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Challenges and Success Factors in Digital Servitization

Towards a Framework for Servitization Success

Master's thesis in Industrial Ecology

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ABSTRACT

In recent decades, it has become increasingly attractive to firms to implement a service logic into their offerings in a process called servitization: a transformation process that manufacturers undergo when shifting from being a product provider to becoming a provider of outcome-based services. Servitization can benefit the company as well as the environment, as it fosters great potential for circular innovation by shifting corporate incentives towards product longevity. However, many firms struggle to successfully pursue service innovations. With the onset of digital technologies, servitization has become more promising, but also more complex. Much like traditional servitization, firms struggle to implement digital servitization (DS) successfully. However, due to the novelty of the field, there is only limited evidence on the factors that lead to the success or failure of DS transformations. This paper collects the available evidence in a systematic literature analysis of empirical case studies documenting DS processes with the primary purpose of building a conceptual framework of the factors that contribute to successful DS. This, in turn, contributes to smaller aims: firstly, to understand which factors are broadly agreed upon and which ones are still contentious; secondly, to suggest directions for further research based on those themes that are still contentious or underanalysed; and thirdly, to understand which success factors for service-based circular business models may contribute to servitization success and vice versa. Based on the analysis, the thesis finds that DS success hinges on a value network consisting of the servitizing firm, its customer and supplier, and several other new partners. The relation between these actors is close and mediated by digital technologies as the actors share knowledge, competences, and information among each other. Notably, though, extant literature makes little to no claims on how circular economy questions are considered in the DS offering's development, suggesting that this is not yet a salient concern among servitizing firms. Based on this analysis, the thesis suggests further research into the topics of DS paradoxes; customer relations for DS; the structure of the value network; business models for DS; digital servitization in the circular economy; and risk management for DS.

Keywords: Digital Servitization, Case Research, Systematic Literature Review

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1. Introduction

As markets deregulate, margins for products decrease, and customer demands shift, it becomes increasingly attractive for firms to incorporate services into their business model. This idea, termed servitization within academic literature, was introduced by Vandermerwe & Rada (1988) and has grown in relevance ever since (Tukker, 2015). Especially as digital technologies rapidly grow more sophisticated, offering services becomes accessible and attractive to more companies. In fact, digital technologies have become so relevant to servitization that a wholly new concept has emerged: digital servitization (DS) (Favoretto et al., 2022). Many authors advocate for (digital) servitization, as it has numerous advantages over traditional manufacturing business models. For instance, it provides companies with a more stable revenue stream that offers a more suitable response to customer demands (Oliva & Kallenberg, 2003). Benefits extend beyond firm-level competitive advantages, as servitization is also perceived as a key step towards dematerialized consumption in a circular economy (Kuhl, Tjahjono, Bourlakis & Aktas, 2018). DS specifically is a major facilitator of circularity, since it allows firms to improve variables such as product longevity by monitoring product usage and identifying needs for preventative maintenance (Kuhl et al., 2018).

Despite these theoretical benefits, many firms fail to find success through DS. While they invest great sums into their service branch, they may not see proportional financial returns, in a phenomenon termed the ‘service paradox’ (Dimitrijeva et al., 2021). Some firms may therefore even choose to abandon services in a process called deservitization (Valtakoski, 2017). On top of that, servitized business models often do not live up to their sustainability potential, as the servitized business models that are most commercially viable generate marginal sustainability benefits at best (Tukker, 2004). Improving this may prove difficult, as there is little interaction between scholars studying servitization from a business perspective and those studying servitization from an environmental perspective (Kuhl et al., 2018). As such, several authors point out that the desirable implementation of (sustainable) DS remains under-analyzed (e.g. Tukker, 2015; Favoretto et al., 2022). For instance, matters such as DS business models, organizational design for DS, digital capabilities for DS and involvement of ecosystem actors still require further research (Favoretto et al., 2022). These gaps need to be bridged to further our understanding of DS, and with that ensure sustainable DS success. Therefore, the purpose of this thesis is to map which challenges and success factors can hinder or support a manufacturing firm’s digital servitization trajectory. In pursuing this purpose, the thesis distinguishes factors that are common in the literature from those that are still contentious to provide directions for future research. Finally, the study aims to understand how commercial success factors interact with servitization’s sustainability potential, to initiate a bridging effort between these two domains.

