

Towards a Framework for Product-Service System Business Model Implementation

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Entrepreneurship and Innovation

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Für meine Familie

Abstract

Manufacturing companies are increasingly focused on service-led growth to gain new revenue streams and achieve sustainable competitive advantages. In this regard, offering product-service systems (PSS) is proposed as an attractive solution for manufacturing companies to achieve economic, environmental, and social benefits. More specifically, through the integration of provider and customer operations, efficiency is increased because each party focuses on its core competencies, and operations are optimized. For example, prolonged product lifetimes and increased resource utilization are part of the sustainability achievements that can be achieved through successful PSS implementation.

Still, successful implementation of PSS is rare. The business model has become a common unit of analysis in PSS and the crucial factor that may differentiate successful and unsuccessful PSS companies. Revising business models toward PSS provision and the implementation of the PSS business model is a challenging process that constitutes a major reason why companies struggle to increase the service degree of their offerings. This thesis suggests that a better understanding of tactics, risk management, service network adjustment, and activity alignment is associated with PSS business model implementation. Therefore, the purpose of this thesis is to advance the understanding of PSS business model implementation.

Comprised of a cover story and five separate but interrelated articles, this dissertation explores the implementation of product-service systems business models. The results are based on a systematic literature review and four case studies with Swedish manufacturing companies. The thesis is empirical based on 107 interviews with employees from four different manufacturing companies and eight distributors of one of the case companies.

This thesis contributes to the PSS literature by proposing a four-phase PSS business model implementation framework. The framework goes beyond selecting a PSS business model to also include the configuration of related tactical sets, risk identification and management, and adjustment of the delivery practices, along with activity alignment. All phases are crucial for PSS business model implementation and therefore make specific contributions by themselves. Furthermore, by applying agency theory to mitigate adverse customer behavior, this thesis contributes to the increased legitimacy of the PSS research field.

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- Paper 2** **Reim, W.,** Parida, V., & Sjödin, D. R. (2016). Risk management for product-service system operation. *International Journal of Operations & Production Management*, 36(6), 665-686.
- Paper 3** **Reim, W.,** Sjödin, D. R., & Parida, V. (in press). Mitigating adverse customer behaviour for product-service system provision: An agency theory perspective. *Industrial Marketing Management*.
- Paper 4** **Reim, W.,** Sjödin, D. R., & Parida, V. Servitization of service network actors – A contingency framework for matching challenges and strategies in servitization. (*Second round of review*)
- Paper 5** Lenka, S., **Reim, W.,** Frishammar, J., & Parida, V. Activity alignment for product–service system business model implementation. (*Under review*)

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Part I

1 Introduction

This chapter provides an explanation of the main motivation for undertaking this research. The background section describes the area of investigation for this thesis and is followed by a more detailed discussion of the research problem. Based on these two sections, the overall purpose and specific research questions are stated. .

1.1 Background

The integration of products and services by manufacturing companies is a growing trend in today's globally competitive business environment (Mont, 2002). This trend is especially evident in product-centric manufacturing companies that are investing heavily in developing industrial services related to their products (Parida et al., 2015; Smith et al., 2014). In this regard, offering product-service systems (PSS) is proposed as an attractive solution for manufacturing companies to achieve economic, environmental, and social benefits (Adrodegari et al., 2017; Vezzoli et al., 2015).

Product-service systems is defined as a system of products, services, supporting networks, and infrastructure that is designed to be competitive, satisfy customer needs, and have a lower environmental impact than traditional business models (Mont, 2002, p. 239). More specifically, through the integration of provider and customer operations, efficiency is increased because each party focuses on its core competencies, and operations are optimized. Thus, PSS has great potential to affect the triple bottom line through positive economic, environmental, and social effects for industry and society (Mont et al., 2006). Such improvements add, for example uptime, which can lead to intensified use of products and timely replacement with newer, more efficient, and innovative products (Sundin and Bras, 2005). Building on a true life-cycle costs perspective, PSS creates incentives for optimizing energy and consumables as well as prolonging a product's life, which improves resource utilization and the companies' competitiveness when PSS is successfully implemented (Boehm and Thomas, 2013; Kohtamäki et al., 2013; Tukker, 2004). Famous examples of PSS are outcome- or results-based services such as Rolls Royce's "Power by the Hour" offer in which the

airplane operator pays for every hour the engine is used and not buys the engine itself (Baines et al., 2017).

Moving toward offering PSS implicates that the companies' business model undergoes significant modifications (Kindström, 2010; Meier et al., 2010). Business models are commonly defined as describing the design or architecture of a company's value creation, delivery, and capture mechanisms (Osterwalder and Pigneur 2010; Teece, 2010). The business model has become a common unit of analysis in PSS literature as the crucial factor that may differentiate successful and unsuccessful PSS companies (Barquet et al., 2013; Ferreira et al., 2013; Ng et al., 2013). Furthermore, the business model perspective is not only suitable for classifying businesses with similar characteristics but also to provide a lens for redesign activities to innovate the business model (Baden-Fuller and Morgan, 2010; Kastalli et al., 2013). PSS business models require a whole set of new resources and involve multiple, even unfamiliar stakeholders, which are challenging to develop and coordinate (Maglio and Spohrer, 2013).

Following the studies of Casadesus-Masanell and Ricart (2010) and Yip (2004), it has been argued that the business model is a key choice that derived the fulfilment of a company's differentiation strategy. Hence, this is one of the main arguments for PSS business model implementation because the combination of product and service components is difficult to compete with from unestablished competitors (Barguet et al., 2013; Ulaga and Loveland, 2014). However, implementing a PSS business model successfully is a complex and challenging task, as demonstrated by the high failure rates in which companies do not generate the expected higher returns (Gebauer et al., 2005; Ulaga and Reinartz, 2011).

1.2 Research Problem

Although recent studies have highlighted many potential benefits of PSS, these benefits have not been fully realized, and thus an implementation gap has emerged (Catulli et al., 2017). Comprehensive insights about how companies can adopt and implement PSS business models remain limited (Baines et al., 2007; Gaiardelli et al., 2013; Meier et al., 2010; Yoon et al., 2011). One reason is that PSS requires radical transformations for

product- and service-oriented companies extending beyond a company throughout its value-chain involving customers, suppliers, and service partners (Martinez et al., 2010). PSS offerings without careful consideration to business models run the risk that the economic and environmental potential will be offset by rebound effects and adverse behavior (Kuo, 2011; Tukker, 2004). For example, increasing the utilization of a car in a car pool can lead to a situation where drivers are less careful because they do not drive their own car as well as more people having access to cars, which could increase overall car usage; hence, this situation would offset environmental gains from the PSS offering. Thus, PSS business model implementation is a complex process that needs to take many aspects and strategic decisions into account. However, deeper insights into how PSS business model implementation can be successfully managed has been lacking in the literature (Adrodegari et al., 2017; Baines et al., 2017; Kindström and Ottosson, 2016).

To this background, this thesis focuses on addressing four research gaps related to PSS business model implementation. First, it is of major importance to choose the business model that fits the company's overall situation and strategy (Adrodegari et al., 2017). PSS literature commonly classifies three distinct categories of PSS business models: product-oriented, use-oriented, and result-oriented (e.g., Baines et al., 2007), and these categories clearly differ in terms of their mechanisms for creating, delivering, and capturing value. Product-oriented PSS struggles often because services are simply added onto the product instead of being integrated. This leads to a situation in which no effective PSS is created because no synergy effects are archived from the combination of products and service (Kuijken et al., 2017). Similarly, a result-oriented PSS poses high requirements on the provider, including competence development and a changing mindset to become a service provider (Azarenko et al., 2009). There are several methodologies and tools concerning the selection and development of a PSS business model but leaving the implementation unconsidered (Dimache and Roche, 2013; Maxwell et al., 2006; Weking et al., 2018). Thus, our current understanding of the required activities for implementing PSS business models is a rather neglected research area (Azarenko et al., 2009; Mont et al., 2006). It is important to study different operations or implementation practices that companies employ in order to maximize value and revenue creation through each of the chosen PSS business models. These

practices can be regarded as tactics or tactical sets, which are defined as the residual choices that can be adapted according to the chosen business model (Casadesus-Masanell and Ricart, 2010; Evans et al., 2007). Thus, a company's business model will determine the range of tactics available to the company under that model, and this range will differ for each business model. Thus, a business model describes how value is created, delivered, and captured. In contrast, tactics determine how much value is created, delivered, and captured when a particular business model is applied. For example, deciding to implement a total care solution for construction equipment requires a service network to realize the value from this PSS, but the organization, competences, and efficiency of the network are tactical aspects that will determine how much value can be realized. Therefore, a structured aggregation and understanding of tactics within PSS are necessary for companies to implement PSS business models.

Second, providing PSS entails increased risks for manufacturing companies, as they shift from pure transaction to relational engagements with customers and often assume operational responsibilities for customers' processes and engage in value co-creation (Nordin et al., 2011; Benedettini et al., 2015; Wallin et al., 2015). In particular, introducing the PSS business model intensifies liability and interactions with the customer and also increases the likelihood for conflicts, disagreements, and opportunistic behavior (Kindström, 2010; Richter et al., 2010). In the context of PSS operations, providers are exposed to new types of risks at a significantly higher level, which are not fully understood. Prior studies have frequently mentioned increased risk and noted that companies' inability to manage risks is the central issue prohibiting the PSS transition (Azarenko et al., 2009; Hou and Neely, 2017; Meier et al., 2010; Richter and Steven, 2009). However, detailed and holistic insights into different PSS-related risks continue to be a limited and under-researched area (Erkoyuncu et al., 2011; Sundin et al., 2010). Operational risks related to providing PSS are multifaceted and include both technical and behavioral risks (Richter et al., 2010) as well as risks related to the provider's delivery competences. More importantly, in a PSS context, risks are not negative *per se* but rather represent an opportunity for providers to generate additional revenue by assuming and managing risks for the customers (Tukker, 2004). Thus, the key to providing PSS successfully lies in systematically managing identified risks by

implementing diverse risk management approaches. Prior attempts to integrate risk-management literature insights into a PSS context are either too general or fail to specify when and how the approaches should be used (Ulaga and Reinartz, 2011). Advancing the general understanding of PSS risk management requires matching different PSS operational risks to potential risk management responses. The ability to do so largely depends on identifying key decision-making criteria. Previous PSS studies have provided limited insights to such decision-making criteria (Lindström et al., 2013), which create a need for further research.

Third, as companies transform toward the provision of PSS, they must increase efforts to manage co-creation of value with customers through support of their service networks that deliver products and services in local markets (Baines et al. 2009; Gebauer et al., 2013; Parida et al. 2014; Wallin et al., 2015). To a large extent, the success or failure of PSS implementation in different markets largely depends on the role of the service network partners such as distributors (Durugbo and Riedel, 2013; Parida et al., 2015). Distributors are the local intermediaries who are responsible for customizing and delivering PSS offerings and co-creating value with local customers. Accordingly, a global provider's implementation of PSS business models is rarely possible without the support and corresponding transition of the service network. However, PSS business model implementation creates numerous challenges for the service network actor, as it represents radical transition of the *modus operandi* for this local actor and requires large-scale changes in its operational processes (Gebauer et al., 2013; Raja and Frandsen, 2017; Story et al., 2017). Despite the critical role of the service network, the existing literature predominantly focuses on aspects of the manufacturers' PSS implementation. Indeed, a key challenge for service network actors is adapting manufacturing companies' PSS efforts to local conditions. Furthermore, different factors influencing the strategic approaches can include the combination of customer and market heterogeneity or the heterogeneity in the service network actor's characteristics (e.g., financial slack, operational skills, and organizational maturity). Yet there is limited synthesis of how different service networks apply diverse strategic approaches to meet the challenges of PSS implementation and become PSS providers in their local market (Ulaga and Loveland, 2013; Rabetino et al., 2017).

