support processes is to reduce resources, improve flexibility, and in this particular case, manufacture conform to the same standards (e.g. quality). The example above explains why SBUs are not entirely separate organizational units as seen in traditional business units.

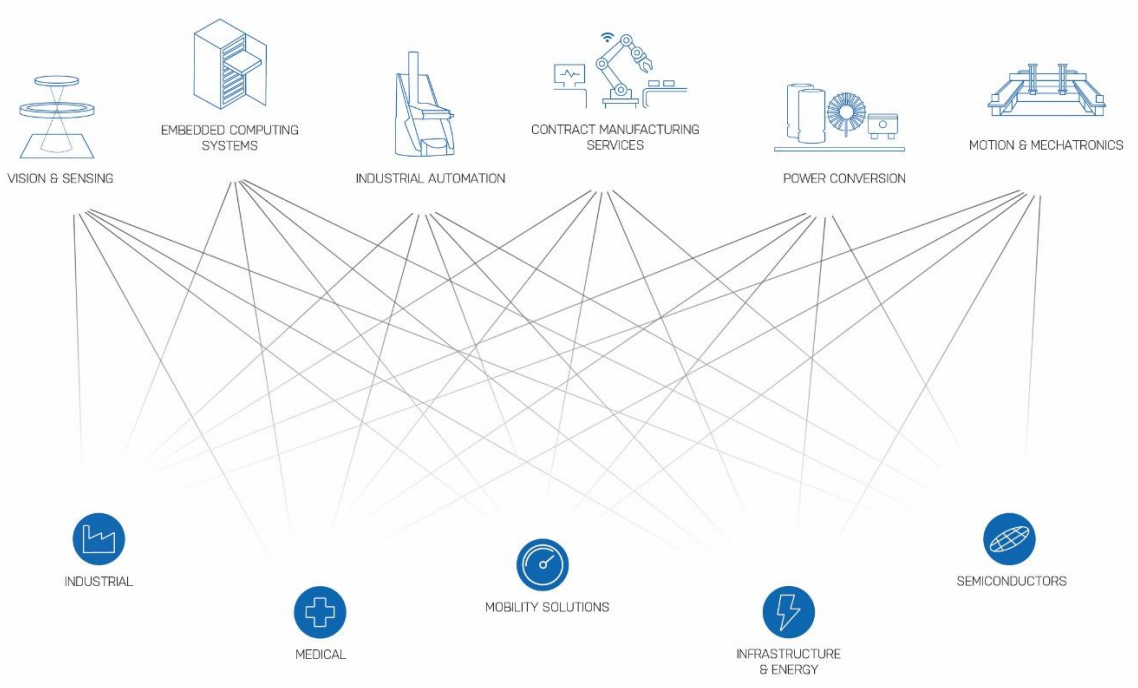


Figure 1: strategic business units and markets of PT (PT, 2020)

The company values of PT can be defined by three main aspects, namely equality, responsibility, and trust. It consists of a flat organization with autonomous teams with minimal bureaucracy. The firm aims for minimal hierarchical layers with limited managerial roles. Therefore, its culture can be defined as supporting the individual with much responsibility and a strong technical drive. Originally, PT has been very product-oriented in all aspects of its organization. However, PT has ambitions to extend its service business, giving services a more prominent role within its offering.

1.2 Problem analysis

This section elaborates on the problem context of the research, including the problem description and problem statement.

1.2.1 Problem context

PT originates from a physical goods-based (i.e. hardware and electronics) mindset, where the firm's traditional activities were centered around their business model of technology solutions. This business model entails developing and manufacturing customer-specific products engineered to order (ETO). As a firm, PT is transitioning towards offering more off-the-shelve (OTS) products, consisting of a portfolio of components, modules, and sub-systems. OTS products are different from ETO products as they are market-focused rather than customer-specific. The firm most frequently acts as a first-tier supplier to Original Equipment Manufacturers (OEMs) within both business models. The move towards OTS products enables the firm to develop and serve OEM customers more market-focused. This move also highlights the firm's ambitions and enables the firm gradually to provide more stand-alone equipment in the role of an OEM provider to end-customers. All SBUs are following this growth strategy except for the SBU of contract manufacturing services. This SBU follows a different business model where manufacturing solutions are used to manufacture customer-specific products on customer-owned designs.

Due to the firm's growth strategy to expand the portfolio of OTS and OEM products, the value of the offering might shift from purely physical products to other value-added components such as software and service. More specifically, the software component in addition to hardware becomes increasingly important as it delivers added value to customers and is a key differentiator from the firm's perspective. Moreover, in line with the firm's growth strategy, services can become a vital component in the firm's offering for OTS products and even more so for OEM products. This is especially true in industrial markets where customers are described as increasingly demanding services (Vandermerwe, Rada, 1988). This puts pressure on the firm's SBUs to choose and provide suitable services to its customers.

The current organizational maturity regarding services is centered around the firm's business model of technology solutions. Therefore, services currently have a limited role in the firm's offering. Moreover, the current services are very reactive in nature. Each SBU is responsible for the development of products and services. Subsequently, each SBU is on its own transition towards offering OTS products and original equipment and deciding on the right mix of these business models within their portfolio. PT's corporate objectives are to grow sustainably by increasing revenue and productivity. The firm faces several related problems regarding services that have a direct impact on corporate objectives. First, PT has a low organizational maturity regarding services. Second, there is a lack of knowledge (and thus uncertainty) regarding the barriers & challenges of servitization. And third, there is the risk of no uniformity within the firm on how to organize services. Due to this, the firm's current (installed-base) services are unprofitable, and the potential of other services is unexploited. These problems are rooted in servitization and can be explained by the firm's current organizational maturity regarding services. Servitization can be best described as the transition made by manufacturing firms to extend the service business resulting in making services a more prominent part of the offering alongside physical goods (Baines et al., 2009). The concept of servitization will be explained in more detail in Chapter 3. The problems faced by PT and their relationship are illustrated in a cause-effect tree in Figure 2 and will be elaborated on next.

1.2.2 Problem description

Low organizational maturity regarding services

PT is originally a product manufacturer with little emphasis on value-added services. Due to this, the current organizational maturity regarding services is low. It implies that the firm is not organized to provide various services. The growth ambitions of PT highlight the increase in products developed under the OTS business model and the resulting increase in the scope and size of installed-base services. Depending on the business model and the type of products and services the firm offers or wishes to offer to customers, a certain maturity regarding services is required. From the firm's perspective, they must be able to provide and support suitable services to customers.

Due to the current organizational maturity regarding services, the firm is not organized to provide various services profitably. Resulting in current installed-base services that are unprofitable, where the firm covers the service costs made or even incurs additional service costs. A product's installed-base is the total number of products currently under use; installed-base services are the range of product-related services required by a customer over the product's lifetime to run it effectively in the context of its operational process (Oliva & Kallenberg, 2003). Here, unprofitable Installed-base services are centered around hardware and software products developed as technology solutions sold to customers. These services range from standard installed-base service (i.e. break-fix repair, replacement) to more advanced services such as maintenance service in the form of yearly recurring service-level agreements (SLAs).

An SLA is an agreement made with customers, which implies that customers receive a predefined support level. This agreement formalizes that PT has to respond within a specific time interval (stand-by-fee) after an incident has occurred at the customer's application. The current SLAs consist of a bucket of money that is negotiated upon each year with the customer. Currently, installed-base services in the form of SLAs incur high costs and low returns for the firm. This is due to software improvements, bug fixes, and overall maintenance are sporadically provided without recouping the costs or generating revenue. Moreover, some customers might require more support than others. These costs of software improvements, bug fixes, and overall maintenance put high pressure on the relationship between the account manager and the customer as to who is responsible for finding a solution and who has to pay for it financially. To conclude, PT has a low organizational maturity regarding services due to the firm's origins as a product manufacturer, focusing on physical products rather than value-added services, which results in unprofitable installed-base services.

Lack of knowledge of the barriers and challenges of servitization

Alongside various services related to the installed base, which are currently unprofitable, the current growth ambitions of PT towards developing original equipment serving end-customers present various new service opportunities. Specifically, these service opportunities are represented by advanced services or different product-service combinations. However, managers experience uncertainty in their decision-making about which product-service combination to offer along the product-service continuum and how to offer them (i.e. develop and deliver). The product-service continuum is a construct in which products and services can be placed, ranging from products with services as add-on (i.e. installed-base services) to services with tangible goods as add-on (Baines et al., 2009). Examples of original equipment with unexploited service opportunities within PT are automated guided vehicles (AGVs) within SBU E and a cloud-based software platform within SBU A.

These service opportunities also present challenges. Conclusively, managers within the firm face uncertainty about where to position various propositions along the product-service continuum and the

barriers and challenges inherent to servitization. This uncertainty and lack of knowledge prevent them from increasing the service offering and exploiting the service potential. Nonetheless, the limited breadth of services currently offered by the firm (basic services such as break-fix repair) is not surprising. There is a strong focus on the relative importance of goods within PT, where the importance of services is still underexposed.

Risk of no uniformity within the firm how to organize services

A challenge for PT is how to cope with offering various services and product-service combinations across and within SBUs. As propositions mainly originate within a single SBU, SBUs independently have to choose a suitable product-service combination for their propositions. This can result in differences in product-service combinations between SBUs and differences in service components between SBUs. Although this is not necessarily a disadvantage, the support organization is in charge of providing the specific services. Due to the limited breadth of services within PT, the firm's current processes related to service delivery (e.g. break-fix service and lifecycle management) are sufficient. However, as the firm's growth can also impact the breadth and variety of services offered, the firm needs to be organized to support these services.

The culture of PT highlights the importance of a standardized way of working, meaning that processes and way of working should ideally be cross-SBUs. Processes, the way of working, or the way resources are allocated should be independent of the SBUs. However, due to the current organizational division into SBUs, the firm faces the risk of having different ways of working to deliver services across the SBUs. As is in line with the firm's culture and organizational hierarchy, the firm wants to maintain flexibility by reducing the risks mentioned above and find a way to provide services across the SBUs. Thereby preventing to have differences between SBUs regarding support processes such as providing services.

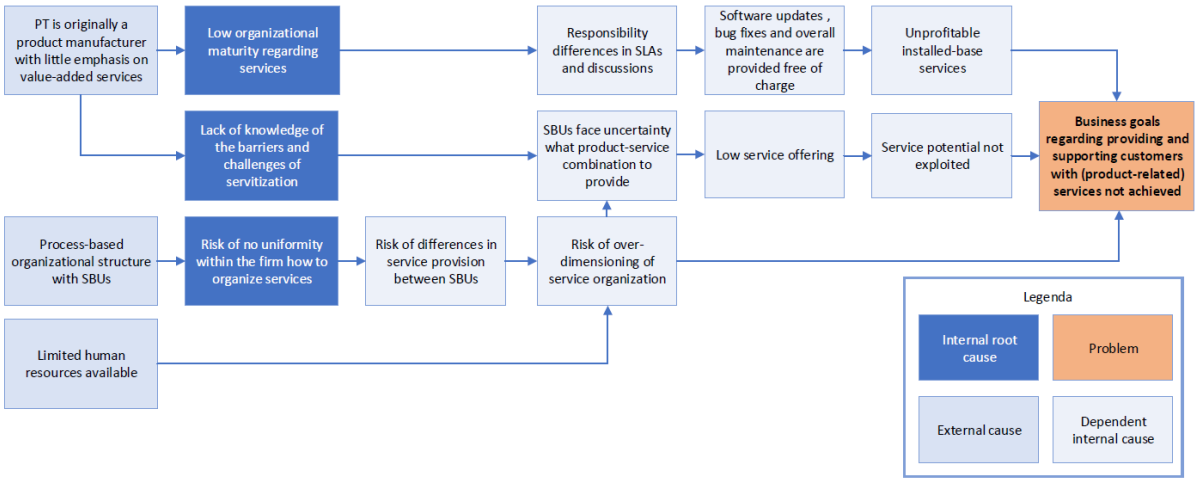


Figure 2: cause-effect diagram

1.2.3 Problem statement

The growth of PT towards offering more OTS products and original equipment brings challenges to the firm regarding services. The firm faces difficulties with reaching its corporate objectives as certain installed-base services are unprofitable, and the potential of various services under different business models is not exploited. Specifically, SBU managers face uncertainty in choosing and offering different product-service combinations as they face a lack of knowledge regarding the barriers and challenges of servitization. Furthermore, due to a low organizational maturity regarding services, the firm is not organized to provide various service including the risk of no uniformity within the firm on how to organize services across the SBUs. Therefore, the following problem statement is defined:

PT is growing and is transitioning along the product-service continuum. Consequently, the firm faces challenges in offering various services and product-service combinations across their strategic business units. Moreover, the firm has a low organizational maturity regarding services. There is a risk of no uniformity within the firm how to organize services. And managers face uncertainty about the lack of knowledge of the barriers and challenges of servitization.

1.3 Research question

The goal of this master thesis project is to design a solution that helps the organization with improving the process of transitioning along the product-service continuum and extending the service business. This research is conducted within the company PT which is currently undergoing this transition along the product-service continuum. Therefore, the following research question is defined:

Research question:

How can PT transition along the product-service continuum to better provide diverse services to customers across their strategic business units?

1.4 Sub-research questions

To answer the main research question, several sub-research questions are formulated. These sub-research questions relate to the concepts within the main research question. The first sub-research question explores what servitization entails; and what constructs are used to define products, services, and product-service combinations. It firstly takes a theoretical perspective and correlates this with empirical findings within the case company. More specifically, it empirically investigates the current portfolio and future ambitions of products and services across the SBUs of the case company. Moreover, it explores how in the organization services are provided to customers, which is necessary information to answer the research question.

1A. What is servitization, what product-service combinations are there, which combinations does PT currently offer, and what are their future ambitions?

1B. How in the organization are services provided to customers?

The second sub-research question investigates the barriers and challenges faced by manufacturing firms to transition along the product-service continuum. Furthermore, the barriers and challenges faced

by the case company are explored. This question is answered by conducting a literature review used as input for empirical data collection from managers and other individuals within the case company.

2. What are the barriers that inhibit PT to follow the servitization path?

The third sub-research question focuses on exploring the actions manufacturing firms can utilize and the mechanisms to successfully transition along the product-service continuum. This question is answered by conducting a literature review on this topic. Moreover, the findings are validated by collecting empirical data from an industry expert on servitization outside the case company.

3. How can manufacturing firms successfully transition along the product-service continuum?

The fourth and last sub-research question combines the three earlier posed sub-research questions to develop a solution design following the chosen methodology. This is achieved through synthesizing the collected data being a review of the literature and empirical data. This sub-research question gives guidance on how to improve and implement the possible transition process by coping with the barriers hereof and utilizing the transition actions and mechanisms described in the previous sub-research questions.

4. How should the transition to other product-service combinations and an improved service offering be formulated?

2. Methodology

This chapter elaborates on the methodology of the master thesis. Firstly, a generic overview of the chosen methodology is introduced. This is followed by the specific approach of this research, which entails which steps were taken to set up and execute the research. After that, the data collection and analysis are described in more detail, covering both literature and practice. Furthermore, the steps towards a solution design and the evaluation hereof are explained. Lastly, the quality of the research is discussed.

This research finds its beginnings within a company with a practical business problem, leading to implementing the design science methodology (DSM). DSM links practice and science by designing a solution using scientific knowledge (Romme & Endenburg, 2006). A second reason to choose DSM is to develop prescriptive knowledge to answer the research questions, as there is an increasing need for the research community to engage prescriptively in the servitization change process by engineering the tools and techniques needed by practitioners (Baines et al., 2009). The emphasis of DSM is initially on a single organization's business problem, whereafter the outputs can be expanded to others for generalization (Denyer, Tranfield, van Aken, 2008).

This research incorporates the synthesized design science framework by Keskin and Romme (2020), see Figure 3. This framework presents a generic process that needs to be contextualized within each project. The integrated framework is based on earlier frameworks by Van Aken (2004), Romme and Endenburg (2006), and Holmström et al. (2009). These frameworks elaborate on a methodology that combines design and research activities, exploration of the problem context, synthesis of empirical findings and literature, creating solutions (i.e. artifacts), and evaluating the designed solution (Keskin & Romme, 2020). Complementary, this research was inspired by Van Burg et al. (2008) and Dubois and Gadde (2002), in which theoretical and empirical analyses were carried out simultaneously.

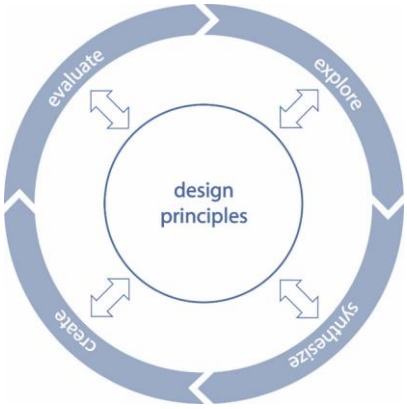


Figure 3: design science process by Keskin and Romme (2020)

Design principles lie at the core of design science. These design principles are constantly being refined within the iterative process of exploration, synthesis, creation, and evaluation. A definition of design principles is formulated by Romme and Endenburg (2006) as follows:

> *"A coherent set of imperative propositions, grounded in the state-of-the-art of organization science, for producing new organizational designs and forms and redeveloping existing ones." (Romme & Endenburg, 2006, p. 288)*

These design principles are input for the solution design and an output of the research. They describe how to obtain prescriptive knowledge based on the change of the current situation (Romme & Endenburg, 2006).

2.1 Research approach

The research follows a design science approach that combines science (i.e. literature) with practice (i.e. empirical data). Apart from the generic design science process depicted earlier, the specific approach taken within this research is shown in Figure 4 below, inspired by design science. It follows an iterative approach divided into an exploration step, synthesis step, creation step, and evaluation step. These steps are explained below.

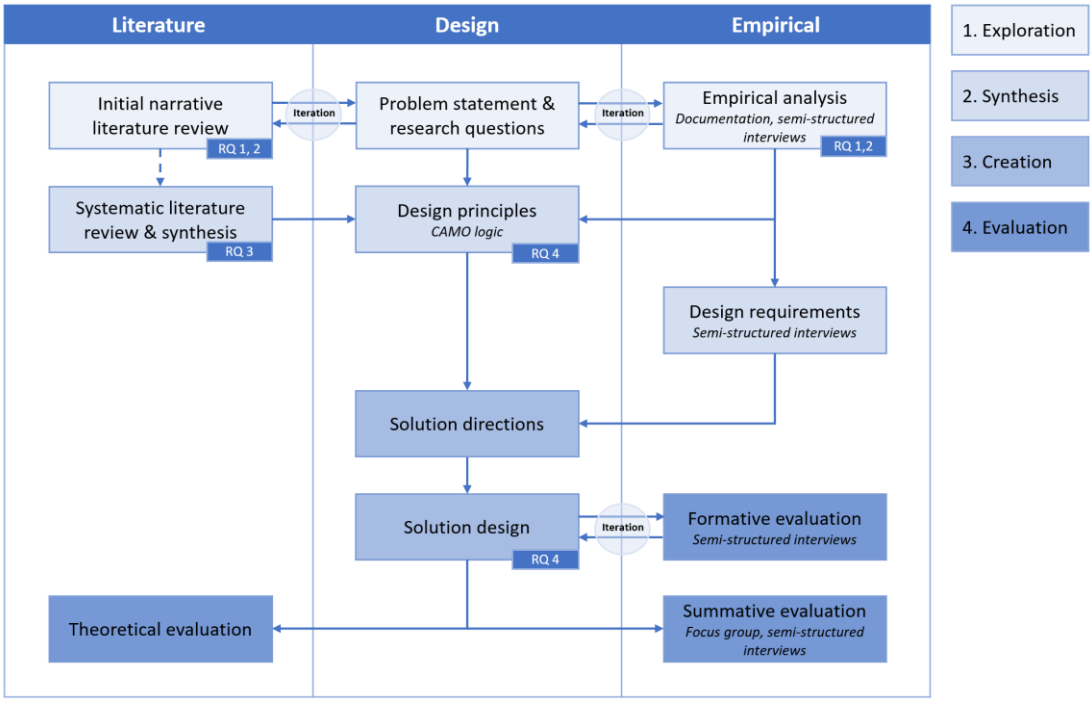


Figure 4: research approach inspired by design science

The first step is exploration, in which the context and business problem are investigated, and the boundaries of the research are drawn. The goal here is to get a well-founded and in-depth understanding of the business problem using both literature and empirical data. In this step, initial interviews were conducted with several managers, process owners, and several other employees within the case company. See Appendix 9.1 for a detailed overview of the interviewees and the format of these interviews. Based on this initial exploration, a problem statement and subsequent research questions were drawn. Furthermore, the methods used within this research were identified based on fit with the research question. Apart from gathering empirical data to formulate a problem statement & research questions, empirical data was also collected to answer several research questions. To collect empirical data, mainly qualitative methods were applied, as qualitative research methods can give an in-depth understanding of a phenomenon occurring within people, groups, and organizations (Van Aken et al., 2012). See Chapter 2.2.2 for an overview of the data collection methods.

The second step is synthesis. Here, a mental model of the design space is created through inductive and abductive sensemaking (Kolko, 2010). Information collected in the previous step can be used as input as this information contains a rich amount of scientific and empirical data. Moreover, a systematic literature review and empirical data collection and analysis (based on the research questions defined in the exploration step) provide additional information to develop design principles and design requirements. Design principles were synthesized based on collected and analyzed data using the four CAMO dimensions (Denyer et al., 2008). CAMO can be explained by an actor and its actions (A) which trigger a particular

mechanism (M) toward achieving a desired outcome (O) in a specific context (C) (Keskin & Romme, 2020). Moreover, requirements are prerequisites that have to be considered in the development of a solution. The requirements of the designed solution were constructed together with the case company. In this research, a single case-study approach was applied, taking a holistic company perspective and investigating the individual SBUs regarding the case company's current portfolio and future product-service ambitions. The case study approach was used to understand the servitization phenomenon and subsequent barriers and challenges within the case company. Moreover, empirical data is collected by retrieving relevant documents and conducting individual semi-structured interviews with the firm's SBU managers, board of management, business development managers, account managers, process owners, and the business control manager. A more detailed overview of the data collection methods used within the synthesis step and the sources of information are presented in Chapter 2.2.2.

The third step is creation, which entails developing a solution design to solve the problem defined earlier and reach the desired outcomes of the research. Based on the previous steps, solution directions are drawn, and an informed decision (i.e. based on literature and practice) is made about an appropriate solution direction. After the first draft of a solution design, semi-structured interviews were organized with the business control manager (i.e. company supervisor). This formative evaluation led to the improvement of the solution design through three iterations.

The final step in the design science process is evaluation, including the evaluation with the business control manager discussed before leading to improvements of the solution design. In the evaluation step, theoretical and practical evaluation takes place, which entails assessing both the designed solution and an academic reflection on the research findings. From a theoretical perspective, the goal is to demonstrate the solution's relevance in theory and identify the mechanisms that explain how the designed solution generates the desired outcomes (Keskin & Romme, 2020). From a practical perspective, the solution is evaluated based on its functionality, completeness, consistency, usability, fairness, and organizational fit (Hevner et al., 2004). This is achieved through summative evaluation of the designed solution with two SBU managers in a focus group, and several semi-structured interviews with the managers of the other SBUs, the CCO, the COO, and the business control manager.

The structure of the thesis is visually depicted in Figure 5. The relation of the thesis structure with the design science process by Keskin and Romme (2020) is as follows: Chapter 1 and 2 present the exploration step. Chapter 3, 4, and 5 present the synthesis step. Chapter 6 presents the creation step. Chapter 7 presents the evaluation step.

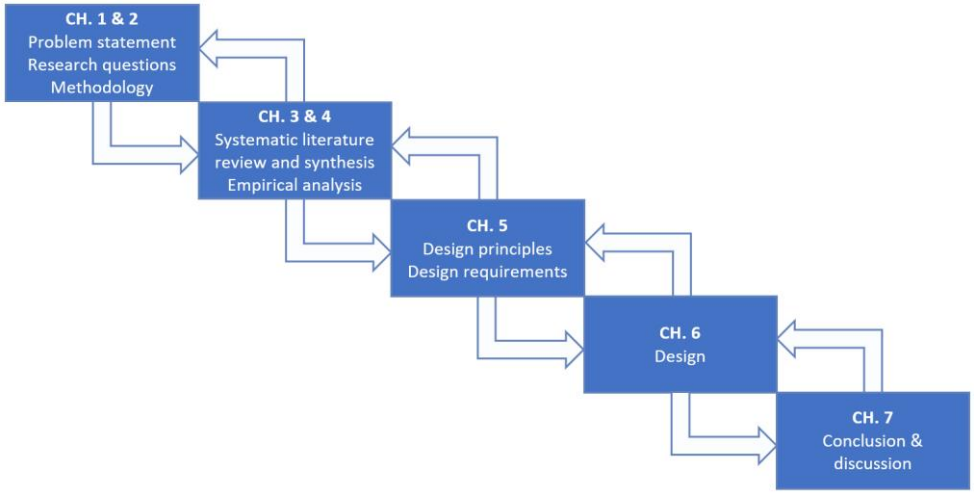


Figure 5: thesis structure

2.2 Data collection and analysis

To analyze the servitization phenomenon within the case company and from a theoretical perspective, both literature and empirical data are collected and analyzed. This section explains the execution and methods for the literature review, the empirical data collection, and subsequent analysis.

2.2.1 Narrative and systematic literature review

As part of the explorative phase of the research, an explorative literature study was conducted on various topics (see Appendix 9.2). This was done to get a well-founded understanding of the concepts used in literature and frame the business problem within the scientific field. Furthermore, as part of the exploration and synthesis step, a narrative and systematic literature review were conducted. Table 1 presents an overview of the literature topics and the search strings used.

Table 1: literature topics and search strings for relevant research questions

RQ	Topic of RQ	Exemplary search strings
Q1	What is servitization, and what product-service combinations are there?	"servitization" OR "service infusion" OR "extending service business" AND manufacturing firms
Q2	What are the barriers & challenges of manufacturing firms to follow the servitization path?	"servitization" OR "service infusion" OR "extending service business" AND "barriers" OR "challenges" OR "paradox"
Q3	How can manufacturing firms successfully transition along the product-service continuum?	"servitization" OR "service infusion" OR "product-service continuum" AND " transition(ing)" AND "manufacturing"

An overview of the approach of the literature review is depicted in Figure 6. First, an initial narrative literature review on the topic of servitization resulted in 22 articles. Second, a narrative literature review focused on servitization barriers & challenges resulted in an additional 32 articles. Third, a systematic review of literature on servitization transition actions and mechanisms resulted in 48 articles, applying backward snowballing on the 16 articles found earlier, and an additional search using the search strings defined in Table 1.

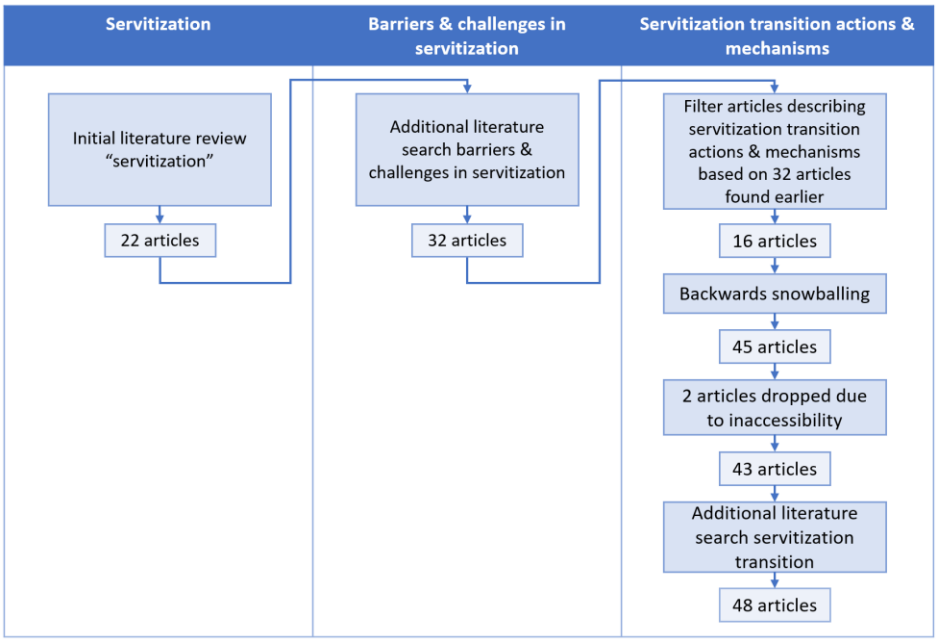


Figure 6: literature review approach

Within the literature review, two broad selection criteria were applied: first, servitization (or similar concepts) should be the main topic of the study. Second, the study should focus on manufacturing firms. From all collected articles, the abstract, introduction, and conclusion were red. Subsequently, articles were categorized as having high, medium, or low relevance, also considering the number of citations of the articles and the year of publication. Two databases were used for the literature review, respectively Google Scholar and JSTOR, representing a digital library of academic journals, books, and primary sources. Google Scholar was used as it has a user-friendly way of searching which provided quick results, including chapters and sections of books. JSTOR was used in addition to Google scholar to improve search validity and reduce the possibility of overlooking important scientific works.

2.2.2 Empirical data collection

The empirical data relevant for this research is collected for a large part within the case company, except for an external interview with an industry expert (i.e. assistant professor marketing at the Eindhoven University of Technology). The methods for data collection are documentation, semi-structured interviews, and a semi-structured focus group. Table 2 shows an overview of the data collection methods and sources used to answer the sub-research questions following the design science steps.

Table 2: an overview of the data collection methods and sources

DS steps	RQ	Method	Goal	Source of information
Exploration	Q1	Documentation	Obtain secondary information about firm strategy, vision, and goals	The firm's business plan, website, various process-related documents
Exploration	Q1 + Q2	Semi-structured interviews	Obtain first-hand information of firm strategy, vision, and goals & obtain an overview of the current portfolio and future ambitions of product-service combinations & retrieve barriers and challenges of servitization	Chief Execution Officer
				Chief Commercial Officer
				Chief Operations Officer
Exploration	Q1 + Q2	Semi-structured interviews	Obtain information on current portfolio and future ambitions product-service combinations & retrieve barriers and challenges of servitization	5 SBU managers
Exploration & Synthesis	Q3	Semi-structured interview	Validate literature findings servitization transition of manufacturing firms	Industry expert (external)
Exploration & Synthesis	Q2	Semi-structured interviews	Retrieve barriers and challenges of servitization	2 Business development managers
				2 Account managers
Exploration & Synthesis	Q2	Semi-structured interviews	Retrieve intra-organizational barriers and challenges of servitization	10 process owners
Evaluation	Q4	Semi-structured interviews	Formative evaluation of iterations of solution design for improvement	Business control manager (i.e. company supervisor), (3 interviews)
Evaluation	Q4	Semi-structured Focus group	Summative evaluation of designed solution	2 SBU managers
Evaluation	Q4	Semi-structured interview	Summative evaluation of designed solution	2 SBU managers
				Chief Commercial Officer
				Chief Operations Officer
				Business control manager

Documentation

The first method used for data collection is documentation, which is used to obtain insight into the firm's strategy, vision, goals, and current organization with regards to providing services. The used documents consist of the firm's most recent business plan, the firm's website, and several documents related to processes (e.g. service process, account management process). Van Aken et al. (2012) state that the importance of this secondary source of data can provide information that is uncollectable for employees. Moreover, it is a reliable source of information (Van Aken et al., 2012). The disadvantage of using documentation as a data collection method is that it does not allow for additional information (i.e. follow-up questions) to be retrieved. This is dealt with by validating the retrieved information from documentation during semi-structured interviews with the management board of the case company.

Interviews

The second data collection method is semi-structured interviews. The explorative nature of the research and the type of research questions formulated resulted in selecting a qualitative approach, as the information processed here is qualitative in nature (Blumberg et al., 2014). Qualitative methods are appropriate when studying complex phenomena and when many different variables are incorporated (Eisenhardt, 1989). The decision to apply individual interviews (i.e. face-to-face) instead of multiple participants or group sessions (i.e. focus-groups) was due to the nature of the information. Participants could be more open to freely discuss specific sensitive topics and provide honest opinions within interviews (Van Aken et al., 2012). However, the disadvantage of interviews is that the interviewer has a dual role. The researcher must obtain unbiased content-oriented information while managing the interview appropriately such that all topics are discussed while maintaining a pleasant atmosphere (Van Aken et al., 2012). The implementation of an interview guide supported this. This interview guide was set up before the interviews and validated by the company supervisor and one of the university supervisors. The interview guides used within this research can be found in Appendix 9.3, 9.4, 9.5, and 9.6. The average duration of all interviews was approximately one hour each. Due to the global Covid-19 pandemic, the firm's guidelines advised personnel to work from home as much as possible. Due to this, all interviews were conducted via video calling. See Appendix 9.7 for more information about the impact of Covid-19.

Within the research-proposal phase as part of the exploration phase, unstructured interviews were conducted with the CCO, five SBU managers, business & sales managers, and several lead engineers. Using a multitude of perspectives, a broad knowledge base was gathered regarding the case company's context and business problem to formulate research questions. Apart from this explorative phase of interviews, the following data collection consisted of five rounds with individuals or specific groups of people (see Table 2).

The first round of semi-structured interviews was conducted with the management board, including the CEO, CCO, and COO. This group of individuals was chosen as they have a vital position regarding the firm's strategy, vision, and goals. The second round consisted of semi-structured interviews with the managers of all six SBUs of the firm. This group was selected as these managers are responsible for developing a strategic plan for their SBU, including the products and services developed within their SBU. Here, questions were asked about the current portfolio of products and services and future ambitions. Moreover, the barriers and challenges they identify within the servitization transition were discussed. The third round consisted of an external semi-structured interview with an industry expert on the topic of servitization (i.e. assistant professor marketing at the Eindhoven University of Technology). Here, literature findings on how firms can successfully transition along the product-service continuum were discussed during a semi-structured interview. The fourth round of semi-structured interviews was conducted with

two business development managers and two account managers as they are in direct communication with customers in developing propositions and after-sales. Together, they are commercially responsible for the lifecycle of products from the cradle to the grave.