To reach these goals, the study uses a systematic literature analysis of scientific articles that present empirical case studies on digital servitization trajectories. It specifically focuses on case studies, as most extant empirical research on servitization success is based on such small-sample case studies, with few studies exploring emerging trends between studies (Tukker, 2015). As such, this study’s contribution lies in collecting these small-sample case studies and synthesizing their content to create a holistic idea of DS’s challenges and success factors. Based on this analysis, the study creates a framework for DS success that reflects our current knowledge on the topic.

The remainder of this text is structured as follows: in chapter 2, the paper defines servitization, documenting how prior literature conceptualizes the transformation to services. Chapter 3 explains the study’s methodology and chapter 4 outlines the results. Finally, chapter 0 develops

the results into a framework of DS success and relates these results to the circular economy. This section also makes suggestions for future research based on remaining questions that were discovered in the literature.

2. What is servitization?

Servitization can be defined as a “transformation process manufacturers undergo when shifting from being a product provider to becoming a provider of outcome-based services” (Dmitrijeva, Schroeder, Bigdeli & Baines, 2022, p.142). It is often associated with business model innovations, as the need to monetize service offerings requires the firm to vastly reconsider how it offers value to its customers. This is especially true if these services were previously offered for free (Foss & Saebi, 2017). As such, conceptualizing servitization necessitates an understanding of organizational transformation both in terms of the firm’s structure and its business model.

This chapter aims to build such a theoretical understanding of the servitization process: to achieve this, it starts by defining products and services and placing them in relation to each other in section 2a. Then, section 2b conceptualizes the process of servitization itself, asking why a company would choose to shift its focus to include services; how servitization manifests in a firm; and how a successful servitization process is likely to develop. Section 2c asks which factors may cause a servitization process to yield unfavorable outcomes. Lastly, sections 2d **The role of data in servitized business models** and 2e more thoroughly consider digital servitization and the role of servitization within the circular economy.

a. Defining products and services

Distinguishing between a goods-centered view and a service-centered view, Vargo & Lusch (2004) describe the goods-centered view as one where the primary purpose of economic activity is to make and distribute things that can be sold. To be sold, these items must be embedded with utility and value already during the production and distribution processes. As such, all the firm’s commercial decisions revolve around maximizing the output value of the product, to compete with the value embedded in competitors’ products. To optimize this, the good is standardized and produced away from the market. However, Vargo & Lusch (2004) point out why this approach may not be desirable: standardization without consumer involvement adds to marketing costs and worsens the firm’s ability to meet consumer needs.

Here, the service-centered view enters the picture. Services are intangible, being performed rather than produced (Vandermerwe & Rada, 1988). They can be defined as “the application of specialized competences through deeds, processes and performances for the benefits of another entity or the entity itself” (Uлага & Reinartz, 2011, p.15). Thus, within the service-centered view, a firm’s competitive advantage lies in their ability to apply their unique fundamental knowledge and skills. The application of these specialized skills and knowledge is the fundamental unit of exchange within the service-oriented view (Vargo & Lusch, 2004). It therefore departs from restricted, traditional perspectives on services that perceive them as residuals, there only to enhance the performance of a tangible product; in fact, goods rather become distribution mechanisms for service provision (Vargo & Lusch, 2004).

The relationship between goods and services is fluid, as the two can substitute each other: for instance, one can buy a razor to shave one’s own beard or go to a barber to have their beard shaven (Vandermerwe & Rada, 1988). In both cases it is not the product that the consumer desires, but the outcome: a shaven face. As such, products can be said to embody services. Uлага & Reinartz (2011) nuance this relation between products and services by arguing that a service may either be directed at a supplier’s good or at a customer’s process. Later authors often embrace the distinction between services supporting the product (SSP) and services supporting the client (SSC). While SSP focus more on ensuring proper functioning of and customer access to the product, SSC focus on supporting the consumer in their strategies and

actions. (e.g. Lexutt, 2020; Brax et al., 2021). Hence, different types of services exist, which may relate to physical products in different ways and take different places in the service value proposition.

b. Conceptualizing servitization

i. Why servitization?