Finally, implementing PSS implies that companies need to align all the activities of its internal stakeholders (i.e., functions, departments) as well as external value chain actors (e.g., distributors) into a coherent business model. This can represent a major challenge for the operational setup of the entire organization, and many companies struggle to manage this change (Baines et al., 2017; Lee et al., 2012; Päivärinne and Lindahl, 2016). The notion of alignment of the components of a business model has been suggested by some researchers in the literature to achieve internal and external fit with the company's strategy of providing PSS (Adrodegari et al., 2017; Ferreira et al., 2013; Kindström, 2010). However, the explanation of how such alignment can be achieved in the implementation of a PSS business model is still missing in the literature. Therefore, there is a gap in the understanding of the key activities that are necessary for the implementation of a PSS business model and how its underlying constituents can be aligned to achieve internal and external fit with the company's business strategy of how it creates, delivers, and captures value through PSS.

1.3 Research Purpose

The arguments put forward in the previous sections highlight that the implementation of PSS business models is a challenging process, which is a major reason why companies struggle to increase the service degree of their offerings. Therefore, the purpose of this thesis is *to advance understanding of PSS business model implementation in manufacturing companies.*

More specifically, the stated purpose is divided into four research questions:

RQ1: How are tactics configured for PSS business model implementation in manufacturing companies?

RQ2: How can manufacturing companies apply risk management for PSS business model implementation?

RQ3: How can manufacturing companies adjust service network for PSS business model implementation?

RQ4: How can manufacturing companies ensure business model activity alignment for PSS business model implementation?

2 Theoretical Background

This chapter provides the theoretical background for this thesis. First, an overview of the product-service systems (PSS) research field is presented. This is followed by a description of the literature connected to PSS business models, PSS risk management, PSS service networks, and PSS business model alignment. All sections also present existing gaps in the literature and how they contribute to the development of a PSS business model implementation framework.

2.1 Product-Service Systems

Initial studies on PSS defined the concept of PSS as a marketable set of products and services capable of jointly fulfilling customers' needs in an economical and sustainable manner (Goedkoop et al., 1999; Mont, 2002). Over the years, however, sustainability was treated more as an inherited result of PSS, and the focus shifted to achieving economic benefits and customer satisfaction (Baines et al., 2007). In hindsight, several studies have acknowledged that, in certain cases, PSS results in a negative effect on the environment through less careful behavior and rebound effects (Catulli, 2012; Kuo, 2011; Tukker, 2004). In recent years, however, the emphasis has shifted to achieving sustainable benefits by recognizing the need to work actively to realize the full sustainability potential of PSS (Tukker, 2015). This development also indicates the benefits of PSS, which enables the provider company to generate revenue from its products through the whole life-cycle as well as positive effects for the environment due to effective utilization of products. This means that customer needs are served and a win-win situation is created (Mont, 2002). While PSS has significant potential to be beneficial for providers, customers, and the environment, there are several barriers that hinder its implementation, e.g., customers may hesitate to use PSS because they dislike ownerless consumption, or the provider organization may be unwilling to provide resources to shift the company toward PSS provision (Baines et al., 2007).

In order to define and understand PSS, it is helpful to look at the categorization into product-, use-, and result-oriented PSS (Tukker, 2004). These categories differ in the

degree of product emphasis, responsibilities, and ownership. This also shows that PSS is broadly defined, as it includes everything that has some product and service dimension reaching from maintenance over leasing to even outsourcing. In the PSS literature most of the studies focus on case studies and examples to show the value of PSS and further to identify characteristics of PSS offers (Baines et al., 2007). Furthermore, drivers and barriers have been covered as well as a more life-cycle and engineering approach (Meier et al., 2010; Tukker, 2015).

Implementing and adopting PSS, however, has not been as widespread as expected, and especially higher PSS level implies even more challenges and risks that make providing PSS more difficult. The challenges that hinder successfully operating PSS usually concern the transformation process required when implementing PSS (Baines et al., 2009; Martinez et al., 2010; Raja et al., 2017) as well as strategic alignment within the company and with customers (Isaksson et al., 2009; Martinez et al., 2010). In the PSS literature, various studies that have tried to provide specific tools and frameworks to overcome these challenges (Nordin et al., 2011; Roy and Cheruvu, 2009; Sakao et al., 2013). Additionally, many researchers have pointed out that the challenges companies face when implementing PSS often negatively affect company performance (Gebauer et al., 2005; Kohtamäki et al., 2013; Parida et al., 2014). To address these challenges, researchers have proposed that designing a well-structured business model could contribute to a comprehensive approach in PSS provision (Boons et al., 2013; Kindström and Kowalkowski, 2014). Such an approach has the potential to contribute to improved performance, especially in companies that implement advanced, result-oriented PSS (Parida et al., 2014; Visnjic et al., 2016).

2.2 PSS Business Models

The business model as a concept has been part of the business jargon for a long time and is even considered as a widely used buzzword without a clear understanding of what it actually means. Only recently, critical and developmental management research about business models has begun to emerge (Foss and Saebi, 2017; Zott et al., 2011). A common argument in the literature states that the business model refers to the logic of the company, including how it operates and how it creates value for stakeholders

(Magretta, 2002). However, over the last few years, more and more agreement has arisen for a common definition, as used by Teece (2010) and Osterwalder and Pigneur (2010), which basically states that business models describe the design or architecture of the value creation, value delivery, and value capturing mechanisms that a company employs.

The framework developed by Casadesus-Masanell and Ricart (2010), which looks on the relation among strategy, business models, and tactics, is helpful in understanding the relationship between PSS and business models. The authors suggest that a company's strategy decides which potential business models it can adopt. Furthermore, tactics are defined as the residual choices at operational level that are left after deciding which business model to go for. This would, within PSS, mean that a company strategy includes an increased focus on services and that this opens up for any PSS business model, which is part of the above-mentioned categories (product-oriented, use-oriented, and result-oriented). After choosing a particular PSS business model, which decides how value is created, delivered, and captured, the tactical sets will decide how much value in the end is created and captured.

The literature, however, lacks clarity surrounding the contents of the business model components (value creation, delivery, and capture), and they seem open for interpretation as to exactly what activities they entail. The initial literature on the PSS business model concept has commonly been used to categorize different types of PSS such as product-, use-, or results-oriented (Meier et al., 2010; Tukker, 2004). The literature frequently touches upon different aspects that constitute the business model components. On the one hand, value in PSS is created by taking over work tasks from customers and accomplishing them more efficiently, which also improves the relationship with the customer and enhance his or her loyalty (Meier et al., 2010; Tukker, 2015). Missing out on the potential to gain insights into customers' knowledge and utilizing the knowledge about customers are strong barriers against value creation in PSS (Isaksson et al., 2009; Zarpelon Neto et al., 2015). For example, customers who do not favor ownerless consumption constitute a frequently mentioned barrier against successful PSS (Baines et al., 2007; Mont, 2002).

Value delivery is characterized by the high skill, competence, and experience levels required to control the entire process of providing PSS (Meier et al., 2010). In addition, new organizational structures and new partners need to be integrated into PSS provision. Given these parameters, challenges occur because processes need to be developed, industrialized, and automated; the staff needs to be qualified; and stakeholders need to be identified and integrated into a PSS-oriented organization (Kindström, 2010; Neely, 2008).

To capture value, it is important to design PSS such that customers are willing to pay for the added value (Mont, 2002). At the same time, costs need to be handled efficiently. In addition, the profitability of PSS is often difficult to show because cash flows are uncertain, and quantifying savings may be difficult (Erkoyuncu et al., 2013; Gebauer et al., 2005). Pricing and absorbing risks are significant problems that manufacturers need to address when capturing value from PSS (Baines et al., 2007). Although the business model concept is clearly visible in PSS studies, research that shows the benefits and success of actively using the business model concept to develop and implement PSS are still rare (Adrodegari et al., 2017; Parida et al., 2015; Seidel et al., 2017).

Previous studies have acknowledged the importance of PSS business model implementation (Kowalkowski et al., 2015; Maxwell and Van der Vorst, 2003; Wise and Baumgartner, 1999), but only a few studies have explained the mechanism by which such intent can lead to competitiveness. When companies pursue PSS implementation strategies, they add service or product elements to their operations in different ways and under varying conditions. This explains why certain companies are more successful with PSS, whereas others fail despite adopting a similar PSS strategy. Several methodologies can be found in the literature that, for example, focus on life-cycle assessment or digital capabilities relevant for PSS business model implementation (Fargnoli et al., 2018; Pagoropoulos et al., 2017). However, most frameworks only describe or analyze PSS business models (Oliveira et al., 2018; Weking et al., 2017) without providing insight into how a company should implement the developed business models. Following the studies of Casadesus-Masanell and Ricart (2010) and Yip (2004), it has been argued that selecting a business model is one key choice that

drives the fulfilment of a company's differentiation strategy. Indeed, recent PSS studies have highlighted the fact that business models are central to implementing PSS successfully (Adrodegari et al., 2017; Kindström, 2010; Mont et al., 2006).

2.3 PSS Risk Management

Prior studies have highlighted that reducing risks for customers tends to be the most common reason for adopting PSS (Meier et al., 2010; Nordin et al., 2011; Rexfelt and Hiort af Ornäs, 2009; Sakao et al., 2013; Kohtamäki et al., 2015). The assumption that customers want more reliability (Roy and Cheruvu, 2009; Sundin et al., 2010) and are willing to pay extra (i.e., a risk premium) for the reduced risk has driven providers to engage in PSS (Shih and Chou, 2011). This implies that the risks for providers in most cases increase significantly (Azarenko et al., 2009; Ng et al., 2013; Sjödin et al., 2016). This explains why risks are mentioned frequently in the PSS literature. Still, few studies have attempted to conceptualize and discuss PSS risks. For example, Nordin et al. (2011) categorized that the risks relevant for PSS were related to breakdowns, capacity constraints, and logistical challenges. In addition, several researchers have proposed that strategic risks usually cover issues related to implementing PSS, including organizational change or the market acceptance (Oliva and Kallenberg, 2003; Stoughton and Votta, 2003).

In PSS, many authors have identified various operational risks but without providing a holistic picture. Primarily, authors focus on unexpected breakdowns of the product (Erkoyuncu et al., 2011; Sakao et al., 2013; Steven, 2012), which leads to increased repair and maintenance costs (Meier et al., 2010) and other penalties. This view dominates because moving toward PSS usually implies that the provider is responsible for repairs and breakdowns, which is a new situation for most of them. These technical issues may also relate to risks that are more readily associated with the state of the technology such as obsolescence (Azarenko et al., 2009; Richter et al., 2010; Romero Rojo et al., 2009).

Other risk factors that are not yet well understood but are gaining increasing attention relate to unintended and adverse customer behavior (Roy and Cheruvu, 2009). The likelihood of adverse customer behavior increases significantly because the provider

takes over responsibility for product performance from the customer (Caldwell and Settle, 2011; Erkoyuncu et al., 2013; Ng and Yip, 2009). PSS literature has merely acknowledged such adverse behavior, but this behavior is poorly understood (Roy and Cheruvu, 2009). A specific example is when a customer only buys PSS agreements for machinery that the customer knows is prone to breaking down (Hypko et al., 2010). Being unaware and unable to handle these relational challenges can be viewed as a major reason why manufacturing companies do not adopt a full-scale PSS strategy and miss out on the huge economic and environmental potential of PSS for both providers and customers.

Additionally, operational risk can also be related to the company's competence and capability to provide the agreed-upon product-service to customers (Mont, 2002). This is important for PSS because the company must acquire numerous new capabilities and resources to be able to offer PSS (Parida et al., 2013). In many cases, the provider partly takes over the customers operations, and the customer is therefore dependent on the reliability of the PSS offered (Nordin et al., 2011; Sakao et al., 2013; Meier et al., 2010). Thus, far more risks are relevant to PSS operations than only unexpected breakdowns. An increased understanding of such risks during the early development stages of the PSS business model can enable improved risk analysis to reduce the complexity and ambiguity associated with identifying and managing risk (Erkoyuncu et al., 2013).