The output of the previous data collection rounds delivered intermediary findings on the first and second research question. For the case company's servitization barriers and challenges specifically, a further intra-organizational data collection step was deemed necessary. To select the relevant processes within the case company, a small-sized questionnaire was set up and sent to all process owners within the firm. The questionnaire and results of hereof can be found in Appendix 9.8. Based on the results of this questionnaire, ten processes were deemed relevant regarding the servitization phenomenon. Subsequently, the relevant process owners were invited for an in-depth interview regarding the earlier found internal servitization barriers within the firm.

Three solution design and change plan iterations were made through three semi-structured interviews (formative evaluation) with the business control manager (i.e. company supervisor). After this formative evaluation step, summative evaluation was performed with the SBU managers, CCO, COO, and the business control manager through semi-structured interviews. The goals of the evaluation were inspired by Venable et al. (2016). First, to determine how well the designed solution achieves the main purpose of the solution. Second, to evaluate the formulated CAMO principles based on theory and practice leading to the designed solution.

Focus group

Due to time constraints and the participant's agendas, the planned focus group to evaluate the solution design with all SBU managers was divided into a smaller focus group and several individual semi-structured interviews. The focus group was conducted with the managers of the SBUs, which were also included in earlier interview rounds. During a focus group, a panel of experts on a specific topic is asked to discuss open questions and relevant issues (Blumberg et al., 2014). Focus groups present several disadvantages which the organizer must be aware of and cope with accordingly. Firstly, the organizer should be well-trained to intervene during the meeting. Secondly, dominant participants might overrule other participants or disproportionally provide more information than others (Blumberg et al., 2014).

2.2.3 Empirical data analysis

The empirical data analysis is conducted systematically to obtain reliable information as much as possible. Furthermore, data analysis methods described by Van Aken et al. (2012) and Blumberg et al. (2014) served as input for the chosen data analysis methods.

Within this research, content analysis is applied. Content analysis is a research technique used to make replicable and valid inferences by interpreting and coding textual material. This analysis method was deemed appropriate as it is a useful tool to analyze qualitative data, such as documents or transcripts of qualitative interviews and focus groups (Blumberg et al., 2014). Content analysis is a helpful tool to categorize the data into groups of similarity, reducing the amount of information. However, this method is subject to interpretation bias. To reduce this to a minimum, the coding process, codes, and interpretation of a small number of codes were discussed with a colleague researcher with the same educational background, working at PT. Furthermore, this research applied a template approach to coding (similar to directed content analysis). A template approach, or directed-content analysis, uses existing concepts and theories as input within the coding process. As both the theoretical and empirical analyses were carried out simultaneously, the initial literature on servitization found within the exploration phase was used to develop an initial coding scheme. This initial coding scheme was based on servitization stages, categories,

and servitization barriers and challenges. The initial coding scheme can be found in Appendix 9.9. Based on the explorative literature and the empirical data, open coding was applied to discover new information and validate this with the pre-existing literature. Lastly, axial coding was used to define groups of codes, categorizing and grouping the data.

The data collected during all data collection rounds was recorded[1], transcribed, and coded, including the first exploration round. The final evaluation step was only transcribed to interpret the findings. The coding process was done using the software package NVivo, which is a suitable tool to transcribe the collected data. Moreover, it can be used for both qualitative and quantitative data. The coding process was executed in an iterative manner where the transcripts have been read multiple times to improve coding consistency. This was also done between the individual transcripts, where a transcribed document early in the data collection process was checked later on the consistency of coding.

To analyze the collected data, open coding was applied in addition to an initial coding scheme. Within the interviews, a product-service template was used. This template is based on the servitization pyramid by Coreynen et al. (2017), discussed in more detail in Chapter 3.1.4. The template can be found in Appendix 9.10. The template was used to explain the servitization phenomenon clearly to the interviewees. While sharing the researcher's screen, the template was filled in by the researcher and the interviewee. Subsequently, the servitization barriers and challenges were coded in specific barriers and challenges for each quadrant, also making a distinction between internal and external barriers. Barriers and challenges not specific to a quadrant were grouped in a generic category. Based on the subsequent interview with the industry expert on servitization, servitization maturity models were added as a framework. This resulted in a comprehensive overview of the services currently offered within the case company and their future ambitions.

After several rounds of open coding, axial coding was applied to link and cluster relevant similar codes based on their topic. This resulted in an abstract overview of servitization barriers within the case company. The overview is based on two main categories: internal and external servitization barriers. By grouping the challenges and barriers within categories, linkages between codes are determined. The (final) coding scheme can be found in Appendix 9.11.

2.3 Design

Within the third step of the research approach (creation), a solution is designed based on design science and CAMO principles. This solution design answers the fourth sub-research question; how should the transition to other product-service combinations and an improved service offering be formulated? The CAMO principles are synthesized based on the results of the theoretical and empirical analysis. Moreover, solution directions and requirements for the design were derived from the conducted interviews. Resulting in functional requirements, boundary conditions, and user requirements, in line with Van Aken et al. (2012). The solution design was developed within three iterations with the company supervisor and evaluated according to the process described in chapter 2.2.2.

[1] The respondents are asked permission before recording the conversation as defined in the General Data Protection Regulation (GDPR) from the EU.

2.4 Quality of the research

Empirical quality is an essential criterion in academic research. The most important research-oriented quality criteria are controllability, reliability, and validity (Yin, 2003). For the research to be controllable, researchers have to explain how they executed a study. Practically, this means that data collection methods and participants are discussed with the supervisors and explained in detail within this thesis. Furthermore, the coding process is explained, and an initial and final coding scheme are included as appendices.

Van Aken et al. (2012) explain that reliability can be interpreted as research independent of the researcher, meaning that other studies could replicate the research. Four types of biases can lead to unreliable results; these are the researcher, the instruments, the respondents, and the circumstances (Van Aken et al., 2012). Each of the potential biases and how these are reduced to a minimum is explained subsequently. First, the researcher's potential bias is reduced to a minimum by regular feedback meetings with the company supervisor. Second, instrument reliability was achieved using multiple research instruments; an approach called triangulation (Yin, 2003). This research used documents, interviews, and focus groups as data collection methods. Third, by conducting a large number of interviews throughout all layers of the organization (some respondents were interviewed multiple times), respondent reliability increased. Lastly, to reduce the impact of circumstances on the reliability of the research, data was collected at different moments in time. It must be noted that due to the impact of Covid-19, the circumstances were not ideal. As working-from-home was the de-facto standard and video calling inhibited personal face-to-face contact.

A third requirement to ensure the quality of the research is validity. Research results are valid when justified by the way it is generated (Van Aken et al., 2012). The construct of validity can be divided into construct validity, internal validity, and external validity. Construct validity is ensured by using data collection methods that cover the aim of the research. Furthermore, the guides for data collection are reviewed by the supervisors to obtain high validity. Internal validity is achieved as much as possible by reaching saturation of the data; in other words, when new data collection methods do not reveal further information. Regarding external validity, a limitation might present itself within this research. Although the literature offers a very general view of the servitization phenomenon, the data collected within the case company is specific to that context. Researching other companies could improve external validity. However, interviews with different companies would require the same level of detailed analysis, which would be challenging to achieve within the time available within this research. Moreover, it would require firms in a similar context with a similar business problem. It could be challenging to find these companies. Conclusively, the unit of analysis was within a single case (PT). To improve external validity, future research could be executed among other (similar) firms.

3. Literature review

This chapter elaborates on the outcome of the narrative and systematic review of the literature. It answers the first three sub-research questions from a theoretical perspective. The chapter firstly introduces the topic of servitization. Moreover, it investigates what product-service combinations are there (i.e. how can different product-services be defined). The second section elaborates on the barriers and challenges faced by manufacturing firms in servitization. Lastly, the third section introduces transition actions and mechanisms for firms to successfully transition along the product-service continuum, overcoming the challenges and barriers of servitization.

Before moving on, clarifying what separates services from goods and how service is defined within this research is required. Different from tangible goods, a service can be almost any human activity. A service can be defined as a deed, a performance, or an effort (Rathmell 1966). A more refined definition of services is the application of specialized competences (i.e. knowledge and skills) through deeds, processes, and performances to benefit another entity (Vargo & Lusch 2004). While in many organizations the label service is used to describe repair and maintenance activities only; here, service is used to describe all activities in which value for a customer is created where production and consumption happen simultaneously.

3.1 Servitization

This section introduces the topic of servitization. A definition of servitization is presented and discussed, covering the concepts closely related to servitization. To understand the servitization transition, the concept of the product-service continuum is introduced, concluding with an integrated servitization framework.

3.1.1 Definition

Vandermerwe and Rada (1988) first mentioned the term servitization and can be most comprehensively explained as the process of creating value by adding services to products (Baines et al., 2009). In servitization, manufacturing firms adopt new approaches to extend their offering with bundled goods, services, support, self-service, and knowledge (Vandermerwe & Rada, 1988).

Although offering services to customers has been the main activity of manufacturing firms for some time, servitization entails a different view and approach. Traditionally, the tendency of managers has been to view services as a necessary evil in the context of marketing strategies; here, services were seen as an add-on to products where the main value offered to customers was considered to stem from physical goods (Baines et al., 2009). Servitization entails that, rather than viewing service activities as unpleasant necessities connected to the sale of products (Wise & Baumgartner, 1999), service activities are seen as activities that create value. Within this research, the definition of Baines et al. (2009) is followed, which define servitization as follows:

> *"Servitization is the innovation of an organizations capabilities and processes to better create mutual value through a shift from selling products to selling Product-Service Systems" (Baines et al., 2009, P3).*

3.1.2 Related concepts

Other research fields are closely related to servitization, such as the research field on product-service systems (PSS). A PSS is a type of business model that combines products and services to fulfill customer needs (Tukker, 2004). Although strong resemblances between the two research fields (Tukker, 2004), there are differences found within the motivation and geographical origin of both research

communities; PSS is primarily related to sustainability and reduction of environmental impact (Baines et al., 2009). As sustainability and environmental impact are not directly related to the case companies' problem and the formulated research question, the term PSS is not used further within this research. However, the term product-service combination is used to denote the (combined) offering of products and services along the product-service continuum, which will be explained further in section 3.1.4.

Similar to servitization, the term service infusion is used in reference to the growing service component in many product-centric firms (Kowalkowski, 2014). Literature is ambiguous about the similarities and differences between servitization and service infusion, and the two terms are used in the extension of each other throughout the examined literature (Kowalkowski, 2014). However, there is a common understanding that service infusion in manufacturing firms is primarily linked to the offering of the business model, where the relative importance of a firm's service offering increases, amplifying its service portfolio, and augmenting its service business orientation. Whereas servitization also encompasses the transition of companies to a service-centric business model and logic, including cultural and attitudinal changes (Grönroos, 2006; Normann, 2001). Prior research confirms that the established product-centric organizational culture and business logic within firms might impede service growth (Gebauer & Friedli, 2005; Homburg, Fassnacht, & Guenther, 2003; Sawhney et al., 2004). Therefore, it is wise to include these perspectives as well within this research. To conclude, servitization can be seen as a more comprehensive term covering aspects within service infusion and other elements such as culture and company logic (Kowalkowski et al., 2017). Moreover, the body of literature using the term servitization compared to service infusion is much larger. Therefore, the term servitization will be used in this research.

3.1.3 Product-service continuum

A transition must be made for firms to follow the servitization path and move from any current place on the product-service continuum to any desired place on the same continuum. For example, a traditional product manufacturer venturing into a value-added manufacturer, or even to a full-service provider. These transitions occur along a product-service continuum. The product-service continuum ranges from high importance of tangible goods with services as add-ons to a high importance of services with tangible goods as add-ons (Oliva & Kallenberg, 2003), see Figure 7 below. It is used commonly by scholars and practitioners studying firms engaged in servitization to locate them on a specific spot on this continuum. Relevant questions within this construct asked in research are what products and services companies currently offer, why they want to expand their offering, with what services, and to what extent. In line with scholarly research, Vandermerwe and Rada (1988) highlight the challenge for top management regarding how far to go, what services to choose, and when more services are too much.

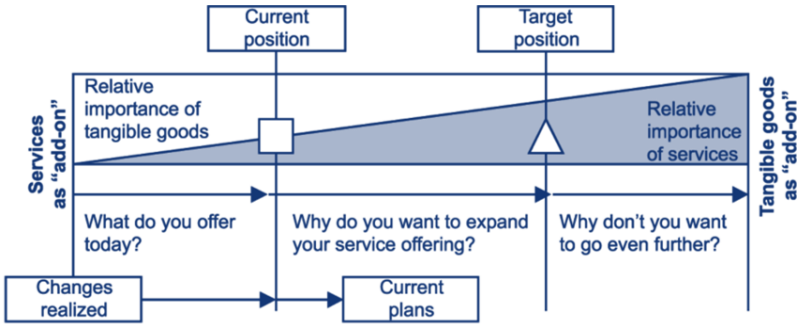


Figure 7: product-service continuum (servitization) by Oliva and Kallenberg (2003)

Service-related sales tend to have higher profit margins than mere product sales (Baines et al., 2009). Nevertheless, a firm's movement towards the right side of the continuum does not necessarily provide the expected higher returns, which is within the literature commonly described as the servitization

paradox (Gebauer et al., 2005). The servitization paradox is a situation where investment in extending the service business leads to an increased service offering and higher costs but does not generate the expected corresponding high returns (Gebauer et al., 2005). However, a firm's movement towards the right side of the continuum means that its portfolio consisting of services and service activities is seen as more important.

To further explain services and their relationship with tangible goods, it is convenient to use different categories. Within the literature, a wide variety of service categorizations are used. Originally developed by Tukker (2004) to categorize PSS, a much-used categorization within academia and practice is based around a firm's revenue model. Although initially developed to categorize PSS, it is also used to classify products and services within the general field of servitization. The categorization describes whether the provider promises to perform a deed (i.e. input-based), availability of a product (i.e. performance-based), or agree on a result (i.e. output-based).

Parida et al. (2014) argue that the categories originally proposed by Tukker (2004) are highly generalized and suggest a more differentiated categorization. This more detailed view on the categorization of services continues to build on the PSS definition by Tukker (2004) and shows a more refined version where the focus of the service receives a central place (Kindström & Kowalkowski, 2014; Ulaga & Reinartz, 2011), see Figure 8. This service focus can be broadly divided into product focus and customer process focus. A provider may offer services focused on the functioning of their products or services designed to improve the customer's processes (Ulaga & Reinartz, 2011).

The service focus on products aligns with the case company's situation and the formulated research questions within this research. Therefore, this view is further elaborated and used in this research. Here, services are divided into input-based services focused around the lifecycle of the product (e.g. spare parts, repair), performance-based services (e.g. preventive maintenance, remote monitoring), and result-based services (e.g. functional result).

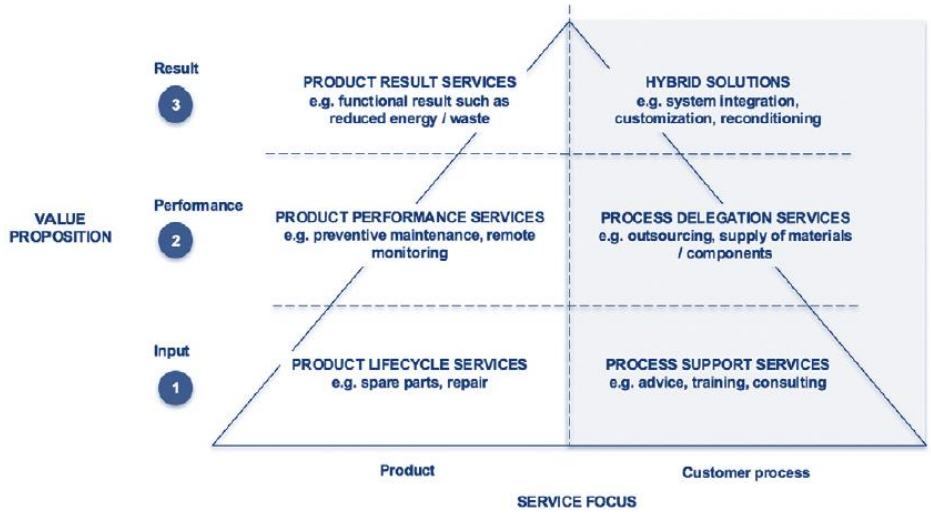


Figure 8: servitization pyramid by Coreynen et al. (2017)

To better understand how firms make the servitization transition, maturity models can provide guidance and a supportive framework. A maturity model shows how capable an organization or system is in achieving specific goals. Moreover, it shows the level of an organization or system regarding a specific topic. The Service Maturity Model (SMM) by Atos Consulting (2011) and further defined by ABN AMRO (2016) provides a detailed overview regarding servitization. The SMM by Atos Consulting (2011) is attached in Appendix 9.12. It consists of four maturity levels which will be explained in more detail below. Moving from maturity level one (i.e. product manufacturer) to maturity level four (i.e. integrated solutions

provider), the firm's business model(s) and organizational structure become more service-oriented; and thus more mature regarding services (Atos Consulting, 2011). This corresponds to moving to the right side of the product-service continuum (Oliva & Kallenberg, 2003). To illustrate the maturity levels, examples of the types of services offered within each maturity level are given based on ABN AMRO (2016). It is important to note that moving to the right side of the continuum increases the portfolio of services offered, where firms build upon the services offered in the first maturity level. Moreover, the categories are not mutually exclusive and exceptions do exist.

The first maturity level is labeled product manufacturer. Services offered here include break-fix service (i.e. repair), commissioning & guarantee, spare parts supply, and advice & consultancy. The second maturity level is labeled value-added manufacturer. Services offered here include (preventive) maintenance, integration & training, and spare parts management. The third maturity level is labeled full-service provider. Services offered here include information management and leasing or renting. The last and fourth maturity level is labeled integrated solutions provider. Services offered here include managed services and output services. The maturity levels differ from each other on a range of different elements specific to the business model; these are the maturity of the market, the type of relationship with the customer, the value proposition, the service proposition, the percentage of service revenue, and the type of revenue model. The complete overview is attached in Appendix 9.12.

3.1.4 Servitization framework

To analyze the case company's current portfolio and future ambitions and determine its maturity regarding servitization, an integrated servitization framework is set up (see Figure 9). This framework combines the previously described product-service continuum by Oliva and Kallenberg (2003), the servitization pyramid by Coreynen et al. (2017), and the servitization maturity levels by Atos Consulting (2011). These are depicted on the horizontal axis at the bottom of the framework. Furthermore, the six business model elements from the SMM from Atos Consulting (2011) are also incorporated and depicted on the left side of the framework. The following example illustrates this; when a firm's maturity level can be defined as a product manufacturer, service is seen as a necessity where the service proposition mainly focuses on product sales and warranty.

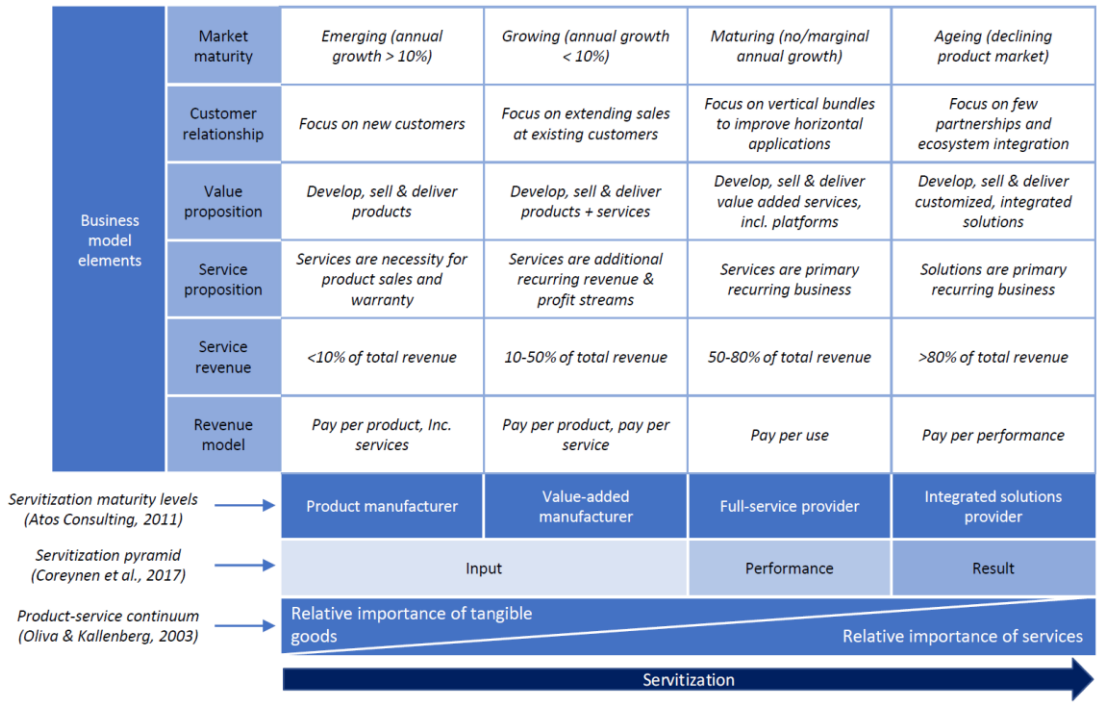


Figure 9: integrated servitization framework

3.2 Barriers & challenges in servitization

This section introduces servitization barriers and challenges of manufacturing firms found within the literature. It contributes to answering the second sub-research question; what are the barriers that inhibit PT to follow the servitization path?

Although the literature is scarce in detailing the barriers and challenges inherent in the transition to services (Oliva & Kallenberg, 2003), the analysis of the literature reveals three servitization perspectives. These are an internal perspective (intra-organizational), an external perspective, and a technological perspective (Vandermerwe & Rada, 1988). These perspectives were also mentioned during the interview with an expert on the topic of servitization. The study by Neely and Hou (2013) is used as a frame of reference within the analysis. Their work covers a broad range of studies through a systematic review of literature focused on servitization barriers. The reference frame was supplemented with an additional 32 articles covering servitization barriers and challenges of manufacturing firms. Based on the absence of technological barriers within the empirical analysis, the technological perspective is not included in the literature review.

3.2.1 External servitization barriers

The external perspective covers external barriers faced by manufacturing firms within the servitization transition. The literature describes two main categories: competitors, suppliers, & partners, and customers (Neely & Hou, 2013). Table 3 shows an overview of the external barriers found in the literature. The article by Neely and Hou (2013) distinguishes existing barriers before servitization and barriers during servitization. As this distinction was not found in most other studies covering servitization barriers and challenges, this distinction was not applied within this research.

Vandermerwe and Rada (1988) explain that venturing into servitization can change the business the firm is in, resulting in increased competition with competitors, but possibly also with suppliers, partners, or even customers. This highlights the challenge of the increasingly complex competitive environment of the servitization phenomenon for firms. Regarding customers, servitization requires a more extensive supplier-customer relationship focusing on service co-production, effective information management, and knowledge about the business context of customers (Brax et al., 2005). Additional challenges are the growth of heterogeneous market demands and the lack of control over customers' behavior. Moreover, customer trust in the supplier firm and acceptance of different types of product-service combinations present additional complexities of the servitization phenomenon.

Table 3: external servitization barriers

Main barrier category	External servitization barriers	Source(s)
Competitors, suppliers, & partners	Complex competitive environment involving different actors	Vandermerwe & Rada (1988)
Customers	Extensive supplier-customer relationship	Brax et al. (2005)
	Heterogenous demands	Vandermerwe (1994)
	Lack of trust from customers	White et al. (1999)
	Difficult to get cooperation & acceptance from customers	Vandermerwe & Rada (1988)
	Lack of control over customer's behaviors	Heiskanen & Jalas (2003)

One of the barriers mentioned in the research by Neely and Hou (2013) is not included in the table above. This barrier is called society & environment. Due to this barrier focusing solely on the sustainability aspects of PSS, it is not of relevance here and thus not included.

3.2.2 Internal servitization barriers

An analysis of the literature on servitization barriers reveals that literature has mostly emphasized internal aspects as the main challenge for firms transitioning along the product-service continuum (Mathieu, 2001; Brax et al., 2005). Servitization involves a different strategic thrust, level of organizational complexity, and an order where the old traditional managerial recipes no longer fit (Vandermerwe & Rada 1988). Transitioning along the product-service continuum constitutes a major managerial challenge as services require organizational principles, structures, and processes new to the product manufacturer (Hellander & Möller 2008; Oliva & Kallenberg 2003; Baveja, Gilbert, and Ledingham 2004; Neu & Brown 2008). Moreover, these transitional efforts require significant managerial commitment as the new set of capabilities diverts financial and managerial resources from the firm's traditional sources of competitive advantage (Oliva et al., 2012). As described by Kotter (1995), managerial commitment is a crucial ingredient for successful organizational change. An overview of the internal servitization barriers found within the literature is presented in Table 4. Again, the article by Neely and Hou (2013) is used as a frame of reference, also incorporating barriers found within other studies.

Table 4: internal servitization barriers

Main barrier category	Internal servitization barriers	Source(s)
Financial	Lack of capital for investment	DiPeso (2000)
	Difficult to price services	Steinberger et al. (2009)
Resources, capabilities, knowledge & information	Lack of human resources	Cook et al. (2006)
	Lack of expertise	Brax et al. (2005)
	Lack of understanding of customer demands and product properties	Mont (2002)
	Lack of innovation ability	MacDonald et al. (2011)
Activities & processes	Difficult to design service packages or scenarios	White et al. (1999)
	Difficult to measure services	White et al. (1999)
	Missing market-oriented and clearly defined service development process	Gebauer et al. (2005)
	Lack of value selling, focusing service offers on the value proposition to the customer	Gebauer et al. (2005)
	Lack of relationship marketing	Gebauer et al. (2005)
	Lack of clear service strategy	Brax et al. (2005); Davies (2003); Gebauer et al. (2005); Oliva & Kallenberg (2003)
Organizational structure	Lack of service-based organizational structures	White et al. (1999)
	Separate service SBU	Oliva & Kallenberg (2003); Gebauer et al. (2005)
	Lack of (global) infrastructure (i.e. to respond to service requirement locally)	Maxwell et al. (2006); Oliva & Kallenberg (2003)
Firm culture	Lack of service-oriented culture	Mont (2002); Oliva & Kallenberg (2003); Gebauer et al. (2005)
Cognitive phenomena managers	Sticking to what they know best and risk aversion of the uncertainty of services (internal resistance to servitization)	Vandermerwe & Rada (1988); Gebauer et al. (2005)
	Overemphasis on obvious and tangible characteristics	Gebauer et al. (2005)
	Failure to recognize the economic potential	Gebauer et al. (2005)

Manufacturing firms venturing into services may encounter different financial challenges. DiPeso (2000) explains the need for capital investment to extend the service business and successfully market

product-service combinations, where the supplier firm maintains ownership. Separately, the costs associated with servitization can result in a short-term performance decline before leading to substantial financial returns (Visnjic et al., 2014), described as the servitization-paradox.

Another barrier for manufacturing firms described in the literature is the lack of service capabilities, knowledge, and information. Specific resources and capabilities are needed to transition along the product-service continuum (Gebauer et al., 2008; Neu & Brown, 2008; Kowalkowski & Kindström, 2014; Oliva & Kallenberg, 2003; Visnjic & Van Looy, 2013). The category of knowledge & information proposed by Neely and Hou (2013) is adapted to include resources and capabilities. Firms seldomly understand how the resources and capabilities that underpin manufacturing extend to enable service innovation (Spring & Araujo, 2013; Ulaga & Reinartz, 2011). When firms eventually understand this, their resources and capabilities to transition might be insufficient or even counterproductive (Kowalkowski & Kindström, 2014). In line with the previously described financial challenge, manufacturing firms find it difficult to augment their sales arguments, capabilities, and pricing models to align with more service-based value propositions (Coreynen et al., 2017). Conclusively, firms need to invest in operational service capabilities and resources such as service delivery, service sales skills (Barney, 1991; Peteraf, 1993), and information systems and tools for services (Penttinen & Palmer, 2007); including more dynamic capabilities enabling service deployment (Teece et al., 1997) from a managerial and reorganizational perspective (Visnjic & Van Looy, 2013).

Initially named by Neely and Hou (2013) as products & activities, this category focuses on the development of products, services, and how to measure services; this category can be extended to emphasize and include processes as well. There are major barriers to servitization for manufacturing firms, which can be found in a firm's activities and processes (Oliva & Kallenberg, 2003). Manufacturing firms venturing into servitization require different organizational processes in place (Neu & Brown, 2008; Oliva & Kallenberg, 2003; Vargo & Lusch, 2004). For example, the need for a clearly defined and market-oriented service development process (Gebauer et al., 2005); presenting new activities and definition challenges for manufacturers (Bjurklo et al., 2009; Reed & Storrud-Barnes 2009; Baines et al., 2009).

A firm’s organizational structure can be defined as the specific arrangement of organizational design factors and can pose a significant barrier for manufacturing firms venturing into servitization (Gebauer et al., 2010). Kowalkowski et al. (2014) argue that an adequate organizational structure inhibits servitization, and an appropriate structure facilitates it. An example hereof are the structural differences between a product manufacturer that provides few services and merely supports the product's functioning and a full-service provider that offers advanced services such as preventive maintenance (Gebauer et al., 2010; Raddats et al., 2015). Conclusively, Gebauer et al. (2010) argue for the need to align organizational design with a firm’s service strategy.

A firm’s culture has been posited frequently within the literature as a barrier to servitization; as firms have to gradually change their product-centered culture into a service-oriented culture, depending on their desired place on the continuum (Mathieu 2001; Brax et al., 2005; Gebauer et al. 2012; Vargo & Lusch 2004). Unfortunately, product-centered manufacturing firms often are unwilling to change from their prevailing product-centric practices, norms, and values (Kowalkowski & Kindström, 2014).

The last category of servitization barriers found within literature is the cognitive phenomena of managers (Gebauer et al., 2005; Vandermerwe & Rada, 1988). Although not explicitly categorized in the article by Neely and Hou (2013), it deserves special attention as it is mentioned frequently within the analyzed body of literature. Finne et al. (2013) describe that the servitization challenges are mostly related to managerial issues and internal to the supplier firm. Managers may doubt the economic potential of

services or perceive service as beyond their scope of competences (Oliva & Kallenberg, 2003; Gebauer et al., 2005). Moreover, managers may overemphasize obvious and tangible characteristics (Gebauer et al., 2005).

3.3 Servitization transition

This section introduces the different approaches visible within the literature to examine the servitization transition. It continues with an overview of the actions and mechanisms found within the literature for manufacturing firms to successfully transition along the product-service continuum.

3.3.1 Servitization transition approaches

There are different approaches to servitization visible within the examined literature. A first approach is a business model (re-)design approach (Kowalkowski & Kindström, 2014; Visnjic & Van Looy, 2013; Barquet et al., 2013; Witell & Löfgren, 2013). A business model explains a firm's approach to making money, who its customers are, and what customers value that is important to address (Magretta, 2002). Moreover, it covers revenue models, structures, activities, processes, customer relationships, and the firm's position in the ecosystem (Chesbrough, 2007). A well-known framework is the business model canvas by Osterwalder and Pigneur (2010). Kindström (2010) argues that the strategic alignment towards servitization should be visible in changes throughout the business model. Although frequently used within the body of literature examined, the business model approach only covers a portion of the servitization transition which on its own might not be enough to successfully make the transition (Spring & Araujo, 2013; Ulaga & Reinartz, 2011). For example, the business model approach does not include soft elements such as culture. Kowalkowski and Kindström (2014) exemplify this by proposing an alternative version of the business model canvas, the service business model. Furthermore, an appropriate organizational architecture must be developed according to the chosen business model (Atos Consulting, 2011; Gebauer et al., 2006; Galbraith, 2002; Quinn et al., 1990). Although vital for any firm, the business model approach covers many external factors such as key partners, key activities, customer relationships, customer segments, and distribution channels (Osterwalder & Pigneur, 2010). Another approach found within literature is intra-organizational, focusing on the internal aspects of the business model only. This intra-organizational approach covers a firm's organizational structure, resources & capabilities, activities & processes, and culture & cognitive aspects.

3.3.2 Servitization transition actions and mechanisms

An analysis of literature on transition actions and mechanisms for manufacturing firms to successfully achieve servitization is necessary. An overview of these transition actions is presented in Table 5. There is a large body of literature focusing on individual transition aspects, focusing on the business model, culture, organizational design, capabilities, and more. However, only a few articles take a holistic approach covering all elements required to successfully transition (Baines et al., 2009). Therefore, within this research, a firm's service strategy, business model, culture & cognitive phenomena of managers, organizational structure, activities & processes, and resources & capabilities are incorporated. The actions and mechanisms corresponding to each category are described next.