Servitization's initial spread in popularity was propelled by deregulation, technological developments, globalization, and competitive pressures (Vandermerwe & Rada, 1988). There are several reasons why servitization is expected to work better within this changing environment than traditional manufacturing. For one, services are more visible and labor dependent than products, and therefore harder to imitate in an economy where mass-production is easier (Oliva & Kallenberg, 2003). Indeed, servitization protects a firm's competitive edge by differentiating their offerings and setting up barriers to competitors, third parties, or customers, while also creating dependencies between the firm and its customers (Vandermerwe & Rada, 1988). Moreover, services represent a more consistent revenue stream, which is considered counter-cyclical and recession-resistant, as they provide continuous revenue throughout a product's life cycle. During periods where consumers are less likely to purchase new products, such as economic crises, they still require servicing of the installed base. In fact, services may even sell better as consumers try to make their product last longer (Oliva & Kallenberg, 2003; Bernedittini et al., 2015). As such, servitization is sometimes described as a necessity in the face of stabilizing product outputs and declining profitability (Martinez, Bastl, Kingston & Evans, 2010). This holds especially true as contemporary consumers appear to be seeking not merely standardized products, but certain solutions and outcomes. Thus, servitized offerings are more appropriate for a modern customer base than existing systems of mass production (Mont, 2002; Oliva & Kallenberg, 2003). Overall, a firm often has little choice but to pursue servitized offerings.

However, servitization is not attractive out of necessity alone: it can also provide companies with a competitive edge. For instance, it enriches the value proposition through avenues such as integrated and customized solutions to client needs; unique relationships with clients to enhance consumer loyalty; reduced effort on the consumer's part to make the product work; and faster innovation due to better understanding of the consumer's wishes (Tukker, 2004; Tukker & Tischner, 2006). Servitization can provide a firm in an already-mature industry with an innovation-based growth strategy, as it implies adding value to extant products through refurbishing or upgrading. These actions add value to the firm's products by making it last longer, extending its function, or even offering strategies for using the product at the end of its life cycle (Mont, 2002).

Finally, a company has several unique advantages, competences, and resources that it can and should leverage when creating value through servitized offerings. Compared to other actors that may be able to service their installed base, product manufacturers have the advantage of lower customer and knowledge acquisition costs and lower capital requirements (Oliva & Kallenberg, 2003). They also have access to several unique resources, such as data on their products' usage; principles for product development and manufacturing; well-directed product sales force and distribution networks; and well-trained field agents (Ulaga & Reinartz, 2011; Khanra, Dhir, Parida & Kohtamäki, 2021). As such, there are ample reasons why a manufacturing firm would pursue a servitization strategy.

ii. Understanding servitization

In their seminal article on servitization, Vandermerwe and Rada (1988) describe a servitizing industry as one where the dividing line between traditional manufacturers and service companies becomes progressively less clear. In this new market, manufacturers sell more services, start selling knowledge instead of goods, and take on a consulting role within their industries. Importantly, servitization is not static; it is a process, which entails a move away from products to extend or expand their coverage of services. As such, servitization is often perceived as a transformation or transition towards increasingly sophisticated services, where the level of servitization stands in direct relation to the firm's number of service offerings (Baines, Bigdeli, Sousa & Schroeder, 2020). The 'level of servitization', as such, becomes a measurable property (Brax et al., 2021). Several metrics may be used for defining servitization success, be they financial or non-financial: for instance, one could look at company revenue after servitization; service-related revenue; the number of service types offered by the firm; the share of revenue that the firm derives from services; customer satisfaction; or quality of the customer relationship (Lexutt, 2020; Brax et al., 2021). This study follows Lexutt (2020) in defining servitization success as a positive direct impact on the financial performance of the business and/or a positive indirect or non-financial impact on the performance of the firm.