Although the field of risk management has matured over the last decades, the literature on risk management within PSS is still in a nascent stage (Meier et al., 2010). Prior literature has identified four main approaches or methods to respond to risks: risk avoidance, risk reduction, risk sharing/transfer, and risk retention (Dorfman, 1998; Rejda, 2008). Avoidance would mean evading all possibilities that the risk or loss can occur. For PSS, this would basically implicate a lack of offering PSS or only offering PSS without being responsible for breakdowns. Reducing PSS risks can be reached by improved quality (Tukker, 2004), proactive risk mitigation activities (Romero Rojo et al., 2009), and good data and information handling, e.g., from sensors (Roy and Cheruvu, 2009; Steven, 2012). Risk reduction is usually connected to increased resource levels (e.g., more spare parts in stock or more technicians available). It is

therefore important to carefully consider whether the sustainability potential of PSS might be offset with the increased use of resources (Mont, 2002).

Risk sharing or transfer includes, for example, insurance agreements but applies to other cases in which the risks are completely or partly borne by someone else, including customers, retailers, or delivery partners (Rejda, 2008; Parida et al., 2014). In PSS, risk sharing is seen as an important and effective method of risk handling (Caldwell and Settle, 2011; Datta and Roy, 2013; Meier et al., 2010) because the financial losses can be reduced by spreading it across partners (Sundin et al., 2010). Finally, the fourth approach, risk retention, represents a situation where the provider bears all or certain risks and attempts to profit from retaining that risk by pricing the offering accordingly. This so-called risk premium is one of the reasons PSS has the potential to increase profits significantly (Gruneberg et al., 2007; Tukker, 2004). This is the case because the provider is often better equipped to handle certain risks (Roy and Cheruvu, 2009) by pooling them together (Spring and Araujo, 2009).

Furthermore, the behavioral risk related to PSS offers constitutes agency problems (e.g., adverse customer behavior), which have been widely reported in the PSS literature, but insights into how to manage such problems remain limited (Roy and Cheruvu, 2009). Overall, the literature has identified various mechanisms for managing agency problems (e.g., sharing or trust), but these mechanisms have not been studied together. In particular, prior literature fails to provide a clear understanding of when (i.e., under which conditions) certain mechanisms are most applicable and how that will impact PSS business model implementation.

In summary, several studies within the PSS literature have addressed issues of different risk responses, but the existing PSS risk management literature to date covers only limited aspects (Gruneberg et al., 2007; Schrödl and Turowski, 2014). Moreover, several researchers describe specific processes for risk management in PSS (see Erkoyuncu et al., 2011, or Steven, 2012) but do not discuss the use in detail or are limited to only one or a few relevant risks, thus delimiting their applicability. As such, many researchers identify risk management for PSS as an important future research area, often discussed together with developing appropriate contracts and decision

support for PSS business model implementation (Durugbo, 2013; Lindström et al., 2013; Meier et al., 2010).

2.4 PSS Service Networks

The PSS literature typically focuses on the manufacturers' internal implementation processes or the relationship between provider and customer (Barguet et al., 2013; Stroughton and Votta, 2003; Tukker, 2004). In contrast, the role of the service network in manufacturers' PSS business model implementation efforts has largely been overlooked.

In PSS, service network actors such as distributors can be regarded as the intermediaries in an extended value creation network, providing the forward link to customers and the backward link to the manufacturer (Story et al., 2017), thus ensuring delivery of PSS business models. Service networks extend beyond organizational boundaries. Customers, suppliers, partners, and distribution networks all work toward value co-creation (Sakao et al., 2009; Parida et al., 2015).

The few studies that have focused on service partners recognize that readiness and willingness to offer advanced services to heterogeneous customers go hand-in-hand with the PSS business model implementation of the service partners (Durugbo and Riedel, 2013; Lockett et al., 2011; Parida et al., 2015). For example, Schweitzer and Aurich (2010) describe the importance of understanding global service networks, which are responsible for delivering advanced services in cooperation with customers throughout the product life cycle. Thus, investigating the role of service network actors in PSS provision is vital to understanding not only their role in mediating partnerships between providers and customers (Evans et al. 2007) but also the underlying dynamics that explain the service network actors' commitment, communication, and distributed work practices in PSS provision.

Even though some prior studies have indicated the important role of service networks in the manufacturers' PSS business model implementation processes (Parida et al., 2015), only few studies have actually focused on the challenges and strategies that service

network actors face in their own PSS business model implementation processes (Burton et al., 2017). For example, customer segments and needs are likely to vary significantly from country to country. This variation creates major managerial and operational challenges for service network actors, who must cope with diverse customer characteristics and incentive models and establish new partnerships with value network actors (Pawar et al., 2009; Legnani and Cavalieri, 2010). Furthermore, Zarpelon-Neto et al. (2015) highlight local regulations, resource allocation, internal culture, commercial feasibility, and lack of knowledge as major problems that prevent service network actors from offering PSS. Thus, understanding the challenges and complexity associated with PSS business model implementation in service networks is an important area of inquiry (Kowalkowski et al., 2011; Raja and Frandsen, 2017; Wilson, 1999).

2.5 PSS Business Model Alignment

Based on its definition, the business model describes the architecture that aligns various elements to capture the essence of the cause–effect relationships among customers, the organization, and money (Fiss, 2011; Teece, 2010). Accordingly, alignment in the literature has been defined as the adjustment of an object in relation to other objects so that the arrangement can lead to the optimization of results (Drazin and Ven de Van, 1985; Venkatraman, 1989). Adjustment of the constituents of the business model is therefore necessary in order to align them with the overall business logic of a company when it moves toward providing PSS (Baden-Fuller and Mangematin, 2013; Kindström, 2010; Saebi et al., 2017). This is because the way value is created, delivered, and captured differs substantially from the way it is configured in the product-based business model. Consequently, the company’s activities must also evolve to enable the implementation of the new PSS business model (Kindström and Ottosson, 2016).

Although scholars have stressed the need to evolve activities and for alignment of their components in implementing a PSS business model (Helms, 2016; Kindström, 2010; Kindström and Kowalkowski, 2014), the explanation of how such alignment can be achieved in the implementation of a PSS business model is missing in the literature. As such, significant opportunity exists to use a business model framework to align its components toward a common goal of achieving internal and external fit with the

company's business strategy of how it creates, delivers, and captures value through PSS.

3 Research Methods

In this chapter, the methods used in the dissertation papers are presented and discussed. The chapter starts with a brief description of my research journey. Subsequently, a more detailed description of the research methods is presented. This description includes sections on the research strategy, literature review, and case studies. Regarding the case studies, the description includes case selection, data collection, data analysis, and research quality.

3.1 Research Project and Research Journey

After finishing my master's degree in Innovation and Industrial Management from the University of Gothenburg, my academic journey continued as a PhD student at the group of Entrepreneurship and Innovation at the Luleå University of Technology in a project focusing on business models for servitizing Swedish manufacturing companies. This provided a perfect opportunity to further develop my knowledge in a research setting. The research was initiated as part of The FASTE Laboratory – A VINNOVA Excellence Center for Functional Product Innovation. The project started in 2006 with a focus on the technical advances needed for a shift toward functional products, the project management realized after a while that there is a need for business model development in order to implement functional products and to show the economic viability of functional products. My PhD project was initiated in June 2012 based on this realization. In addition to the inter-disciplinary research groups, the FASTE Laboratory included six main industrial partners, all large Swedish manufacturing companies, which also presented the main source of data collection for this PhD thesis. Later, I also had the opportunity to connect to a three-year VINNOVA project about global product-service systems which was built around 13 Swedish manufacturing companies and aimed to improve their ability to offer global PSS.

I started my research process with a systematic literature review on PSS and business models. The term business models was used frequently in PSS literature but not in a structured or conscious way, and there was a need to review the literature in order to

clarify when the term business models is appropriate to use and when the literature discusses different tactics to maximize generated value. The first version of this work was presented at the 19th international conference on Engineering Design (Reim et al., 2013b) and was then further developed into paper 1, submitted to the Journal of Cleaner Production in spring 2013, and published online in summer 2014 (Reim et al., 2015).

While working with the literature review also the empirical work related to FASTE started. The project part on business models was divided into two research questions, one on agreement formulation and the other on risk sharing that I focused on. Consequently, Case Study I was designed to identify and manage risks for companies engaging in PSS. The preliminary results were presented at the TESConf in Cranfield in November 2013 (Reim et al., 2013a), and after coming back from parental leave, I developed the final results into a journal paper. A three-month stay at the research group of Prof. Stark at the Technical University of Berlin/Fraunhofer Institute was very valuable in finalizing that paper and for inspiration from one of the dominant research projects in PSS. It became paper 2, and the paper was submitted to the International Journal of Operation and Production Management during autumn 2014 and was published in spring 2016 (Reim et al., 2016). The insights from Case Study I showed that, in addition to the technical and delivery capability risks, the risk for adverse customer behavior was very specific and important for the provision of PSS, but the understanding for this issue was very limited and rarely studied. Case Study II was designed around adverse customer behavior, and two case companies from the FASTE partner companies were chosen that had experienced several cases of adverse customer behavior during their efforts with PSS implementation. The main data collection was done during 2014, and the first version of paper 3 was presented at the CINet conference in Budapest 2014 (Reim et al., 2014). During 2015, the paper was further developed and was accepted for publication in Industrial Marketing Management in spring 2018.

During Case Study I and II, which included a large Swedish manufacturer of construction equipment, it became obvious that their efforts towards offering PSS are restricted by the ability of their distributors to offer PSS. Realizing that their distributors vary greatly in terms of their maturity to offer PSS and knowing that the literature has

yet neglected the major role of distributors in PSS provision, Case Study III was developed to fill that gap. Eight very different distributors, their respective regional managers, as well as employees from the head office have been interviewed to identify the challenges and strategies related to their servitization efforts. The first data had already been collected in 2014, and the first findings of the study were presented in 2017 at IPDMC in Reykjavik (Reim et al., 2017b). After returning from parental leave, I finalized paper 4 during 2017 and sent it to an academic journal.

In 2017, I got the opportunity to join a study from the team of the global PSS project, which became my Case Study IV, and it clearly showed the need for the integration of a business model perspective and consequently my field of research. Contributing some part of the data collection, I was mainly responsible for adding the research background on PSS business models and including the lens of business models to the analysis, which significantly affected the outcome of a business model activity alignment framework. The first version of paper 5 was presented at the IPSS conference in Copenhagen (Reim et al., 2017a). After completion of this final paper, in addition to completing research applications and teaching, I mainly focused on the introduction text of this PhD thesis.

3.2 Research Approach

This thesis includes both a systematic literature review and four exploratory case studies. The different approaches have been chosen to ensure a match between methodology, research purposes, and the maturity of the studied field (Edmondson and McManus, 2007). Even though PSS and servitization are well-established areas in literature and practice, theoretically these fields are still in a rather nascent phase (Kowalkowski et al., 2017). When working with a nascent theory, development requires researchers to ask open-ended questions that aim to uncover novel phenomena, to provide understanding of how processes unfold, or to provide insights into unexplained relationships (Edmondson and McManus, 2007), such as the ongoing process to increase the service degree of an organization. Accordingly, this thesis adopts a qualitative approach that aims to further explore the phenomena of PSS business model implementation.

PSS is an emerging field with a fast-increasing amount of publications (Tukker, 2015), and the term business models is widely used to in one way or another refer to changes within the company's way of working when changing to PSS. Therefore, the first study of this thesis is a systematic literature review with the aim to advance our understanding of implementing PSS business models with a specific focus on research related to business models and operational tactics. According to Cook et al. (1997), a systematic review differs from a traditional general review in that it adopts a replicable, scientific, and transparent process. This leads to the development of collective insights based on theoretical synthesis of existing studies. Systematic review studies are common in the field of medicine, and studies in the domains of engineering and social science have started to adopt this methodological approach more frequently (Geraldi et al., 2011; Pittaway et al., 2006), particularly as the number of studies on PSS has increased dramatically. Furthermore, because PSS shares conceptual closeness with related topics (e.g., industrial product–service systems, integrated product and service offerings), there is a need to synthesize the findings of the existing studies and provide directions for future research on the important topics of PSS business models and tactics.