Table 5: servitization transition actions

Category	# articles	Action(s)	Source(s)
Service strategy	4	Develop a clear service strategy	Gebauer et al. (2005); Gebauer et al. (2010); Quinn et al. (1990); Coreynen et al. (2018)
Business model	4	Incrementally change business model elements	Amit et al. (2012); Neu & Brown (2008); Kindström (2010); Geum et al. (2011); Atos Consulting (2011)
	3	Radically adapt or develop a new (service) business model	Barquet et al. (2013); Witell et al. (2013); Atos Consulting (2011)
Firm culture & cognitive phenomena	6	Cultural change service culture (i.e. business logic); that supports the integration of goods and services	Oliva et al. (2003); Gebauer et al. (2005); Kowalkowski & Kindström (2014); Raddats et al. (2015); Ryan (2013); Kowalkowski (2011); Salonen (2011)
	2	Managerial commitment	Donaldson (1995); Kotter (1995)
Organizational structure	2	Appropriate organizational structure	Kowalkowski & Kindström (2014); Atos Consulting (2011)
	7	Align organizational structure to service strategy	Bessant & Davies (2007); Fisk et al. (2011); Galbraith (2002); Gebauer (2008); Gebauer et al. (2010), Neu & Brown (2005); Reinartz & Ulaga (2008)
	6	Separate service organization	Oliva & Kallenberg (2003); Baines et al. (2009); Sawhney et al. (2004); Kowalkowski & Kindström (2014); Oliva et al. (2012); Gebauer et al. (2010)
	2	Tight integration and intra- and inter-firm collaboration (integration of services into the product business)	Galbraith (2002); Homburg et al. (2000)
	3	Field service organization: create an infrastructure to respond to local demand	Oliva & Kallenberg (2003); Kowalkowski & Kindström (2014); Ulaga & Reinartz (2011)
Activities & processes	1	Market-oriented and clearly defined service development process	Gebauer et al. (2005)
	2	Monitor effectiveness & efficiency of service delivery	Gebauer et al. (2005); Oliva & Kallenberg (2003)
	1	Initiating relationship marketing	Gebauer et al. (2005)
Resources & capabilities	10	Service-related resources and capabilities	Den Hertog et al. (2010); Fischer et al. (2010); Kowalkowski & Kindström (2014); Coreynen et al. (2017); Ulaga & Reinartz (2011); Parida et al. (2014); Penttinen & Palmer (2007); Teece et al. (1997); Kowalkowski et al. (2013); Bjurklo et al. (2009); Paiola et al. (2012)
	1	Motivating co-production, relationship building, information management	Gustafsson et al. (2005)

1. Service strategy

For manufacturing firms to transition along the product-service continuum and support different services and business models, they need to develop a service strategy (Gebauer et al., 2005; Gebauer et al., 2010; Quinn et al., 1990). This is further emphasized by Coreynen et al. (2018), who explain that manufacturing firms need to take a pro-active approach and develop a service strategy rather than being reactive. The lack of a clear service strategy will lead to an unsuccessful endeavor (Gebauer et al., 2005; Davies, 2003; Oliva & Kallenberg, 2003; Gebauer, 2005; Brax et al., 2005). As explained by Gebauer et al. (2008), the strategy element can depend on the unit of analysis. Moreover, manufacturing firms can pursue distinct strategies (Govindarajan, 1989), which at the same time, can differ in terms of competitive positioning from the corporate strategy (Gupta & Govindarajan, 1984). Conclusively, alongside a more general emphasis on services within the corporate strategy, different SBUs can have various strategies.

Gebauer et al. (2005) explain that successful firms go through two phases regarding service strategy. In the first phase, the service strategy was an evolving strategy for manufacturing firms, as the strategy here was not deliberate or explicit (Mintzbergh & Waters, 1985). Here, services are offered as an add-on to the product where the contributions on services are relatively low in terms of strategy. In the

second phase, a deliberate service strategy is implemented with a clear focus on increasing the total value created through services (Gebauer et al. 2005).

Developing a service strategy requires different fundamental requirements. Gebauer et al. (2005) propose three requirements: first, a successful service strategy cannot be developed without a comprehensive understanding of the market regarding customer needs, market potential, and future service trends. Second, once the information relevant to the strategy has been collected, all areas of the firm affected by the strategy are involved in the development process. Third, the entire strategy development process must be systematically transparent. Gebauer et al. (2005) also describe that the service strategy should define how the company differentiates itself from competitors through its service offering. Other requirements are that the service strategy is aligned with corporate goals (Gebauer et al. 2008). Furthermore, Gebauer et al. (2008) explain that the strategy's service orientation should also be determined, including the number of services offered and how strongly these are emphasized to customers.

2. Business model

As explained earlier, the business model must be redesigned for successful servitization. Here, there are two approaches highlighted in the literature. The first approach is to reconfigure the elements of the business model. The second approach is to develop a new (service) business model. This choice is highly dependent on the type of products and services offered, as more radical propositions further to the right of the product-service continuum arguably require the development of a new business model, as opposed to changing only specific elements when the change is incremental (Coreynen et al., 2017; Kowalkowski & Kindström, 2014). Atos Consulting (2011) elaborates on six specific business model elements that need to be changed to transition along the product-service continuum; these are the maturity of the market, the relationship with the customer, the value proposition, the service proposition, the service revenue, and the revenue model. A detailed overview of the recommended changes for each maturity level is depicted in Figure 9 of Chapter 3.1. Interesting are the following three elements: first, the value proposition, emphasizing what is sold commercially to the customer. Second, the service proposition, emphasizing whether services are a necessity or a value-added component. And third, the revenue model, whether the customer pays only for products and not for services, specifically for services, or even pay-per-use or pay-per-performance.

Firms need to carefully consider the type of business model they want to deploy. Most firms offer lower value-added services at first, such as maintenance and installation services, and later move to higher service levels, such as training, leasing, and operational services (Coreynen et al., 2018). In this transition process, firms generally do not abandon the first level of services but rather build a new level on top of the first, managing the co-existence of various supplier roles (Parida et al., 2014; Kowalkowski et al., 2015). This transition seems to be the most common choice for manufacturing firms since they can use earlier gained knowledge moving forwards (Eggert et al., 2014; Visnjic et al., 2014).

3. Firm culture & cognitive phenomena managers

A significant factor in any change of business strategy is the firm's existing culture (Nadkami & Narayanan, 2007; Gebauer et al., 2008; Neu & Brown, 2008; Oliva & Kallenberg, 2003). Within the analyzed literature, the term culture is interchangeably referred to as business logic (Ryan, 2013). Within the servitization phenomenon, three broad business logics can be defined; goods-dominant logic, service-dominant logic, and in between these two, an integrated logic. The transition is not a one-dimensional effort to transform manufacturing organizations into service-oriented organizations, but a deliberate and balancing act in which multiple business logics must co-exist (Windahl & Lakemond, 2010); this is deemed

an integrated logic (Ryan, 2013). Kowalkowski (2010) argues that firms that do not transition entirely to the right side of the continuum should not substitute the goods-dominant logic with service-dominant logic; instead, an integrated approach should be taken.

Gebauer et al. (2010) explain that the culture within manufacturing firms can be divided into the values and behavior of management and the values and behavior of individual employees. Moreover, Kowalkowski and Kindström (2014) explain that although large-scale cultural change requires time, certain measures can prompt shorter effects. For example, firms can create internal awareness of the importance and potential of adding services. Furthermore, firms can replace the outdated terms of (for example) "after-sales service" with "services" and "service solutions", which signals a shift in mindset (Kowalkowski & Kindström, 2014). Moreover, to drive change and foster a service-oriented culture, service leadership capability is necessary. As established product-driven firms are often unwilling to change from their product-centric practices, norms, and values, leadership is needed to attract and retain key individuals working with service (Kowalkowski & Kindström, 2014). Managers should commit to extending the service business and change their thinking from services as add-ons to services as value-added activities (Gebauer et al. 2005). Moreover, leadership can also boost value-added thinking towards the employee level (Gebauer et al. 2005).

4. Organizational structure

The effective implementation of a service strategy requires not just managerial motivation but also supporting organizational arrangements (Gebauer et al., 2005). In line with Gebauer et al. (2005), the research by Oliva et al. (2003) proposes to create a separate organization to handle the service offering; with a dedicated sales force, service technicians, and information monitor system to track and monitor the business. In doing so, both cultural and cognitive barriers can be reduced or even overcome as this separate unit can focus on extending the service business. Furthermore, running the product-service business separately could mitigate the risk of moving outside the existing organizational capabilities (Sawhney et al., 2004).

There are mixed opinions within the literature on whether the service business should be integrated or disintegrated from the product business. As described above, Oliva and Kallenberg (2003) suggest separating the service and product business. In contrast, Neu and Brown (2005) propose to integrate the product and service business. The more recent research by Gebauer et al. (2010) gives guidance to these contrasting views to make the separation or integration decision based on the service strategy. The authors argue that a separation of the service business is preferred for the strategy of customer support services, operational services, and maintenance services. In contrast, with R&D-oriented services, the product and service business should be integrated ideally.

For manufacturing firms to transition along the product-service continuum and extend the service business, the right infrastructure must be set up to respond to local demand (Oliva & Kallenberg, 2003; Kowalkowski & Kindström, 2014; Ulaga & Reinartz, 2011). Thus, this requires manufacturing firms to set up a field-service organization.

5. Activities & processes

For manufacturing firms to make the servitization transition, they need to establish a market-oriented and clearly defined service development process (Gebauer et al., 2005). Here, information about the needs of the customer is obtained through market research and lead customers. Moreover, Gebauer et al. (2005) argue that service offers should be focused on the value proposition to the customer. Furthermore, Gebauer et al. (2005) advocate that relationship marketing should be initiated, rather than the traditional

transactional view on sales. Also vital for manufacturing firms is to monitor the effectiveness and efficiency of service delivery (Gebauer et al., 2005; Oliva & Kallenberg, 2003). This monitoring system can enable firms to account for service's contributions to the business and could also be used to make a case to the rest of the organization on how important services are for the firm's profitability (Oliva & Kallenberg, 2003).

6. Resources & capabilities

Prior research outlines several general resources and capabilities that manufacturing firms need to acquire for successful servitization (Coreynen et al., 2018). Examples hereof are the research by Ulaga and Reinartz (2011) and Kowalkowski and Kindström (2014). Ulaga and Reinartz (2011) explain four types of resources necessary for successful product-service offerings: data on the installed base product usage, product development and manufacturing assets, product sales force and distribution network, and field service organization (can be interpreted as a resource). Moreover, they explain the following necessary capabilities: service-related data processing and interpretation capability, execution risk assessment and mitigation capability, service design capability, product-service sales capability, and product-service deployment capability. Furthermore, Kowalkowski and Kindström (2014) elaborate on a list of resources and capabilities for service innovation, a necessary component within servitization. This list of resources and capabilities is categorized based on the service business model. A comprehensive list is included in Appendix 9.14.

3.3.3 Generic transition frameworks

A large body of the examined literature focuses on descriptive guidelines and arrangements (Baines et al., 2009). Examples hereof are articles by Gebauer et al. (2005), Baines et al. (2007), Goedkoop et al. (1999). This was also mentioned by the industry expert interview, who noted that guidelines, rules, and concrete actions are most helpful for managers. The article by Atos Consulting (2011) further substantiates this by presenting different organizational architectures for the four maturity stages of product manufacturer, value-added-manufacturer, full-service provider, and integrated solutions provider, see also Appendix 9.12.

Coreynen et al. (2018) developed a framework for how product manufacturers can transition along the product-service continuum, focusing on the upscaling of PSS. Their framework consisted of 3 parts: design, rollout, and logic. Rabetino et al. (2017) propose a strategy map. Here, prescriptive information is presented in a framework incorporating a financial perspective, customer perspective, internal perspective, and learning & growth perspective. It shows how the strategic logic of servitization can be explained by linking the key practices adopted by manufacturers to support the servitization process. Oliva and Kallenberg (2003) propose a transformational process focused on the servitization transition focused on the installed base. Here, prescriptive knowledge is given in a four-step process: consolidating, entering, expanding, and taking over the end user's operation. Baines et al. (2020) propose a model to understand and facilitate the servitization transformation process consisting of four stages: exploration, engagement, expansion, and exploitation. Contextual factors in the model are organizational readiness, customer pull, value network positioning, organizational commitment, and technology push. Unfortunately, the scope of the study by Baines et al. (2020) does not consider content (i.e. what should be changed) and thus is not very prescriptive. Moreover, it shows servitization as a general endpoint, whereas the endpoint of the servitization transition can differ between firms. See also Appendix 9.13. These transition frameworks offer prescriptive guidelines or processes which manufacturing firms can use. Thus, these are valuable directions that can be utilized towards a solution design.

Conclusively, the analyzed literature and the interview with the industry expert revealed that manufacturing firms could benefit most from prescriptive guidelines, rules, and concrete actions. This is

used as input for the solution design. Furthermore, the transition frameworks found within the literature do not cover a full-holistic perspective covering the necessary transition elements. These elements include service strategy, business model, firm culture & cognitive phenomena of managers, organizational structure, activities & processes, and resources & capabilities. Thus, this is considered towards a solution design.

3.4 Chapter summary

This chapter covered the review of the literature in this research. It answered the following sub-research questions from a theoretical perspective: firstly, what is servitization and what product-service combinations are there (i.e. what does servitization entail, and how can different product-services be defined). Secondly, what are the servitization barriers & challenges faced by manufacturing firms. And thirdly, the actions and mechanisms on how manufacturing firms can successfully transition along the product-service continuum.

In servitization, different classifications are used to describe strategies, types of services, and firm maturity. This research incorporates the servitization pyramid of Coreynen et al. (2017), which makes a distinction between service with a product or customer process focus. Here, the value proposition of the product-service combination is used to distinguish between input-based services, performance-based services, and result-based services. As these are specific to certain propositions or business models, the maturity levels by Atos Consulting (2011) and further defined by ABN AMRO (2016) provide a more detailed classification of firms or SBUs. Here, a distinction is made (in ascending order) between product-manufacturer, value-added manufacturer, full-service provider, and integrated solutions provider.

Literature reveals different servitization perspectives. These are an internal perspective, an external perspective, and a technological perspective (Vandermerwe & Rada, 1988). Moreover, based on the available literature, a collection of servitization barriers and challenges faced by manufacturers is found. The external barriers are grouped under (i) competitors, suppliers, & partners, and (ii) customers. The internal barriers are grouped under (i) financial, (ii) knowledge & information, (iii) activities & processes, (iv) organizational structure, (v) firm culture, and (vi) cognitive phenomena managers. This contributes from a theoretical perspective in answering the second research question: what are the barriers that inhibit a manufacturing firm to follow the servitization path.

Different approaches to describe the servitization transition are visible within the literature. Within the analyzed articles, most incorporate a non-holistic approach focusing on specific components (Baines et al., 2009). However, it is commonly argued within the literature that specific approaches such as a business model redesign approach are insufficient (Spring & Araujo, 2013; Ulaga & Reinartz, 2011). Visible within the examined literature are the following key components within the successful servitization transition: the (i) service strategy, (ii) business model, (iii) organizational structure, (iv) resources & capabilities, (v) activities & processes, supported by (vi) the firm's culture and the cognitive phenomena among managers. Respective to these key components, actions and mechanisms were discovered on how manufacturing firms can successfully make the servitization transition. This contributes from a theoretical perspective in answering the third sub-research question: how can manufacturing firms successfully transition along the product-service continuum.

Conclusively, the analyzed literature and the interview with the industry expert revealed that manufacturing firms could benefit most from prescriptive guidelines, rules, and concrete actions. Furthermore, the transition frameworks found within the literature do not cover a full-holistic perspective, including the necessary key transition elements found within the literature as described above. These findings are considered for the rest of the research and solution design.

4. Empirical analysis

The empirical analysis focuses on answering two sub-research questions introduced in Chapter 2. Data is collected from within the case company and answers the following two questions: firstly, it empirically answers what product-service combinations are there within PT's current portfolio, what their future ambitions are, and how in the organization are services provided to the customer? Secondly, what are the barriers that inhibit PT to follow the servitization path?

4.1 Current portfolio of products and services and future ambitions

This section analyses the firm's current business models. Moreover, it investigates the firm's current portfolio of products and services, and future ambitions.

4.1.1 Current business models

There are currently four general business models within PT: technology solutions, OTS products, original equipment (OEM), and contract manufacturing services. The firm has a strong background in technology solutions, is currently engaged in bringing OTS products to the market, and is expanding its portfolio to end-markets with original equipment. This move towards including OTS products and original equipment highlights the firm's growth strategy. Technology solutions are customized solutions built from existing technical building blocks. OTS products are existing modules, components, and sub-systems. Regarding technology solutions and OTS products, PT most frequently acts as a first-tier supplier to OEMs. Separately, original equipment represents turn-key manufacturing applications independently serving end markets.

Within PT, a single SBU is centered around the business model of contract manufacturing services, utterly different from the earlier discussed business models. Here, PT acts as a contract manufacturer, using manufacturing solutions to manufacture customer-specific products on customer-owned designs. This SBU has no portfolio of physical products. Instead, it is centered around performing services only. A customer can approach PT to produce a product using their own design or formula. PT is responsible for developing the product based on the requirements and the design of the customer. The problem statement and formulated research questions focused on the servitization transition to the right side of the continuum (i.e., from product manufacturer to extending the service business). As this SBU is focused on services without physical products, it is therefore deemed out of scope and not investigated further.

4.1.2 Current portfolio of products, services, and future ambitions

Table 6 shows an overview based on empirical data of the current portfolio of services and future ambitions of SBUs A to E. The services are grouped under four maturity levels: product manufacturer, value-added-manufacturer, full-service provider, and integrated solutions provider. As described in the theoretical analysis, input-based business models relate to the maturity level of product manufacturer and value-added manufacturer, performance-based business models relate to the maturity level of full-service provider, and result-based business models to the maturity level of integrated-solutions provider. Conclusively, the layout of Table 6 is based on the integrated servitization framework presented in the theoretical analysis of Chapter 3.

Table 6: overview of current service portfolio PT and future ambitions

	Relative importance of tangible goods / Relative importance of services											
	Product manufacturer				Value-added manufacturer				Full-service provider		Integrated solutions provider	
	Input								Performance		Result	
	Obsolescence management	Break-fix service (repair)	Commissioning & guarantee	Spare parts supply	Advice & consultancy	(preventive) maintenance	Integration & training	Spare parts management	Information management	Leasing or renting	Managed services	Output services
SBU A	X	X	X	X	X	O	O	O		O		O
SBU B	X	X	X	X	X			O				
SBU C	X	X	X	X	X		O	O				
SBU D	X	X	X	X	X		O	O				
SBU E	X	X	X	X	X	O	O	O		O		

X = currently offered
O = future ambitions

SBU A

SBU A mostly operates on the business model of technology solutions and OTS products, with currently no OEM propositions. The portfolio within this SBU consists of mainly computing products (i.e. hardware) and software. Services within this SBU are geared towards product manufacturer services such as obsolescence management, break-fix repair, spare parts supply, and commissioning & guarantee. The SBU mainly acts as a first-tier supplier selling to OEMs. Customers are provided with diagnostic information about the products during operation so they can maintain the products themselves. Advice and consultancy are offered in the sales phase with the primary goal of achieving product sales. The portfolio also consists of stand-alone software products which are priced using a licensing structure. Additionally, SLAs are provided to customers on both hardware and software products. Within the SBU, there are wishes to extend the portfolio of services offered to include preventive maintenance, training, or spare-part management. Moreover, regarding one of their software products, there is visible potential to provide this using performance or result-based business models.

"We currently provide mostly input-based services. However, the stand-alone software platform has the potential to touch upon different quadrants (i.e. performance or result based business model)." (Manager SBU A)

SBU B

SBU B operates mainly on the business models of technology solutions, with a small part being OTS products. Here, deep-tech vision products are developed and sold to mainly OEMs. Services within this SBU are geared towards product manufacturer services such as break-fix repair, spare parts supply, and commissioning & guarantee. Advice and consultancy are offered in the sales phase, with the primary goal of achieving product sales. Post-sales, integration is offered to the customer. Within this SBU, there are no ambitions to increase the service portfolio apart from providing spare-parts management.

SBU C

SBU C operates primarily on the business models of technology solutions and OTS products, with OEM products in development. The portfolio consists of power transformation products that are sold to mainly OEMs. Services within this SBU are representative of the maturity level of product manufacturer. Including break-fix repair, spare parts supply, and commissioning & guarantee. Advice and consultancy are offered in the sales phase, with the primary goal of achieving product sales. Services they would like to offer in the future are preventive and predictive maintenance using diagnostics; by calculating the lifetime of products in operation. Moreover, the SBU could benefit from providing training and integration services. Although the SBU manager sees potential to sell certain products using a performance-based business model, leasing or renting the equipment, within the SBU they have not yet concretely experimented with these business models in their market.

SBU D

SBU D operates on both the business model of technology solutions and OTS products, with currently no OEM propositions. Its portfolio consists of motion products and mechatronic systems. In addition to physical motion products, a sophisticated motion software platform is provided with physical products. Services offered are typical to the maturity level of a product manufacturer, such as break-fix repair, spare parts supply, commissioning & guarantee; and value-added manufacturer services such as commissioning, integration, and SLAs. The SLAs are made with a small number of major and strategic customers, with a budget used as a stand-by fee for on-site maintenance and support on software. The manager of SBU D mentioned that there is a strong desire to make the currently offered services profitable. These include the SLAs with customers on hardware and software.

SBU E

SBU E operates on the business model of technology solutions, with a strong focus on OEM propositions in the pipeline. The portfolio consists of automation solutions for logistics, warehousing, and manufacturing. They are originally intended to improve PT's manufacturing facility and processes, now focusing on attracting external customers in the respective markets. Services offered here are product manufacturing services such as break-fix repair, commissioning & guarantee, spare parts supply, and advice and consultancy. The OEM propositions can be offered using a performance-based business model rather than a traditional input-based business model. Currently, there is a desire for a performance-based business model where the equipment is leased. This impacts the type of services provided significantly as these business models require other types of supporting services with examples such as preventive maintenance, remote monitoring, and rental plans.

"We have a strong preference for a lease construction. We see that if we calculate with assumed numbers and assume a certain use-case, that we expect a more sustainable source of income." (Manager SBU E)

To summarize, most SBUs develop technology solutions and OTS products using traditional input-based business models. This is mainly due to the type of product and position in the value chain, limiting the ability to offer various services and deviate from the standard input-based business model. Original equipment and stand-alone software deserve special attention as these have the most potential to be positioned further to the right along the product-service continuum. Moreover, as these can be sold using different business models, including various services, the required service maturity can differ from PT's current maturity. Therefore, original equipment and stand-alone software are discussed in more detail next.

OEM propositions: original equipment & stand-alone software

By its very nature, original equipment is often sold to end-customers except when a distribution model is chosen working with a value-added reseller (VAR). Thus, original equipment presents different possibilities to extend the types of services offered, but it also impacts the firm's required maturity regarding services (i.e. servitization maturity). An overview of PT's current business models within the servitization framework is shown in Figure 10. For OEM propositions, a distinction is made between (stand-alone) software and original equipment (i.e. hardware). Moreover, it includes the business models of technology solutions and OTS products. Figure 10 shows the potential of original equipment and stand-alone software to extend the service business and transition within the product-service continuum, as indicated by the blue stars.

Regarding stand-alone software, there are several revenue streams possible. Firstly, software can be bundled with hardware, where the price of software is built up as a markup on the physical product's price. Secondly, using an unbundle strategy, it can be sold separately. This is especially true for stand-alone software, which then functions as an individual product or service. Stand-alone software can be sold using an input-based business model with a one-time license purchase or a yearly recurring license fee. This highlights the potential of stand-alone software within the product-service continuum, as shown in Figure 10.

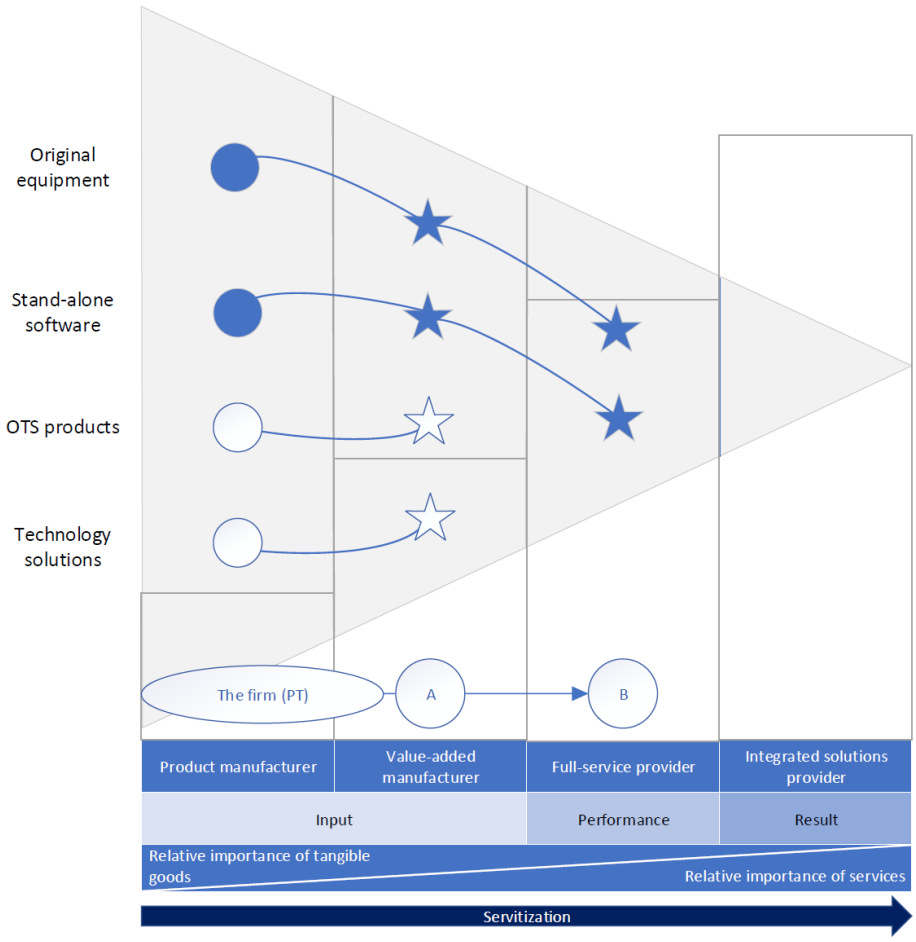


Figure 10: empirically filled in framework based on Chapter 2

4.2 Organizational structure & current processes

This section describes the organizational structure and relationship to service-related processes in this research. It empirically contributes to answering the first sub-research question: how in the organization are services provided to customers.

4.2.1 Organizational structure

The structure of an organization outlines how activities are directed to achieve the organization's goals. An example of these activities are rules, roles, and responsibilities. Moreover, it determines how information flows between levels within the company, such as processes. The organizational structure aligns with PT's values, emphasizing three major points: equality, trust, and responsibility. The structure emphasizes a flat organizational hierarchy. It follows a process-based organizational structure that follows the orientation of professionals with similar backgrounds. A simplified version of PT's organizational structure is illustrated in Figure 11 below.

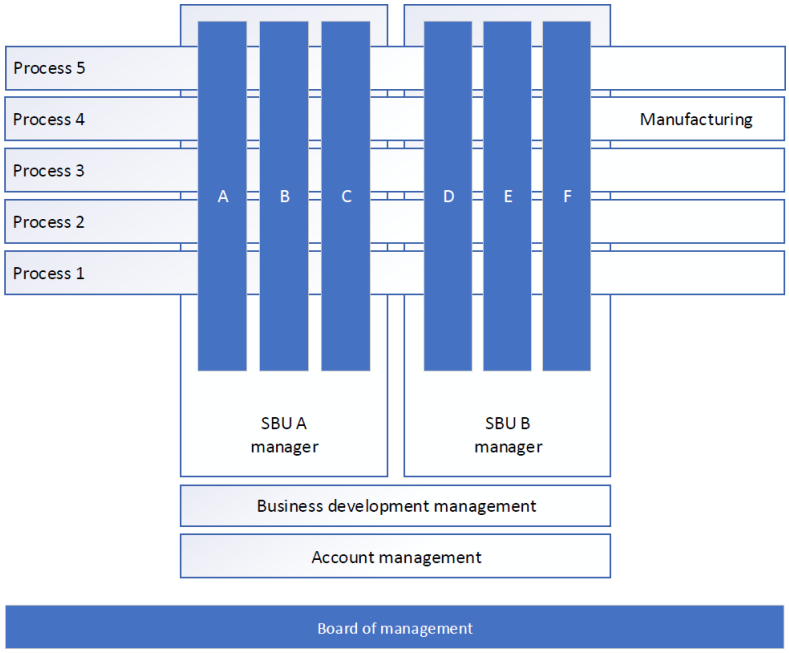


Figure 11: simplified organizational structure PT

The columns A-F in Figure 11 represent the various projects during different stages of the product lifecycle. Within PT, projects and SBUs are divided based on technology, not on market segment. Furthermore, projects are mostly specific to a single SBU. However, several SBUs might be involved in projects regarding one market segment (e.g. medical); when for example, diverse technologies are needed. A project can touch upon different processes during its lifecycle, represented by processes 1-5. As an illustration, process D represents the manufacturing process, where products are manufactured.

4.2.2 Product lifecycle

The lifecycle of products within PT is of considerable importance for this research to answer the first and second sub-research questions. The lifecycle of products within PT can be visualized using two different levels of abstraction. The first is explained by three distinctive phases, including relevant support processes and roles (see Figure 12). These three phases are the sales phase, the development phase, and the product lifecycle phase. These phases are explained next.

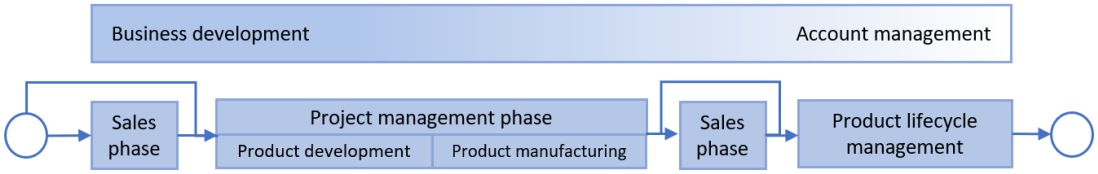


Figure 12: product lifecycle at PT

Sales Phase

The sales phase starts with a sales opportunity. After identifying and qualifying the opportunity, the feasibility and conditions are determined. This phase also entails negotiating with the customer and setting customer agreements. The sales phase can end while the business development manager's role continues during the project management phase or the product lifecycle phase resulting in a handoff to account management. An overview of this and other relevant processes is displayed in Figure 13.

Project management phase

The project management phase entails managing the project between the sales and product lifecycle management phases. This process makes use of (new) product development (NPD) and product manufacturing. Within NPD, R&D engineers within several processes are responsible for developing prototypes according to predefined requirements within project management, which are grouped within a project team. After validating that the product complies with all requirements, a handoff occurs between product development and product manufacturing. In product manufacturing, the product is manufactured in a standardized way, often in series production.

Product lifecycle management phase

The product lifecycle management phase commences after the project management phase is completed. Within this phase, a product team takes over the project team's previous responsibility during its entire lifecycle after a product is released. Establishing a product team is intended to set up the infrastructure that will ensure the proper management of the product lifecycle by the product team. Moreover, this team provides support and maintenance to a customer according to the specific customer's agreements. The product lifecycle managers are responsible for taking care that the predefined KPIs on Quality, Logistics, Technology, Costs, and Sustainability (QLTCS) are achieved.

Within the product lifecycle management phase, support and maintenance are provided to customers according to predefined agreements. These support and maintenance activities are mainly geared towards QLTCS aspects regarding the predefined agreements.

Specific customers have an SLA agreement with PT regarding maintenance and support on-site. For this, an SLA team is set up to perform the actual maintenance and support. The SLA team mostly consists of engineers from the service process. For specific customers, a phone number is available which connects to one of the members of the SLA team.

Business development & account management

Similar to sales, a business development manager is responsible for generating leads with potential customers. Business development managers are involved in the early stages of the product lifecycle. For the business model of technology solutions, a sales phase is a prerequisite to the project management phase, where external requirements are formulated. For the business model of OTS products and original

equipment, this mainly means that internal requirements are a prerequisite for the project management phase followed by a sales phase.

For every (new) customer, an account manager is assigned who follows the account management process and is responsible for setting up a customer account team. Most customers are assigned to an account manager who is responsible for the predefined KPIs on QLTCS. Parallel to monitoring the relationship with the customer in an ongoing way, structured evaluations are scheduled to measure customer satisfaction. These are executed by an independent employee on all QLTCS aspects.

Service process

The current service process is part of manufacturing and is centered around providing mainly product manufacturer services such as break-fix repair. Customers can send products back to PT when for example, a product fails in the field. Customers can send products back for any reason as PT currently has an open-door policy, meaning that an RMA (return material authorization) is missing. Furthermore, the service process is used for internal purposes to repair products during product development or product manufacturing.

"The current service organization is mostly focused on products. For example, when products break in the field and are returned to PT. It is not that easy with an entire AGV solution or an automatic line installed somewhere." (Manager SBU E)

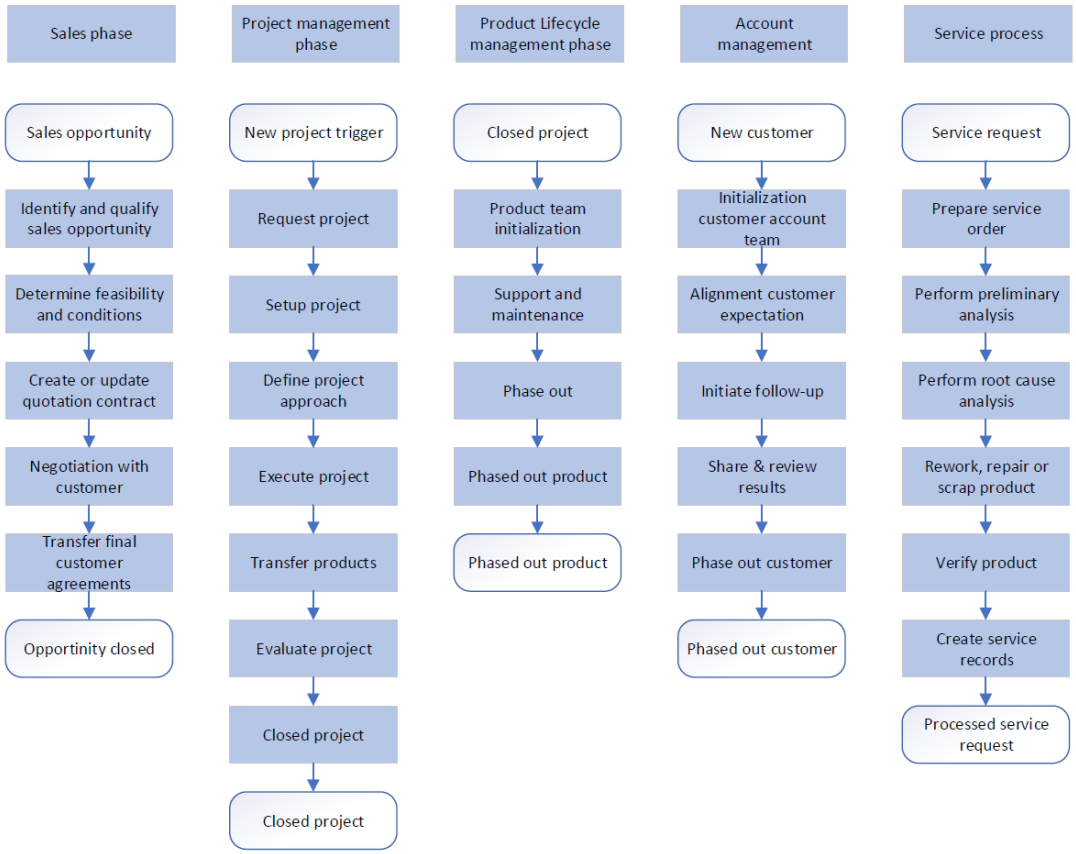


Figure 13: service-related lifecycle processes PT

4.3 Servitization barriers and challenges

This section empirically analyses the servitization barriers and challenges from the case company. It empirically contributes to answering the second sub-research question: what barriers inhibit PT to follow the servitization path.