What, then, does the transformation to services entail? Its most essential aspect is a deeply customer-centric mentality: a servitized firm collaborates with and learns from customers while adapting to their dynamic individual needs (Vargo & Lusch, 2004). The firm has a close relationship with its customers, involving them from the early stages of product design (Mont, 2002; Vargo & Lusch, 2004). Moreover, the manufacturer accepts a higher degree of responsibility for the product's full life cycle, extending their involvement and responsibility to life cycle phases which fall outside of the traditional buyer-seller relationship (Mont, 2002). This also means that the relationship between the company and the customer becomes much more central to the value proposition, and that the servitization process may be associated with a shift in property rights between different actors within the value chain (Mont, 2002). These new dynamics, in turn, require a change in the company's traditional structure and an extended involvement of the firm in question with other companies (Mont, 2002).

As servitization is ultimately a business strategy, it is important that it fit within a viable business model. Business models play a crucial role in converting the value delivered to customers to value captured by an enterprise, as they describe the way an enterprise generates and provides value to its customers as well as the way it turns the payments received for this value into profits (Han, Heshmati & Rashidghalam, 2020). Servitized business models can differ vastly in their approach to services; one can especially discern large differences between SSP-oriented and SSC-oriented business models. A good example of the former is Oliva and Kallenberg's (2003) strategy of servicing a firm's installed base. Here, the servitizing firm reviews the total number of their products under use and builds a strategy around the range of product- or process related services that the users of this installed base may require. At the other end of the spectrum, one can find an example of an SSC-oriented business model in Storbacka's (2011) solution business model, which sees the producer selling comprehensive solutions rather than mere products. Such solution business models are characterized by high complexity and longitudinal collaborations, which involve careful balancing of producer and consumer interest over the course of several years. This, then, showcases the variation that may exist between different servitization approaches.

iii. How does successful servitization develop?

The journey to services is often presented among a continuum, as in Oliva & Kallenberg's (2003) product-service continuum or Martinez et al.'s (2010) servitization continuum. The product-service continuum, depicted in Figure 1, views servitization as a progression characterized by an ever-increasing relative importance of services compared to tangible goods. This progression is visualized as a diagonal change line: the firm must ask themselves where on the change line they currently are, and where they hope to end up (Oliva & Kallenberg, 2003). Importantly, the firm's position on the line does not necessarily accurately represent the position of individual branches of the firm: especially larger firms consist of multiple branches that work with several customers. One branch may sell highly complex servitized solutions while another branch may still be quite low on the product-service continuum. The continuum is a simplification, rather approximating the 'average' position of the firm.

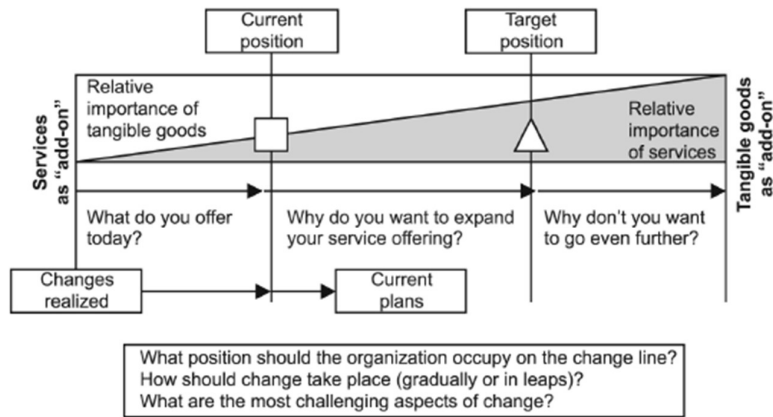


Figure 1: The product-service continuum (Oliva & Kallenberg, 2003)

Martinez et al.'s (2010) understanding of servitization resembles that of Oliva and Kallenberg. They describe it as a progression with different levels. The progression starts with product-oriented services as an 'add-on' to the physical product and culminates in user process-oriented services (Martinez et al., 2010). Their servitization continuum diagram visualizes the customer-supplier interface (see Figure 2). The figure displays how the relationships with the customer progresses from transactional to mutual as the company achieves greater levels of servitization. These models present an interesting interpretation of the dynamic between SSC and SSP: suddenly, these are no longer two different approaches to servitization, but two different degrees of servitization attainment. Thus, in an idealized scenario, SSP would eventually culminate in SSC. However, firms may have legitimate reasons for choosing to remain at a lower servitization level, meaning that SSP-oriented business models and other 'low levels of servitization' must be considered in an analysis of servitization (Oliva & Kallenberg, 2003).