Even though the amount of literature in PSS has increased significantly over the past years, theory building is just in the starting phase, and recommendations for future studies also call for more detailed insights into certain topics connected to PSS implementation (Kowalkowski et al., 2017). Against this background, exploratory case studies as the research approach fit the purpose of research development related to a particular phenomenon (Edmondson and McManus, 2007; Eisenhardt, 1989b). Information from rich real-life cases can help identify new aspects and phenomena derived from reality (Eisenhardt, 1989b; Yin, 2003). In particular, multiple case studies are well suited to new research topics in which new perspectives are sought and little knowledge of a complex phenomenon is available (Eisenhardt, 1989b). Accordingly, multiple case studies provide multifaceted, complementary insights into distributor servitization by allowing us to compare and contrast cases. Case studies are also appropriate to capture the contextual conditions that affect human behavior in different situations and facilitate deep understanding of dynamic relationships, processes, and activities in different stages (Eisenhardt, 1989b; Yin, 2003).

3.3 Literature Review

Paper 1 is based on a systematic literature review on PSS business models, with a specific focus on research related to business models and operational tactics. A literature search was conducted through the Scopus database, one of the largest multidisciplinary abstract and citation databases of peer-reviewed literature (Geraldi et al., 2011). The articles resulting from the initial search were refined through three steps that were inspired by previous studies that adapted the systematic review approach (Farashahi et al., 2005; Petticrew, 2001).

The first step begins by setting certain practical screening criteria to ensure that only quality publications are included in the review. During the first search, therefore, only peer-reviewed, English journal papers have been included (Seuring and Müller, 2008). Indeed, publications that cover the topic of PSS may not always be published in highly ranked journals, because PSS is still an emerging topic. Using other literature review papers on PSS, several keywords closely related to studying similar phenomena were identified (Baines et al., 2007; Baines et al., 2009; Meier et al., 2010). In addition to *product–service systems (PSS)*, the terms *industrial product service systems (IPSS)*, *service-dominant logic*, *servitization*, *functional products*, *functional product development*, *integrated product service engineering*, *functional sales*, *integrated product service offering*, *service transition*, *hybrid offerings*, *product bundling*, *shared economy*, and *sharing economy* were used in the search. This search, which was intended to be all-inclusive, resulted in identifying 596 articles considered relevant for analysis.

In the second step, theoretical screening criteria have been applied. Because the purpose of the literature review is to focus on PSS business models and tactical practices, only conceptual or empirical articles that discuss implementing or applying PSS business models were included. More specifically, for inclusion in the review, the articles had to either explicitly discuss business models, implicitly discuss business models, or refer to operational tactics. For this evaluation, at least two researchers separately read the articles' titles and abstracts. Based on the criteria assessment, each article was either included or excluded. In cases in which researchers' views on the abstract screening

differed, both researchers scanned the entire article for relevance. This time-consuming process resulted in excluding 544 journal articles that did not meet the inclusion criteria. The remaining 52 articles were considered for further analysis.

In this final stage, all 52 articles that met the inclusion criterion were downloaded and read in detail as a final analysis of the content. Each article's cited references were used as a secondary source of literature analysis. This led to the identification of 15 additional articles that were perceived to provide prominent contributions to the understanding of PSS business models and tactics. Thus, the systematic literature review was based on 67 articles, with a specific focus on implementing PSS business models and tactics. For the analysis of these articles, an open-coding content analysis technique was employed. While inductively reviewing the studies, it was also acknowledged that each study can contribute to several different headings. Thereafter, all headings were collected on a coding sheet, and categories were generated (Elo and Kynäs, 2008). Through open coding, the main themes were discussed in relation to operational tactical sets for different PSS business implementation models. In total, five tactical sets emerged from this review as clearly unique and widely influential.

Previous researchers have argued that doing a systematic review of literature can ensure that bias (i.e., systematic error) is limited, chance effects are reduced, and the legitimacy of data analysis is enhanced. All of these benefits lead to more reliable results that form the basis for drawing conclusions (Becheikh et al., 2006; Tranfield et al., 2003). The systematic literature review process places strong emphasis on the importance of ensuring a high level of validity and reliability. Therefore, to ensure that the analysis would remain objective, the literature review process and analysis protocol were discussed with researchers both within and outside the field. This approach enables an increased validity of the literature review by decreasing the risk of the file drawer effect, a bias among unpublished studies that may distort systematic reviews. To address concerns related to reliability, two steps were taken. First, four researchers participated in the present review to increase inter-rater reliability during the literature analysis (Seuring and Müller, 2008). Second, the researchers clearly and carefully explained each of the steps followed during the systematic literature review to increase the possibility of future replication.

Papers 2 to 5 have undergone continuous and iterative literature reviews regarding the specific focus areas of the papers. This was based on the main keywords of the papers, including risk management, agency theory, service networks, and alignment. The literature search was not limited to the field of PSS but included the research streams of servitization, service dominant logic, hybrid solutions, and functional products. The dominant journals in the field are *Journal of Cleaner Production*, *International Journal of Production Research*, *Journal of Manufacturing Technology Management*, *International Journal of Operations and Production Management*, and *Industrial Marketing Management*. Created article alerts from the dominant journals in the field and recommendations from colleagues, reviewers, and peers have been highly valuable for the detection of relevant literature for this thesis work.

3.4 Case Studies

3.4.1 Case Selection

This research builds on the outcomes from two VINNOVA-funded projects related to PSS that involved multiple large Swedish manufacturing companies at different stages of their PSS business development. Therefore, the companies involved in the case studies have been selected from the pool of project companies. This presents several advantages. First, the case companies have already committed to be part of the research project, which makes it less challenging to find suitable contact persons. Second, good contacts with the main responsible actors for the PSS business model development are already established, and the receptiveness for the topic is high in all companies. Finally, all companies are actively working with PSS development and have experience in that area, and thus less focus is needed on explaining the overall concept, and time can be used to only discuss relevant issues.

From the set of project partner companies, theoretical sampling was used to select the cases for each of the papers for this thesis (Eisenhardt and Graebner, 2007). The purpose of the paper provided the basis for the selection of relevant and suitable cases for the studied research area. In detail, for Case Study I (single case study), the case company was chosen because of its long experience with PSS provision and operations in global markets. In particular, the case company has directed significant attention to

risk management due to its global operations and the need to manage high diversity in customer requirements and value chain configurations. Furthermore, the company has undertaken significant steps to restructure the organization and processes to ensure successful PSS operations within global markets. Thus, the case company represents an appropriate case for the study.

For Case Study II (two case companies), the selection of these cases was motivated by several factors. First, both companies had reported experiences of facing the challenge of adverse customer behaviour. Second, both companies have adopted a way to monitor the usage of their products and could thus provide insights into the benefits and drawbacks of employing such systems in PSS relationships. Third, they have a wide range of customers that vary globally, especially in terms of relationship duration, which ranges from completely new customers to long-term, trusted partnerships. This also forces the company to apply different contract types to different customers. Finally, the strong, established contacts with these companies allowed us to go beyond overall company-level challenges to focus on the PSS agreement between the provider and the customer as the level of analysis. Focusing on agreements allows for deeper analysis of contract characteristics (e.g. types of equipment, monitoring capability, risk premium, and length of contract) and customer characteristics (e.g. cost sensitivity, length of relationship, and cultural difference).

For Case Study III (multiple case study), theoretical sampling was used to identify eight distributors of a construction equipment manufacturer (case company in Case Studies I and II), and we jointly agreed on the selected cases. The selection focused on distributors that were appropriate to study distributor-specific challenges and related strategies. Building on the categorization by Raddats and Kowalkowski (2014) of servitization types into enthusiasts, pragmatists, and doubters, we selected distributors based on their maturity in terms of offering advanced services. All selected distributors had initiated a servitization transformation but were at different stages of realizing this transformation. Furthermore, distributors from different global regions had been selected to capture regional variations as much as possible. Finally, both internal and independent distributors have been identified to analyze the effect of owner structure on servitization.

For Case Study IV (three case companies), three large global manufacturing companies from diverse industries have been selected that had recently introduced PSS into the marketplace. Manufacturers were selected from different industries with a distinct range of PSS offerings. Moreover, global companies have a greater need to adapt their business model, as they have diverse segments of global customers to whom they will offer PSS (Parida et al., 2015).

3.4.2 Data Collection

All four case studies have been mainly based on semi-structured interviews with key informants asking open-ended questions. For example, in Case Study I on risk management, we asked questions such as “Which are the main risks that could have an impact on you PSS offer?”, “Where to you see problems arising from the service delivery process?” or “What are you basing cost calculations on?” In some cases, the case companies also shared internal documents before the interviews that were used to help the researchers understand their operations before the interview to reduce time used for general explanations and increase the focus on the research-related questions. In every case study, an interview guide was developed around the main research questions and settings of the studies. However, departures from the specific questions in the interview guide were often made to explore interesting themes or illustrative cases uncovered during the interviews.

Almost all interviews have been done in person; only a few have been conducted via phone or Skype. Most commonly, several researchers joined the interviews, which significantly facilitated understanding and analysis of the cases. In total, all case studies together sum up to 107 interviews. The interviews lasted between 40 and 90 minutes, and interviews were recorded and transcribed as input for analysis together with the notes the researchers took during the interviews. Because the analysis had usually already started after the first interviews, the subsequent interviews built on the outcomes of the initial analysis and could therefore vary in structure.

The selection of informants was based on different criteria. For example, selected respondents had to be actively involved in the current service provision and development of their companies. In addition, the selected respondents had to belong to

various levels and units within the company structure and had to occupy a wide range of positions, such as product managers, sales managers, and regional managers. We thereby substantially reduced the bias in the data collection (Eisenhardt and Graebner, 2007). Respondents also varied in terms of age, years in employment, academic training, and position. During the interview, respondents were asked to recommend other potential respondents that could help us gather additional insights. Thus, our respondents were chosen in a sequential and purposeful manner, providing variety and nuances to our data collection (Strauss and Corbin, 1990). In addition to the interviews, our case study was triangulated with other sources of secondary data such as annual reports, project documents, and operational process descriptions and tools (e.g., value calculators). Thus, multiple methods of collecting data were used so that we could converge on the facts of our cases and achieve data triangulation (Yin, 2003). An overview of the case studies and data collection can be found in Table 1.

Table 1: Case Study Overview

Study	Main Purpose	Data collection	Paper
Case Study I – single case study <i>(Swedish construction equipment provider)</i>	To conceptualize and develop a PSS risk management decision support framework for PSS operation	Semi-structured and open-ended interviews <i>(25 interviews)</i>	Paper 2 – Risk Management for Product-Service Systems Operation
Case Study II – Multiple case study <i>(Swedish construction equipment provider, Press-hardened automobile parts manufacturer)</i>	To identify agency problems and propose mechanisms to mitigate adverse customer behavior in PSS provision	Semi-structured and open-ended interviews <i>(26 interviews)</i>	Paper 3 – Mitigating adverse customer behavior for product-service system provision: An agency theory perspective
Case Study III – multiple case study <i>(eight distributors for a global Swedish manufacturing company)</i>	To understand how diverse distributors manage servitization in their local markets	Semi-structured and open-ended interviews <i>(27 interviews)</i>	Paper 4 – Distributor servitization: Challenges, strategies, and consequences
Case Study IV – multiple case study <i>(three case companies – heavy machinery, telecommunications infrastructure, machine tools)</i>	To provide insights into how manufacturing companies can benefit from using the business model as an organizing device to align and coordinate key activities in PSS	Semi-structured and open-ended interviews <i>(29 interviews)</i>	Paper 5 – Activity alignment for product-service system business model implementation

3.4.3 Data Analysis

The data analysis for all four case studies was quite similar. The analysis usually started after the first four to six interviews by compiling the data, identifying patterns, and further investigation where more information was needed. The subsequent interviews built on the outcomes of the initial analysis and were reported back for validation and clarification.