4.3.1 Servitization perspectives

For studying the servitization topic, different high-level perspectives can be taken. Within this research, the following three broad perspectives are recognized: internal perspective, technology perspective, and external perspective, see Figure 14. These are based on the interview with the industry expert. Firstly, an internal perspective focuses on internal barriers such as organizational design, culture, resources and capabilities, and the internal business model. Secondly, a technology perspective focuses on technological barriers such as data, new technologies, and connected products. Thirdly, an external perspective focuses on external barriers to servitization, such as the business model towards external customers and suppliers, the market, and the value chain. The empirical analysis did not reveal major technological barriers within PT. Therefore, it is not substantiated further. The empirically discovered internal and external barriers are elaborated on next.

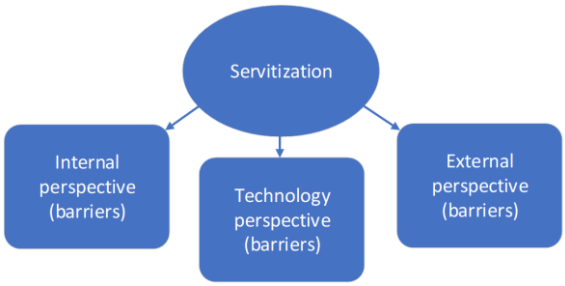


Figure 14: high-level perspectives servitization

4.3.2 External servitization barriers

The interviews with different individuals within PT revealed various external servitization barriers. Figure 15 shows a high-level overview of these barriers. Each external barrier is elaborated next.

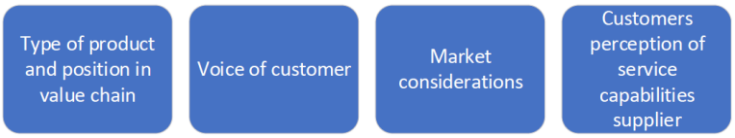


Figure 15: external servitization barriers

The type of product and position in the value chain are barriers that significantly impact a manufacturing firm's servitization possibilities. PT's current business models of technology solutions and OTS products are most frequently sold to OEM customers, where PT then acts as a first-tier supplier. Here, there are substantial limitations regarding servitization. Firstly, most OEMs want to buy these components and subsystems using an input-based business model rather than purchasing these as-a-service. This limitation is mainly due to the type of the product and its interrelatedness to the OEM's system or end-product. Moreover, as the OEM sells to the end-customer, the OEM is mainly in charge of the service domain towards the end-customer. Furthermore, there are frequently contractual agreements between the first-tier supplier and the OEM party explaining that the OEM is in charge of services towards the end-customer; thus, preventing PT from extending the service business.

The voice of the customer is an external barrier to servitization highlighted within the empirical analysis. For example, interviewees mentioned that some customers would prefer one-time costs instead of higher operational costs (i.e. recurring). This servitization restraint by customers might also be related to geography and customer culture. For example, it would arguably be more difficult to bring product-service business models to the market in China. Furthermore, taking software as a specific case, some customers don't want to pay for software annually via a license structure but prefer to purchase one-time. Conclusively, this can be an inhibiting factor to servitization.

"The relevant question is: which SBU does lend itself for that service piece, making a revenue out of services. That really depends on the market and the willingness within the market." (Manager SBU B)

Alongside the voice of the customer, another external barrier relates to market and competitor considerations. Within some markets, there is a de-facto standard in the types of business models used. For example, when competitors do not charge separately for software or a particular service. Thus presenting the supplier with a disadvantage compared to its competitors. Customers will more likely turn in favor of suppliers who provide similar value but for less visible costs. This applies to stand-alone software products or services, where within certain markets, competitors do not charge separately for software to customers.

Another factor is the customer's perception of supplier service capabilities. This entails that a customer considers the supplier's service capabilities before purchasing its products and services. This can be interpreted in different ways; for example, having a track record in the field of services, having a global footprint as a firm, or simply showing the customer that the firm has a certain service maturity.

External barriers are an essential component in answering the research question. Moreover, they also relate to internal barriers within the firm and can explain the current maturity regarding services within PT. Although external barriers could be mitigated or even overcome, it is much more difficult for firms to do so compared to internal barriers. This can be partly explained as the firm has no direct influence over these external barriers. Due to this, external barriers are considered contextual constraints within this research, which have to be considered within the servitization transition of PT.

4.3.3 Internal servitization barriers

Alongside external barriers, the empirical data revealed a multitude of internal barriers. Figure 16 shows these on an abstract level. The internal barriers are elaborated in more detail next.

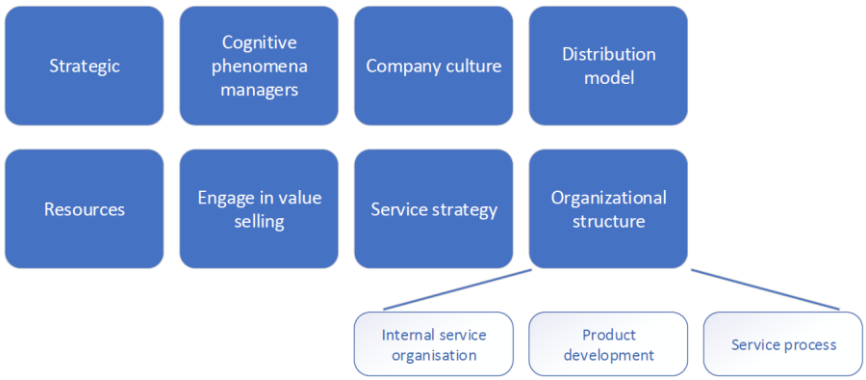


Figure 16: internal servitization barriers

Strategic

The empirical analysis firstly discovers strategic incentives as barriers within servitization. Table 7 presents an overview of the strategic barriers found within the empirical analysis. The first barrier is related

to consultancy services and is illustrated by executing consultancy services for free to maintain intellectual property ownership. In technology-intensive markets where intellectual property often has high value to a firm, it can be a strategic decision to provide certain services for free. The second barrier applies to software which in addition to hardware can be seen as a service. Here, the firm strategically decides not to create a stand-alone revenue stream for software, which implies visibly billing the software separately to the customer. In doing so, the supplier firm can position itself better and gain a competitive advantage over competitors. Whenever the possibility arises to create a vendor lock-in with software, this can be a strategic motive not to create a stand-alone revenue stream. A vendor lock-in means that a customer has become dependent on the supplier's products and services where the customer is subsequently no longer able to switch supplier (without substantial effort and investment).

Table 7: strategic barriers

Strategic barriers
Transfer of intellectual property
Vendor lock-in

Cognitive phenomena

The second construct is the cognitive phenomena of managers as servitization barrier, see Table 8. Managers within the firm highlighted that traditionally, more effort has been spent towards developing and selling products rather than developing and selling services. Cognitive barriers among managers can be interpreted as barriers towards servitization. Moreover, several cognitive phenomena among managers are also found within the literature, see Chapter 3. Firstly, there is the belief among managers that other firms are better in services, raising the question internally whether investing in the service business will enable the firm to outperform the competition. Secondly, there is the belief that there is no necessity to do more with services. As the firm is still in a growth trajectory, managers state no need to deviate from the current approach. Thirdly, some managers do not recognize the economic potential of services; they believe that selling products with a good margin can be more profitable. Fourth, there is an overemphasis on obvious and tangible characteristics, which is highlighted by the view that services are not seen as a separate product and thus do not require the same attention. This is also emphasized by managers stating that it is better to bundle products and services rather than unbundling, which results in PT offering product-related services where the price of services is accumulated in the physical product price. Fifth, services are seen as a necessity and enabler for physical products. It is seen as a necessary component to offer products rather than having potential on its own to add value. Sixth, managers are uncertain what to charge for services, resulting in not capitalizing on the service offering.

"Until now, products have received a central place. Then, the service is dependent on the type of products. You can however claim something for service(s), but it remains very basic, and does not generate revenue." (Business development manager Y)

"Service is currently a necessary evil within PT, and we don't really like to do it." (Manager SBU D)

Table 8: cognitive phenomena managers

Cognitive phenomena managers
A belief that other firms are better in services
A belief that there is no necessity to do more with services
Failure to recognize the economic potential
Overemphasis on obvious and tangible characteristics
Services as need and enabler for physical products
Uncertainty what to charge for services

Culture

A firm's culture can be a significant internal barrier for servitization, as highlighted in Chapter 3. The empirical analysis confirms this and further reveals the underlying barriers within the culture umbrella, see Table 9. The first cultural barrier is a product-focused culture. This was frequently mentioned during the empirical data collection and is not strange since the culture is adequately aligned with the firm's current maturity regarding services, acting as a product manufacturer. Second, the interest of individual employees is highlighted as an important barrier to service growth. Mentioned frequently within the case company is that the individual employees love to work on exciting and new projects rather than on service-like projects.

"Our engineers love to work on new projects every two to three years, and to develop cool things. So in that sense, services are a different kind of sport." (Process owner lifecycle management)

A third barrier is the firm operating using a customer-dependent model and activities. Essentially, the firm lets customers decide what products and services the firm should develop, being very reactive. This reactive approach also has a negative side effect. It results in many separate agreements and types of services offered to customers, negatively impacting the time and resources used for service delivery. The last cultural barrier discovered during the empirical analysis is the ambiguity of the definition of services within the firm. Reactive break-fix repair of physical products is often referred to as services, while other activities are not labeled as such. For example, commissioning of products and advice & consultancy are not emphasized as services (i.e. value-added activities). The empirical analysis revealed that it is necessary to define the definitions of various services within the firm clearly.

Table 9: cultural barriers

Cultural barriers
Product-focused (culture)
The interest of individual employees
Customer dependent model/activities
Definitions of service not clear

Distribution model

Another empirically found barrier is the impact of the chosen distribution model on servitization potential: distributing through VARs and delegating the service responsibility. A distribution model encompasses how the product gets delivered to the end customer. There are many different models to accomplish this; for example, directly to the end-customer or indirectly through a VAR. Working through a VAR distribution model often transfers the service potential to the VAR. Where the VAR is then able to make a substantial business and revenue out of services. When manufacturing firms do not have the right service maturity, it can push them to work with VARs to reach their end-customers. Separately, choosing to work with VARs can also present significant benefits such as increased customer reach, scalability, market recognition, and time-to-market.

"Of course you are going to hand over a part of your margin if you are working with value-added resellers. However, if with that the reach and scalability increases, it might outweigh the downside of working with value-added resellers." (CEO)

Resources

Resources, or the lack thereof, are a general barrier for many firms in a growth trajectory. However, this is especially true for the firms who want to extend their service business. Table 10 shows an overview of the type of resource-related barriers found in the empirical data collection. A first barrier here is employees, or the lack thereof. As evident from the empirical analysis, the lack of employees (i.e. engineers) requires PT to decide where to deploy these resources. This decision is closely linked with the firm's strategy and cognitive mindset of managers towards servitization. A second barrier is the cost of setting up an infrastructure for a global service organization, which is required to provide value-added services such as on-site maintenance and to support performance-based product-service combinations. Setting up this infrastructure requires high investments for any firm. The last recourse-related barrier discovered in the empirical analysis is capital need investment of the supplier (i.e. liquidity). When deciding on selling AGVs to customers using a performance-based business model (i.e. leasing the equipment), the equipment stays in ownership of the supplier. By maintaining ownership, high investment is required from the supplier that is only slowly recouped.

"An important barrier for us is resources because we are in a growth trajectory. You need the capacity to offer more services, the right people at the right place." (Business development manager X)

Table 10: resources barrier

Resources
Employees
Costs of a global service organization
Capital need investment supplier

Value selling

One approach to define the commercial price of physical products is to look at the bill-of-material, including man-hours spend on product assembly. This is an approach used by many product manufacturers. However, this is a problematic approach regarding intangible services and performance or result-based business models where the firm has to assess the value of the solution offered. Thus, the firm has to engage in value selling, which can be a barrier to servitization. Value selling is defined as using the value perceived by the customer to determine the commercial sales price. Due to PT's inexperience with value selling, it presents an internal servitization barrier.

Strategy

The empirical analysis also reveals barriers related to strategy, see Table 11. The empirical analysis shows that each SBU is responsible for developing a strategic plan. However, as services are seen as reactive and supporting activity and independent of the SBUs, there has not been the need to develop a strategy regarding services since the product-focused strategy aligns with the firm's current maturity regarding services. Alongside a service strategy, PT is experiencing a lack of focus within its organization. This can be explained partially by the low hierarchical structure and minimal managerial roles. Moreover, the firm has many young engineers with much ambition. This results in the firm seizing many different opportunities, which puts pressure on the focus of the organization. Similarly, managers within the firm are occupied with tactical and day-to-day activities, representing an underemphasis on long-term thinking. Conclusively, interviewees mentioned that a clear service strategy is necessary to successfully extend the service business.

"To get to that level of maturity, you need to have a strategy actually on how you are going to get there, and how you are going to sustain it afterward." (Process owner service)

Table 11: strategy

Strategy
Service strategy
Focus within the organization (shifting priorities)
Long-term thinking

Organizational structure

Defined in Chapter 4.2.1, the organizational structure is referred to as roles, rules, processes, and responsibilities. For completeness, it is divided into new product development (NPD) process, internal service organization, and service process; these will be elaborated in more detail.

New product development process

The empirical analysis reveals various barriers within the NPD process inhibiting servitization, see Table 12. Firstly, there is a lack of emphasis on design for service. Design for service entails that products, modules, and components are developed to make it easier to maintain them or swap or repair internal components. Managers highlight this as an essential factor to extend the service business. Secondly, there is a lack of service thinking within NPD. When integrating more product-related services or developing product-service combinations, employees within the organization should already think about what services will be offered to the customer and how the complete solution should be. Interviewees state that service thinking should be emphasized early within the NPD process or even within the sales phase before.

"You need to think about services already from the beginning, as a concept. When we are going to make or offer a product to a customer, you should already think in that stage, are we going to offer just a product, or are there any services attached to it?" (Process owner service)

Thirdly, a separate product management role is missing, functioning as an internal customer concerning the requirements and validating the project delivery. As PT's traditional business models were focused on customer input within the development, this is quite different when developing original equipment for multiple end-customers. Currently, this role is partly fulfilled by the SBU managers. However, managers state that this is insufficient to accommodate the growth towards original equipment and subsequent extension of the service business. There is also a higher level of requirements concerning the previous barrier when choosing a performance-based business model. An example hereof is guaranteeing uptime. Subsequently, these high-level requirements have to be translated to lower-level requirements.

Table 12: barriers within the NPD process

New product development process
Design for service
Service thinking within NPD
Product management role
A higher level of requirements

Internal service organization

Moving along the product-service continuum brings substantial challenges to the firm's internal service organization. Almost all interviewees explain that this requires a different organization. The internal servitization barriers related to the service organization are shown in Table 13.

"This requires a completely different organization. Because you need PT personnel which is on-call and close to the customer. Then, you make a rigorous change to the company. Customers are going to demand that you can be on-site within X number of hours." (Process owner project management)

Firstly, moving along the product-service continuum requires the firm to set up a front-desk with 24/7 support to customers, which is currently not in place. Especially true for original equipment sold to end-customers and a portfolio of solutions sold as a performance or result-based business model, customers require short and quick communication lines to the supplier. Alongside a front desk, managers state hidden sales potential behind setting up an online service desk portal, where customers can ask questions and where support can be provided. Secondly, servitization requires closeness to the customer and subsequently a global infrastructure, or field-service organization, to provide services; this is currently not in place. Thirdly, managers within PT highlight the need for a dedicated group, process, or place within the organization to perform customer service apart-from break-fix service, including advanced services such as remote maintenance. There is ambiguity among the interviewees about whether this should be a dedicated group, who should be responsible for these advanced services, and where in the organization this should be organized.

"If you look at other companies who are acting as a full-service provider, they indeed have a whole service team ready, where you can make service agreements. We do not have this, so within the organizational structure, there is missing something." (Process owner AM)

Fourth, managers stated that the firm lacks the right competencies regarding services. Several managers within PT state that it might be necessary to hire people with different skills, such as service business and servitization experts. Moreover, frequently mentioned is the hiring or application of field-service engineers who have a different mindset and skillset regarding executing services, who are even more customer-focused.

"I think we can agree that it requires a different group of people than we mainstream have within the firm." (Project manager LCM)

Lastly, the empirical analysis revealed the need for a training center where customers can be trained to better work with the firm's products and execute services. This training center could subsequently be used to train employees within PT into (for example) service engineers.

Table 13: internal service organization barriers

Internal service organization
Front-desk and 24/7 support
Field-service organization and global infrastructure
A dedicated (separate) place for advanced services within the organization
Service competences
Training center

Comparing stand-alone software or software-as-a-service to physical products (e.g. complete solutions such as AGVs), the organizational impact is much lower. The empirical analysis revealed that this is mainly because the service aspect is different. Although both software and hardware often require integration efforts by the supplier, with software, services such as on-site maintenance are much less every day's business.

Service process

As PT has a process-oriented organizational structure, it is vital to consider the current service process. Several internal servitization barriers are related to the current service processes within PT, see Table 14. First, the current service process is focused on break-fix repair. Within the LCM process, there is a building block for maintenance, but it does not describe exactly how to support advanced services such as integration and remote maintenance adequately. There is no comprehensive process and responsible

person for service activities other than break-fix repair, which also holds for service or support towards maintaining software. Having a process in place for both can also reduce the problems PT is currently facing with providing support on software such as PMP. Second, the firm does not have a market-oriented and clearly defined service development process in place. This highlights the need for a more proactive approach for developing suitable services. Taking this proactive approach, PT can standardize the service offering and tailor it to customers' requirements instead of the other way around. Thus, reducing the variability of services offered. Noticeable is that a service development process shares resemblance with thinking about services early in the NPD process.

"I don't think we have a process that describes how to execute on-site maintenance executed by our SLA teams … What we often also see is that if we don't have certain services in place, then the customer is going to dictate what they want, and we then fill this requirement in. This creates a widespread of different services." (Project manager LCM)

Third, there is no central coordination and no one responsible for setting up services. This is highlighted as one of the barriers to servitization. Interviewees mentioned that due to this, the firm cannot grow the service business successfully as activities are not streamlined or coordinated.

"Services we just simply see as a lot of different kind of activities which are just spread all over the organization, and completely not centralized." (Process owner service process)

"There is no one responsible specifically for setting up services, so there is no central coordination. It seems useful to have someone busy with that, to streamline these activities. Otherwise, you get a widespread of different service models." (Manager SBU C)

Lastly, there is no suitable and traceable cost-profit structure for services. Currently, service orders such as break-fix repair and on-site maintenance are booked on a customer account. However, these are not automatically traced back to the individual SBUs, making it difficult to see which expenses are made for services executed on products from the respective SBUs. Managers within PT highlight this as a barrier to extending the service business.

Table 14: service process barriers

Service processes
Process to support advanced services
Market-oriented and clearly defined service development process
Central coordination and no one responsible for setting up services
Suitable and traceable cost-profit structure for services

4.3.4 Conclusion & interpretation of empirical findings

The discovered servitization barriers within the empirical analysis are mostly related to the internal (service) organization. Referencing the analyzed body of literature in Chapter 3, to successfully transition along the product-service continuum, the internal (service) organization needs to be improved to reach the required maturity level. The empirical analysis revealed that the SBU managers, account managers, and business development managers stated mostly external factors and the internal service organization as a significant barrier to servitization. They are saying that without the right components within the organizational structure, PT is not able to successfully transition along the product-service continuum. Interestingly, from the COO interview, it became evident that he (representing the support organization) wants to know from the SBU managers what services they want to offer. Several process owners (part of the support organization) also supported this. This contradiction represents a gap in the organization between the SBU managers and the support organization. Conclusively, it highlights the necessity to

develop a clear service strategy (with adequate emphasis on services within the SBU managers' strategic plans) to ignite the servitization transition. The following quote highlights this gap:

"There currently is a gap between the service strategy and the execution of the strategy."
(Manager SBU E)

4.4 Desired situation

In this chapter, the desired situation is explained based on the empirical analysis. By formulating a desired situation, solution directions and design requirements can be distilled, contributing to answering the fourth sub-research question: how should the transition to other product-service combinations and an improved service offering be formulated?

The management board aims for sustainable competitive advantage. The management board realizes that extending the service business, and turning it into profits rather than costs, is crucial. As described in Chapter 1, PT faces uncertainty regarding the barriers and challenges inherent to the servitization transition. Therefore, the management board and the SBU managers would like to have insight into the various barriers and challenges inherent to this transition. Specific for the SBU managers, they would like to grip the transition process through a roadmap, process, or framework. Several SBU managers mentioned that they would like to know how to support various services or models.

"It is very valuable to know how to support different types of services, or business models, so that we know how to incorporate that in our processes." (Manager SBU A)

However, the empirical analysis revealed different responsibilities regarding the transition process specific to the SBU managers and the support organization. More specifically, the SBU managers would like to know how to support their future service ambitions. In contrast, the COO mentioned it is up to the SBU managers to come up with the specific services that need to be supported within the organization.

"We currently do not have a servitization roadmap, or strategy in place." (Manager SBU B)

Thus, to support the firm in making the servitization transition, two stakeholder groups should be supported. First, SBU managers should be empowered to think about what services they could offer. Furthermore, the solution should guide managers in developing a service strategy. Second, how in the organization these various services should be supported, guiding the COO and the support organization.

4.5 Summary empirical analysis

In this chapter, the following two sub-research questions are answered from an empirical perspective. First, what product-service combinations are there, which combinations does PT currently offer, what are their future ambitions, and how in the organization are services provided to the customer? Second, what are the barriers that inhibit PT to follow the servitization path?

The empirical analysis revealed that PT follows a process-based organizational structure where all activities are organized within a process. Moreover, it showed that the lifecycle of products within PT can be defined on an abstract level in the following three phases: sales phase, project management phase, and product lifecycle management phase.

The empirical analysis (including the expert on servitization) revealed three different servitization perspectives visible within the examined literature: internal, external, and technology. However, technological barriers were not frequently mentioned to be applicable within PT. Within the interviews, internal barriers were mentioned most often, and external barriers less frequent.

The external barriers can be categorized in (i) type of product and position in the value chain, (ii) voice of the customer, (iii) market considerations, and (iv) customer's perception of service capabilities; each is explained briefly. First, as PT often acts as a tier-one supplier, PT's customer (i.e. an OEM) is responsible for providing service to the end-customer, making it arguably difficult for PT to extend the service business. Second, servitization can be restrained by customers who do not wish to incur recurring costs related to service, software, or even products marketed via performance or result-based business models. Third, market and competitor considerations can inhibit servitization. For example, there are de-facto standards in specific markets regarding certain business models (e.g. when competitors do not charge separately for software or a specific service). Lastly, the customer's perception of the supplier's service capabilities can present a barrier. Without proof (i.e. a track record in the field of services), customers might be wary of closing a deal.

The internal barriers are categorized in (i) strategic, (ii) cognitive phenomena managers, (iii) firm culture, (iv) distribution model, (v) resources, (vi) engaging in value selling, (vii) service strategy, and (viii) organizational structure. Each is explained briefly. First, there are strategic reasons not to extend the service business in some cases, such as preventing intellectual property transfer and creating vendor lock-in. Second, cognitive phenomena among managers presents a significant barrier to servitization. These cognitive phenomena include the belief that other firms are better in services, a belief that there is no necessity to do more with services, failure to recognize the economic potential, overemphasis on obvious and tangible characteristics, services as a need and enabler for physical products, and the uncertainty what to charge for services. Third, there are barriers related to the firm's culture, including a product-focused culture, individual employees' interest in technology and product development, activities depending on the customer, and unclear service definitions (i.e. language). Fourth, the chosen distribution model inhibits servitization when the service responsibility is delegated to a VAR. Fifth, lack of resources can impede the firm from servitization. This covers human resources and financial resources, including the costs of setting up a global service organization or the capital needed to offer performance or result-based business models. Sixth, immaturity regarding value selling (i.e. intangible offerings such as services) presents a barrier as the firm experiences difficulties capitalizing on this. Seventh, another barrier strongly emphasized within the interviews is the need to have a strategy regarding services within PT as this is missing. This barrier also includes a general abundance of clear focus within the organization and a general scarcity of long-term thinking. The empirical analysis revealed that a strategy is necessary to reach other levels of servitization maturity. Lastly, internal barriers are related to the organizational structure specifically and are briefly explained below.

The barriers related to the organizational structure are visible within the internal service organization, NPD, and the service process. Within NPD, the servitization barriers consist of insufficient design for service, scarcity of service thinking, a missing product management role, and the difficulty of translating higher level requirements into lower-level requirements. Regarding the internal service organization, barriers represented are the lack of a front-desk and 24/7 support, an inadequate field-service organization (i.e. no global infrastructure), no dedicated place for advanced services within the organization, a lack of service competencies, and the absence of a training center. Regarding service processes, barriers to servitization are an inadequate process to support advanced services, a missing market-oriented and clearly defined service development process, not having central coordination and no one responsible for setting up services, and the absence of a suitable and traceable cost-profit structure for services.

5. Synthesis

This chapter elaborates on the formulated design principles and requirements. Following DSM, design principles and requirements are input for the design of a solution. The first section presents the synthesized design principles. Here, both the findings of the theoretical and empirical analysis are synthesized based on the methodology described in Chapter 2. The second section introduces the design requirements derived from the empirical analysis with the case company.

5.1 Design principles

Sub-research question four focuses on the research output in the form of a solution design and change plan, contributing to answering the main research question. For clarity, sub-research question four is repeated below.

"How should the transition to other product-service combinations and an improved service offering be formulated?"

The theoretical and empirical analysis led to insights into the servitization barriers and challenges of manufacturing firms and how they can transition along the product-service continuum. These insights led to eight design principles based on CAMO logic related to the transition categories defined earlier. For clarity, CAMO logic is briefly explained again. CAMO stands for Context, Intervention, Mechanism, and Outcome. CAMO can be explained by an actor and its actions (A) which trigger a particular mechanism (M) toward achieving a desired outcome (O) in a particular context (C) (Keskin & Romme, 2020).

1. Strategy

Based on both the empirical and theoretical analysis, a clear service strategy is vital for any manufacturing firm engaging in servitization (Gebauer et al., 2005; Gebauer et al., 2010; Quinn et al., 1990; Coreynen et al., 2018). Rather than being reactive, manufacturers who wish to transition along the product-service continuum need to change their approach to being proactive regarding services. As discussed, the lack of a clear service strategy will lead to an unsuccessful endeavor (Gebauer et al., 2005; Davies, 2003; Oliva & Kallenberg, 2003; Gebauer, 2005; Brax et al., 2005).

C When manufacturing firms want to transition along the product-service continuum,
A the firm's management and the SBU managers need to proactively develop a deliberate strategy regarding services in which external factors are incorporated, having knowledge of the type of product-service combinations that can be offered,
M leading to an increased focus on increasing the total value created through services,
O which therefore improves the likelihood of a successful servitization transition.

2. Business model (i)

As discussed within the theoretical analysis, manufacturing firms venturing into services need to carefully consider the type of business model they want to deploy. For manufacturing firms wishing to reach a maturity level of value-added manufacturer, incrementally changing elements of the business model seems to be the most common choice since they can use the earlier gained knowledge moving forward (Eggert et al., 2014; Visnjic et al., 2014). For product manufacturers, their value proposition consists of developing, selling, and delivering products; services are necessary for product sales and warranty; and the costs of services are included within the product price (Atos Consulting, 2011).

Conclusively, product manufacturers should incrementally change the business model elements related to the value proposition, service provision, and revenue model (Atos Consulting, 2011).

C When manufacturing firms want to transition along the product-service continuum, from product manufacturer to value-added manufacturer,
A the SBU managers need to incrementally change the elements of the business model related to value proposition (develop, sell & deliver products + services), service provision (services are additional recurring revenue & profit stream), and revenue model (pay per product, pay per service),
M so that strategic realignment towards services is mirrored in changes throughout the business model,
O which improves the likelihood of a successful servitization transition.

3. Business model (ii)

As extension of design principle 2, for manufacturing firms wishing to reach a maturity level of full-service provider, a radical change of their business model or the development of a new (service) business model is required (Coreynen et al., 2017; Kowalkowski & Kindström, 2014). Adapting the business model elements related to the value proposition, service provision, and revenue model (Atos Consulting, 2011).

C When manufacturing firms want to transition along the product-service continuum, from product manufacturer to full-service provider,
A the SBU managers need to radically adapt their business model related to value proposition (develop, sell & deliver value-added services, including platforms), service provision (services are a primary recurring business), and revenue model (pay per use),
M so that strategic realignment towards services is mirrored in changes throughout the business model,
O which improves the likelihood of a successful servitization transition.

4. Firm culture & cognitive phenomena managers

As found within both the empirical and theoretical analysis, a significant factor in any change of business strategy is the existing culture of a firm (Nadkami & Narayanan, 2007; Gebauer et al., 2008; Neu & Brown, 2008; Oliva & Kallenberg, 2003), also referred to as business logic (Ryan, 2013). Manufacturing firms (including PT) have a dominant product-focused culture and business logic. To successfully make the servitization transition, they must adapt their current culture and business logic. This transition is not a one-dimensional effort to transform manufacturing organizations into service-oriented organizations; instead, an integrated approach must be followed to complement the goods-dominant logic with a service-dominant logic (Kowalkowski, 2010; Ryan, 2013; Windahl & Lakemond, 2010). Furthermore, the transition should be supported by service leadership of managers (Kowalkowski & Kindström, 2014).

C For manufacturing firms to change and implement a revised strategy regarding services, wishing to transition along the product-service continuum to value-added manufacturer, or full-service provider,
A management must advocate an integrated product-service culture (i.e. business logic), with leadership support from management,
M to support the strategy and changed business model elements regarding services,
O leading to improved execution of the strategy and an increased likelihood of a successful servitization transition

Although large-scale cultural changes require time, certain measures can prompt shorter effects (Kowalkowski & Kindström, 2014). For example, by changing KPIs to emphasize an orientation towards services. Or by creating internal awareness of the importance and potential of adding services, replacing the outdated terms of "after-sales service", etc. with "services" and "service solutions", which signal a shift in mindset (Kowalkowski, Kindström, 2014).

5. Organizational structure (i)

As mentioned extensively within the empirical analysis and found in a large body of literature, supportive organizational arrangements are required to implement a service strategy successfully (Gebauer et al., 2005). A large body of literature describes separating the service business from the product business as a key factor in implementing a successful service strategy. Simultaneously, the decision for separation or integration depends on the specific strategy, according to Gebauer et al. (2010). The empirical analysis confirmed that setting up a dedicated group for services could improve the focus on services and reduce the use of engineers used for development of products, to move to the maturity level of a value-added or full-service provider. Whereas moving to an integrated-solutions provider requires the firm to be organized around customer solutions, thus integrating the product and service business (Atos Consulting, 2011).

C For manufacturing firms to implement a service strategy and transition along the product-service continuum to value-added or full-service provider,
A a dedicated organizational group must be set up to handle the service offering,
M which reduces conflict with the product business, reduces occupying workload used for product development, and increases the focus on service activities within the firm and individual employees
O leading to improved execution of the strategy and an increased likelihood of a successful servitization transition

6. Organizational structure (ii)

Although not visible within the analyzed body of literature, the empirical analysis revealed the need for a more coordinated approach regarding services to improve the firm's maturity regarding services. Implying that there should be central coordination, including someone responsible for managing all service-related activities. As all service activities are decentralized, this causes a widespread of different service activities.

C Manufacturing firms who want to improve their maturity regarding services,
A must have a central coordinator in place responsible for coordinating and streamline the service activities within the firm, in close communication with the SBU managers, and relevant service processes,
M which improves coordination, improves communication, and streamlines service activities,
O leading to improved execution of the strategy and an increased likelihood of a successful servitization transition.

7. Activities & processes

Described within the theoretical and empirical analysis, manufacturing firms who want to transition along the product-service continuum need to establish appropriate service-related processes and engage in service-related activities. Manufacturing firms need to integrate a service orientation within the product development process, establishing a market-oriented and clearly defined services development process (Gebauer et al., 2005), and stimulate design for serviceability. Moreover, manufacturing firms should set up processes to deliver various types of services, such as an advanced service delivery process. Furthermore, firms should focus the service offering on the customer's value proposition, advocate relationship marketing rather than the traditional transactional view on sales, and monitor the effectiveness and efficiency of service (delivery) (Gebauer et al., 2005).