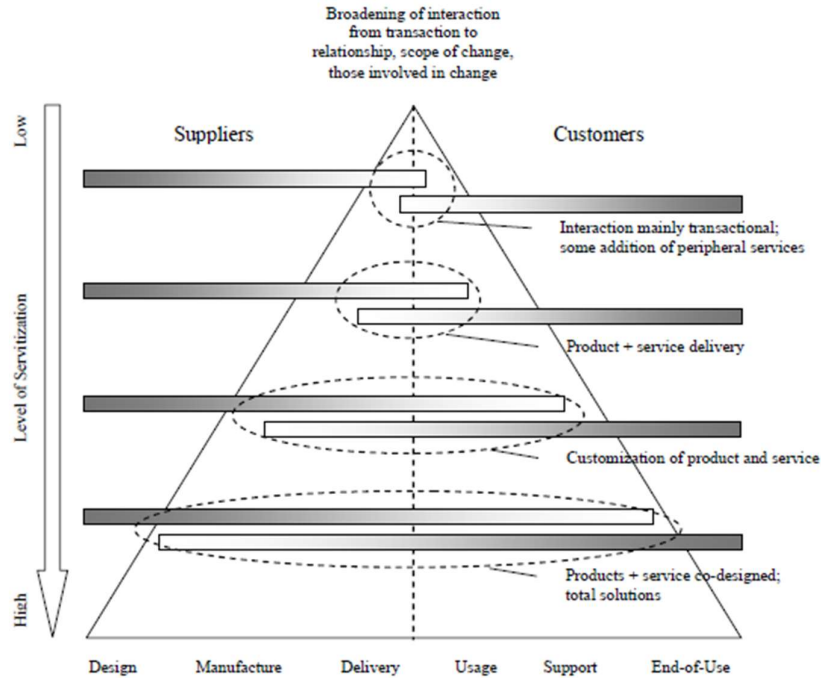


Figure 2: Servitization continuum: a view of the customer-supplier interface (Martinez et al., 2010)

Departing from the understanding that successful servitization progresses along a continuum, the question arises how this process develops. Several authors have attempted to make sense of this process, culminating in several multi-step models. Arguably the first of these were Vandermerwe and Rada (1988), who offered a three-stage description of the servitization transformation. In the first stage, the firm produces goods *or* services, while in the second stage the firm produces *and* services. In the final stage, the supplier provides goods, services, support, knowledge, and self-service. Later authors have suggested ways to nuance this model. For instance, Hullova et al. (2019) develop a servitization readiness decision tree. First, the firm must gain active support of key suppliers; second, the firm and its suppliers must align their goals and incentives for the transformation; third, the firm must align these goals and incentives with those of the customers; fourth, the firm must reflect their commitment to the transition in its strategy and operations; fifth, all the firm's functions must be aligned and incentivized to support the transitions; sixth, the firm must build the capabilities necessary to collect, analyze and unify data within the ecosystem; and finally, the firm must enable knowledge transmission between equipment manufacturers and customers in real time. This presents a relatively simple normative seven-step process for implementing servitization in a firm; other authors chose to focus on specific aspects of the transformation.

For instance, Baines et al. (2020) build a so-called 'servitization progression model', which considers the role of contextual factors on the process and content of servitization-related changes. This model consists of four stages: exploration, engagement, expansion, and exploitation (see Figure 3). Progression between the stages is structured and unidirectional, but the stages themselves consist of organic, unstructured, and iterative subprocesses. While the stages are internal to the organization, progression between and within them is highly influenced by contextual factors related to customers, technology, the value network, and organizational readiness. The firm will only progress between stages once these contextual factors have generated sufficient momentum to reach a tipping point (Baines et al., 2020).