The final data analysis was based on open coding content analysis. Headings (i.e., codes) were written into the transcriptions based on the terms and content they addressed (Elo and Kyngäs, 2008). The codes were combined into first-order categories, which described the experiences of the respondents in their own words. The first-order categories were analyzed for links and patterns and then grouped into theoretically distinct groups (second-order themes). Afterwards, aggregate themes or dimensions were identified (Braun & Clarke, 2006, Gioia et al., 2013; Nag et al., 2007). In practice, this meant we created lists of quotes and other examples related to providing PSS in our case companies, which were then analyzed thematically to help identify codes, themes, and dimensions.

The analysis of the data progressed through an iterative process until saturation of the constructs was reached (Braun and Clarke, 2006). A data structure diagram was developed for each case study that shows the overall data structure of first-order categories, second-order themes, and aggregate dimensions. Figure 1 shows the data structure from Case Study III as an example. Furthermore, several workshops were held with participants from the companies to validate and discuss the research results. The preliminary results of the studies were shared at the validation workshop, and the participants commented on and added to the findings.

3.4.4 Research Quality

The measures of reliability and validity are usually used to ensure quality in scientific research (Yin, 2003). However, for qualitative research, these terms are less appropriate, and aspects of trustworthiness (credibility, transferability, dependability, and

conformability) are proposed as better alternatives to evaluate research quality in qualitative research (Halldórsson and Aastrup, 2003; Lincoln and Guba, 1985).

Credibility refers to the acceptance that there is no single objective reality but that reality exists only in the minds of the respondents (Erlandson et al., 1993). Credibility is determined through the degree of match between the respondents' constructs and the researchers' representation of these (Halldórsson and Aastrup, 2003). Credibility was mainly pursued through triangulation of the data with other respondents, secondary data, and literature. This was done across multiple respondents to detect conceptual patterns that were similar in their essence (Glaser and Strauss, 1967). Furthermore, the feedback from the respondents at the workshops and presentation of initial results increased the credibility of the results.

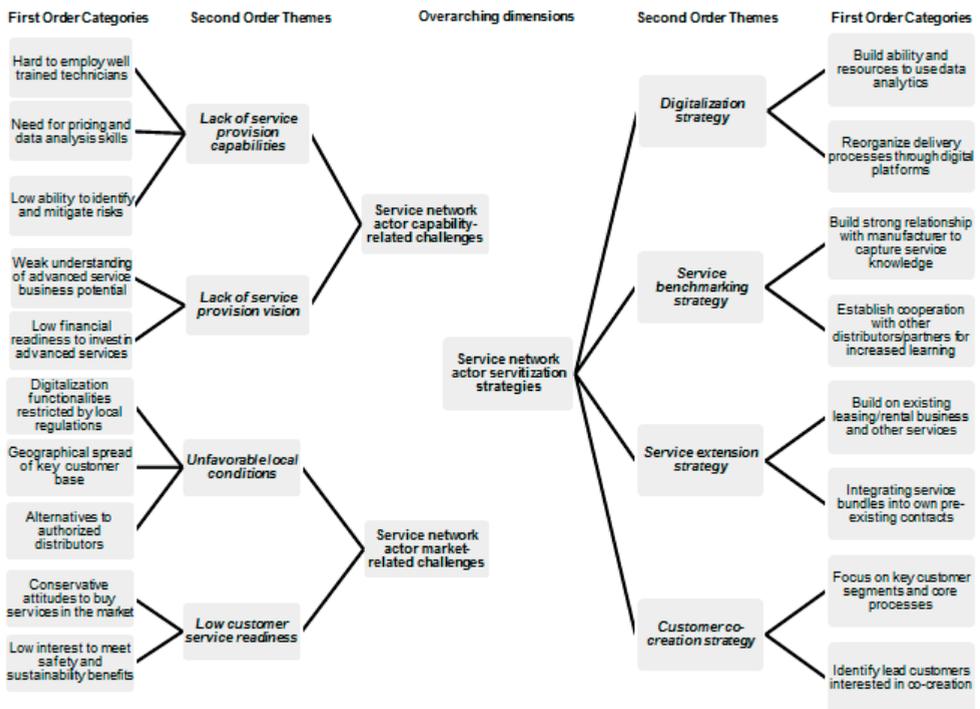


Figure 1: Data Structure Case Study III

Transferability describes the extent to which general claims can be made from the findings about the world (Halldórsson and Aastrup, 2003). Transferability was ensured

by providing a richness of details from all studies which have been discussed among the authors. Furthermore, interviews from multiple respondents from different companies have been conducted to increase the transferability of the studies.

Dependability concerns the stability of data over time, meaning the study and its results could be reconstructed (Halldórsson and Aastrup, 2003; Lincoln and Guba, 1985). Dependability is archived by documenting the logic of the process and the method decisions (Halldórsson and Aastrup, 2003). For this research, besides the detailed descriptions of the applied methods including the case selection, selection of the respondents, and data analysis, the complete records for each phase of the research process have been kept and could be accessed by other researchers.

Confirmability ensures that the findings present the results of the inquiry and not the researcher's biases. Realizing that complete objectivity is impossible in qualitative research, it is important to reduce the influence of personal values as much as possible. Conclusions, interpretations, and recommendations are to be traced back to their sources (Erlandson et al., 1993; Halldórsson and Aastrup, 2003). Therefore, multiple members of the research group jointly conducted interviews and have been involved in the analysis of the data. For example, coding schemes have first been developed independently by the researchers, and in the event of disagreements, they discussed and modified the coding scheme until consensus was reached.

4 Summary of Papers

This chapter summarizes the five appended papers. Together, the findings of the five papers contribute to fulfil the overall purpose of the thesis. The summaries shortly present the research gap and the resulting purpose of the paper. Furthermore, the applied research method and the key findings are presented.

4.1 Paper 1

Reim, W., Parida, V., & Örtqvist, D. (2015). Product-Service Systems (PSS) business models and tactics-a systematic literature review. *Journal of Cleaner Production*, 97, 61-75.

Integration of products and services is a growing trend among companies in today's globally competitive business environment (Mont, 2002). Research on this emerging phenomenon is discussed largely under the topic of Product-Service Systems (PSS) (Baines et al., 2007; Beuren et al., 2013). The rapid growth of the field, however, contributes to the problems associated with accumulating and systematizing research findings. Although recent studies have highlighted several potential benefits of PSS, insights into how companies can adopt and implement PSS business models are still very limited (Baines et al., 2007, Gaiardelli et al., 2013; Meier et al., 2010, Yoon et al., 2011). To address this shortcoming, the purpose of the present study is to undertake a systematic literature review that focuses on how PSS business models are implemented and their associated tactical practices.

In general, the literature suggests that a company's business model explains the design or architecture of the company's mechanisms to create, deliver, and capture value (Teece, 2010; Osterwalder and Pigneur, 2010). This means that every company either explicitly or implicitly employs a particular business model. This literature review focuses on different operation or implementation practices that companies employ in order to maximize value and revenue creation through each of the chosen PSS business models. These practices can be regarded as tactics or tactical sets, which are defined as the residual choices that can be adapted after choosing a business model or as the

business model is applied. Furthermore, the practices must fit the company's operations (Casadesus-Masanell and Ricart, 2010; Evans et al., 2007). Thus, a structured aggregation and understanding of tactics within the PSS literature can help companies successfully implement diverse PSS business models.

Based on an in-depth analysis of 67 articles, it was found that PSS is increasing rapidly as a research field, which is spread across a variety of disciplines and research domains. More specifically, research findings were accumulated from the field to present a framework supporting the implementation of well-established categories of PSS business models, that is, product-oriented, use-oriented, and result-oriented business models. Each business model category is linked to five operational-level tactics that ensure that the model can be implemented successfully and subsequently generate value. These tactical sets include 1) contracts, 2) marketing, 3) networks, 4) product and service design, and 5) sustainability operational practices.

4.2 Paper 2

Reim, W., Parida, V., & Sjödin, D. R. (2016). Risk management for product-service system operation. *International Journal of Operations & Production Management*, 36(6), 665-686.

Providing or operating PSS entails increased risks for manufacturing companies as they shift from pure transaction to relational engagements with customers, assume operational responsibilities for customers' processes, and engage in value co-creation (Nordin et al., 2011; Benedettini et al., 2015; Wallin et al., 2015). In particular, introducing the PSS business model intensifies interactions with the customer and thus increases the likelihood for conflicts, disagreements, and opportunistic behavior (Kindström, 2010; Richter et al., 2010). In the context of PSS operations, providers are exposed to new types of risks at a significantly higher level, which are not fully understood. Prior studies have mentioned increased risk frequently and have noted that companies' inability to manage risks is the central issue prohibiting the PSS transition (Azarenko et al., 2009; Meier et al., 2010; Richter and Steven, 2009). However, there is lack of clear understanding of what constitutes risks and how they can be managed.

Advancing the general understanding of PSS risk management requires matching different PSS operational risks to potential risk management responses. The ability to do so largely depends on identifying key decision-making criteria. None of the previous PSS studies have provided any clear contribution to such decision-making criteria (Lindström et al., 2013). We attempt to fill this theoretical gap by conceptualizing and developing a PSS risk management decision support framework for PSS operation. The paper is based on empirical insights from a single case study of a manufacturing company that is eager to offer complex PSS solutions but is faced with diverse PSS operational risks.

The paper classifies PSS operational risks into three categories: competence risks, technical risks, and behavioral risks. Furthermore, conditions under which each risk can be mitigated are explained using different risk management strategies (avoidance, reduction, sharing/transfer, and retention). Finally, the different risk categorizations, decision criteria, and risk responses are combined into an integrated decision framework of PSS risk management.

4.3 Paper 3

Reim, W., Sjödin, D. R., & Parida, V. (in press). Mitigating adverse customer behavior for product-service system provision: An agency theory perspective. *Industrial Marketing Management*.

Offering product-service systems (PSS) arguably results in economic, environmental, and social benefits but also entails significant challenges related to relational dynamics between the provider and the customer. Increased service content inherently leads to closer and more repetitive interactions with customers (Kowalkowski, 2010), whilst responsibility for product performance moves from the customer to the provider for more advanced PSS (Erkoyuncu et al., 2013). Thus, the logic of PSS offerings raises the likelihood of unintended and unpredictable customer behavior that affects the provider's operations, and the risk of adverse or opportunistic customer behavior increases (Ng et al., 2013; Sakao et al., 2013). Although prior studies suggest that adverse customer behavior during PSS provision is likely, they provide a limited theoretical

understanding of the conceptualization of such relational problems and, more importantly, offer few possible ways to address these problems.

Agency theory provides a relevant theoretical lens to study unintended or adverse behavior. This theoretical perspective is particularly applicable in the context of diverse relationship situations in which there is potential for asymmetric information and opportunistic behavior (Eisenhardt, 1989a). An agency relationship exists when a principal delegates a task to an agent who is performing that task (Jensen & Meckling, 1976). Thus, adverse customer behavior between provider and customer can be examined by adopting an agency theory perspective to explain how the provider (principal) can manage the risk of adverse behavior by the customer (agent). More importantly, applying the lens of agency theory to the study of PSS provision can provide novel insights into how the provider can reduce adverse customer behavior by applying the agency mechanisms that are best suited to PSS provision.

Based on this background, the purpose of this study is to identify agency problems and propose mechanisms to mitigate adverse customer behavior in PSS provision. Based on a multiple case study approach involving two manufacturing companies, several results are presented. First, two underlying reasons for adverse customer behavior are identified and described. These reasons are associated with goal differentiation and monitoring challenges. Second, different agency mechanisms (i.e. sharing, monitoring, and trust) are presented as approaches to mitigate the likelihood of adverse customer behavior. The matching of agency problems with agency mechanisms to mitigate these problems lays the groundwork for developing a framework for agency situation evaluation during the formation and ongoing phases of the PSS agreement. In addition, the choice of agency mechanism is found to be correlated with the maturity and type of customer relationship and can change over time as new customers become known and then become loyal.