C Manufacturing firms who want to successfully transition along the product-service continuum,
A must set up specific activities and processes, including an advanced service delivery process, a market-oriented service development process, initiate relationship marketing, and monitor the effectiveness & efficiency of service (delivery),
M which promotes service development early within NPD and improves the ability and efficiency of the firm to deliver various services,
O leading to an improved maturity regarding servitization and an increased likelihood of a successful servitization transition.

8. Resources & capabilities

Based on the theoretical and empirical analysis, manufacturing firms who want to transition along the product-service continuum need to invest resources, financial and employees, and develop service-related capabilities (Coreynen et al., 2018; Kowalkowski & Kindström (2014); Ulaga & Reinartz, 2011). For example, financial resources are required to improve the organizational structure, including a field-service organization (DiPeso, 2000). These resources are also necessary for manufacturing firms who want to offer business models where ownership of the products is maintained (e.g. performance-based lease construction). Moreover, essential service-related capabilities include a value-selling capability (i.e. engage in value selling) (Gebauer et al., 2005).

C When manufacturing firms want to successfully transition along the product-service continuum,
A they need to invest resources (both financially and employees), develop service-related capabilities, and engage in value selling,
M leading to the implementation of an improved organizational structure (including a field- service organization), and the ability to support various services (including use or result-based business models),
O leading to an improved maturity regarding servitization and an increased likelihood of a successful servitization transition.

5.2 Design requirements

Alongside design principles, the DSM also requires the input of requirements towards a solution design. These requirements resemble the practical demands and restrictions of the solution design. These requirements are synthesized based on the interviews with the SBU managers and other individuals within the case company. As described before, the solution should support PT in making the servitization transition. Moreover, the empirical analysis revealed two main stakeholders for the servitization transition. Therefore, the designed solution should also contribute to supporting these stakeholders.

Within the DSM, requirements are grouped into functional requirements, boundary conditions, user requirements, and optionally design restrictions (Van Aken et al., 2012). Functional requirements describe the main objective of the design. Boundary conditions are conditions the design should be compliant with. User requirements are specifically targeted to the user(s) of the design. Lastly (although not always included), design restrictions comprise the solution space preferred by the principal. The formulated design requirements are elaborated below.

Functional requirements

The designed solution should…

- **F1** Present an overview of the servitization transition process
- **F2** Incorporate an overview of servitization maturity levels, the types of product-service combinations, business models, and services
- **F3** Stimulate managers to think about what service they could offer
- **F4** Guide SBU managers in developing a service strategy and adapt the business model(s)
- **F5** Present an overview of the organizational structure necessary to make the servitization transition along the product-service continuum

Boundary conditions

The designed solution should…

- **B1** Be compatible to be integrated into existing systems and processes within PT
- **B2** Fit with the strategy and objectives of PT
- **B3** Match with the organizational structure of PT

User requirements

The designed solution should…

- **U1** Be understandable by managers within PT
- **U2** Be easy to use by managers within PT

6. Design

"If I had an hour to solve a problem, I'd spend 55 minutes thinking about the problem and 5 minutes thinking about solutions." – Albert Einstein

This chapter elaborates on the solution design of the thesis, which represents a creative leap in the design science methodology after synthesis of theory and practice. Furthermore, it answers the fourth sub-research question: *"how should the transition to other product-service combinations and an improved service offering be formulated"?* The first section explains the scope and the decisions made towards a solution design. The second section elaborates on the designed solution. The third section details the change plan and implementation of the solution. Lastly, the evaluation of the solution is discussed.

6.1 Design scope & decisions

In this section, the synthesized CAMO principles and design requirements are considered to set the scope of the design. Moreover, design decisions are based on previous findings and by a creative leap following design science methodology.

The second and third sub-research questions form the basis of the research. These investigate the barriers and challenges of manufacturing firms venturing into servitization and the actions and mechanisms manufacturing firms can take to successfully make this transition. The collected body of literature presents various barriers, challenges, actions, and mechanisms; however, only a few studies incorporate a holistic approach. This was taken into consideration within this research and the design phase of the solution. The research focused primarily on the firm's growth strategy towards OEM products alongside the current business models of technology solutions and OTS products. Therefore, it mainly incorporated an internal perspective. Moreover, the empirical research discovered mainly barriers applicable to the case company internally. Although not emphasized to the same degree as internal barriers, the external barriers (i.e. external environment) are an essential component within the servitization transition and are therefore considered context.

Considering the original problem statement and the empirical results, the research outcome should support PT in transitioning along the product-service continuum. Specifically, the research outcome should support two main stakeholders within the PT. First, the research should support the SBU managers in incorporating the service component within their strategic plans. Furthermore, it should present them with an overview of the various services that could be offered to customers relative to the four servitization maturity levels. Second, the research should support the organization as a whole in making the servitization transition. Here, the primary stakeholder is the CCO which is in charge of the firm's process-based organizational structure.

Considering the two main stakeholders and realizing that a holistic approach is valuable, the solution design has three components. The first component consists of a framework to guide PT to make a servitization transition. It incorporates a holistic overview illustrating the main barrier categories and actions to make the servitization transition. The second component is aimed explicitly at the SBU managers to incorporate services within their strategic plans (i.e. developing a service strategy). The third component is specifically aimed at the support organization and the CCO in detailing the improvements regarding the organizational structure. Each of these three components is elaborated in the next section.

6.2 Design specification

This section elaborates on the designed solution. First, the synthesized servitization transition framework is explained (component 1). Second, the synthesized overview of servitization maturity levels and services is elaborated, including the solution supporting the SBU managers (component 2). Third, the improved organizational structure is elaborated (component 3).

6.2.1 Servitization transition framework

A framework is developed to support PT specifically and manufacturing firms in general to make a successful servitization transition. This framework represents a holistic approach to servitization, including the main barriers and servitization transition components (see Figure 17). A larger version is included in Appendix 9.19. The framework shows concrete actions manufacturing firms should implement to achieve a higher organizational maturity regarding services. The actions are synthesized from both literature and empirical data. Furthermore, the actions are based on the earlier defined CAMO principles categorized under service strategy, business model, firm culture & cognitive phenomena managers, organizational structure, activities & processes, and resources & capabilities.

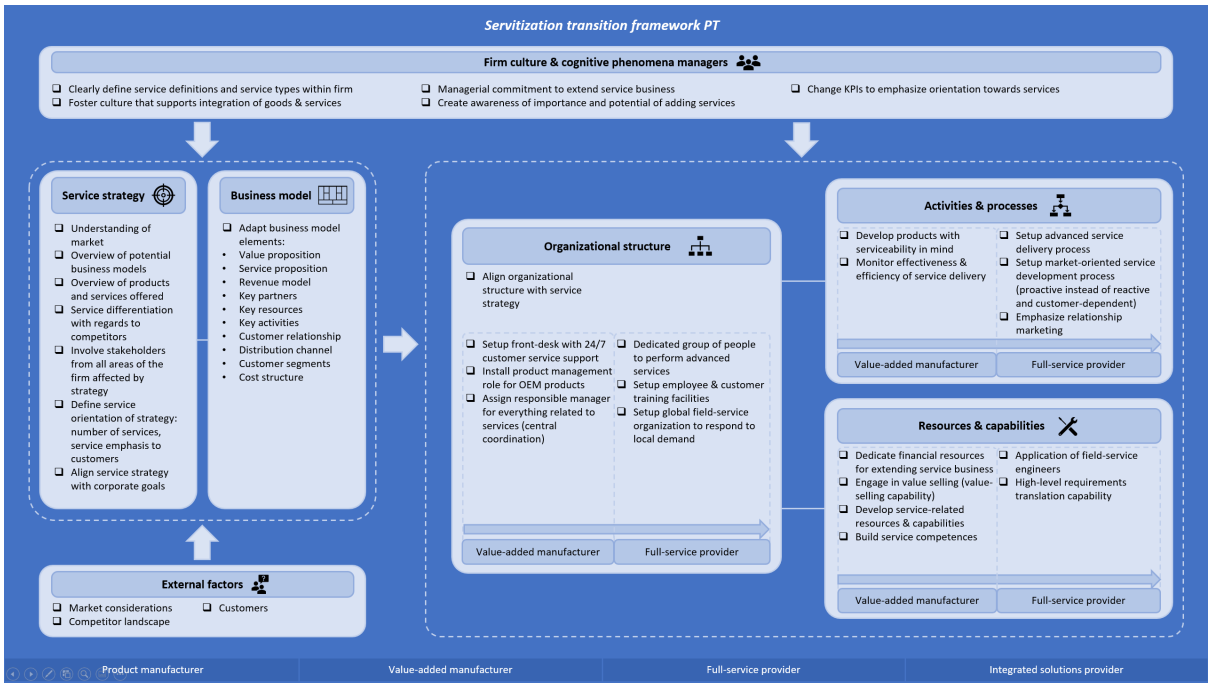


Figure 17: developed servitization transition framework

The servitization transition framework presents the described CAMO principles synthesized from both literature and empirical analysis. It starts with the firm's strategy regarding products and services and their desired place on the product-service continuum. After modifying the current strategy to incorporate services, elements of the business model should be adapted, such as the value proposition, service proposition, revenue model, etc. Both the firm's strategy and business model can be influenced by two main factors: external factors and the firm's culture or the cognitive phenomena among managers. External factors consist of market considerations, competitor landscape, and the customer, among others. These account for the contextual factors that have to be considered within the strategy and business model formulation. Furthermore, the firm's culture and cognitive phenomena among managers can impact the firm's (lack of) service strategy. Depending on the strategy and business model, the organizational structure must be adjusted appropriately. Subsequently, this requires service-related activities & processes, and

resources & capabilities new to the firm. The firm's culture and cognitive phenomena among managers and individual employees play an essential role in supporting the organizational structure, activities & processes, and resources & capabilities, based on the formulated strategy. Regarding the actions for the organizational structure, including activities & processes, and resources & capabilities, a distinction is made using the earlier discussed servitization maturity levels. It makes a distinction between a value-added manufacturer and a full-service provider, which are the potential destinations for PT on the product-service continuum. An enlarged version of the servitization transition framework is included in Appendix 9.19.

6.2.2 Service strategy & business model checklist

As described before, the SBU managers represent the first stakeholders. Following the requirements, the solution design should stimulate managers to think about what service(s) they could offer. This is achieved simultaneously by providing an overview of the servitization maturity levels and the services and business models (input, performance, result) for each maturity level, see Table 15. Subsequently, to guide managers in developing a service strategy and change the elements of the business model accordingly, an eight-step process (i.e. checklist) is constructed, see Figure 18. This process is based on the theoretical analysis described in Chapter 3.3.3. To conclude, the overview of the servitization maturity levels, product-service combinations, and services, together with the strategy & business model checklist, can empower the SBU managers to incorporate services within their strategic plans. The evaluation hereof is described in Chapter 6.4.

Table 15: a synthesized overview of servitization maturity levels, product-service combinations, and services

Relative importance of tangible goods												Relative importance of services
Product manufacturer				Value-added manufacturer				Full-service provider		Integrated solutions provider		
Input								Performance		Result		
Obsolescence management	Break-fix service (repair)	Commissioning & guarantee	Spare parts supply	Advice & consultancy	(preventive) maintenance	Integration & training	Spare parts management	Information management	Leasing or renting	Managed services	Output services	

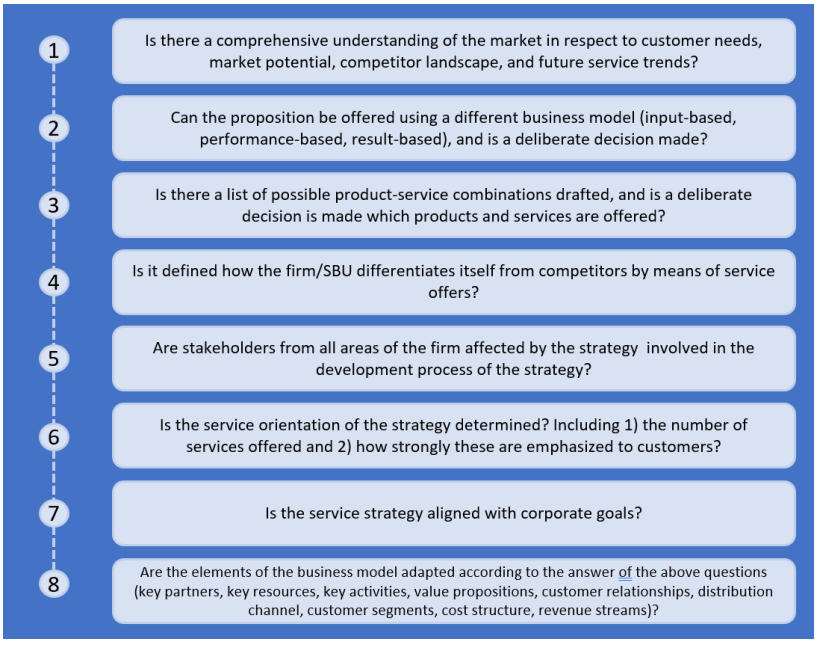


Figure 18: service strategy & business model checklist

6.2.3 Organizational structure

The added components within the organizational structure are shown in Figure 19 below. These components are based on the developed CAMO principles described in Chapter 5.1. The components consist of (1) central coordination, (2) an advanced service delivery process, (3) an advanced service(s) group, (4) a market-oriented service development process, and (5) a product management role. In Figure 19, the green-colored boxes represent the added components (e.g. process and groups), with a corresponding explanation within the arrowed boxes. Each of the components is explained next.

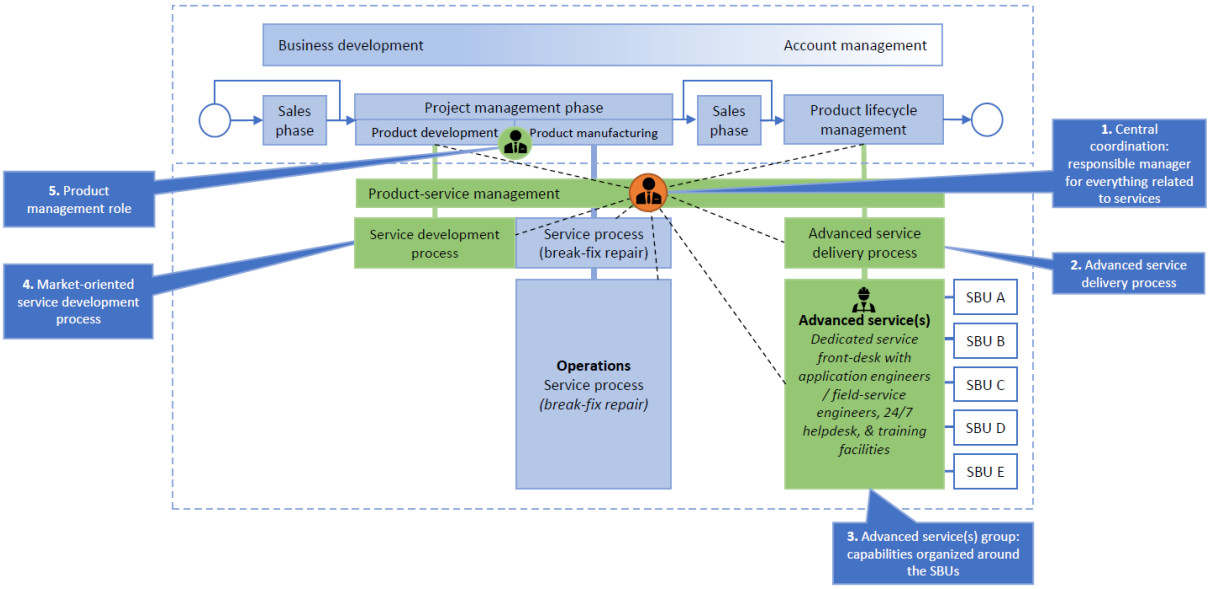


Figure 19: organizational structure & processes embedded within PT's current organization

1. Central coordination: responsible manager for everything related to services

There should be a central and coordinated approach for everything related to services in the improved organizational structure, from product development to product lifecycle management. First, central coordination can lead to improved communication between different groups and processes within the firm. For example, between business development and account management, and between project management and product lifecycle management. Second, central coordination can streamline and improve activities and processes and reduce the enormous diversity of service-related activities within PT. Depending on the wishes of PT, this role could either be created additionally or could be filled in by the COO.

2. Advanced service delivery process

An advanced service delivery process should be set up to support and deliver various types of (advanced) services. This process should describe how these services are executed and by whom. The process of Lifecycle Management currently describes how to perform lifecycle management, where there is a step for (advanced) maintenance within that process. However, the current LCM process is mainly focused on obsolescence management. Moreover, the maintenance step currently does not describe how to execute advanced services, such as (among others) maintenance, integration & training, and leasing. This process will enable service engineers to deliver various advanced services to customers. Through standardization of this process, a unified way of working is created, preventing a proliferation of different ways to deliver (advanced) services.

3. Advanced service(s) group

The third step is to create a dedicated service group for advanced services. This group is separate from the current service group that focuses primarily on break-fix repair and is part of operations (i.e. manufacturing of products). The present service group within PT is also very much used as a breeding ground for students to become R&D engineers. The human resources within this group are likewise utilized to perform on-location maintenance (i.e. SLA teams) for one or two lead customers; however, this is deemed insufficient for making the servitization transition as mentioned frequently within the empirical analysis. Alongside the SLA team for lead customers, the advanced service group should be focused around products (i.e. product-service combinations) instead. The advanced service group should consist of a dedicated service front-desk with application engineers or field-service engineers who have the right mindset and skillset and are ambitious about services rather than developing new products. Moreover, it should consist of a 24/7 helpdesk available to customers including training facilities. These training facilities could fulfill a dual role, providing either training to customers or internal employees. Within the advanced service group, service engineers should be organized around the technical SBUs. As became evident within the empirical analysis, the service engineers' capabilities should be sufficiently high to provide proper support. Contrastingly, it would arguably be difficult to train service engineers capable of delivering services across all SBUs. Also, some SBUs might not require such an advanced service group.

4. Market-oriented service development process

The fourth step is to embed service development early within the development of a product or a proposition. This could be achieved by a large extend by setting up a market-oriented service development process alongside NPD. Here, customer needs should be identified systematically through market research and workshops with lead customers. Moreover, there should be a close link between the service development process and the NPD process, as they are complementary to each other. Furthermore, products should be developed with serviceability or complementary services in mind, which is promoted by emphasizing service development early within NPD. Finally, the market-oriented service development process emphasizes a more proactive approach to develop suitable services within PT. Taking this proactive approach, PT can standardize the service offering and tailor it to customers' requirements instead of the other way around. Subsequently, reducing the variability of services offered.

5. Product management role

As mentioned within the empirical analysis, a product management role should be created. This role functions as an internal customer by validating the project delivery and using the right NPD criteria throughout the project development process. This step goes hand-in-hand with the growth strategy of the firm towards providing OEM products. As PT's traditional business models focused on customer input within the development, this role was previously unnecessary. However, for developing original equipment serving multiple end-customers, a different approach is required. By creating this product management role, delivering OEM products will have a higher chance of success.

6.3 Change plan

The implementation of the service strategy and business model checklist arguably does not require an extensive change plan. The implementation hereof and the roles involved are clearly explained in a RACI table included in Appendix 9.16, explaining which individuals or groups are Responsible, Accountable, Consulted, and Informed regarding the designed solution and change plan. Moreover, the implementation of the organizational structure elements is also included within the explanation of the design discussed in Chapter 6.2. Although the main components are explained before, firm culture and cognitive phenomena

among managers cannot be neglected as it is an essential factor in making a successful servitization transition. Thus, the plan to address the firm's culture and cognitive phenomena among managers is discussed next.

6.3.1 Firm culture & cognitive phenomena managers

The interference of a firm's culture and the cognitive phenomena among managers within that firm regarding making a successful servitization transition cannot be neglected. Although emphasized broadly within the literature that firms should implement an integrated culture that focuses on products and services, there are fewer clear answers to achieving this within a manufacturing firm. Although overall, a change in a firm's culture and the cognitive processes among managers result from a long-term emphasis on services within other areas of the framework (i.e. within the firm), there are short-term actions that PT can use or implement.

First, definitions of services within PT should be clearly defined, making a distinction between different types of services within PT. The types of services visible in Table 2 should be used by SBU managers, management, and operations to achieve this. Second, managers should change their thinking from services as an add-on to services as value-added activities. Third, management should commit visibly to extend the service business. Management should in communication towards the SBUs also check if they are thinking about value-added service activities, for example, within their strategy or business models. Furthermore, leadership support is necessary to foster an integrated product-service-oriented culture, where leadership can boost the value-added thinking towards the employee level. Fourth, Key performance Indicators should be changed to incorporate a changed view on the importance of services. Subsequently, it should highlight an increased focus on service revenues and a clear emphasis on services within customer satisfaction; also, including the measurements executed by the customer satisfaction process and account management process within PT. Moreover, this requires a sanity check on the firm's Key Performance Indicators to incorporate a view on services. Lastly, the interest among employees towards services and service activities could hamper a successful transition. This can be overcome by creating awareness of the importance and potential of adding services and promoting a service orientation among employees; otherwise, hiring new engineers, such as more service-oriented engineers (e.g. field service engineers). The latter is part of an increased focus towards services with resources & capabilities and the subsequent hiring process, for which the human resources group is responsible.

Practically, a clear communication plan could also promote the emphasis on services within the firm's culture. This could be picked up by the marketing department responsible for internal and external communications. Furthermore, it can also be emphasized by the CEO within internal communications; for example, through using the firm's intranet portals to communicate video messages where an increased focus on services is highlighted. Other pages could be the news page or the internal wiki page. Most importantly, the changes should be incorporated and visible throughout the firm's internal business strategy drafted by management. This strategy already includes culture components; however, it currently focuses on lifecycle management (i.e. obsolescence management and repair), thus presenting a limited focus on value-added services (i.e. advanced services).

Differently is how the firm positions itself towards the external environment (e.g. customers, suppliers, competitors). Additions could be made to the website, for example, where a dedicated place (i.e. sub-page) is created for everything related to services. Here, the firm can propagate their ambitions and goals and the types of services offered. Subsequently, this could also be beneficial for internal communications and attracting new employees as this is one of the website's purposes, according to the marketing manager of PT.

6.4 Solution design evaluation

The goals of the evaluation were inspired by Venable et al. (2016), making a distinction between formative and summative evaluation. Formative evaluation is typically conducted during the development of a solution design to iterate and improve the design. In contrast, summative evaluation involves making judgments about how well the designed solution achieves the solution's primary purpose. The formative evaluation consisted of three semi-structured interviews with the business control manager (also representing the company supervisor). The solution design iterations are included in Appendix 9.17.

The summative evaluation of the designed solution consisted of several rounds. They were conducted with several of the firm's SBU managers, the CCO, the CEO, and the business control manager. Due to planning difficulties regarding the agendas of the participants, the initially proposed focus group consisting of all SBU managers was divided into three sessions, resulting in a focus group with two SBU managers (SBU B and D) and two individual interviews with the manager of SBU E and SBU A. Moreover, third-party software to conduct a collaborative evaluation was prohibited (i.e. the use of MIRO) as per company policy. Therefore, the decision was made to use a presentation that showed the solution design during the semi-structured interviews. This presentation facilitated an open discussion and fostered the evaluation of the solution design components. All evaluation sessions were transcribed subsequently to reliably interpret the data and maintain transparency of the evaluation process. The following sections elaborate on evaluating the design principles and requirements formulated in Chapter 5, including highlights of the evaluations. A detailed description of the evaluation sessions is included in Appendix 9.18.

6.4.1 Evaluation of solution design

Table 16 shows an overview of the outcome of the evaluation sessions focusing on the elements of solution design component 1 (the servitization transition framework), which represents the synthesized design principles. Each design principle is subsequently empirically-supported, partly supported, or not supported. Due to time constraints, some design principles were not evaluated within specific evaluation sessions; these are marked with N.E. (i.e. not evaluated).

Table 16: outcome of the empirical evaluation of design principles

Design principles	**Evaluation session 1:** Managers SBU B&D	**Evaluation session 2:** Manager SBU E	**Evaluation session 3:** Manager SBU A	**Evaluation session 4:** COO	**Evaluation session 5:** CEO	**Evaluation session 6:** Business control manager
DP 1	Supported	Supported	Supported	Supported	Supported	Supported
DP 2	N.E.	N.E.	N.E.	N.E.	N.E.	Supported
DP 3	N.E.	N.E.	N.E.	N.E.	N.E.	Supported
DP 4	Supported	Supported	Supported	N.E.	N.E.	Supported
DP 5	**Not supported**	Supported	Partly supported	Supported	N.E.	Supported
DP 6	Supported	N.E.	**Not supported**	Partly supported	N.E.	Supported
DP 7	Supported	Supported	Supported	Supported	Supported	Supported
DP 8	Supported	Supported	Supported	Supported	Supported	Supported

Design principle 1 covers the strategy component within the servitization transition supported by the evaluation sessions. All managers stated that the servitization transition indeed starts with including a service orientation within their strategic plans, considering the external factors.

"It indeed starts with drafting a roadmap or strategy regarding services, based on the external factors such as customers." (Manager SBU A)

Design principles 2 and 3 cover the business model component within the servitization transition. Here, support was given regarding the need to change the business model along with the strategy. However, due to time constraints, the differences between incremental business model innovation and radical business model innovation were not evaluated. Conclusively, the element of the business model within the servitization transition is supported. However, specifically regarding incremental or radical innovation (i.e. change), no strong support for or against this can be given.

Design principle 4 covers the transition component of firm culture & cognitive phenomena among managers within the servitization transition. It was evaluated with four managers who all supported this transition element and design principle. However, the actions and mechanisms within this component were not evaluated explicitly. Thus, support can be given towards this design principle; however, it should be investigated further to ensure the underlying actions and mechanisms.

Design principle 5 covers the firm's organizational structure regarding the servitization transition, detailing an explicit organizational group to set up and handle the service offering. Three out of five managers supported this transition component and design principle. Interestingly, the focus group with the managers of SBU B & D questioned if it would be useful to find a central group for advanced service delivery or whether this should be decentralized. The managers mentioned that this was due to the wide range of highly technical competences within PT. Conclusively, this contrasts the earlier found results that strongly emphasize a separate group to handle the (advanced) service offering. Although unanimous support is given regarding the need to change or add elements to the organizational structure regarding a successful servitization transition (e.g. dedicated service-front desk, field-service engineers, 24/7 support, and training facilities), no full support can be given regarding an explicit organizational group. Therefore, this could be investigated further to ensure full support. Design principle 6 also covers the firm's organizational structure regarding the servitization transition by advocating central coordination and assigning a responsible manager to coordinate the firm's service activities. Supported by two out of four managers. Explicitly not supported by one manager which represents circular reasoning; thus, highlighting the underemphasis of service within the ideas of managers.

Design principle 7 covers the activities & processes within the servitization transition, specifically advocating an advanced service delivery process and a market-oriented service development process. All managers in the evaluation session positively supported both.

"We have to standardize our processes and set up an advanced service delivery process indeed." (Manager SBU B)

Design principle 8 covers resources & capabilities within the servitization transition supported in all evaluation sessions. All managers stated the need to have and use both financial resources and employees. Moreover, it was confirmed that specific service-related capabilities are needed, which lay outside the firm's current capabilities.

6.4.2 Evaluation of design requirements

This section explains the outcome of the evaluation of the design with the design requirements. Figure 17 shows an overview of the outcome of the evaluation of design requirements. Each solution component is validated with the requirements defined in Chapter 5.2. Each of the requirements is briefly explained next.

Table 17: outcome of the evaluation of design requirements

Requirements	Solution design components		
	Component 1: Servitization transition framework	**Component 2:** Servitization framework, service strategy & business model checklist	**Component 2:** Organizational structure
F1	✔		
F2		✔	
F3		✔	
F4		✔	
F5			✔
B1	✔	✔	✔
B2	✔	✔	✔
B3	✔	✔	✔
U1	✔	✔	✔
U2	✔	✔	✔

The servitization transition framework (solution design component 1) meets requirement F1 as intended, presenting an overview of the servitization transition process. During the evaluation sessions, all managers expressed positively to the holistic approach of the transition framework. For example, the manager of SBU B said that he believes all components to make a successful servitization transition are in there. Managers positively cited the framework presents a holistic approach bringing the two stakeholder groups together (i.e. SBU managers and the COO representing the support organization). The manager of SBU B also mentioned the frequent internal discussions between him and the operations part of the organization, where he asked the support organization: "what services can you offer?" In contrast, the support organization asked the question back: "what services do you want to offer?" The following quote highlights this gap between the two parts of the organization:

"There currently is a gap between the service strategy and the execution of the strategy, your solution will contribute to filling that gap, but I think it will still be difficult." (Manager SBU E)

The servitization framework and the service strategy & business model checklist (solution design component 2) meets requirements F1-F5 as intended. All managers stated the usefulness of the overview of servitization maturity levels, the types of product-service combinations, business models, and services.

"For me, it (interpretation: the overview of maturity levels and types of services) is a very comprehensible overview which presents me with insight into what I could offer, and in what way. Also, the strategy steps could help me, also with asking the right questions." (Manager SBU E)

The CCO also mentioned it as a valuable tool to assist the SBU managers in addressing their service needs towards him, being the responsible manager of the organizational structure. However, he mentioned that it is up to the individual SBUs to come up with the services they want to offer to their customers, and then it is up to him to arrange this. He liked the idea of setting up a roadmap together with the SBU managers over time to increase the service portfolio and organizational support. Conclusively and in his opinion, it was more important to determine the future services to be provided starting at the SBU managers and then look at how to arrange this within the organization (also providing support of the importance of design component 2).

"This is an overview that makes sense. This is where you can say, in order to move further to the right, we have to arrange this and that… I am very curious, could we set up a roadmap, maybe even together with the SBU managers?" (COO)

The improved organizational structure (solution design component 3) meets requirement F5 as intended, presenting an overview of the organizational structure necessary to make the servitization transition. Although the individual components of the organizational structure (including processes) were validated in section 6.4.1., certain managers were still wary of thinking about how the organization should look before a strategy has been developed.

All three solution design components are in accordance with the requirements regarding boundary conditions (B1, B2, & B3) and user requirements (U1 & U2). The solution design components were all considered to be compatible with the existing systems and processes of PT, fitting with the strategy and objectives of PT, matching with the current organizational structure, understandable by managers, and easy to use by managers.

7. Discussion and conclusion

This chapter concludes the research set out to investigate how a manufacturing firm can transition along the product-service continuum. The results of the research are presented and discussed, covering the four sub-research questions. Next to that, the theoretical and practical implications of the research are presented, followed by limitations and recommendations for future research. Conclusively, the main research question is answered.

7.1 Results & discussion

This research incorporated a case study approach to design science within PT to answer the following main research question: "*How can PT transition along the product-service continuum to better provide diverse services across their strategic business units?"* To answer this question, four sub-research questions were formulated. Each of the sub-research questions and the findings hereof will be discussed below.

1A. What is servitization, what product-service combinations are there, which combinations does PT currently offer, and what are their future ambitions?

Although various explanations of the servitization phenomenon exist, Baines et al. (2009) explain servitization as the innovation of an organization's capabilities and processes to better create mutual value through a shift from selling products to selling product-service systems. Within the research stream of servitization, different classifications are visible. For example, to describe strategies, business models, or the types of services. As this research set out, it incorporated the product-service continuum (Olivia & Kallenberg, 2003) and the servitization pyramid (Coreynen et al., 2017). All of which are well-known and supported frameworks within servitization. In the servitization pyramid, the product-service combination's value proposition is used to distinguish between input-based, performance-based, and result-based business models (i.e. services) (Coreynen et al., 2017). The empirical analysis revealed that these three servitization classifications are too broad to cope with the context of traditional manufacturing firms. Moreover, these classifications are related to a specific proposition or business model, thus not accurately classifying more significant elements such as SBUs or firms. To better explain servitization and which product-service combinations exist, servitization maturity levels were included in an integrated framework. Servitization maturity levels can provide a more explicit classification of firms or SBUs considering organizational readiness to support these service activities. A distinction is made between the following servitization maturity levels (in ascending order): product-manufacturer, value-added manufacturer, full-service provider, and integrated solutions provider (Atos consulting, 2011; ABN AMRO, 2016).

PT currently provides mainly products sold using an input-based business model, with input-based services such as obsolescence management, break-fix service, commissioning & guarantee, spare parts supply, and occasionally provides advice & consultancy. Conclusively, this typifies PT as being a product manufacturer regarding servitization maturity. Nevertheless, several service activities such as SLA agreements with specific customers (such as on software) are also provided by PT which shows resemblances with the maturity level of a value-added manufacturer, although both still revolving around input-based services. PT intends to develop more original equipment and shift its maturity towards a value-added manufacturer, where services can be a profitable income source. Providing services such as (preventive) maintenance, integration & training, and spare-parts management. Furthermore, the firm is currently developing original equipment which they want to market using a performance-based business model (e.g. leasing), which requires a servitization maturity similar to that of a full-service provider. Conclusively, the empirical analysis revealed two ambitions regarding maturity within the servitization transition (to value-added manufacturer and full-service provider). Moreover, the integrated framework

presents a valuable framework to accurately describe the current product-service combinations of manufacturing firms (including PT) and their future ambitions.

1B. How in the organization are services provided to the customer?

PT follows a process-based organizational structure. Process-based organizational structures are designed around the end-to-end flow of different processes. Because PT mainly revolves around the current business models of technology solutions and OTS products, customers mostly dictate which services are provided to them; consequently, leading to a limited service portfolio. The lifecycle of products within PT consists of three phases: sales phase, project management phase, and product lifecycle management phase. At PT, there is a strong handoff between project management and the product lifecycle management phase resulting in a wide variety of different agreements with customers that are supported accordingly. Within PT, services are mainly seen as break-fix repair, performed by a separate process and group within the product manufacturing phase (e.g. service process). For all other service activities, a customer account management team or product team is set up to handle issues regarding QLTCS (Quality, Logistics, Technology, Costs, Sustainability). These teams mainly focus on maintaining the realized value rather than providing additional value-adding services (including advanced services such as maintenance).