Lexutt (2020) engages more deeply with the final factor, organizational readiness: she proposes managerial commitment, organizational structure, and strategy as cornerstones to an organizational culture that supports servitization success. Organizational culture, in turn, also supports and reinforces the new strategy. Thus, the transformation to services generally requires a cultural shift from manufacturing orientation to service orientation (Lexutt, 2020).

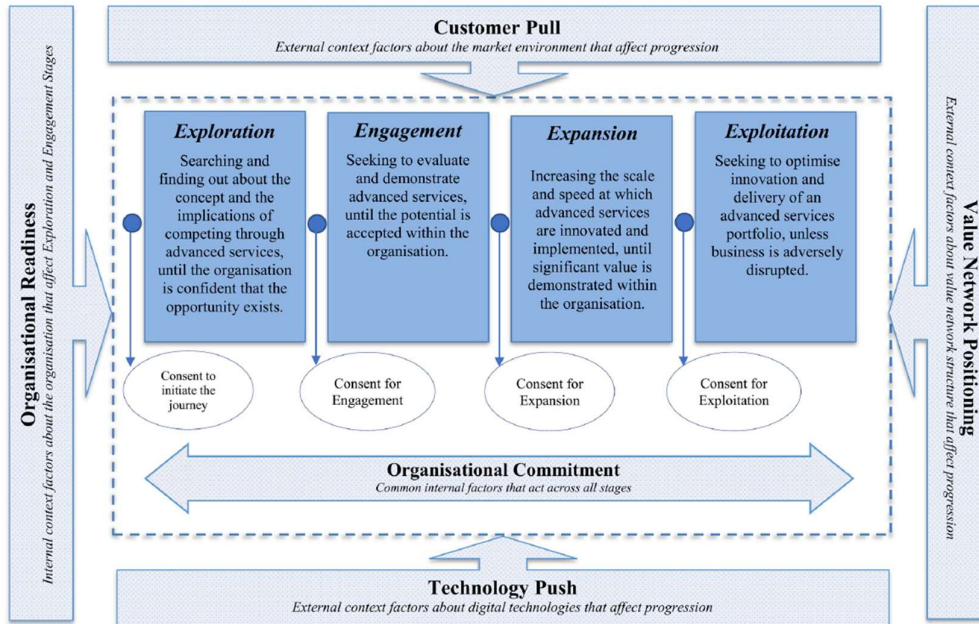


Figure 3: Baines et al.'s (2020) servitization progression model.

Meanwhile, Valtakoski (2017) takes a knowledge-based perspective. Using a four-phase (solution development, supplier selection, solution implementation and supplier outcomes) model, he analyzes the knowledge production that takes place between supplier and consumer. At each stage, the customer and supplier take steps towards co-creating knowledge. During the solution development stage, the customer performs an organizational search to find new configurations to improve performance; during the supplier selection stage, the consumer draws upon its existing knowledge base and acquires new external knowledge to decide which functions it needs to reach its desired configurations; during the solution implementation phase, the consumer and supplier firms engage in processes of knowledge transfer, adaptation and integration to develop the complex servitized system; and during the servitization outcomes phase the consumer and supplier learn from each other through their close collaboration. As such, the role of knowledge is different in each stage of the process, while knowledge also shapes the way the firm moves from stage to stage.

Finally, De Brentani (2001) emphasizes the importance of the nature of the service innovation transformation itself. Specifically, she highlights the difference between radical and incremental innovation. Relating this back to prior servitization typologies, one could expect SSC to be radical, while SSP is more incremental. Both have their own advantages. For instance, radical innovations may be less subject to market competition due to the offering's newness. To reach this level of competitiveness, though, the firm has to offer higher quality and prove a high customer need fit. This can be hard for services since these are intangible and entail a very new value proposition. After all, customers are used to the technologies that were previously the standard, and radically different products may be incompatible with consumer values (De Brentani, 2001). Customer communication is therefore even more important for discontinuous innovation, to prove that the customer that they are gaining unique and

worthwhile benefits and help them understand and accept the value proposition (De Brentani, 2001).