4.4 Paper 4

Reim, W., Sjödin, D. R., & Parida, V. Servitization of service network actors – A contingency framework for matching challenges and strategies in servitization. (*Second round of review*).

As companies move toward the provision of PSS, they must increase efforts to manage co-creation of value with customers through support of their service networks that delivers services in local markets (Baines et al. 2009; Gebauer et al., 2013; Parida et al. 2014; Wallin et al., 2015). Thus, the success or failure of servitization efforts in different markets largely depends on the role of the service network partners such as distributors (Durugbo and Riedel, 2013; Parida et al., 2015). Thus, the service network actors are the local intermediaries that are responsible for customizing and delivering PSS offerings and co-creating value with local customers. Accordingly, a global provider's transition toward PSS provision is rarely possible without the support and corresponding transition of the service network actors. However, service network actor servitization creates numerous challenges, as it represents radical transition of the modus operandi for this local actor and requires large-scale changes in their operational processes (Gebauer et al., 2013; Story et al., 2017).

Despite the critical role of service networks, the PSS literature provides scarce insight into their transformation challenges. Existing literature has predominantly focused on aspects of the manufacturers' transition. However, the challenges that service network actors face differ from those that manufacturers encounter (Durugbo and Riedel, 2013; Hakanen et al., 2016). Indeed, a key challenge for service network actors is adapting manufacturing companies' PSS business model implementation efforts to local conditions. However, knowledge of such organizational and market challenges is limited, so this area needs further attention.

Based on the previous discussion, this paper provides distributor-specific servitization insights, which are largely missing from the PSS literature (Ulaga and Loveland, 2013, Rabetino et al., 2017). Accordingly, the purpose of the paper is to understand how diverse service network actors approach servitization under varying conditions. The paper presents an exploratory case study of multiple distributors of a global PSS

provider within the construction equipment industry. Empirical insights were gathered from eight distributors from different global regions such as Europe, South America, and the Middle East.

The analysis reveals that distributors face major internal and market-related challenges that hinder their servitization. This study identifies four unique strategies (service extension, service benchmarking, digitalization, customer co-creation) that distributors implement to meet these challenges. This study's primary contribution is presented through a contingency framework for the application of strategies to manage challenges in service network servitization.

4.5 Paper 5

Lenka, S., **Reim, W.**, Frishammar, J., & Parida, V. Activity alignment for product-service system business model implementation. (*Under review*).

Offering product-service systems (PSS) is inherently challenging. It implies that a supplier company needs to shift its focus from the design and sale of physical products toward providing functionalities and results by combining products and services (Adrodegari and Saccani, 2017; Barquet et al., 2013). Providing PSS implies that companies need to align the interests of its internal stakeholders (i.e., functions, departments) as well as external value chain actors to deliver functionalities or results. This can represent a major change in the mindset and operational setup of the entire value network (Baines et al., 2017; Ferreira et al., 2013). Within the business model perspective, describing the overall company's logic has been proposed to provide a better understanding of how to approach successful PSS provision (Boons et al., 2013; Kindström and Kowalkowski, 2014; Reim et al., 2015). The alignment of the components of a business model (value creation, delivery, and capture) is therefore crucial to achieve internal and external fit with the company's strategy of providing PSS (Adrodegari et al., 2017; Ferreira et al., 2013; Kindström, 2010). However, there is a gap in our understanding of the key activities that are needed for the implementation of a PSS business model and how its underlying constituents can be aligned to achieve

internal and external fit with the company's business strategy of how it creates, delivers, and captures value through PSS.

To address this gap, the purpose of the present study is to provide insights into how manufacturing companies can benefit from using the business model as an organizing device to align and coordinate key activities in PSS. The analysis is grounded in case studies of three global industrial manufacturing companies that offer PSS to their global customer base. A comprehensive framework of a PSS business model describes the activities that have been developed. The paper sheds light on what and how the underlying constituents of a business model need to be aligned such that the company can overcome the challenges and successfully implement a based business model. The paper showcases the need for horizontal alignment (i.e., aligning activities within business model components), as well as vertical alignment (i.e., aligning activities across business model components), which is necessary to ensure both internal as well as external fit of how it creates, delivers, and captures value through PSS. Finally, the development of a typology of alignment problems that companies encounter while undertaking activities for implementing PSS shows the need for business model activity alignment.

5 Towards a Business Model Implementation Framework

This chapter integrates the findings of the appended papers and uses them as inspiration for the development of a framework for the PSS business model implementation. The overall framework and the individual steps are explained in detail.

5.1 Framework Introduction

The purpose of this thesis is to advance the understanding of PSS business model implementation. Therefore, the developed PSS business model implementation framework (Figure 2) provides a stepwise approach for companies that make a strategic decision to increase the service extent of their operations. The framework is a result of a highly iterative process and inductive reasoning based on the findings in the appended papers. The papers did not result from the application of the framework; however, the evolvement of paper ideas and study design followed a similar logic as the framework in terms of sequences of analysis steps needed for PSS business model implementation. Thus, the relationships that are described in the framework are not that extensively explored in the single papers. The framework provides an initial suggestion of stepwise process for PSS business model implementation and how the elements are linked to each other. The framework does not claim that all possible aspects are included, but it makes a synthesis of the key aspects that have been studied across the appended papers.

The framework shows that, in the first phase of PSS business model implementation is the business model configuration. This phase includes the PSS business model selection, which defines how value will be generated with the PSS offer as well as the configuration of PSS business model tactics, which affects how much value is generated. Implementing a PSS business model is usually accompanied with an increased risk level at the provider company because the company takes on additional tasks and a higher responsibility for the performance of its products. Dependent on the chosen PSS business model and the applied tactics, the provider is exposed to different risks that, in the second phase of the PSS business model implementation framework, need to be identified and then managed. The third phase takes into consideration that most manufactures have to rely on service network actors to provide PSS to their

customers. PSS provision implies an intensified relation to the customers compared with a pure product sale, which therefore requires adjusting the delivery practice of the service network to the PSS offer. These service network actors are exposed to various challenges, and different strategies can be applied to overcome these challenges in order to successfully offer PSS. The three first phases show many different ongoing activities related to PSS business model implementation in terms of value creation (e.g., which business model and tactics to choose), value delivery (e.g., how to integrate the distributor network), and value capture (e.g., how to manage PSS risks). These activities are all critical, and their outcomes need to be optimized. However, to secure an overall positive result of the PSS, it is crucial that all activities are aligned with each other toward the common goal of successful PSS business model implementation.

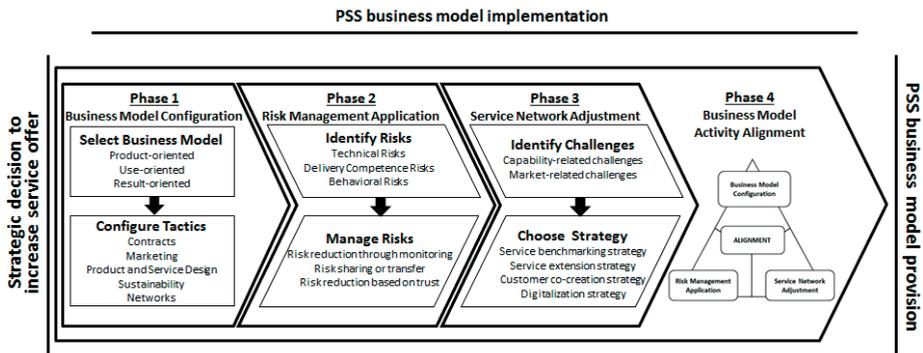


Figure 2: PSS business model implementation framework

5.2 Detailed Explanation of the Framework

5.2.1 Phase 1: Business Model Configuration

A strategic decision to increase the service extent of a manufacturing company usually entails the implementation of a PSS business model. Therefore, the first step in Phase 1 is to select the business model that should be implemented. There is a wide range of potential PSS business models; however, most PSS offers can be categorized into product-oriented, use-oriented, or result-oriented business models, which are the most prevalent types of PSS business models. These three categories are clearly different in terms of creating, delivering, and capturing value. For example, for a tool manufacturing company that intends to make a product-oriented offering (e.g., tool

optimization software), activities that surround creating, delivering, and capturing value will continue to be linked primarily to products but with an added service function. With a result-oriented offer (e.g., total care solution), in contrast, the PSS provider takes full responsibility for providing the promised results by intimately combining products and services. However, the selection of the business model depends to a large extent on the company's resources, capabilities, and customer needs. Therefore, it is common that manufacturing companies start with offering product-oriented PSS and then progressively develop more advanced use or result-oriented PSS offers.

While the first step is to select the right PSS business model, a business model is often discussed on an overall level and the components need to be operationalized further by applying specific tactics. Indeed, as identified by this research, scholars tend to discuss PSS business models and implications for implementation using five distinct sets of tactics that elucidate the competitive choices associated with each business model category. Tactics are defined as the company's residual choices at an operational level after deciding which business model to apply (Casadesus-Masanell and Ricart, 2010). As such, a company's business model will determine the range of tactics available to the company under that model, and this range will differ for each business model.

The five influential tactics identified for applying PSS are 1) contracts, 2) marketing, 3) networks, 4) product/service design, and 5) sustainability. The contract tactic addresses how the more advanced relationship between a provider and a customer is incorporated into a formal agreement that balances mutual interests. The marketing tactic communicates the PSS offer's value to customers, while also capturing customers' needs and requirements. Generally, a single company cannot independently create, deliver, and capture PSS value; this means emphasizing the role of the network tactic, where using relationships with external partners becomes central for implementing a PSS business model. The product and service design tactic relates to how a product's higher usability requirements can be handled most appropriately. Finally, the importance of capturing the full environmental and social value is combined in the sustainability tactics, which focuses on not missing this potential or even ending up with negative effects in sustainability.

The five tactics are equally important when considering implementing a PSS business model. However, because each company has a unique business model, these companies are likely to combine and deploy the five tactics in a customized way to maximize the outcome. A manufacturing company that offers a leasing solution would use tactics differently compared with a company that offers a machine availability solution because, for example, the requirements on the service network are much higher for the availability solution as well as the use of sensors, which are important to integrate in the product design.

5.2.2 Phase 2: Risk Management Application

The next phase in PSS business model implementation concerns risk management. Offering PSS implies that providers generally need to assume increased operational risks, which represents a key barrier against their full-scale PSS implementation (Erkoyuncu et al., 2013). Most important is that PSS risks go beyond the technical sphere, and attention needs to be directed toward risks arising from critical aspects such as customer behavior and deficiencies in internal routines. Therefore, the identification of PSS risks related to technical, behavioral, and delivery competence represents a major step toward establishing effective risk management in the context of PSS. Technical risks include all unexpected technical problems together with an information-based aspect; thus, it is important to obtain accurate and reliable information at the right time, e.g., for a PSS business model that promises a certain availability of the machine. Behavioral risks occur when customers behave less carefully if they do not own or are not responsible for the equipment. Adverse selection and opportunistic customer behavior are also aspects that can be categorized as behavioral risks. Delivery competence risk concerns several aspects that will result in not delivering the promised PSS offer. Reasons can be inappropriate organizational structures, lack of resources, or complex supply chains resulting from the PSS implementation.

After identifying the PSS risks, the next step is to manage these risks. Based on risk management theory, four main risk response strategies can be identified: risk avoidance, risk reduction, risk sharing/transfer, and risk retention. Avoiding all the risks related to PSS is almost impossible and would more or less lead to not implementing PSS when

the risks cannot be handled in a different way. With the help of customer segmentation, however, it is possible to filter customers who are not appropriate for PSS offerings. Still, technical or behavioral risks could possibly be avoided when a company does not have any responsibility for the current condition of the machine.

Usually a lot of effort during PSS business model implementation is devoted to reducing risks, but it is important to consider that the costs for reduction should not be higher than the savings. Risk reduction can be accomplished with the help of information and communication technology (ICT) (e.g., sensors or telematics systems) by collecting all the data necessary to monitor and organize the PSS. In addition, increased resource levels can significantly reduce PSS risks, which, however, would increase the costs significantly.