2. What are the barriers that inhibit PT to follow the servitization path?

There are three servitization perspectives found within the literature: an internal perspective, an external perspective, and a technological perspective (Vandermerwede & Rada, 1988). The empirical analysis revealed the interviewees placed little emphasis on technological barriers within PT. It can be argued that this is due to PT being a high-tech manufacturing company with a significant focus on state-of-the-art products operating in TI markets. Interestingly, this could mean that high-tech manufacturing firms wishing to engage in servitization do not experience technological barriers to the same degree as manufacturing firms that are not active in TI markets. Due to this, the technological perspective has been excluded from the theoretical analysis. Regarding the internal and external servitization barriers, Neely and Hou (2013) provide granularity by describing different groups of barriers. This study groups external barriers under (i) competitors, suppliers, & partners, and (ii) customers. The empirical analysis revealed four external barriers. Three of these are similar to the barriers found within the analyzed body of literature and the categories described by Neely and Hou (2013). These empirically found barriers are the (i) voice of the customer, (ii) market considerations, and (iii) customers' perception of service capabilities supplier. Although the latter has not been mentioned explicitly within the literature, it adds granularity to the barriers related to customers. Alongside these findings, the empirical analysis revealed one external barrier not mentioned within the analyzed body of literature which is the type of product and position in the value chain. It can be argued that this is less visible within the literature as most literature covers OEMs as a starting point of the servitization journey. However, the finding can be explained as the value chain within the context of PT is differentiated, providing to either OEMs or end-customers. Moreover, having a portfolio consisting of products, modules, and components.

The empirical analysis revealed a significant emphasis on internal servitization barriers. This seems logical as PT is at the start of its servitization journey, and the firm's maturity is similar to that of a product manufacturer. Subsequently, managers and other employees within PT have a limited external view and most notably mention visible internal barriers. Based on the analyzed body of literature and the study by Neely and Hou (2013), internal barriers can be grouped under (i) financial, (ii) knowledge & information, (iii) activities & processes, (iv) organizational structure, (v) culture, and (vi) cognitive phenomena managers.

Moreover, the empirical analysis discovered several internal barriers confirming the current literature, including (i) resources, activities including (ii) value selling, activities including (iii) missing a clear service

strategy, company culture, (ii) cognitive phenomena managers, and (v) organizational structure. However, Neely and Hou (2013) categorize lack of human resources (Cook et al., 2006) under activity and processes. Arguably it is better to merge it in the financial category renaming it to cover both financial and human resources. Furthermore, the empirical analysis revealed other barriers not visible within the analyzed body of literature, including (i) strategic arguments not to extend the service business and the (ii) type of distribution model. Conclusively, the most significant internal servitization barrier found within the empirical analysis is related to the firm's organizational structure, highlighting that necessary adjustments need to be made accordingly.

3. *How can manufacturing firms successfully transition along the product-service continuum?*

For manufacturing firms to make the servitization transition, they have to deal with the barriers they face, specific to the external environment, the internal environment, or technology. Within the literature, a non-holistic approach is often applied to investigate specific barriers and actions. However, the analyzed literature suggests that these specific approaches (such as a business model redesign approach) alone are insufficient (Spring & Araujo, 2013; Ulaga & Reinartz, 2011).

Through a systematic review of the literature and empirical data, six key transition components were synthesized. These are service strategy, business model, firm culture & cognitive phenomena managers, organizational structure, activities & processes, and resources & capabilities. These components are reflected in the form of eight design principles which form the basis on how manufacturing firms can successfully make the servitization transition. First, a successful servitization transition starts with proactively developing a deliberate strategy regarding services (DP1). Second, the business model should be adapted depending on the desired destination (DP1 & DP2). Third, an integrated product-service culture should be advocated by management with leadership support (DP4). Fourth, the organizational structure should be adapted, including a dedicated organizational group to handle the service offering in combination with central coordination regarding services (DP5 & DP6). Fifth, service-related activities and processes should be set up, including an advanced service delivery process and a market-oriented service development process (DP7). Sixth, resources should be invested (both financially and employees) to develop service-related capabilities, engage in value selling and relationship marketing, and monitor the effectiveness & efficiency of service (delivery). These design principles form the basis of the solution design, which has been developed to answer the final sub-research question.

4. *How should the transition to other product-service combinations and an improved service offering be formulated?*

Incorporating a holistic perspective covering the above design principles, the servitization transition is formulated through a servitization transition framework (solution design component 1). The transition framework distinguishes actions specific to the servitization maturity level of (i) value-added manufacturer and (ii) full-service provider. Which also represents the desired destinations of PT along the product-service continuum. Alongside this servitization transition framework, there are two (groups of) stakeholders in specific which the solution design should support, the SBU managers and the COO (i.e. representative of the support organization). The integrated servitization maturity framework and eight-step process to develop a service-oriented strategy (solution design component 2) is aimed at the SBU managers. It presents them with an overview of the servitization maturity levels and guides them in detailing the potential services and business models they could utilize. Moreover, through the eight-step process, they have guidelines to incorporate services within their strategic plans. Although the service strategy is the first essential component within the servitization transition, the discovered servitization barriers in the empirical analysis were mainly related to the PT's internal organization. Therefore, an improved

organizational structure with added processes or groups is drafted (solution design component 3), which can be utilized and implemented by the COO (i.e. the support organization).

Three iterations were made to arrive at the final solution design. After that, the solution design was evaluated through an unstructured focus group and several rounds of interviews with stakeholders. During the evaluation, the designed solution received positive feedback. Four design principles were fully empirically supported (DP1: service strategy, DP4: culture & cognitive phenomena, DP6: activities & processes, and DP7: resources & capabilities). Four design principles were partly empirically supported (DP2 & 3: business model, DP4: organizational structure advanced service group, and DP5: organizational structure central coordination). Both stakeholder groups reacted positively to the designed solution. First, the SBU managers felt empowered to incorporate a service orientation within their strategic plans knowing the servitization maturity levels and the types of services at each level. Second, the COO approved necessary adjustments needed to be made to the organizational structure. Moreover, he proposed to set up a road mapping session together with the SBU managers to see which services specifically would be added to the portfolio and supported subsequently.

7.2 Theoretical implications

This research presents several theoretical implications, which are discussed next. This research developed an integrated servitization framework combining the earlier described product-service continuum by Oliva and Kallenberg (2003), the servitization pyramid by Coreynen et al. (2017), and the servitization maturity levels by Atos Consulting (2011). It was discovered that the first two maturity levels from Atos Consulting (2011), being a product manufacturer and a value-added manufacturer, corresponds to the input-based category of Coreynen et al. (2017). Subsequently, relating the maturity level of a full-service provider with the performance-based category of the servitization pyramid and the maturity level of an integrated-solutions provider with the result-based category of the servitization pyramid. This integrated framework provides manufacturing firms with a more detailed view regarding the servitization transition, including the four maturity levels, business models, and various services applicable to each maturity level. Furthermore, it can still be used to relate to previous work revolved around the servitization pyramid by Coreynen et al. (2017) as these are included and combined with servitization maturity. Conclusively, this research contributes to the literature by presenting a synthesized framework and proposing to use maturity levels to detail the steps of a manufacturer within the servitization transition.

Various servitization barriers and challenges were discovered within the case company contributing to the current body of literature. Within the scientific field, it remains a much-researched area of interest, which is visible by the multitude of recent studies focused on the barriers and challenges of manufacturing firms regarding servitization (Neely & Hou, 2013; Kowalkowski & Kindström, 2014; Visnjic & Van Looy, 2013; Coreynen et al., 2017; Finne et al., 2013; Coreynen et al., 2018; Rabetino et al. 2017; Baines et al., 2020). This research reinforces the current body of literature on servitization barriers. Moreover, it discovered several novel internal and external barriers. The discovered external barrier is labeled type of product and position in the value chain, which is described as whether a manufacturer produces products, modules, or components (i.e. technology solutions or OTS products), and their position in the value chain. The research found that the servitization potential is much higher and the barriers less applicable regarding products (i.e. original equipment) directly serving end-customers. Regarding internal barriers, this research contributes by arguing that there could be strategic motives not to extend the service business (e.g. providing services for free rather than making it a value-added activity and profitable revenue stream). Moreover, the decision of the distribution model (selling to VARs or end customers directly) can impact the servitization potential and thus poses a significant barrier not found within the current body of literature. Furthermore, this research argues that technological servitization barriers are less experienced

by high-tech manufacturing firms active in TI markets compared to manufacturing firms active in less TI markets, which presents a contribution to the servitization literature.

Within the literature, certain studies focusing on specific service strategies and the impact on the organization (Gebauer, 2008; Gebauer et al., 2010). Other studies incorporate the servitization pyramid by Coreynen et al. (2017). However, few studies focus on this relationship with servitization maturity. This can be partly explained by the novelty of maturity frameworks within servitization to describe manufacturing firms. Regarding service strategies, it provides mainly a general endpoint for firms rather than describing a journey. Conclusively, this research contributes to the servitization literature by using maturity as the main topic within the servitization transition.

A design science methodology is not often applied within the literature stream of servitization. Nevertheless, the literature describes an increasing need for the research community to engage prescriptively in the change process by engineering the tools and techniques needed by practitioners (Baines et al., 2009). This research contributes to both literature and practice by providing a servitization transition framework with prescriptive knowledge that guides manufacturing firms in successfully making the servitization transition.

Different approaches to describe the servitization transition are visible within the literature. Within the analyzed articles, most incorporate a non-holistic approach focusing on specific components (Baines et al., 2009). However, within the literature, it is commonly argued that a business model redesign approach alone is insufficient (Spring & Araujo, 2013; Ulaga & Reinartz, 2011). Although the elements are separately found within the literature, this research contributes to the current body of literature by emphasizing the following necessary components within the servitization transition from a holistic perspective: a service strategy, a reconfigured business model, an integrated product-service culture, a supporting organizational structure, supporting service-related activities & processes, and service-related resources & capabilities. Moreover, it proposes that more research should investigate the servitization phenomenon by applying a holistic approach.

7.3 Practical implications

This research is valuable for PT in supporting the transition process of the firm within servitization. Foremost, the results of this research provide PT with insight and knowledge of servitization barriers and challenges specific to their external and internal environment, thus reducing the uncertainty of the transition process. This includes unobservable barriers such as barriers related to PT's culture and cognitive phenomena among managers. The servitization framework presents this holistic overview of the necessary servitization elements useful to the board of management, SBU managers, and other managers and process owners within PT. Secondly, the servitization maturity overview with corresponding services within each level provides a valuable overview to SBU managers to extend their service business. This simultaneously presents the first major step for PT: all SBU managers should incorporate a service orientation within their strategic plans (i.e. service strategy). Secondly, new elements should be included within the organization implemented either by or via the COO; consequently, improving the maturity of PT regarding services.

7.4 Limitations and recommendations for future research

Seven limitations impact the results of this research. These limitations are elaborated next, including recommendations for future work or research if applicable. Firstly, this research is executed within a single manufacturing firm, leading to empirical results related to the specific context of one firm. Although the analysis of literature incorporated a holistic perspective based on several multiple-case

studies executed either within and among various manufacturing firms, the empirical results and the subsequent design of this research are strongly influenced by the case company's barriers and challenges specific to that context. Although a multiple-case study approach among different manufacturers engaged in servitization could have reduced this limitation, improving external validity, it would have been difficult to fit into the chosen design science methodology. Moreover, the interviews with other firms would require the same level of detailed analysis, which was difficult to achieve in the time available within this research. Moreover, it would require the inclusion of firms in a similar context and business problem, which could provide difficulties in finding these companies. The servitization transition framework's main components are representative of a more expansive view that other manufacturing firms can use. This also holds for the servitization maturity and services overview and the eight-step process to incorporate services within a firm's strategy. However, this does not hold for the added components within the organizational structure. These are specifically tailored to the context of the case company, which therefore presents a limitation in a broader sense. In general, future research could be executed among other manufacturing firms engaged in servitization to improve external validity.

Secondly, an external expert on servitization was consulted to improve the reliability and interpretation of the theoretically found barriers, challenges, and transition actions and mechanisms. Although this is an additional step, it still incorporated only one external expert on the topic. Thus, input by other experts on the topic of servitization has not been included. Consequently, the results hereof represent the knowledge and opinions of a single individual, which therefore represents a minor limitation of this research.

Thirdly, the research incorporated a limited external perspective. As evident from the outcome of this research, external factors are an essential component to consider when developing a service strategy. However, this research did not include interviews with the firm's customers considering the customers' perspective. To address this, questions were asked within the empirical analysis towards the SBU managers and board of management related to external factors and barriers. Nevertheless, future research should be executed to specifically investigate the external perspective further. To firstly improve the robustness of the currently found external factors and possibly extend these findings. And secondly, to examine the servitization potential specific to the external environment of the case company.

Fourthly, based on the review of literature, a servitization framework was adapted focusing on servitization maturity. Although strong arguments are given to incorporate this four-step maturity framework within this case, other frameworks are also visible within the examined literature. Taking a different framework as a basis could either confirm the current research findings or present new insights. A frequently used alternative framework is a service strategy framework, emphasizing the service strategies incorporated by manufacturers. These strategies include a customer service strategy, basic services for the installed base, maintenance services, R&D-oriented services, and outsourcing services (Gebauer et al., 2010).

Fifthly, three design solution iterations were made based on three evaluation interviews with the business control manager (i.e. company supervisor). As per the chosen methodology, the outcome of a design science research can be significantly improved by having co-creation sessions and various design iterations, especially by using focus groups. This research initially planned to have one or two focus groups with relevant stakeholders to improve the designed solution. Unfortunately, due to time constraints and the participants' agendas, this was replaced by one small-sized focus group and six semi-structured interviews through summative evaluation. Conclusively, building on the current research while closely involving different employees within the case firm to iterate and improve the designed solution(s) could be interesting as future research, especially for PT.

Sixthly, this research incorporated a holistic approach regarding the servitization transition. A holistic approach is deemed valuable from both a theoretical and practical perspective as the case company is inexperienced with servitization (i.e. making the servitization transition). Thus, investigating only a specific element would be less valuable to manufacturing firms with inexperience regarding servitization, including the case company. Nevertheless, a holistic approach influences the particular outcome of the research, as a certain level of abstractness is maintained without detailed investigations on specific components. Furthermore, during the evaluation sessions of the designed solution, specific stakeholders revealed specific questions they would like to have answered, which could be fruitful avenues for future research. For example, how to set up a global service organization considering limited resources, including calculating the financial costs hereof.

Lastly, this research assumes that the extension of the firm's service business and servitization maturity contributes to turning services into a profitable component rather than a cost. However, the financial consequences of servitization are arguably not a direct result hereof. This phenomenon is called the servitization paradox (Gebauer, 2005). Due to the current scope and constraints of the research, it is not investigated to what degree the extension of the service business directly impacts the profitability of the services offered by the case company, which could be an avenue for future research. It might be interesting to see the impact on profitability after specific steps within the servitization transition have been made by PT in the foreseeable future.

7.5 Conclusion

Servitization is no longer a distant term as the traditional manufacturing industry is increasingly experiencing the needs and desires to extend their service business. Although a much-researched stream within the literature, academics and practitioners (i.e. manufacturing firms) still face many unknowns regarding the barriers and challenges of servitization. This research set out to investigate how a manufacturing firm can successfully make this servitization transition. A case study approach to design science was incorporated within the manufacturing firm PT to answer this question. Simultaneously carrying out a narrative and systematic literature review and empirical analysis, consisting of 22 semi-structured interviews within the case company with candidates with varying functions and one external interview with an expert on servitization. Through investigating servitization barriers and challenges faced by manufacturing firms and PT particularly, including the actions and mechanisms found within the literature on how to mitigate or cope with these barriers and challenges, an answer is brought to the following question, which presents the main research question of this research:

> "*How can PT transition along the product-service continuum to better provide diverse services across their strategic business units?"*

The servitization of manufacturing firms is not a one-time endeavor but rather a journey with different destinations. Although it presents significant challenges for manufacturing firms, it is a valuable journey to pursue. Servitization offers new opportunities for growth, sustainability, and competitiveness. However, only if all aspects of this servitization journey are considered and dealt with appropriately. Through this research, I tried to create this servitization transition process for PT. Including a holistic overview of the internal and external servitization barriers faced by PT and the transition actions and mechanisms involved; consequently, supporting the SBU managers in developing a service-oriented strategy and detailing the necessary organizational changes that need to be implemented to facilitate the servitization transition. Through this research, PT has the knowledge and guidelines available to embark on their servitization journey. I believe that PT has an exciting future ahead regarding servitization in making themselves a knowledgeable product-service provider.

8. Bibliography

ABN AMRO. (2016). Servitization: dienstverlening is de toekomst van de industrie. Retrieved from https://insights.abnamro.nl/2016/10/servitization-dienstverlening-is-de-toekomst-van-de-industrie/ at 20-11-2020.

Aken, J. E. V. (2004). Management research based on the paradigm of the design sciences: the quest for field-tested and grounded technological rules. Journal of management studies, 41(2), 219-246.

Amit, R., & Zott, C. (2012). Creating value through business model innovation. 2012.

Atos Consulting. (2011). Servitization in product organizations: Creating business value beyond products. 1-26. Retrieved from https://www.consultancy.nl/media/Atos%20Consulting%20-%20Servitization%20in%20Product%20Companies-2772.pdf at 20-11-2020.

Auguste, B. G., Harmon, E. P., & Pandit, V. (2006). The right service strategies for product companies. McKinsey Quarterly, 1, 40.

Baines, T., Bigdeli, A. Z., Sousa, R., & Schroeder, A. (2020). Framing the servitization transformation process: A model to understand and facilitate the servitization journey. International Journal of Production Economics, 221, 107463.

Baines, T. S., Lightfoot, H. W., Benedettini, O., & Kay, J. M. (2009). The manufacturing servitization: A review of literature and reflection on future challenges,". Journal of Manufacturing Technology Management, 20(5), 547-567.

Baines, T. S., Lightfoot, H. W., Evans, S., Neely, A., Greenough, R., Peppard, J., ... & Wilson, H. (2007). State-of-the-art in product-service systems. Proceedings of the Institution of Mechanical Engineers, Part B: journal of engineering manufacture, 221(10), 1543-1552.

Barney, J. (1991). Firm resources and sustained competitive advantage. Journal of management, 17(1), 99-120.

Barquet, A. P. B., de Oliveira, M. G., Amigo, C. R., Cunha, V. P., & Rozenfeld, H. (2013). Employing the business model concept to support the adoption of product–service systems (PSS). Industrial Marketing Management, 42(5), 693-704.

Baveja, S. S., Gilbert, J., & Ledingham, D. (2004). From products to services: why it's not so simple. Harvard Management Update, 9(4), 3-5.

Barquet, A. P. B., de Oliveira, M. G., Amigo, C. R., Cunha, V. P., & Rozenfeld, H. (2013). Employing the business model concept to support the adoption of product–service systems (PSS). Industrial Marketing Management, 42(5), 693-704.

Bessant, J., & Davies, A. (2007). Managing service innovation. Innovation in services, 21(2), 139-161.

Bjurklo, M., Edvardsson, B., & Gebauer, H. (2009). The role of competence in initiating the transition from products to service. Managing Service Quality: An International Journal.

Blumberg, B., Cooper, D., & Schindler, P. (2014). Business Research Methods. McGraw-Hill Education.

Chesbrough, H. (2007). Business model innovation: it's not just about technology anymore. Strategy & leadership.

Coreynen, W., Matthyssens, P., De Rijck, R., & Dewit, I. (2018). Internal levers for servitization: How product-oriented manufacturers can upscale product-service systems. International Journal of Production Research, 56(6), 2184-2198.

Coreynen, W., Matthyssens, P., & Van Bockhaven, W. (2017). Boosting servitization through digitization: Pathways and dynamic resource configurations for manufacturers. Industrial marketing management, 60, 42-53.

Davies, A. (2003). Are firms moving downstream into high-value services. Service innovation. organizational responses to technological opportunities & market imperatives. Series on technology management, 9, 21-340.

Den Hertog, P., Van der Aa, W., & De Jong, M. W. (2010). Capabilities for managing service innovation: towards a conceptual framework. Journal of service Management.

Denyer, D., Tranfield, D., & Van Aken, J. E. (2008). Developing design propositions through research synthesis. Organization studies, 29(3), 393-413.

DiPeso, J. (2000). P2: Putting environmental issues in a new light. Environmental Quality Management, 10(1), 13-13.
Cook, M. B., Bhamra, T. A., & Lemon, M. (2006). The transfer and application of Product Service Systems: from academia to UK manufacturing firms. Journal of cleaner production, 14(17), 1455-1465.

Donaldson, W. G. (1995). Manufacturers need to show greater commitment to customer service. Industrial Marketing Management, 24(5), 421-430.

Dubois, A., & Gadde, L. E. (2002). Systematic combining: an abductive approach to case research. Journal of business research, 55(7), 553-560.

Eggert, A., Hogreve, J., Ulaga, W., & Muenkhoff, E. (2014). Revenue and profit implications of industrial service strategies. *Journal of Service Research*, *17*(1), 23-39.

Eisenhardt, K. M. (1989). Building theories from case study research. Academy of management review, 14(4), 532-550.

Finne, M., Brax, S., & Holmström, J. (2013). Reversed servitization paths: a case analysis of two manufacturers. Service Business, 7(4), 513-537.

Fisk, R., Patricio, L., Raddats, C., & Burton, J. (2011). Strategy and structure configurations for services within product-centric businesses. Journal of Service Management.

Galbraith, J. R. (2002). Organizing to deliver solutions. Organizational dynamics, 31(2), 194.

Goedkoop, M. J., Van Halen, C. J., Te Riele, H. R., & Rommens, P. J. (1999). Product service systems, ecological and economic basics. Report for Dutch Ministries of environment (VROM) and economic affairs (EZ), 36(1), 1-122.

Govindarajan, V. (1989). Implementing competitive strategies at the business unit level: Implications of matching managers to strategies. Strategic management journal, 10(3), 251-269.

Gebauer, H. (2008). Identifying service strategies in product manufacturing companies by exploring environment–strategy configurations. Industrial marketing management, 37(3), 278-291.

Gebauer, H., Edvardsson, B., Gustafsson, A., & Witell, L. (2010). Match or mismatch: Strategy-structure configurations in the service business of manufacturing companies. Journal of Service Research, 13(2), 198-215.

Gebauer, H., & Friedli, T. (2005). Behavioral implications of the transition process from products to services. Journal of Business & Industrial Marketing, 20(2), 70–78.

Gebauer, H., Ren, G. J., Valtakoski, A., & Reynoso, J. (2012). Service-driven manufacturing: Provision, evolution and financial impact of services in industrial firms. Journal of Service Management.

Gebauer, H., Fleisch, E., & Friedli, T. (2005). Overcoming the service paradox in manufacturing companies. European management journal, 23(1), 14-26.

Gebauer, H., Krempl, R., Fleisch, E., & Friedli, T. (2008). Innovation of product-related services. Managing Service Quality: An International Journal.

Geum, Y., Lee, S., Kang, D., & Park, Y. (2011). The customisation framework for roadmapping product-service integration. Service Business, 5(3), 213-236.

Grönroos, C. (2006). Adopting a service logic for marketing. Marketing theory, 6(3), 317-333.

Gupta, A. K., & Govindarajan, V. (1984). Business unit strategy, managerial characteristics, and business unit effectiveness at strategy implementation. Academy of Management journal, 27(1), 25-41.

Gustafsson, A., Edvardsson, B., & Brax, S. (2005). A manufacturer becoming service provider–challenges and a paradox. Managing Service Quality: An International Journal.

Heinonen, K., Holmlund, M., Strandvik, T., Witell, L., & Löfgren, M. (2013). From service for free to service for fee: business model innovation in manufacturing firms. Journal of Service Management.

Heiskanen, E., & Jalas, M. (2003). Can services lead to radical eco-efficiency improvements?–a review of the debate and evidence. Corporate social responsibility and environmental management, 10(4), 186-198.

Helander, A., & Möller, K. (2008). How to become solution provider: System supplier's strategic tools. Journal of Business-to-Business Marketing, 15(3), 247-289.

Hevner, A. R., March, S. T., Park, J., & Ram, S. (2004). Design science in information systems research. MIS quarterly, 75-105.

Holmström, J., Ketokivi, M., & Hameri, A. P. (2009). Bridging practice and theory: A design science approach. Decision Sciences, 40(1), 65-87.

Homburg, C., Fassnacht, M., & Guenther, C. (2003). The role of soft factors in implementing a service-oriented strategy in industrial marketing companies. Journal of Business to Business Marketing, 10(2), 23-51.

Homburg, C., Workman, J. P., & Jensen, O. (2000). Fundamental changes in marketing organization: The movement toward a customer-focused organizational structure. Journal of the Academy of Marketing Science, 28(4), 459-478.

Hou, J., & Neely, A. (2013). Barriers of servitization: Results of a systematic literature review. Frameworks and Analysis, 189.

John, G., Weiss, A. M., & Dutta, S. (1999). Marketing in technology-intensive markets: Toward a conceptual framework. Journal of Marketing, 63(4_suppl1), 78-91.

Keskin, D., & Romme, G. (2020). Mixing oil with water: How to effectively teach design science in management education?. BAR-Brazilian Administration Review, 17(1).

Kindström, D. (2010). Towards a service-based business model–Key aspects for future competitive advantage. European management journal, 28(6), 479-490.

Kindström, D., & Kowalkowski, C. (2014). Service innovation in product-centric firms: A multidimensional business model perspective. Journal of Business & Industrial Marketing.

Kolko, J. (2010). Abductive thinking and sensemaking: The drivers of design synthesis. Design issues, 26(1), 15-28.

Kotter, J. P. (1995). Leading change: Why transformation efforts fail.

Kowalkowski, C. (2010). What does a service-dominant logic really mean for manufacturing firms?. CIRP Journal of Manufacturing Science and technology, 3(4), 285-292.

Kowalkowski, C. (2011). The service function as a holistic management concept. journal of business & industrial marketing.

Kowalkowski, C., Gebauer, H., Kamp, B., & Parry, G. (2017). Servitization and deservitization: Overview, concepts, and definitions. Industrial Marketing Management, 60, 4-10.

Kowalkowski, C., Windahl, C., Kindström, D., & Gebauer, H. (2015). What service transition? Rethinking established assumptions about manufacturers' service-led growth strategies. Industrial marketing management, 45, 59-69.

Kowalkowski, C., Witell, L., & Gustafsson, A. (2013). Any way goes: Identifying value constellations for service infusion in SMEs. Industrial Marketing Management, 42(1), 18-30.

Macdonald, E. K., Wilson, H., Martinez, V., & Toossi, A. (2011). Assessing value-in-use: A conceptual framework and exploratory study. Industrial Marketing Management, 40(5), 671-682.

Magretta, J. (2002). Why business models matter.

Mathieu, V. (2001). Service strategies within the manufacturing sector: benefits, costs and partnership. International Journal of service industry management.

Maxwell, D., Sheate, W., & Van Der Vorst, R. (2006). Functional and systems aspects of the sustainable product and service development approach for industry. Journal of cleaner production, 14(17), 1466-1479.

Mintzberg, H., & Waters, J. A. (1985). Of strategies, deliberate and emergent. Strategic management journal, 6(3), 257-272.

Mont, O. K. (2002). Clarifying the concept of product–service system. Journal of cleaner production, 10(3), 237-245.

Motwani, J. G., Sower, V. E., Gebauer, H., Friedli, T., & Fleisch, E. (2006). Success factors for achieving high service revenues in manufacturing companies. Benchmarking: An International Journal.

Nadkarni, S., & Narayanan, V. K. (2007). Strategic schemas, strategic flexibility, and firm performance: The moderating role of industry clockspeed. Strategic management journal, 28(3), 243-270.

Neu, W. A., & Brown, S. W. (2005). Forming successful business-to-business services in goods-dominant firms. Journal of service research, 8(1), 3-17.

Neu, W. A., & Brown, S. W. (2008). Manufacturers forming successful complex business services: Designing an organization to fit the market. International Journal of Service Industry Management.

Normann, R. (2001). Reframing business: When the map changes the landscape. John Wiley & Sons.

Oliva, R., Gebauer, H., & Brann, J. M. (2012). Separate or integrate? Assessing the impact of separation between product and service business on service performance in product manufacturing firms. Journal of Business-to-Business Marketing, 19(4), 309-334.

Oliva, R., & Kallenberg, R. (2003). Managing the transition from products to services. International journal of service industry management.

Oostrum, M. (2019). Organizational change in servitization journeys: a qualitative research into her Dutch manufacuring SME's servitize.

Osterwalder, A., & Pigneur, Y. (2010). Business model generation: a handbook for visionaries, game changers, and challengers. John Wiley & Sons.

Paiola, M., Gebauer, H., & Edvardsson, B. (2012). Service business development in small-to medium-sized equipment manufacturers. Journal of Business-to-Business Marketing, 19(1), 33-66.

Parida, V., Sjödin, D. R., Wincent, J., & Kohtamäki, M. (2014). Mastering the transition to product-service provision: Insights into business models, learning activities, and capabilities. Research-Technology Management, 57(3), 44-52.

Penttinen, E., & Palmer, J. (2007). Improving firm positioning through enhanced offerings and buyer–seller relationships. Industrial Marketing Management, 36(5), 552-564.

Peteraf, M. A. (1993). The cornerstones of competitive advantage: a resource-based view. Strategic management journal, 14(3), 179-191.

Quinn, J. B., Doorley, T. L., & Paquette, P. C. (1990). Beyond products: services-based strategy. Harvard business review, 68(2), 58-60.

Raddats, C., Burton, J., & Ashman, R. (2015). Resource configurations for services success in manufacturing companies. Journal of Service Management.

Rathmell, J. M. (1966). What is meant by services?. Journal of marketing, 30(4), 32-36.

Reed, R., & Storrud-Barnes, S. F. (2009). Systematic performance differences across the manufacturing-service continuum. Service Business, 3(4), 319-339.

Romme, A. G. L., & Endenburg, G. (2006). Construction principles and design rules in the case of circular design. Organization science, 17(2), 287-297.

Reinartz, W., & Ulaga, W. (2008). How to sell services more profitably. Harvard business review, 86(5), 90-6.

Ryan, L. (2013). Facilitating the Transition from Product to Product Service System. In Proceedings of the 2nd Cambridge Academic Design Management Conference (pp. 125-138).

Salonen, A. (2011). Service transition strategies of industrial manufacturers. Industrial Marketing Management, 40(5), 683-690.

Sawhney, M., Balasubramanian, S., & Krishnan, V. V. (2004). Creating growth with services. MIT Sloan management review, 45(2), 34-44.

Spring, M., & Araujo, L. (2013). Beyond the service factory: Service innovation in manufacturing supply networks. Industrial marketing management, 42(1), 59-70.

Steinberger, J. K., van Niel, J., & Bourg, D. (2009). Profiting from negawatts: Reducing absolute consumption and emissions through a performance-based energy economy. Energy Policy, 37(1), 361-370.

Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. Strategic management journal, 18(7), 509-533.

Tukker, A. (2004). Eight types of product–service system: eight ways to sustainability? Experiences from SusProNet. Business strategy and the environment, 13(4), 246-260.

Ulaga, W., & Reinartz, W. J. (2011). Hybrid offerings: how manufacturing firms combine goods and services successfully. Journal of marketing, 75(6), 5-23.

Van Aken, J., Berends, H. & der Bij, H. V. (2012). Problem solving in organizations (second). Cambridge University Press. 12, 13.

Van Burg, E., Romme, A. G. L., Gilsing, V. A., & Reymen, I. M. (2008). Creating university spin-offs: a science-based design perspective. Journal of Product Innovation Management, 25(2), 114-128.

Vandermerwe, S. (1994). Quality in services: the 'softer'side is 'harder'(and smarter). Long Range Planning, 27(2), 45-56.

Vandermerwe, S., & Rada, J. (1988). Servitization of business: adding value by adding services. European management journal, 6(4), 314-324.

Vargo, S. L., & Lusch, R. F. (2004). Evolving to a new dominant logic for marketing. Journal of marketing, 68(1), 1-17.

Venable, J., Pries-Heje, J., & Baskerville, R. (2016). FEDS: a framework for evaluation in design science research. European journal of information systems, 25(1), 77-89.

Visnjic, I., & Van Looy, B. (2013). Servitization: Disentangling the impact of service business model innovation on manufacturing firm performance. Journal of operations management, 31(4), 169-180.

Visnjic, I., Wiengarten, F., & Neely, A. (2014). Only the brave: Product innovation, service business model innovation, and their impact on performance. Journal of product innovation management, 33(1), 36-52.

White, A. L., Stoughton, M., & Feng, L. (1999). Servicizing: the quiet transition to extended product responsibility. Tellus Institute, Boston, 97.

Windahl, C., & Lakemond, N. (2010). Integrated solutions from a service-centered perspective: Applicability and limitations in the capital goods industry. Industrial Marketing Management, 39(8), 1278-1290.

Wise, R., & Baumgartner, P. (1999). Go downstream. Harvard business review, 77(5), 133-141.

Yin, R. K. (2003). Design and methods. Case study research, 3(9.2).

9. Appendix

9.1 Explorative interview format

Internal unstructured exploration interviews: defining the business problem

Contacted persons:

ID	Function
Interviewee A	Chief Commercial Officer (CCO)
Interviewee B	Business control manager
Interviewee C	Manager SBU B
Interviewee D	Manager SBU A
Interviewee E	Manager SBU E
Interviewee F	Manager SBU C
Interviewee G	Manager SBU D
Interviewee H	Business development manager X
Interviewee I	Global category manager
Interviewee J	Process owner sales process
Interviewee K	Process owner SBU management
Interviewee L	Sales manager(s) from all SBUs

Semi-structured interview format

Only questions applicable to the responsibility level of the interviewee were asked

- What is your role within the company?
- What is the strategy of the company?
- How does the company look like on an organizational level?
- What are the problems with executing the current strategy?
- Can you tell me about software products and services within the SBU?
- What for and in what customer process is this software used?
- Did the company incur costs for the development of these software products?
- Does the company make money with sales or licensing of these products?
- What business models/revenue models do we use for our physical and software products?
- What services do we currently provide?
- How is the organization set-up with regards to services?
- What are the problems with regards to providing services?
- What would be the ideal future scenario?

9.2 Search terms explorative literature study

Search terms explorative literature study

Key words
Business model(s)
Business model transition
Business model hardware software
Servitization
Service
Maintenance
Service maintenance process
Product-service systems (PSS)
Service operations management
Service-level agreement (SLA)
Solutions
Revenue model & pricing

9.3 Interview format board of management

Main RQ	How can PT transition along the product-service continuum to better provide diverse services to customers across their strategic business units?
RQ 1	A: What is servitization, what product-service combinations are there, which combinations does PT offer, and what are their future ambitions? B: How in the organization are services provided to customers?
RQ 2	What are the barriers that inhibit PT to follow the servitization path?
RQ 3	How can manufacturing firms successfully transition along the product-service continuum?
RQ 4	How should the transition to other product-service combinations and an improved service offering be formulated?

	Background information	**Research question 1**	**Research question 2**	**Research question 3**	**Research question 4**	**Closing question**
Q1	X					
Q2	X					
Q3 Key Q		X				
Q4 Key Q		X				
Q5 Key Q	X		X			
Q6 Key Q	X		X			
Q7 Key Q				X		
Q8 Key Q					X	
Q9						X
Q10						X

Introduction script interview :

First of all, I would like to thank you for taking part in this interview as part of my research. As I discussed earlier, the purpose of this research is to find out how PT can successfully offer various services and product-services, this transition is called servitization. The research is aimed at mapping the diversity of product-service combinations within PT, which ambitions are there, which challenges and barriers exist that make it difficult to offer more and different services, and how these barriers can be overcome.

The interview will last approximately one hour in which I will ask questions about the company's strategy, vision, and goals with regard to products and services, the ability to offer different services, and the challenges in this.

Due to the guidelines of the university I am obliged to ask if I can record the conversation, this is an important contribution to my research and therefore I would like to ask if you are ok with this .

- Yes: Thank you. Please let me know at any time if I need to pause the recording or if something has been said has to be deleted from the recording.
- No: Thank you for letting me know, I will just take notes of our conversation.

Before we start the interview, do you have any questions? [discuss questions]
If you have any questions during the interview, you are free to ask them at any time, I will be happy to answer them.

Introductory questions:

Q1. As member of the board of management you are an integral part of the management team. Can you tell me more about your role within the management team regarding the vision, goals and strategy of the company?

Specific questions:

Q2. PT started as a design agency in "year", to which production and contract manufacturing services were later added, can you tell me why the company is now focusing on a larger OEM role with *Ready to use* products?

Q3. What is the company's strategic vision for products and services?

Q4. [overview product-service combinations]

With regard to the overview of the different product-service combinations, where do you see PT growing towards?

Q5. Can you explain how these decisions are made and processes are determined and formulated by either the **program managers** or **management**?

- Elaborate: how is the degree of product-service combinations determined
- Elaborate: who determines the degree of product-service combinations

Q6. Can you tell us whether the responsibility of the service provision lies with the programs or centrally across the company?

- Elaborate: how do you ideally see this?

Q7. Are there challenges or barriers (possibly internal, organizational barriers) that make it **difficult** to offer different product-service combinations?

- Elaborate

Q8. What is your personal view on how PT can successfully offer different services and product-service combinations?

Concluding questions:

Part of my research is to design and deliver an artifact, this can be a specific tool or design.

Q9. I am curious if you have any ideas about what kind of tool or design could help you successfully execute this servitization strategy and market different product-service combinations.

Q10. Do you have any questions or topics that you would like to explain further?

Closing script

I would like to thank you for making the time available for this interview. Interviews with the managers of all programs are scheduled for next week. With them I want to discuss the current product-service combinations within the programs and the intentions in 2 sessions. In addition, I want to find out what challenges and barriers are present in making the so-called servitization transition. I also want to critically look at the design of a tool with which can gain insight into this process and make it easier to implement. If you have additional questions or comments after our conversation, please do not hesitate to let me know. I think this was a great conversation and thank again for your time.

9.4 Interview format SBU managers

Main RQ	How can PT transition along the product-service continuum to better provide diverse services to customers across their strategic business units?
RQ 1	A: What is servitization, what product-service combinations are there, which combinations does PT offer, and what are their future ambitions? B: How in the organization are services provided to customers?
RQ 2	What are the barriers that inhibit PT to follow the servitization path?
RQ 3	How can manufacturing firms successfully transition along the product-service continuum?
RQ 4	How should the transition to other product-service combinations and an improved service offering be formulated?

	Background information	Research question 1	Research question 2	Research question 3	Research question 4	Closing question
Q1	X					
Q2	X					
Q3	X					
Q4	X					
Q5 Key Q	X					
Q6 Key Q		X				
Q7 Key Q		X				
Q8 Key Q		X				
Q9 Key Q		X				
Q10 Key Q	X			X		
Q11 Key Q			X			
Q12			X			
Q13					X	
Q14						X
Q15						X

Introduction script interview:

First of all, I would like to thank you for taking part in this interview as part of my research. As I discussed earlier, the purpose of this research is to find out how PT can successfully offer various services and product-services, this transition is called servitization. The research is aimed at mapping the diversity of product-service combinations within PT, which ambitions are there, which challenges and internal barriers exist that make it difficult to offer more and different services, and how these barriers can be overcome.

The interview will last approximately one hour in which I will ask questions about the company's strategy, vision, and goals with regard to products and services, the ability to offer different services, and the challenges herein.

Due to the guidelines of the university I am obliged to ask if I can record the conversation, this is an important contribution to my research and therefore I would like to ask if you are ok with this.

- Yes: Thank you. Please let me know at any time if I need to pause the recording or if something has been said has to be deleted from the recording.
- No: Thank you for letting me know, I'll just take notes of our conversation.

Introductory questions:

Q1. As SBU manager you are responsible for the success of the planning and implementation of the SBU. For how long have you held this position and could you explain your role?

Q2. What are the main activities within your SBU?

Q3. Can you tell me what is the strategic vision of the SBU in terms of products and services?

Q4. How is this strategic product-service vision determined?

- Elaborate: is this, for example, done in consultation with the management team?

Q5. In what way is there collaboration, discussion, or consultation between the SBUs about the product-service strategy and the ability to offer different product-service combinations?

Specific questions:

Q6. [overview product-service combinations]

Can you tell us more about what products and services are currently being offered to the customer within the SBU?

- **Product**
    - Which product lifecycle services do we offer? (spare parts, repair, warranty)
    - Which product performance services do we offer? (maintenance, helpdesk, training)
    - Which product result services do we offer? (Support agreements, outsourcing, outcome-based contract)
- **Customer process:**
    - Which process support services? (advice, training)
    - Which Process Outsourcing Services? (outsourcing, supply of materials)
    - Which Hybrid services? (system integration, customization, reconditioning)
- Elaborate: is the overview complete?

Q7. With regards to the overview of the different product-service combinations, which product-service combinations and services would you like to be able to offer in your SBU?

- Elaborate: why these products and services?
- Elaborate: is the overview complete?

Q8. With regard to the current product-service combinations, would you prefer to offer them in a different way?

Q9. Can you tell me **how** it is determined which product-service combinations and services are offered within the SBU?

- Elaborate: by whom?

Q10. Can you tell us whether the responsibility of the service provision lies with the SBUs or centrally across the company?

- Elaborate: how do you ideally see this?

Q11. Are there challenges or barriers (possibly internal, organizational barriers) that make it **difficult** to offer different product-service combinations?

Q12. Can you tell me what the company has done to overcome these barriers?

Q13. What is your personal view on how PT can successfully offer different services and product-service combinations?

Concluding questions:

Part of my research is to design and deliver an artifact, this can be a specific tool or design.

Q14. I am curious if you have any ideas about what tool or design could help you with the successful execution of this servitization strategy and the implementation of different product-service combinations.

Q15. Do you have any questions or topics that you would like to explain further?

Closing script

I would like to thank you for making the time available for this interview. In a few weeks, I want to organize a 2nd round of interviews after analyzing the data. In this round, I want to discuss the exact barriers and challenges in the servitization transition. I also want to take a critical look at the design of a tool with which we can gain insight into this process and make it easier to implement.
If you have additional questions or comments after our conversation, please do not hesitate to let me know. I think this was a great conversation and thanks again for your time.

9.5 Interview format process owners

Main RQ	How can PT transition along the product-service continuum to better provide diverse services to customers across their strategic business units?
RQ 1	A: What is servitization, what product-service combinations are there, which combinations does PT currently offer, and what are their future ambitions? B: How in the organization are services provided to customers?
RQ 2	What are the barriers that inhibit PT to follow the servitization path?
RQ 3	How can manufacturing firms successfully transition along the product-service continuum?
RQ 4	How should the transition to other product-service combinations and an improved service offering be formulated?

	Background information	Research question 1	Research question 2	Research question 3	Research question 4	Closing question
Q1	X					
Q2						
Q3			X			
Q4 Key Q			X			
Q5 Key Q			X			
Q6 Key Q			X			
Q7 Key Q			X			
Q8 Key Q						X
Q9						X
Q10						
Q11						

Introduction script interview :

First of all, I would like to thank you for taking part in this interview as part of my research. As I discussed earlier, the purpose of this research is to find out how PT can successfully offer various services and product services, this transition is called servitization. The research is aimed at mapping the diversity of product-service combinations within PT. Which ambitions are there, and what challenges and barriers are present which make it difficult to offer more and different services, and how these barriers can be overcome.

The interview will take about 45 minutes in which I will ask questions about being able to offer different services, product-service combinations, and the challenges within the organization.

In connection with the university guidelines, I am obliged to ask if I record the call, this is an important contribution to my research and so I would ask if you are ok with this .

- Yes: Thank you. Please let me know at any time if I need to pause the recording or if something has been said to be deleted from the recording.
- No: Thanks for letting me know, I'll just take notes of our conversation.

Before we start the interview, do you have any questions? [discuss questions]
If you have any questions during the interview, you are free to ask them at any time, I will be happy to answer them.

Introductory questions:

Q1. Can you give a brief introduction of the process you are responsible for?

Specific questions:
[Overview of product-service combinations & maturity]

Q2. PT is now focusing on OTS products and OEM propositions, which include Cloud software or logistics solutions such as AGVs. Service on this installed base (after-sales service), but also other types of service provision are growing. How do you see the impact within your process here?
Q3. In what way is there collaboration, discussion or consultation between the different people about being able to offer different services and product-service combinations?

- Continue to ask: who is involved in this, between which people?

My research in this round focuses on the internal challenges or barriers that make it difficult to do servitization, being able to offer different services & product-service combinations

Structure
Q4. Is your process involved in the organizational structure and can you tell whether your you think the current organizational structure is suitable for servitization?
Q5. Can you explain whether you think the current service process is suitable for servitization?

- How would you see this different/improved?
- How do you think the ideal service organization should look like?

Q6. Can you tell more about the current organization of people who deal with services from your process owner role?
Q7. Are the responsibilities of services relevant to your process, and where does the responsibility of service provision lie?

- Continue to ask: how do you see this ideally?
- Central x specific to the SBU?

Resources & capabilities
Q8. Does PT have a servitization strategy, and is this important for your process?
Q9. Is a service development process relevant to you (process)?
Q10. Are service competences applied or needed in your process, and can you give your view on the current competences with regard to different services.

- Continue to ask: do we have the right competences with regard to different services?

Culture
Q11: How do you view culture as a factor within servitization from your process role?

- Continue to ask: and do you think we have the right culture to facilitate servitization?

Concluding questions:
Q12. Do you see other internal challenges or barriers that make it **difficult** to offer different services & product-service combinations?
Q13. Do you have any questions or topics you would like to explain further?

Closing script
I want to thank you for making the time available for this interview.
If you have additional questions or comments after our conversation, please do not hesitate to let me know. I think this was a great conversation and thanks again for your time.

9.6 Interview format industry expert

Main RQ	How can PT transition along the product-service continuum to better provide diverse services to customers across their strategic business units?
RQ 1	A: What is servitization, what product-service combinations are there, which combinations does PT currently offer, and what are their future ambitions? B: How in the organization are services provided to customers?
RQ 2	What are the barriers that inhibit PT to follow the servitization path?
RQ 3	How can manufacturing firms successfully transition along the product-service continuum?
RQ 4	How should the transition to other product-service combinations and an improved service offering be formulated?

	Background information	Research question 1	Research question 2	Research question 3	Research question 4	Closing question
Q1	X					
Q2	X					
Q3 Key Q		X				
Q4 Key Q		X				
Q5 Key Q		X				
Q6 Key Q			X			
Q7 Key Q				X		
Q8 Key Q				X		
Q9					X	
Q10					X	
Q11						X

Introductie script interview:

Allereerst wil ik je bedanken voor het willen deelnemen aan dit interview als onderdeel van mijn onderzoek. Zoals ik eerder heb besproken, is het doel van dit onderzoek om erachter te komen hoe PT succesvol verschillende services en product services kan aanbieden, deze transitie wordt servitization genoemd wordt. Het onderzoek is gericht op het in kaart brengen van de diversiteit van product-service combinaties binnen PT. Welke ambities er zijn, welke uitdagingen en barrières er aanwezig zijn welke het moeilijk maken om meer en andere services aan te kunnen bieden, en hoe deze barrières overkomen kunnen worden.

Het interview zal ongeveer een uur duren waarin ik verschillende vragen ga stellen over servitization, product-service categorieën, en hoe bedrijven de transitie maken binnen het product-service continuüm. Naderhand kunnen we mocht hier tijd voor zijn kijken naar oplossingsrichtingen die passen bij dit vraagstuk.

In verband met de richtlijnen van de universiteit ben ik verplicht om te vragen of ik het gesprek mag opnemen, dit is een belangrijke bijdrage aan mijn onderzoek en daarom zou ik willen vragen of je dit oke vindt.

- Ja: Bedankt. Laat mij alsjeblieft weten op elk willekeurig moment als ik de opname moet pauzeren of als er iets wat gezegd is geschrapt moet worden van de opname.
- Nee: bedankt voor het laten weten, ik zal alleen notities maken van ons gesprek.

Voordat we beginnen aan het interview, heb je nog enige vragen? [bespreek vragen]

Mochten je tijdens het gesprek vragen hebben ben je vrij om deze op elk moment te stellen, ik zal deze graag beantwoorden.

Introductie vragen:

Q1. Zou je wat kunnen vertellen over je achtergrond en expertise op het gebied van servitization, en de activiteiten die daarbij komen.

Q2. Voor het interview heb ik een document via de mail opgestuurd. Hierin geef ik een korte beschrijving van het bedrijfsprobleem, de onderzoeksvragen, de eerste empirische resultaten en literaire achtergrond naar hoe bedrijven deze servitization transitie kunnen maken. Voordat ik verder ga, heb je de kans gehad om door mijn gestuurde document heen te lezen, of moeten we hier nog even bij stilstaan?

[probleem statement]
[onderzoeksvragen]

Specifieke vragen:

Q3. *Bij het bedrijf zijn er op dit moment drie ontwikkelingen. Enerzijds OEM producten welke als een typisch PSS beschouwd kunnen worden, anderzijds service op de installed-base, en als laatste software welke als een product of service aangeboden kunnen worden. Binnen mijn onderzoek maak ik gebruik van de servitization piramide van Coreynen et al., (2017) en de service strategieën van Gebauer et al., (2010).* Graag zou ik wat meer uit willen weiden over de servitization piramide. **Wat is het verschil tussen services met een product-focus en services met een customer-proces focus?**

Q4. Ik heb een overzicht gemaakt van de verschillende product-service combinaties afgeleid van de servitization piramide van Coreynen et al., (2017). Is dit overzicht juist en toepasbaar binnen mijn onderzoek?

Eerste resultaten empirische deel:

[bespreken resultaten]

Vanuit het empirische deel heb ik servitization drivers, enablers, generieke externe en interne barrières, maar ook specifieke externe en interne barrières gelinkt aan de plek binnen de piramide van Coreynen et al., (2010).

Q5. Graag zou ik deze resultaten met je willen bespreken.

[bespreken empirische resultaten]

Als onderdeel van het beantwoorden van mijn 2^{e} sub-onderzoeksvraag heb ik een literatuurstudie uitgevoerd naar hoe manufacturing bedrijven succesvol de transitie maken naar de rechter zijde binnen het product-service continuüm. Hier zou ik het graag met je over willen hebben.

[overzicht transitie perspectieven & mechanisme]

Q6. Vanuit de literatuur zijn de volgende categorieën zichtbaar. Is deze lijst volledig?

- Doorvragen: zijn de categorieën juist?
- Missen hier nog onderdelen?

Q7. Wat is jouw kijk op hoe bedrijven de servitization transitie kunnen maken naar het aanbieden van meer services en product-service combinaties?

Afsluitende vragen:

Een onderdeel van mijn onderzoek is om een artifact te ontwerpen en op te leveren, dit kan een bepaalde tool of design zijn.

Q8. Ik ben benieuwd of je ideeën hebt wat voor een tool of design zou kunnen helpen bij het succesvol uitvoeren van de servitization transitie, en het kunnen wegzetten van verschillende product-service combinaties, kun je hier wat meer over vertellen?

Q9. Heb je advies hoe ik de oplossingsrichting of het onderzoek nog meer kan scopen?

Q10. Heb jij nog vragen of onderwerpen die je graag verder zou willen toelichten?

Afsluitende script

Ik wil je bedanken voor het beschikbaar maken van je tijd en expertise voor dit interview. Graag zou ik in de volgende fase van mijn onderzoek richting een design of artifact wat het bedrijf helpt met haar probleem dit willen valideren met onder andere jou als industry expert. Ik hoop dat je hiervoor open staat en dat dit mogelijk is. Wellicht dat er tussentijds nog een contact moment kan plaatsvinden als dit waardevol of nodig blijkt te zijn. Hiervoor zal ik dan contact met je opnemen.

9.7 Impact analysis due to Covid-19

Since March 2020, the World Health Organization has labeled the Covid-19 disease as a pandemic. This impacted the research in several ways of which not all were visible initially. Firstly, all communication had to be executed online indefinitely, this master thesis project is partly executed from home instead of the traditional company environment. After the start of the following phase of the research, empirical data has been collected internally within the firm and an external industry expert. This required flexibility as certain data collection methods had to be executed via video conferencing instead of face-to-face meetings. To cope with this, the company provided all assets needed to communicate and work from home. Although unsure what the full impact of this is on the quality of the empirical data collection it is worth mentioning that this risk exists.

9.8 Questionnaire process owners

Hello process owner!

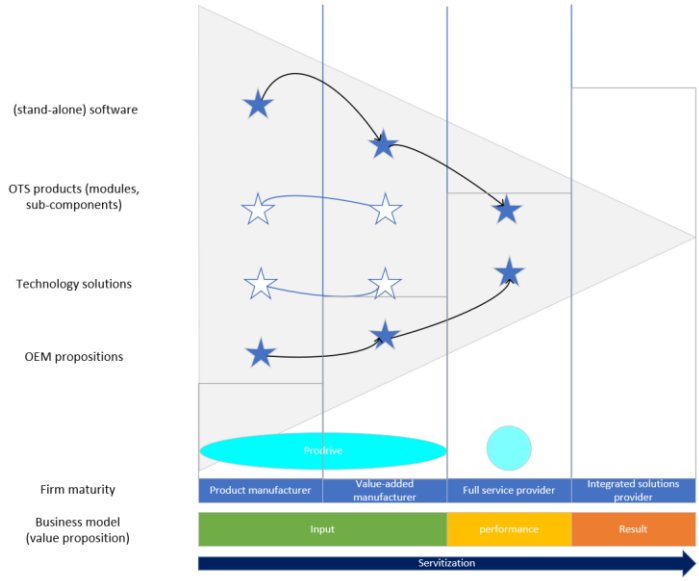
By advice of JK (company supervisor for my master thesis project) I am contacting you as I need your input for a short (5 min) questionnaire!

My name is Rick Lewis (graduate student), and currently I am researching servitization at PT.

By answering a few questions you can help me with creating an overview of all relevant processes for my research. The questionnaire consists of 14 closed questions with the possibility to answer yes/no, and one open question.

Possible examples of servitization within PT:

From basic service (repair) on physical products to advanced service-level agreements, to (preventive) maintenance (on products or software), cloud computing software, to logistics solutions (AGV) sold as a service.



This questionnaire is used as a screening to see which processes are relevant for my research. Subsequently, interviews will be planned with the relevant process owners. Therefore I would like to ask you to fill in your company initials and name of the process you are responsible for.

Please fill in your company initials (for example RL)

Please fill in the name of the process you are responsible for

Questions

Please answer the following questions with yes or no. There is no right or wrong.

Organizational structure

What is an organizational structure? *"An organizational structure outlines how certain activities re directed in order to achieve the goals of the organization. These activities can include rules, roles, and responsibilities. Moreover, it determines how information flows between levels within the company."*

1. Does your process interact with the way the organization is structured? [yes/no]

2. Do you see the current organizational structure as adequate to facilitate servitization? [yes/no]
3. Do you see the current service process and the organization of people interacting with services as adequate for servitization? [yes/no]
4. Do you believe the responsibility of services to be relevant for your process (e.g. trouble shooting, spare parts management, upgrades, repair)? [yes/no]

Resources & capabilities

5. Is your process directly involved with providing solutions to issues raised by customer feedback (e.g. helpdesk, support)? [yes/no]
6. Is servitization strategy relevant for your process? [yes/no]
7. Does the firm have a clear servitization strategy? [yes/no]
8. Is a service development process relevant for you? [yes/no]
9. Does your process resonate with the coordination and the responsibility of developing and providing services?
10. Are central coordination and the responsibility of setting up services relevant for your process? [yes/no]
11. Are service competences (e.g. people responsible for dealing with service-related topics) applied or necessary within your process?
12. Do you believe we have the right competences with regards to different services?
13. Do you think culture could be an inhibiting factor for servitization?
14. Do you believe the firm has the right culture that facilitates servitization?

Closing question

15. Are there other topics not mentioned in the questions above related to your process and that of servitization? If so, please give a short description.

[open question]

Thank you for filling in this quick questionnaire! After collecting all information from the relevant process owners you will be invited for an interview if your process has relevance to my research.

Heatmap results questionnaire process owners

1. Does your process interact with the way the organization is structured?	2. Do you see the current organization al structure as adequate to facilitate servitization?	see the current service processes and the organization of people interacting with services as adequate for servitization?	4. Do you believe the responsibility of services to be relevant for your process (e.g. troubleshooting, spare parts management, upgrades, repair)?	5. Is your process directly involved with providing solutions to issues raised by customer feedback (e.g. helpdesk, support)?	6. Is servitization strategy relevant for your process?	7. Do we (Prodrive) have a clear servitization strategy?	8. Is a service development process relevant for you?	9. Does your process resonate with the coordination and the responsibility of developing and providing services?	10. Are central coordination and the responsibility of setting up services relevant for your process?	11. Are service competences (e.g. people responsible for dealing with service-related topics) applied or necessary within your process?	12. Do you believe we have the right competences with regards to different services?	13. Do you think culture could be an inhibiting factor for servitization?	14. Do you believe we have the right culture that facilitates servitization?	Please fill in your company initials (for example rjclew)	Please fill in the name of the process you are responsible for	
YES	NO	NO	YES	YES	YES	NO	YES	YES	YES	YES	NO	YES	NO			
1	0	1	1	1	1	1	1	1	1	1	0	1	1	leoeeu	Project management	12
1	0	1	1	1	1	1	1	1	1	0	1	1	1	basbre	Program Management	12
1	0	1	1	1	1	1	1	1	1	1	1	1	0	jerspi	Packaging & Outbound-Logistics	12
1	0	1	1	1	1	1	1	1	1	1	1	0	0	pawtow	Service	11
1	0	1	1	1	1	1	1	1	1	1	1	0	0	koebak	Account Management	11
1	1	0	1	1	1	1	0	1	1	0	1	1	1	AnnKon	Product Life Cycle Management	11
1	1	1	0	1	1	1	0	0	1	1	1	1	0	robbax	Information Technology	10
1	0	1	0	0	1	1	1	1	1	1	0	1	1	wouwes	magnetics, cable harness manufacturing	10
1	1	1	1	1	1	1	1	1	1	0	0	0	0	bralin	Planning	10
1	1	0	1	0	1	1	0	1	1	1	1	1	0	JanJans	Calibration & Maintenance	10
1	1	1	0	1	1	1	1	1	1	1	0	0	0	DC	System development	10
1	0	1	1	1	1	1	0	1	1	1	0	1	0	simbor	Software Development	10
1	1	1	1	0	1	1	1	0	1	0	1	0	0	TIMWIL	Machining	9
0	0	1	1	1	1	1	1	0	1	1	1	0	0	Jushar	improvement	9
1	1	1	0	0	0	1	1	1	0	0	1	1	1	JK	Performance	9
0	1	1	1	1	1	1	1	0	1	0	0	1	0	BraLan	Change Management	9
1	0	1	1	0	1	1	1	1	0	0	1	1	0	pj	Business Planning, Objectives & Review	9
1	0	1	1	0	1	1	1	1	0	0	0	1	0	bjojac	SA	8
1	0	0	1	1	1	1	1	0	1	1	0	0	0	JERVERB	Purchasing	8
1	0	0	1	1	1	1	1	1	0	1	0	0	0	MicRoz	Non-Conforming Goods	8
1	1	1	0	0	1	1	1	0	0	0	0	1	0	maugri	marketing	7
1	0	0	1	1	1	1	1	0	0	0	0	1	0	RicJas	Sales Process & Customer Satisfaction Process	7
1	0	1	1	1	1	1	0	0	0	0	1	0	0	rictre	Mechanics development	7
1	0	1	1	1	0	1	1	0	0	0	0	0	0	maredе	New Product Development - Electronics	6
1	0	0	0	0	1	1	1	1	0	0	0	1	0	paubav	laboratory	6
1	1	1	1	0	0	1	0	1	0	0	0	1	0	MARTHE	Financial Management	6
1	0	0	1	0	0	1	0	0	0	1	0	1	0	ruukan	Facilities	5
1	0	1	0	0	0	1	1	0	0	0	0	0	0	petver	Business Process Definition; Auditing	4
1	0	0	1	1	1	0	0	0	0	0	0	0	0	mathan	Injection Molding	4
1	0	0	0	0	0	1	0	0	0	0	1	1	0	huusch	Incident Management and Escalation	4
30	30	30	30	30	30	30	30	30	30	30	30	30	30			
28	9	21	22	18	24	29	21	17	16	13	13	18	5			

9.9 Initial coding scheme

Initial coding scheme from literature (2-11-2020):

Main code	Sub category 1	Sub category 2	Source(s)
Input Product lifecycle services (installed-base service)	Basic service (product-oriented service)		Tukker (2004); Gebauer et al. (2010); Coreynen et al. (2017); Kindström & Kowalkowski (2014); Ulaga & Reinartz (2011)
Use/performance	Advanced service		Tukker (2004); Kindström & Kowalkowski (2014); Ulaga & Reinartz (2011); Gebauer et al. (2010); Coreynen et al. (2017); Kindström & Kowalkowski (2014); Ulaga & Reinartz (2011)
Result	Advanced service		Tukker (2004); Coreynen et al. (2017); Kindström & Kowalkowski (2014); Ulaga & Reinartz (2011)
Process support services			Coreynen et al. (2017); Kindström & Kowalkowski, (2014); Ulaga & Reinartz (2011)
Process delegation services			Coreynen et al. (2017); Kindström & Kowalkowski (2014); Ulaga & Reinartz (2011)
Hybrid solutions			Coreynen et al. (2017); Kindström & Kowalkowski, (2014); Ulaga & Reinartz, (2011)
Service strategies	Customer service		Gebauer et al. (2010)
	Basic service for IB		Gebauer et al. (2010)
	Maintenance services		Gebauer et al. (2010)
	R&D Oriented services		Gebauer et al. (2010)
	Operational services		Gebauer et al. (2010)
Generic PSS decision criteria	Market value		Tukker (2004)
	Production costs		Tukker (2004)
	Capital needs for development		Tukker (2004)
	Ability to capture value present in the value chain		Tukker (2004)
Drivers	Financial	Sales margins for service higher and revenue stream more stable	Baines et al. (2009); Oliva & Kallenberg (2003)
	Strategic	Create new opportunities, setting up barriers	Baines et al. (2009); Vandermerwe & Rada (1988)
	Marketing purposes	Support sale physical product	Baines et al. (2009); Finne et al. (2013)
		Customers demand more services	Vandermerwe & Rada (1988)
Driver/enabler	Technological developments/ digitization	Remote monitoring	Neely (2009); Paschou et al. (2017); Porter & JHeppelmann (2014)
		Control	Porter & JHeppelmann (2014)
		Optimization	Porter & JHeppelmann (2014)
		Autonomy	Porter & JHeppelmann (2014)
External barriers	Customers want to purchase one time rather than use or result		Rexfelt & Ornäs (2009)
	Customers do not place high value on service (unwilling to pay)		Beuren, Ferreira, & Cauchick 2013; Witell et al. (2013)
Internal barriers	Cognitive phenomena managers	Sticking to what they know best / Risk aversion of uncertainty of service	Vandermerwe & Rada, (1988); Gebauer et al. (2005)
		Overemphasis on obvious and tangible characteristics	Gebauer et al. (2005)
		Failure to recognize economic potential	Gebauer et al. (2005)

Internal barriers *(continued)*	Cognitive phenomena organization	Cultural change required (service culture)	Oliva & Kallenberg (2003); Gebauer et al. (2005)
	Organization	Separate service SBU	Oliva & Kallenberg (2003); Gebauer et al. (2005)
		Global infrastructure to respond to service requirement locally	Oliva & Kallenberg (2003)
	Organization's processes	Market oriented and clearly defined service development process	Gebauer et al. (2005)
		Value selling: Focusing service offers on the value proposition to the customer	Gebauer et al. (2005)
		Relationship marketing (initiated)	Gebauer et al. (2005)
		Clear service strategy (defined)	Gebauer et al. (2005); Davies (2003); Oliva & Kallenberg (2003); Gebauer (2005); Brax (2005)
	PS design barrier		Coreynen et al. (2018)
	PS rollout go-to-market barrier		Coreynen et al. (2018)

9.10 Product-service combinations template

	Product / Input	Use / performance	Result
Product / software focus	Product lifecycle services	Product performance services	Product result services
	Spare parts, repair, provision, safety inspection	*Preventive maintenance, remote monitoring, rental plans,*	*Functional result, outcome based-contract*
Customer process focus	Process support services	Process delegation services	Hybrid solutions
	Advice, training, consulting	*Outsourcing, supply of materials*	*System integration, customization, reconditioning*

9.11 Coding scheme (final)

Main code	Code 2	Code 3	Code 4	Code 5	Description	Files	References
Servitization drivers					What drives the firm to pursue servitization		
	Belief that negative service leads to customer loss*				Improving and adding more services as these can prevent customer loss	1	1
	Financial						
		Improving revenue margin			Sales margins for service higher and revenue stream more stable	4	7
	Marketing purposes						
		Customers demand more services			The market/customers are more demanding of services	2	2
	Strategic				Strategic drivers for the firm such as a competitive advantage		
		Difficult to differentiate with physical products			Differentiating with services as it is difficult to do so with physical products	1	2
		Services as enabler for growing towards OEM role*			Services as enabler to grow as a firm to more towards an OEM role with end-to-end propositions	1	2
Servitization enabler							
	Culture*						
		High responsibility*			Reliance on the individual within the firm	1	1
		High technical know-how*			High technical know-how & passionate creates bond with customer	1	2
	Tech. dev & digitization				Technological developments and digitization. Such as remote monitoring, control, optimization, and autonomy	3	5
Generic servitization barrier					Generic servitization barriers. Independent of the servitization pyramid of Coreynen et al. (2017)		
	External barrier						
		Type of product and position in value chain*			The type of product (module, component, sub-system) and if it is sold to OEMs or end-customers directly	3	5
		Voice of customer			Customers can inhibit servitization of manufacturing firms	4	8
		Market considerations			De-facto standards and competitors	3	6
		Customers' perception of service capabilities supplier*			Reliance on supplier's service capabilities	2	3
	Internal barrier						
		Strategic*			Strategic incentives as servitization barrier		
		Cognitive phenomena managers			Servitization challenges related to managerial issues		
			Belief that other firms are better in services*		Managers believe that other firms are better than them regarding the service business	1	1
			Belief that there is no necessity to do more with services*		Managers believe there is no need to do more with services	1	1
			Failure to recognize economic potential		Managers do not see or recognize the economic potential which services can offer	5	6
			Overemphasis on obvious and tangible characteristics		Managers overemphasize tangible product characteristics rather than intangible service elements	4	4
			Services as need and enabler for physical products*		Managers see services as a need, rather than a value-added component	6	6
			Uncertainty what to charge for services*		Managers are uncertain what and how to charge intangible services	1	3
		Company culture					
			Product focused culture		Firm culture focused on physical products	6	6