PSS risks can also be managed by either establishing risk and revenue sharing agreements with the customer or by transferring the risk to an insurance company. Sharing agreements creates incentives for both parties to perform as per agreement, and they both equally gain from successfully complying with the agreement. Transferring the risks to an insurance company implies that all of the risks and the higher costs that are accrued when unexpected events occur can be transferred to special insurance companies.

Risk retention in PSS can be archived either through risk pricing or through customer segmentation. Risk retention may be the most convenient solution for the customers if they are willing to pay a certain risk premium to make it possible for the provider to take all of the risks. Calculating the price needs to consider many aspects and can become difficult, especially before the PSS business model is implemented. Another problem is that the provider company has unlimited risks, and if those are too drastic, risk retention may not be the most favorable strategy, and risk retention may only be feasible in certain cases.

For successful risk management, the choice of the appropriate risk response (or set of risk responses) depends on the identified risks for the PSS business model. The risk management decision needs to be based on decision criteria that are associated with the

risk categories to ensure that all risks are taken into account in the selection of the appropriate risk response. Depending on the importance of different risks (e.g., behavioral, technical), certain risk management strategies may be used more widely. In particular, the combination of risk retention and risk reduction should be considered because the more the risks can be reduced, the fewer risks the company must assume. The selection and implementation of a risk response strategy requires considering the costs that are caused by the risk reduction efforts.

5.2.3 Phase 3: Service Network Adjustment

Implementing PSS not only increases the providers' risks, it also results in major changes of the delivery practices, especially of the service network actors because they are usually those who carry out the PSS agreements. When, for example, a distributor's role is limited to the sale of the product, operations are homogeneous, and distributors vary only by size. In contrast, when distributors are supposed to increase the service side of their operations, diversity among global distributors and service providers is vast, and the prerequisites for successful PSS provision differ greatly. Therefore, in Phase 3 of the PSS business model implementation, it is crucial for the manufacturing company, in a first step, to understand the different challenges that hinder service network actors' implementation of PSS business models. In the second step, certain strategies are proposed that can support the service network to cope with challenges and strategically address the adjustment of the delivery practice of the service network to the implemented PSS offer of the manufacturing company.

As indicated by this research, there are two main types of challenges related to the implementation of PSS business models in service networks: service network capability challenges and service network market-related challenges. A typical example of service network capability challenges is the lack of service provision capabilities, including difficulties to employ well-trained technicians and lack of skills to perform price and data analysis that PSS requires. Another example comes rather from the strategic level when PSS is not prioritized. This lack of a service provision vision becomes obvious when distributors have a weak understanding of the PSS potential or a low financial readiness to invest in PSS. An example of service network market-related challenges is

unfavorable local conditions, which include digitalization functionalities that can be restricted by local regulations, i.e., the key customer base can be geographically spread out or there are many alternatives to the authorized distributors available. Another market-related challenge is a low customer service readiness, which can result from conservative attitudes to buy services in the market or low interest to meet safety and sustainability benefits. In conclusion, every service network actor faces specific challenges that vary significantly in terms of how they constrain the PSS business model implementation. The manufacturing company needs to be aware of the individual challenges of its service network to initiate required adjustments that can cope with the challenges.

To handle the challenges, the manufacturer, together with service network actor, can choose among four different strategies: digitalization, service benchmarking, service extension, and customer co-creation. The digitalization strategy is important for building the ability and necessary resources to use data analytics as well as to reorganize delivery processes through digital platforms. Because PSS provision is new to the distributors, the service benchmarking strategy builds on the need to acquire the relevant knowledge for successful service provision and includes building a strong relationship with the manufacturer to capture service knowledge and the cooperation with other distributors/partners. There is also potential for partnerships with third parties, which allows distributors access to new competencies. For the service extension strategy, the distributor can build on existing leasing/rental business and other services as well as integrate service bundles into preexisting contracts. This approach shows also that providing the most advanced services is most beneficial when looking beyond the manufacturers' service templates and creating customized offers. Customers play an important role in the successful PSS provision, and this is taken into account in the customer co-creation strategy. Customers need to see clear benefits before they are willing to engage in a PSS contract. A focus on key customer segments and core processes, for example, makes it much easier to convince customers of the benefits of taking responsibility for product availability. The other part of the customer co-creation strategy is to identify lead customers who are interested in co-creation. It is important to be aware of the services that the customers demand, the services that would benefit

them, and the services they are willing to develop and pay for. Therefore, customers are important drivers of PSS implementation and provide an extremely valuable resource in this process.

Not all strategies need to be utilized to the same extent in all service networks. Certain strategies are better to match certain challenges. For example, the digitalization strategy has considerable potential to address a lack of service provision capabilities and issues that relate to unfavorable local conditions. Most distributors have invested in new IT-related skills. Furthermore, the service benchmarking strategy supports an improved service provision vision. Success stories, as well as promotion and training by the manufacturer or other distributors, usually convince the distributor to prioritize advanced services. The analysis of matches between challenges and strategies indicates that no single best solution can be adopted to meet all challenges. Instead, a contingent decision about the best strategies has to be taken based on the most dominant challenges.

5.2.4 Phase 4: Business Model Activity Alignment

To implement a PSS business model, changes have to be made in many different areas. Most of these new activities relate to one of the business model aspects (value creation, value delivery, and value capture). If these activities are performed in isolation without taking other ongoing activities into account, there is a high chance that the overall value generation will not be maximized. Therefore, in Phase 4 of the framework, the alignment of all activities, relating to PSS provision, needs to be ensured. Examples of these activities are improved resource utilization, development of service networks, and managing risks.

All activities have to be performed toward a common goal and in relation to each other in order to maximize the overall generated value and not only the value of all the individual activities. However, this is challenging, and, even when all the activities necessary for successfully implementing a PSS business model are undertaken, it is common that companies are still unable to accrue the benefits. There is a need to align the activities both within and between each business model component because excelling in individual activities or business model components appeared insufficient in

providing PSS effectively. These two types of alignment are necessary for achieving internal and external fit with the company's strategy of how it creates, delivers, and captures value through PSS. Misalignment of the activities is mainly caused by three types of alignment problems that can affect both horizontal and vertical alignment. These alignment problems tend to emerge when the activities across business model components or an individual business model component were either disregarded, deficient, or disconnected from the others.

In conclusion, after going through the phases of the PSS business model implementation framework the company should be well-prepared to provide the developed PSS business model. The alignment of all activities is crucial to achieve the benefits of a PSS offer. Positive outcomes resulting from the framework application could be increased revenue share coming from service because the PSS business model has been designed with focus on the customer value. Furthermore, the PSS business model could be offered to a larger share of customers because the PSS-related risks are well understood and managed for the specific customer segment. Similarly, through the adjustment of the service network PSS business models can be offered in more markets. Thus, aligning all activities related to PSS business model implementation creates an effective PSS offer in which the combination of products and services provides a much higher value than standalone products or services.

6 Discussion

This chapter presents the main theoretical contribution of this thesis as well as its managerial implications. To conclude, suggestions for future research are described.

6.1 Theoretical Contribution

The purpose of this thesis is to advance the understanding of the implementation of PSS business models. Understanding the phases of the PSS business model implementation process is crucial, as challenges during implementation are a main hinderance to realize the high potential of PSS offers (Barquet et al., 2013; Ceschin, 2013; Catulli et al., 2017). Indeed, prior literature has been overly focused on understanding components of the PSS business model; however, research suggesting concrete implementation practices have been lacking (Adrodegari et al., 2017; Kowalkowski et al., 2017). To this end, the appended papers address various important phases of PSS business model implementation. These insights are further highlighted in Chapter 5 of this thesis to develop a stepwise implementation framework that provides detailed guidance to successful PSS implementation.

This thesis mainly contributes to the emerging PSS literature. The importance of PSS business model development and PSS implementation is frequently discussed in the literature (Adrodegari et al., 2017; Meier et al., 2010). This thesis provides new theoretical insights to further develop multiple aspects of PSS implementation and to facilitate successful PSS provision. By also applying classical theories such as agency theory, this thesis contributes to the increased legitimacy of the PSS research field, which still mainly builds on argumentation from previous PSS-related research, lacking a strong theoretical foundation (Rabetino et al., 2018). In the following section, specific contributions relating to four overarching themes are discussed.

6.1.1 PSS Business Models and Tactics

Most companies are challenged to offer PSS because of their internal inability to design and implement PSS business models successfully. One reason is that knowledge and

experience regarding the PSS business models are still limited (Beuren et al., 2013). Although, prior literature provides well-defined categories of PSS business models, we lack insight related to operational tactics associated with each PSS business model.

PSS offers are often categorized into the product-oriented, use-oriented, and result-oriented business models, as these continue to be the most prevalent types of PSS business models (Baines et al., 2007; Tukker, 2004). Although prior studies have addressed how to implement a specific PSS offering, they tend to avoid linking the discussion to more than one of these PSS business model categories. The three categories adopted in this thesis are clearly different in terms of creating, delivering, and capturing value dimensions. Ultimately, by highlighting the similarities and differences of the three business models, the conceptual understanding of these models for PSS researchers is extended (Tukker, 2004).

More importantly, the major contribution lies in advancing our understanding of PSS operational tactics, which related articles frequently recognize and discuss as being central for business models and PSS literature (Casadesus-Masanell and Ricart, 2010; Evans et al., 2007). This thesis proposes five tactical sets that elucidate the competitive choices associated with each business model category. By unravelling the role of identified tactics in relation to PSS business models, a novel relationship is established between PSS business models and tactics; indeed, this has not been widely discussed previously in the PSS literature. The five influential tactics identified for applying PSS are 1) contracts, 2) marketing, 3) networks, 4) product/service design, and 5) sustainability. It is argued that the five tactics are equally important when considering operational tactics to implement a PSS business model. However, because each company has a unique business model, it is likely to combine and deploy the five operational tactics in a customized way to maximize outcomes. The relationship between PSS business models and tactics can be influenced by internal and external organizational conditions.

6.1.2 PSS Risk Management

Both in theory and practice, risk is frequently mentioned and is a major reason why companies shy away from high-level PSS business model implementation (Meier et al., 2010; Richter and Steven, 2009). Identifying the possible risks and finding the right risk response are crucial for the implementation of PSS business models, as it increases confidence and control in regard to the new PSS offer. This thesis contributes with the categorization of risks into technical, behavioral, and delivery competence risks that structures the fragmented discussion of risks in the literature (Steven, 2012). This is especially important because providers generally need to assume increased operational risks when providing PSS, which represents a key barrier toward their full-scale PSS business model implementation (Erkoyuncu et al., 2013). More important, the categorization of risks beyond the technical sphere directs attention toward risks arising from critical aspects such as customer behavior and deficiencies in internal routines, which have received scarce attention in the present literature (Erkoyuncu et al., 2011; Meier et al., 2010).

Furthermore, risk management strategies for PSS operation are proposed. Specifically, four generic risk responses (risk avoidance, risk reduction, risk sharing/transfer, and risk retention) have been adapted to the PSS context, as these are commonly discussed in the risk management literature (e.g., Dorfman, 1998; Rejda, 2008). The thesis proposes new insights into how different risk responses are used to manage each of the three PSS operational risk categories. In doing so, insights into how elements inherent in PSS business model implementation can be recombined to reduce risks are provided. However, an increased level of risk can actually be rewarding for the provider. But such PSS offers largely require advanced understanding of the trade-off discussion by identifying, comparing, and analyzing costs and benefits of specific PSS provision strategies. In this context, certain risk responses were found to be more favorable and fitting to PSS operational success. For example, risk sharing or transfer is often associated with PSS (Azarenko et al., 2009; Caldwell and Settle, 2011).

An important contribution to PSS risk management is to identify and explain the key decision criteria that provide guidance to selecting an appropriate risk response.