			Interest of individual employees*	The interest of individual employees (e.g. not interested in service but instead on products)		
			Customer dependent model/activities*	Firm culture that is focused on being reactive on the customers' needs and wishes rather than being proactive regarding services	5	9
			Definitions of service not clear*	Not all services the firm provides are seen as services and the definitions revolving around services unclear	3	5
		Resources				
			Employees	Lack of employees within the organization, which also impact the FTE's available for services	8	13
			Costs of global service organization*	Financial resources necessary to set up a global service organization	2	2
			Capital need investment supplier*	Capital needed to provide services to customers while maintaining ownership of physical products	2	5
		Strategy				
			Clear service strategy	No clear service strategy defined	11	18
				Current service strategy not focused on generating profit	Current service strategy not aimed at seeing services as a differentiating and value-added component	1	1
				Current strategy of services reactive	Reactive strategy, whereas a proactive strategy could be better	3	5
			Focus within organization*	Lack of focus within organization and shifting priorities	3	3
			Long-term thinking*	Lack of long-term thinking	4	8
		Distribution model*				
			Service level organization directly impacts distribution model*	Suppliers are forced to change their distribution model to their service level	3	4
		Organization				
			Inadequate product development			
				Lack of design for service*	Not enough emphasis is placed on design for service which entails developing products so that they are easier to maintain	1	2
				Continuous redevelopment for OEM propositions*	OEM propositions require a more continuous development process rather than a one-time NPD trajectory whereafter a handoff occurs. Because the market is high-tech and fast-paced, this requires continuous development	2	5
				Lack of service thinking within NPD*	Thinking about other intangible and valuable components in the form of services separate or attached to products during NPD	7	13
				Missing product management role*	This role functions as the validation of using the right criteria for NPD and functions as a customer, when developing products on their own, without a customer	6	10
				Higher level of requirements*	Service-related requirements such as guaranteeing uptime should be translated into lower level req.	2	3
			Internal service organization			
				Handoff between project management and lifecycle management*	Description of the product lifecycle	9	25
				No front-desk and 24/7 support	There is no front-desk with 24/7 support which customers can contact	13	27
				Inadequate field-service organization, no global infrastructure	There is no global infrastructure or field service organization to support customers on location worldwide	15	40
				Dedicated (separate) place for advanced services within organization*	Managers state the need for a separate SBU or department focused on services.	7	23

				Lack of service competences	Not the right competences in the service domain.	9	18
				No Training center*	No customer training center	2	5
			Service process				
				Inadequate process to support advanced services*	No process for all services other than repair (commissioning, field-service, etc.)	9	17
				No market oriented and clearly defined service development process	There is no place within NPD or specific development process to develop services	8	18
				No central coordination and no one responsible for setting up services*	No central coordination and no one responsible for setting up services specifically	10	18
				No suitable and traceable cost-profit structure for services	The costs and profits of service-related activities are untraceable and thus unclear how they contribute to the firm's overall business goals	1	2
Organizational responsibilities & decision making							
	Repair						
		Repair is not responsibility of SBU, but central process & account responsibility*			Description of responsibilities	1	1
	Advanced services						
		(advanced) Service is responsibility of service process*			Description of responsibilities	5	10
		engineers (pressure on project engineers)*			Description of responsibilities	7	20
		Service development responsibility of SBUs*			Description of responsibilities	2	2
		Service is SBU responsibility*			Description of responsibilities	9	12
		Service is seen as an operational responsibility*			Description of responsibilities	1	3
		Some services can be organized centrally*			Description of responsibilities	3	3
Product-service specific landscape							
	Customer process focus						
		Strategic barrier*			When charging for certain studies (NRA) it also transfers intellectual property ownership to the customer, which could be undesired	3	5
	Product focus						
		Product manufacturer services				7	13
		Input based services			Examples of "product focus - input based services"	6	19
			Internal barriers				
				Delegating service responsibility to distributor*	Choosing to place the responsibility of the service delivery to the distributor for specific reasons	3	4
			Maintenance services added to product (external barriers)		Examples of maintenance services added to products (also PMP SLA added to hardware)	5	8
				Cost of global service organization*	Financial resources required to set up a global service organization	1	1
				Global service organization necessary	Managers state the need for a global service organization to provide customers on location with support worldwide	3	4
				Service responsibility with OEM due to value chain*	The OEM is responsible for the service domain and thus prevents extension of the service business	4	17
			Maintenance services added to product (internal barriers)		Examples of maintenance services added to products		

				Belief that product and service (maintenance) bundling is better	Managers believe that it is better to bundle products and services rather than offering services separately, seeing it as a value-added component	1	2
				Technical barrier	Not all products are capable technically of certain advanced service possibilities	1	1
		Performance-based services					
			Drivers				
				Financial sustainability (internal)	Financial sustainability driver of servitization	1	2
				Low initial capital investment for customers (external)	Including accessibility: due to leasing it is easier for customers to adopt	2	3
			External barriers				
				Better customer relationship to understand willingness to pay (value selling)	The relationship with the customer needs to be closer as the willingness to pay for services and value selling are important constructs here.	1	2
				Customers prefer one-time costs instead of higher operational costs*	Customers want to purchase one time rather than use or result	1	1
				Delegating service responsibility to distributor*	Managers decide to delegate the service responsibility to the VAR thereby losing the responsibility over the service domain and their opportunities	3	6
				Not common in marketplace*	Performance-based services are uncommon in the market	1	2
				OEM propositions can be competing with customer*	A barrier of performance-based OEM propositions is that it can be a competing product or system towards previous customers	1	2
				Sales model limitation due to value chain integration*	The type of product (e.g. component or capital equipment) determines for a large part the place in the value chain and thus limits service possibilities.	3	6
			Internal barriers				
				Dedicated support team required*	A dedicated support team is required to provide performance-based services (e.g. maintenance)	1	1
				High initial capital need investment supplier	The high initial capital needed to produce the products within a product-service combination presents an internal barrier for the supplier.	2	5
				No revenue of physical product*	There is no one-time revenue of the physical product	1	1
				Requires different organization*	Renting or leasing products (a performance-based business model) requires a different organization.	3	4
		Result-based services					
			Barriers				
				Financially less profitable than use-performance*	Belief that result-based services are less profitable than other types.	1	1
				Negative consequences of value selling*	Discussion with customer about value and price	1	2
	Software focus*					3	4
		Drivers				1	3
			Organizational impact minimal with software*		Organizational impact with regards to development, production, and service minimal with software compared to physical products.	3	5
			Revenue potential of information services with software*		Additional software can provide added value which can be a source of revenue	1	1

			Software service different from hardware service*	Arguably, the software part, (i.e. software service), is a separate domain, as it is very specific.	1	1
		Internal barriers				
			High integration effort*	Software requires a high integration effort	1	1
			Technical barrier	Software requires extensive integration effort at customer or test setup at supplier premises.	2	4
			Uncertainties regarding providing software support*	Lack of knowledge what is the best approach to provide software support.	1	2
			Uncertainty how to sell commercial products and software*	Lack of knowledge what is the best approach to sell commercial products and software.	1	5
		SF_Input based services			4	9
			Barriers for pricing stand-alone software			
				Competitors do not charge for software	Competitors do not charge separately for software	2	2
				Customers don't want to pay for software specifically*	Pricing software instead of bundling it with physical products creates a barrier as customers don't want to pay for software specifically.	2	2
				Difficult to change earlier made financial agreements*	It is difficult to change the current agreements with customers regarding software support without damaging the relationship	1	1
				It is an enabler for hardware	Software is an enabler for hardware, thus the firm does not want to charge it separately.	2	5
				Software seen as necessary evil	Software is seen as a necessary evil and not a component where money can be made off from.	1	1
				Strategic (lock-in)*	Software is used as a strategic component to achieve vendor lock-in.	2	2
		SF_Performance based			2	4
			External barrier			
				SaaS pricing customer buying center risk*	SaaS pricing requires a more complex buying unit from the customer in order to be attractive	1	1
				Uncertainty about customer willingness to pay license costs*	Uncertainty if customers are willing to pay for software licensing costs instead of a one-time payment or as part of a physical product.	1	1
				Customers do not want to pay for software service*	Updates, and other services related to software should be provided free of charge from the perspective of the customer.	1	1
			Internal barriers				
				(Proactive) condition monitoring	Monitoring the status and condition of products in the field is required to operate these services	1	1

9.12 B2B Servitization Maturity Model

Source: Atos Consulting (2011)

		Company typology			
		Product manufacturer	Value added manufacturer	Full service provider	Integrated solutions provider
Business Model	Market maturity	Emerging (annual growth > 10%)	Growing (annual growth < 10%)	Maturing (no / marginal annual growth)	Ageing (declining product market)
	Customer relationship	Focus on new customers	Focus on extending sales at existing customers	Focus on vertical bundles to improve horizontal applications	Focus on few partnerships and ecosystem integration
	Value proposition	Develop, sell & deliver products	Develop, sell & deliver products + services	Develop, sell & deliver value added services, incl. platforms	Develop, sell & deliver customized, integrated solutions
	Service proposition	Services are necessity for product sales and warranty	Services are additional recurring revenue & profit streams	Services are primary recurring business	Solutions are primary recurring business
	Service revenue	< 10% of total revenue	10 - 50% of total revenue	50 - 80% of total revenue	> 80% of total revenue
	Revenue model	Pay per product, incl. services	Pay per product, pay per service	Pay per use	Pay per performance
		Organizational Architecture			
KPI's	Overall	Focus on product leadership	Focus on operational excellence	Focus on TCO	Focus on customer intimacy
	Customer	Market growth, new customers	Market share, installed base	Market share, customer satisfaction	Share of wallet, customer advocacy
	Financial	Product profits, warranty costs	Product profits, service revenues	Service profits, customer satisfaction	Customer profits, Net Promoter Score
Management & Organization	Organizational design	Vertically integrated product units	Services as shared service centre	Services as business unit(s)	Business is organized around customer solutions
	Service governance	Service = cost category for the product	Services = cost centre	Service BU's = profit centers	Customer = profit center
	Influence of service organization	Product organizations lead, services is a resource to execute product strategy	Service organization is consulted by product units	Service units influence the "platforms for services" strategy	Services & solutions is in the lead and drives the company strategy
Processes	Key value creation processes	Research & Development, Manufacturing	Sourcing, Supply Chain Management, Manufacturing, Customer Services	Sourcing, customer services, customer integration	Consulting, customer services, customer integration
	Business Planning	Production drives planning	Production and service requests drive planning	Market analysis, projected service needs drive planning	Customer operation drives planning
	Service Process management	Limited visibility & control, reactive, ad-hoc	Immature processes, variations allowed, initial service dashboard	Standardized processes, service portfolio & knowledge mgmt	Well developed processes & control, continuous improvement
People & Culture	Culture	Dominant 'left-to-right' / 'product-out' approach with much emphasis on time to market	Dominant 'left-to-right' / 'product-out' approach with much emphasis on order fulfillment	Dominant 'right-to-left' / 'customer-in' approach with much emphasis on customer service	Dominant 'right-to-left' / 'customer-in' approach with much emphasis on customer value
	People	Focus on knowledge to create products	Focus on product delivery	Focus on services that enhance the product	Focus on value for the customer
	Resourcing	Hire HiPos, nurture SME's	Hire / source best SME's	Hire / source best SME's, partner with best alliances	Hire / source best SME's, partner with best customers / alliances
Information Management	Master data	Product BOM	BOMs for products + product services	Services incl. product platforms	Customer solutions incl. product platforms
	Configuration management	As designed, as built	+ as installed + as maintained	+ as modified + as improved	+ as operated + as replaced
	IT Processes	Aligned with product and production process	Aligned with production and service processes	Driven by services processes	Fully intertwined with customers' processes

Source: B2B Servitization Maturity Model, Atos Consulting, 2011

9.13 Servitization progression model

Source: Baines et al. (2020)

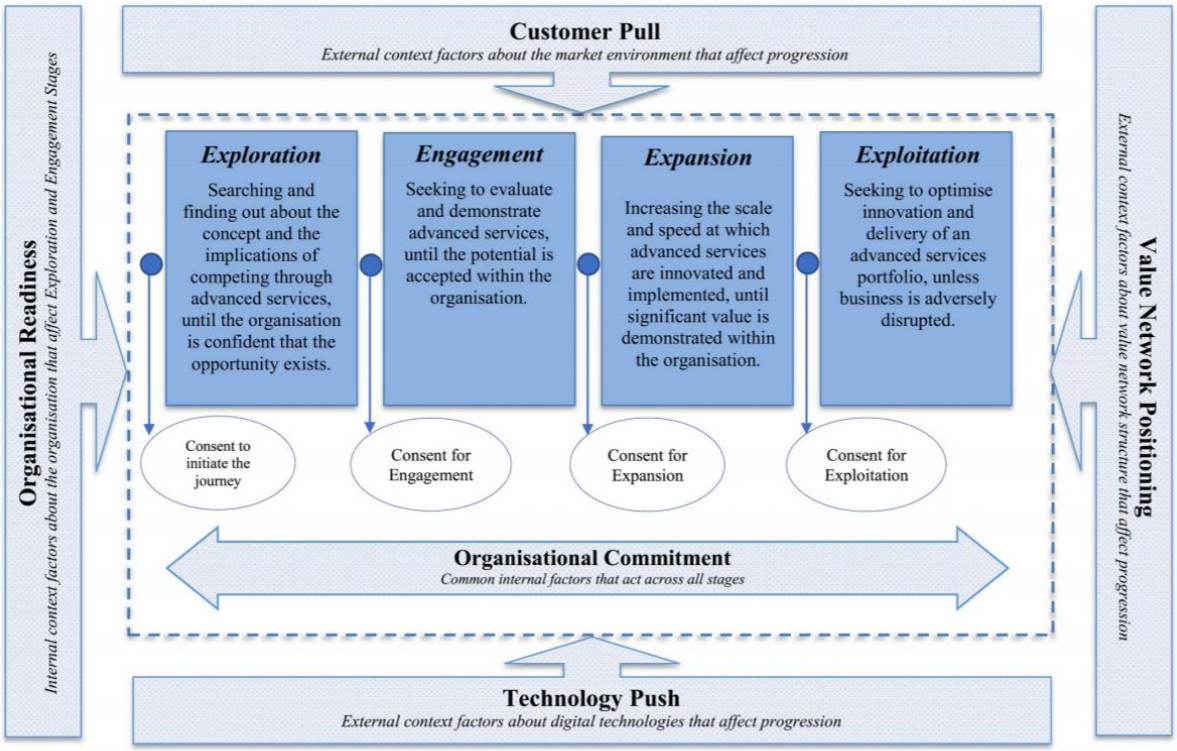


Fig. 3. The servitization progression model.

9.14 Resources and capabilities for successful service innovation

Source: Kowalkowski and Kindström (2014)

Business model element	Resources for service innovation	Capabilities for service innovation
Offering	Customer base Product usage and process data ICT deftness	Offering portfolio management capability Product-service integration capability Design-to-service capability Customer needing interpretation capability
Revenue model	Product usage and process data System knowledge Seamless offering	Pricing capability Value visualization capability Risk assessment and mitigation capability
Development process	Service development process and strategy Lead customers Dedicated service development roles	User involvement and engagement capability Internal sensing capability Formalization and replication capability
Sales process	Service-oriented incentive system Customer involvement Field service organization Back-office specialist support	Value visualization capability Internal coordination capability Customer needing interpretation capability
Delivery process	Field service network Back-office infrastructure Customer involvement	Capacity utilization and prognostication capability Internal-external design capability
Customer relationships	Customer interactor stability Field service organization Customer counseling and adaptiveness	Customer embeddedness capability Proactive-reactive balancing capability Customer portfolio management capability
Value network	Distributor network Customer interface Specialist supplier base Influencer relationships	Orchestration capability Partner knowledge capability Network dynamics understanding capability
Culture	Service awareness Long-term orientation Service champions Service-oriented incentive system	Service leadership capability Service logic translation capability Product-service balancing capability

9.15 CAMO logic

Source: Denyer et al. (2008)

	Component	Explanation
C	Context	The context entails the field problem that is being addressed by the design problem and its background in both endogenous and exogenous factors, and the nature of the human actors that influence the change. The exogenous factors include among others: market position, competition or industry specifics. The endogenous factors include among others: technology, organizational design, stability, or organizational knowledge. The human actors interacting with the design intervention are defined by their competences, experience, or power.
A	Actor / Action	These are the specific actions that can be undertaken (e.g. by managers) to modify behavior or to deliver the expected outcome. Examples of this include among others: leadership style, planning, control systems, training, or performance management. It must be noted that not merely the nature of the intervention must be examined, but also how it is implemented.
M	Mechanism	The organizational phenomena that in a certain context will be triggered by the intervention. To illustrate, a mechanism would be the causal chain of effects of empowering the employees. Employee empowerment provides the opportunity to contribute beyond the operational task, thus increasing responsibility and employee participation, which could all turn into long term potential benefits for the company.
O	Outcome	The results of the action in either a quantitative or qualitative form. Examples hereof are performance improvement, cost reduction, or increased customer satisfaction.

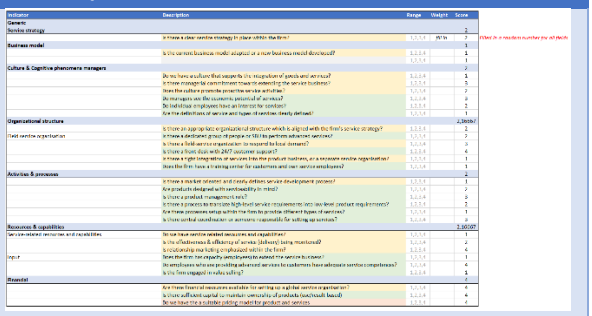
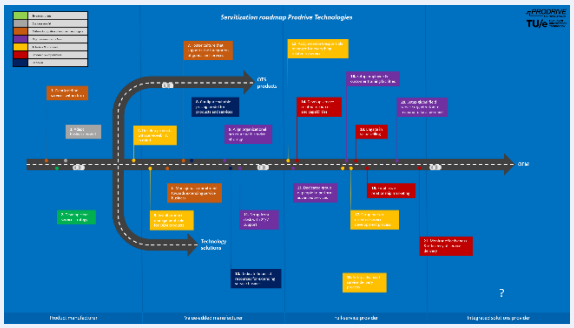
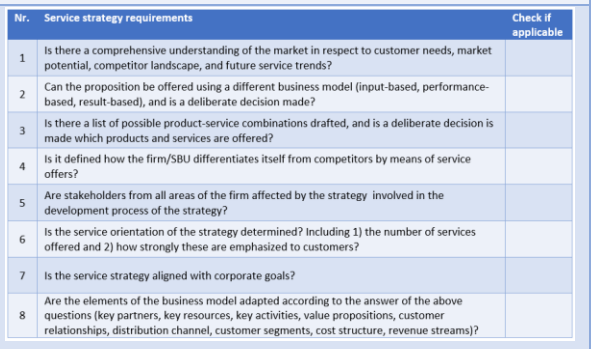
9.16 Change plan RACI table

The below RACI table explains the individuals or groups who are either responsible, accountable, consulted, or informed, regarding (parts of) the solution design and change plan of the servitization transition within PT. Consisting of three solution design components 1) servitization transition framework, 2) service strategy & business model checklist and 3) improved organizational structure.

3 main transition components	Responsible	Accountable	Consulted	Informed
1. Servitization transition framework	SBU managers	Board of management	Business Development Managers, Account managers, process owner (s)	All employees
2. Service strategy & business model checklist	SBU managers(s)	Board of management	Business Development Managers, Account managers, process owner SBU management	All employees
3. Organizational structure: activities & processes	Chief Operations Officer	Board of management	SBU managers Process owners workgroup[2]	All employees
3. Organizational structure: resources & capabilities	HR department, financial department	Chief Financial Officer	Process owner service process, process owner advanced service process, process owner LCM	All employees
Other transition components	**Responsible**	**Accountable**	**Consulted**	**Informed**
Firm culture & cognitive phenomena managers	SBU managers, board of management, marketing & communications	Board of management	Process owners	All employees
External environment	Business development manager(s), account manager(s)	SBU managers	Customers, suppliers, competitors, other external parties	SBU managers

[2] Process owner's workgroup: in lead by the Chief Operations Officer, a workgroup is set up consisting of individual employees from the processes relevant to services (project management, system development, account management, lifecycle management, service, logistics, sales process, customer satisfaction process)

9.17 Solution design iterations

Iterations	Explanation	Visual representation
Iteration 1	A first draft of the solution design incorporated a scoring-model approach, where managers could fill in a score on different components (e.g. barriers). The result would be plotted in a radar chart so to check progress on these components. Based on evaluation of this concept with the company supervisor, this concept was turned into a roadmap (see version 2).	
Iteration 2	Based on the earlier version, a roadmap was developed incorporating the different maturity levels and making a distinction between PT's current business models. After another evaluation round with the company supervisor, this roadmap was turned into a framework showing clearer the cohesion and relation between the main theme's (strategy, business model, culture & cognitive phenomena managers, organizational structure, activities & processes, and resources & capabilities).	
Iteration 3	Specifically for the strategy & busines model component of the transition roadmap/framework, a sequential checklist was developed. During evaluation with the company supervisor, the nature of a checklist would be too controlling and could be perceived negatively by the SBU managers. Subsequently, the decision was made to remove the 'check if applicable' and change the layout into a process-overview.	

Nr.	Service strategy requirements	Check if applicable
1	Is there a comprehensive understanding of the market in respect to customer needs, market potential, competitor landscape, and future service trends?	
2	Can the proposition be offered using a different business model (input-based, performance-based, result-based), and is a deliberate decision made?	
3	Is there a list of possible product-service combinations drafted, and is a deliberate decision is made which products and services are offered?	
4	Is it defined how the firm/SBU differentiates itself from competitors by means of service offers?	
5	Are stakeholders from all areas of the firm affected by the strategy involved in the development process of the strategy?	
6	Is the service orientation of the strategy determined? Including 1) the number of services offered and 2) how strongly these are emphasized to customers?	
7	Is the service strategy aligned with corporate goals?	
8	Are the elements of the business model adapted according to the answer of the above questions (key partners, key resources, key activities, value propositions, customer relationships, distribution channel, customer segments, cost structure, revenue streams)?	

9.18 Summary evaluation sessions

Session 1: with the managers of SBU B & D

The first focus group session was conducted with the managers of SBU B and D. Here, they mentioned that the servitization transition framework presents a clear overview with concrete action points which would be very useful for them and PT in general. Based on the evaluation, the service 'obsolescence management' was added to the maturity overview and list of different services. From a different perspective, they prevalently mentioned that they want to know where their specific opportunities, the value, and the needs of the market might be with regards to services among different SBUs. Although this external expedition is out of scope of the current research, it might be a fruitful future research direction for PT, especially from a practical perspective. It is worth mentioning that these SBUs currently do not have OEM propositions in their portfolio or pipeline. The evaluation also covered the organizational design, where the remark was made if it is useful to find a central group for service delivery, or whether this should be decentralized. This is due to the wide range of highly technical competences within PT. Furthermore, it was mentioned that the processes for advanced service delivery should indeed be standardized and drafted in accordance with the firm's desire to standardize processes. However, the internal distribution of service competences should be decentralized according to them.

Session 2: with the manager of SBU E

The manager of SBU E complimented the holistic approach taken with regards to the servitization transition framework. He said that he believes all components to successfully make the servitization transition are in there. He also mentioned the frequent internal discussions between him and the operations part of the organization; where he asked the operations organization "what services can you offer", whereas the service operations group asked the question back: "what services do you want to offer?". The following quote highlights this gap between the two parts of the organization:

"There currently is a gap between the service strategy and the execution of the strategy, your solution will contribute to filling that gap, but I think it will still be difficult" (Manager, SBU E)

The manager of SBU E said that the eight-strategy steps could help him with formulating a SBU strategy plan; also, to ask the right questions with regards to service during projects. According to him, it could also be implemented within the project management process (which revolves around the stage-gate principle) to make sure the right questions are asked at the right time. Furthermore, he mentioned that the designed solution can be helpful for the operations manager in seeing which actions have to be taken within the organization in order to support the SBU manager's strategic plans. On a different note, the manager also expressed interest in knowing the costs of setting up a worldwide service. Although the specific cost perspective is out of scope of the current research, it might be an interesting avenue for future research.

Session 3: with the manager of SBU A

The manager of SBU A mentioned the overview of the servitization maturity levels and the corresponding services useful for PT to position itself stronger. He also mentioned that within the SBU strategies it would be very useful to start incorporating services as this is currently not done. One interesting remark was made regarding the central coordination or responsible manager for everything related to services. He did not feel the need to organize this specifically for services as he mentioned there are a lot of other subjects which are just as important or even more important. In his opinion, this would then require PT to organize this for all topics of importance. This remark highlighted the still underemphasis on services within PT again confirming the underlying issues related to firm culture and cognitive phenomena of managers.

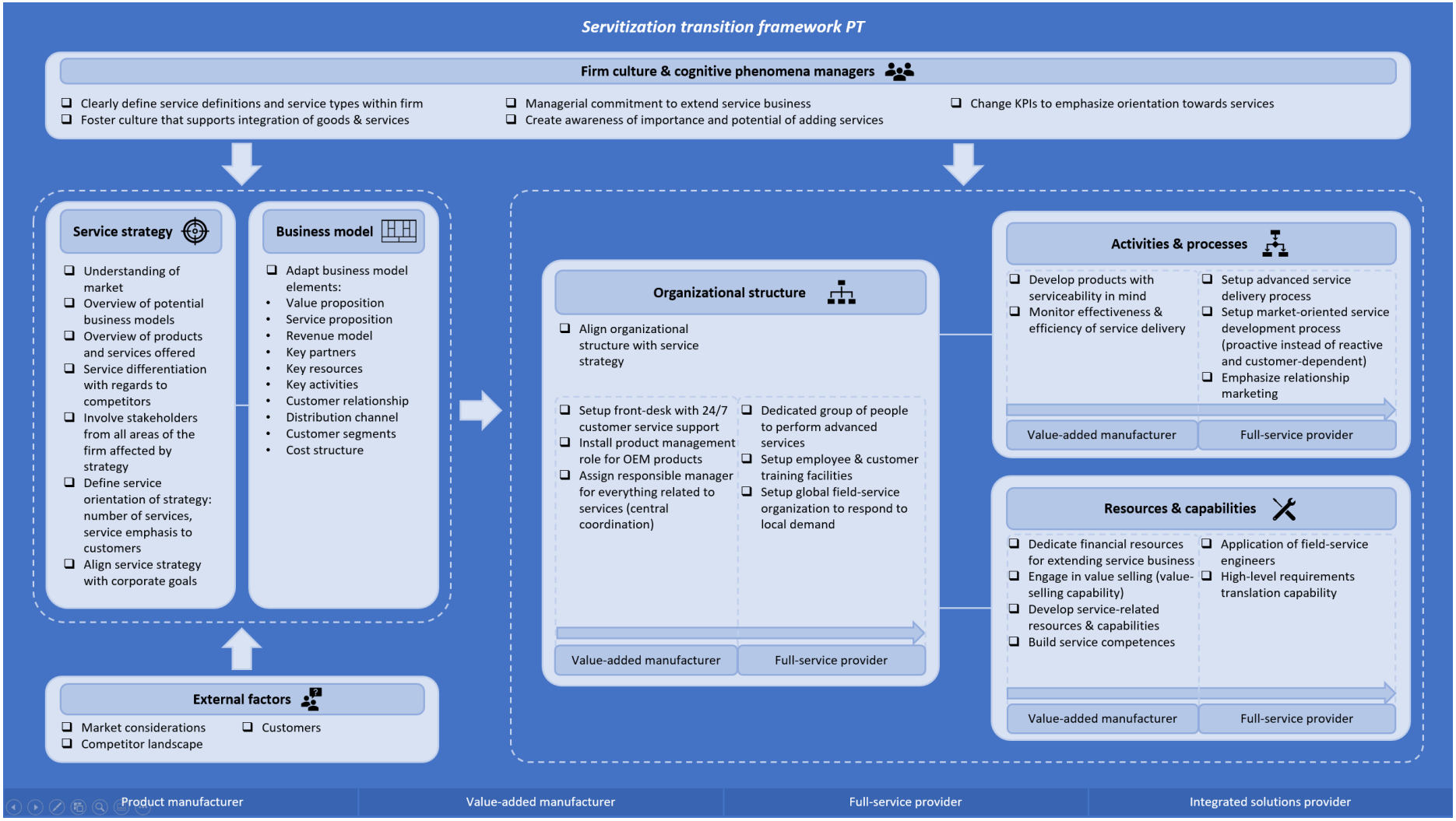
Session 4: with the Chief Operations Officer

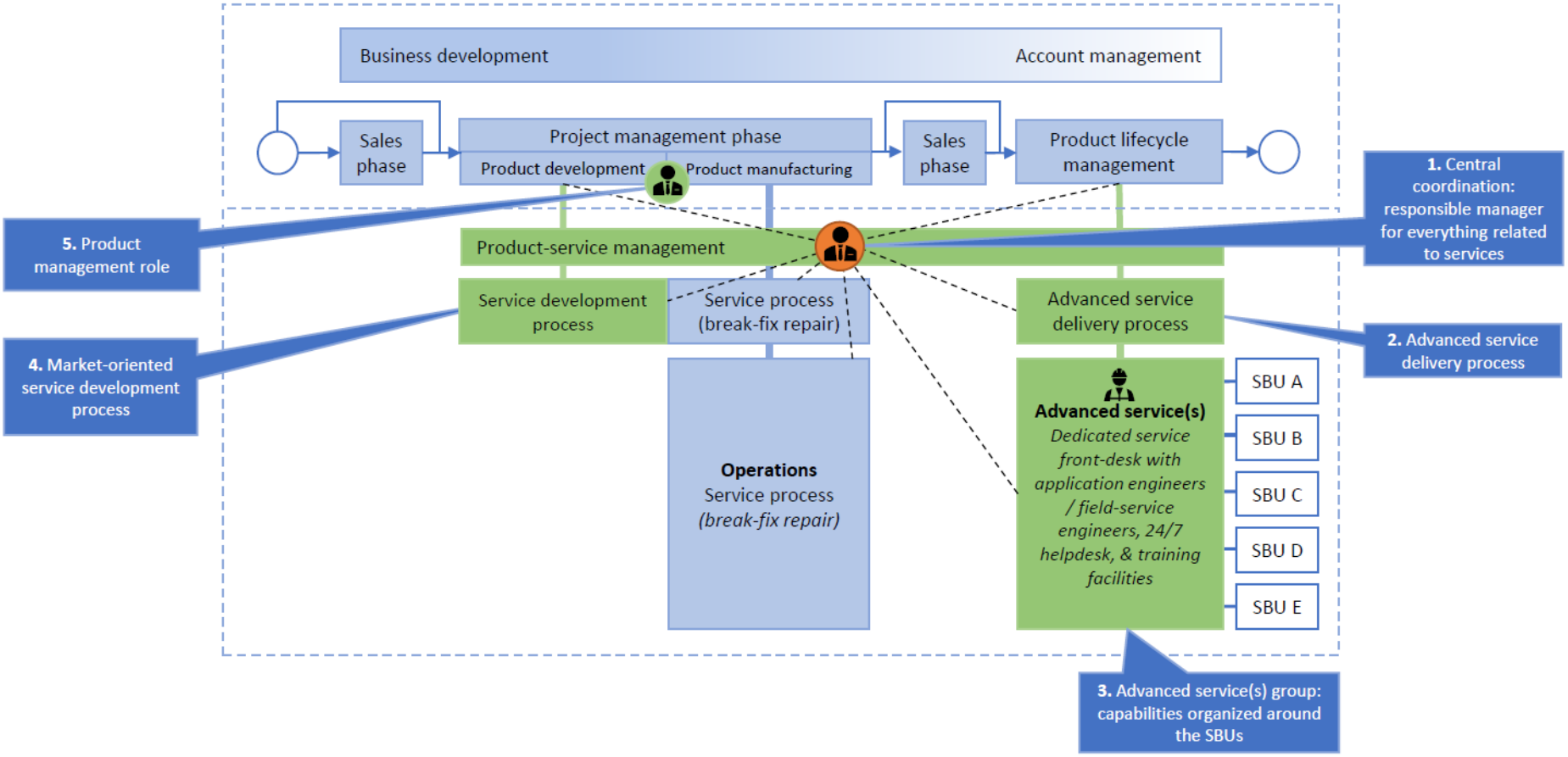
The time for the interview was limited due to a very busy agenda of the CCO and therefore was less than half an hour. The COO mentioned that the overview of the maturity stages and the types of services that can be offered is a very useful overview, especially within the internal communication between the SBU managers and him. Subsequently, he liked the transition framework on what should be organized in order to accomplish this. However, he mentioned that it is up to the individual SBUs to come up with the services they want to offer to their customers, and then it is up to him to arrange this. He liked the idea of setting up a roadmap together with the SBU managers over time in order to increase the service portfolio and organizational support. Conclusively and in his opinion, it was more important to determine the future services to be provided starting at the SBU managers, and then look at how to arrange this within the organization.

Session 5: with the Chief Commercial Officer

The CCO mentioned that the results were very useful with regards to the firm's growth strategy towards developing original equipment. The move towards original equipment especially requires a different service maturity and requires the firm to go outside the beaten track. Although the CCO agreed and understood that the current research focused more hereon, future research could especially investigate the servitization of technology solutions and OTS products using primarily an external perspective with customers. Thus including the services required by customers and their willingness to pay for services. Based on the industry expert interview, researching willingness to pay for services with customers is a separate steam within literature and might be difficult and important enough to require a separate research.

9.19 Final solution design (enlarged)




Business development
Account management
Sales phase
Project management phase
Product development
Product manufacturing
Sales phase
Product lifecycle management
Product-service management
Service development process
Service process (break-fix repair)
Advanced service delivery process
Operations
Service process
(break-fix repair)
Advanced service(s)
Dedicated service front-desk with application engineers / field-service engineers, 24/7 helpdesk, & training facilities
SBU A
SBU B
SBU C
SBU D
SBU E
1. Central coordination: responsible manager for everything related to services
2. Advanced service delivery process
3. Advanced service(s) group: capabilities organized around the SBUs
4. Market-oriented service development process
5. Product management role