Although much of the previous PSS literature has highlighted the importance of risk management, the existing knowledge about how such decisions can be made remains limited (Baines and Lightfoot, 2013; Dimache and Roche, 2013; Durugbo, 2013). To choose the right risk management strategy, decision-making criteria have been identified. The more a criterion leads to a predictable situation, in which the cost of the risks can be calculated by the provider, the more appropriate a strategy based on risk retention becomes. In contrast, in unknown or turbulent or varying settings, it may be most suitable to avoid offering PSS or at least to share the risks. Identifying the criteria shows and motivates which factors affect PSS offerings and also highlights the areas in which further consideration in relation to PSS operations is needed. Thus, it is added to the ongoing discussion on the contingency aspects of PSS (Kohtamäki et al., 2013), underlining in which situations offering PSS is advantageous in order to advance financial performance.

6.1.3 Managing Behavioral Risks Using Agency Theory

The behavioral risk needs special attention as it creates different principal-agent problems that are relevant, from the provider's perspective, in providing PSS agreements. By using the lens of agency theory, two dimensions of agency problems are categorized (i.e., different goals and difficulties in monitoring) (Jensen and Meckling, 1976), which enable a novel yet structured way of analyzing possible sources of adverse behavior in PSS (Hypko et al., 2010; Kuo, 2011; Ng et al., 2013). Drawing on agency theory, it is also shown in this research that combining the trust mechanism with the classic agency mechanisms of behavioral- and outcome-based contracts significantly improves the understanding of the various mechanisms that can be used to, for example, mitigate adverse behavior.

In addition, risks may change over time; therefore, for example, the agency situation has to be evaluated during the formation of the PSS agreement and continuously whilst the agreement is ongoing. Deciding which mechanism is most appropriate for a certain agreement with a certain customer is complex and depends heavily on the maturity of the provider–customer relationship as well as on the type of customer. This complexity exists primarily because the agency situation is dynamic and changes as the customer–

provider relationship develops. Even though the development of a relationship over time when providing PSS has been considered together with the importance of trust (Kindström, 2010; Sundin et al., 2010), scarce attention has been devoted to the influence of the customer relationship on the use of mechanisms to manage adverse customer behavior. Particularly, a holistic view of the total lifetime of PSS agreements has been lacking. This view is crucial because adverse customer behavior can emerge during all phases of the agreement period. Through continuous evaluation of the agency situation, it is possible to align the goals of the provider-customer relationship at all times. Overall, applying agency theory to mitigate adverse behavior in PSS contributes to increasing the theoretical foundation of the PSS research field, which is needed for the credibility of the field (Kowalkowski et al., 2017).

6.1.4 PSS Service Networks

Most studies have primarily focused on presenting manufacturing-centric views on how to implement PSS business models, while largely overlooking the crucial role of service networks (e.g., distributors) as the intermediaries that facilitate PSS provision between manufacturers and global customers (Barquet et al., 2013; Parida et al., 2015). Placing distributors at the center of analysis provides a unique vantage point toward better understanding of how manufacturers' efforts to provide PSS are incomplete unless they are aligned with similar efforts by distributors (Hakanen et al., 2017; Kowalkowski et al., 2011; Kucza and Gebauer, 2011; Zarpelon-Neto et al., 2015).

This thesis contributes by identifying and conceptualizing the challenges that distributors face when attempting to offer advanced services. These challenges differ vastly from those that large manufacturers face during PSS business model implementation (Parida et al., 2014; Zarpelon Neto et al., 2015). Empirical analysis reveals challenges related to the distributor's capability to offer advanced services. These internal challenges include a lack of service provision capabilities and a lack of service provision vision, which directly affect the readiness and willingness of the distributor to actively provide advanced services. The empirical analysis also reveals market-related challenges that distributors face regarding service provision. Such challenges emerge outside the organizational boundaries, which mean that distributors have limited control over managing their negative effects. The mapping of PSS service

network challenges provides a rational understanding of why manufacturing companies' efforts to offer advanced services to global customers fail or face high resistance from service networks.

Another contribution is the identification of four servitization strategies (digitalization, service benchmarking, service extension, and customer co-creation strategy) that can cope with specific or combinations of challenges. Previous literature acknowledges that, due to market heterogeneity, the need for developing customized strategic responses is critical (Ulaga and Loveland, 2013; Zarpelon Neto et al., 2015). Still, we know little about which approaches are relevant and under which conditions. Identifying and decoding these distributor strategies provide evidence of how practically service network actors manage heterogeneity to achieve PSS business model implementation.

Furthermore, empirical evidence is provided for the effectiveness of the proposed strategies in addressing distributor-specific challenges. Through cross-case analysis, support for matching strategies with challenges is advocated. For example, the digitalization strategy is appropriate to improve a lack of service provision capabilities and to overcome unfavorable local characteristics such as physical distance. In contrast, the service benchmarking strategy is promising when the distributor lacks a service provision vision and willingness to provide advanced services and needs stimulation from other actors. There is a clear underlying contingency of which challenges need to be addressed through which strategy, and even the outcome of successful distributor PSS business model implementation can be quite different for heterogeneous distributors. This finding shows the importance of analyzing each distributor's unique conditions and needs to develop an individually adapted distributor strategy.

6.1.5 PSS Business Model Activity Alignment

PSS business model implementation from an activity-based perspective has been largely lacking within the PSS business model (Kowalkowski et al., 2017). Also, how companies can align toward a common goal of PSS business model implementation represents a major challenge (Adrodegari and Saccani, 2017; Baines et al., 2016). This thesis contributes to the literature first by empirically describing an activity-based business model framework and provides specific activity guidelines for companies to adopt in PSS provision. As such, our understanding is extended in terms of using the

business model concept as an organizing device in the context of initiating activities that are unique and necessary for successfully providing PSS (Boehm and Thomas, 2013; Vezzoli et al., 2014).

In addition, an alignment model that proposes the two types of alignment that are necessary to successfully implement a PSS business model is developed. It showcases how both types of alignment, i.e., horizontal (of activities within business model components) and vertical (of activities across business model components), are necessary for successful implementation and, by extension, to the company's performance in provision of PSS. This model provides novel insight to showcase how alignment of activities can actually be achieved while implementing a PSS business model. Such conceptualization of alignment has not been discussed in the literature and further develops our understanding of how to implement PSS business models.

6.2 Managerial Implications

This thesis has several implications for managers in manufacturing companies that are responsible for PSS implementation and strategy development. In particular, the findings should be beneficial for strategic and operational managers at the PSS provider company as well as for the actors in its service network.

First, the implementation of PSS is crucial for the overall generated value economically, socially, and environmentally. Implementing PSS is challenging and complex, and it requires activities in many areas to make use of the full potential of PSS. This study helps managers to make better decisions and takes them stepwise through the implementation of PSS. The first step is to choose the most appropriate PSS type (product-oriented, use-oriented, and result-oriented) and, based on this, make the residual tactical choices to maximize the generated value from PSS. Guidance to conscious choices regarding contracts, networks, product and service design, marketing, and sustainability goes much deeper into the underlying activities that are affected by PSS implementation.

Second, for managers responsible for developing and operating PSS offerings, it is especially important to realize that risk management is a vital activity that extends beyond technical risks that lead to breakdowns of the product to also include risks

related to customer behavior and insufficient competence at the providers' end (e.g., service network). In certain instances, the risks of offering PSS can be so significant that the only sensible action is to avoid the risks by not offering PSS at all. In most cases, however, it will be possible to handle the risks effectively by applying selected risk management strategies. To guide the choice of the right risk response, the identified six criteria were combined in a decision support framework. This will help decision makers critically evaluate their risk management strategies. The results also emphasize the importance of making a separate decision for each specific relationship and agreement and of re-evaluating this decision over time. Furthermore, failure to actively manage risks in PSS could create resistance in a company to use potential PSS offers. This would create negative environmental impacts, as sustainable PSS agreements significantly contribute to higher resource utilization.

Third, this study has managerial implications not only for senior management within manufacturing companies but also for the service network. Any manager who is responsible for developing advanced service offers within a distributor must identify the unique challenges that the distributor faces. Each distributor must address different internal conditions and market-specific local conditions that translate into individual barriers to PSS business model implementation. The proposed set of strategic approaches creates opportunities to cope with challenges and learn how other distributors have used certain strategies to become successful providers of advanced services. However, each distributor must develop its own distributor strategy. This strategy will be determined by matching challenges with strategic approaches. Combining the digitalization strategy, in particular, with the other strategies can lead to major advances in PSS business model implementation. Managers who are responsible for developing advanced service offers at the manufacturer must appreciate that every distributor is unique. This heterogeneity in the distribution network means that PSS business model implementation must be aligned with the maturity and readiness of the distributors. Crucially, the most advanced distributors are a highly valuable resource in the development of advanced service offers. The manufacturer must build on its experience to help other distributors transition toward advanced service provision. Overall, this insight will substantially improve the manufacturer–distributor relationship

because it provides a better understanding of the need for an individual PSS strategy for each distributor.

Finally, practicing managers can take inspiration from this thesis regarding how the business model concept can be used as an organizing device to effectively provide PSS in their companies. The activity-based business model framework could also be used as a guiding and evaluation tool for the ongoing PSS implementation process within the company. This could help a company's decision-makers implement activities that can help effectively coordinate and integrate processes across business functions both within companies and with external actors. Operational managers can use the present study when implementing specific activities that can facilitate a company's overall provision of PSS. Such activities can range from identifying particular activities to implementing activities, keeping in mind how they contribute to a particular dimension of the company's value creation, delivery, and capture. Finally, the alignment problems identified in the study could serve as a guide for managers to identify similar challenges they face in providing PSS and take necessary remedial steps during the provision of PSS.

6.3 Limitations and Suggestions for Future Research

Although the results provide several contributions to the emerging PSS literature, the present study has certain limitations that should be considered when interpreting the results. Accordingly, the limitations provide a starting point for future research. First, this thesis was mainly based on large, global manufacturing companies. The results could be different in other settings such as with small local actors or different industries. For example, industries that are based on natural resources might have totally different opportunities to include services into their portfolio to increase overall value generation and differentiate themselves from competitors. Future research should determine whether these findings hold under other conditions and then further develop them to increase the generalizability for other settings.

Second, most studies, including this thesis, are mainly based on case studies describing PSS as a phenomenon. However, much knowledge has been developed and related to the need for more theory building; PSS needs more quantitative studies to empirically

examine different business models and, for example, test their influence on company performance and growth.

Third, this thesis develops a PSS business model implementation framework starting from choosing a business model and, along with several steps, to finally offer a particular business model. However, the process stopped when the PSS business model is implemented and therefore does not include any conclusions on how successful the PSS business model was. Future research is needed to evaluate whether the implemented business model actually is the right or best one. Certain types of measurements or comparisons need to be developed into an evaluation tool of PSS considering a holistic value approach with the triple bottom-line. The research stream on the circular economy could be useful to build on for this evaluation because of the focus on benefits from the circular design of the system.

Fourth, PSS claims to contribute to the triple bottom-line of generating economic, social, and environmental value. However, research, including this thesis, and companies usually are most focused on capturing as much economic value as possible while threatening social and environmental benefits as something that happens automatically. Future research is needed to show the social and environmental consequences more explicitly, which probably would require long-term studies, as this effect takes time to become visible as a societal change.

Fifth, most of the PSS business models implemented rely on some type of digital technology as an enabler or the main value driver. However, the possibilities of digitalization seem unlimited, and there are a lot of upcoming technologies that need to be utilized within PSS. For example, the application of digital platforms for ensuring front-end customization and back-end efficiency in PSS provision is a highly relevant research domain in which further research is needed. Future research should drive this development forward and build the foundation to make digitalization happen with all its potential.

Finally, commonly the implementation of a business model is simplified, and only one single business model is considered. But, most commonly, companies employ several business models at the same time and even two or more PSS business models in

parallel. To further increase complexity, PSS business models are often network business models that combine the business models of several actors into a common network. Future research should take a more detailed look into this complexity.

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