As such, the literature provides some insights on servitization progression. First, it places the trajectories of services and goods in relation to each other, thereby adding a growth dynamic to the SSP/SSC distinction introduced previously. Secondly, it explains the trajectory of a servitization transformation, highlighting certain important factors such as context, design process, knowledge co-creation, and the nature of the innovation. This background will prove a valuable foundation for the next step in this theoretical framework: conceptualizing servitization success.

c. Servitization challenges

Even though literature on servitization widely advocates its benefits, service transformations often fail (Valtakoski, 2017). Many companies are hesitant to start servitization transformations to begin with: they may be skeptical about the benefits of servitization or consider it beyond the scope of their competences even when acknowledging its benefits (Oliva & Kallenberg, 2003). Even if they realize the potential of servitization and choose to roll out service strategies, significant chances exist that the strategy proves unsuccessful (Oliva & Kallenberg, 2003). What little quantitative evidence exists for servitization outcomes displays not only a trend towards servitization, but also a countertrend where firms reduce or curtail service provision: so-called deservitization (Valtakoski, 2017; Kowalkowski, Gebauer, Kamp & Parry, 2017). At the product level, deservitization may manifest as the replacement of customization and services with standardized, lower-cost products, while at the company level deservitization may manifest as the liquidation of or divestment from the service branch of the company (Kowalkowski et al., 2017). The reason for such divestment may simply be that the service provision proves uneconomical. As discovered by Brax et al. (2021), the relationship between servitization and performance is most reliably positive in strategies with a low level of servitization. A medium-high level of servitization, which corresponds to the middle of the product-service continuum, more likely decreases firm performance. When confronted with such decreasing performance impacts, the firm may prefer to deservitize. Even if the firm still decides to continue their trajectory, a suboptimal strategy probably results in servitization failure. This relationship is depicted in Figure 4.

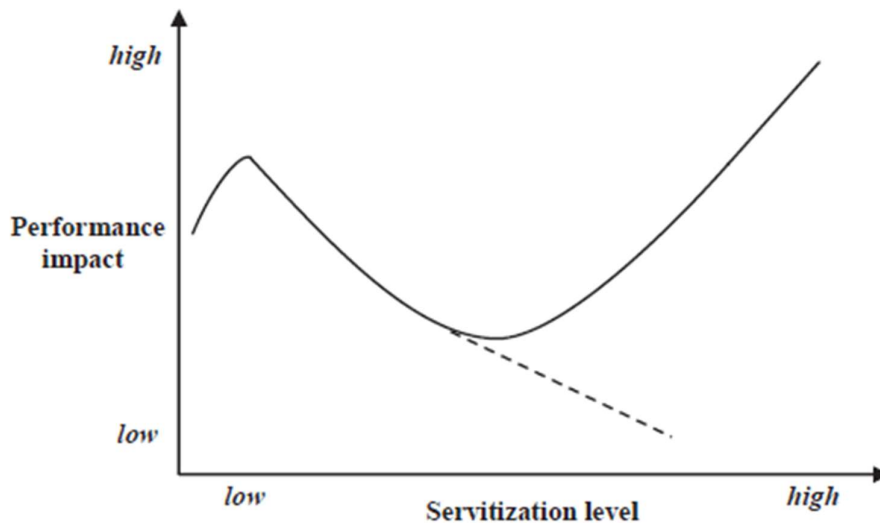


Figure 4: The relationship between servitization and performance (Brax et al., 2021).

Several compelling explanations exist for servitization's poor track record, including but not limited to company culture and mind-set; finding the right metrics and statistics to measure success; the development process; necessary infrastructure and social systems; the delivery of integrated offerings through the business model; the need for increased stakeholder involvement; internal processes and capabilities and the disruption thereof; the leveraging of unique resources; strategic alignment; customer management; and supplier relationships (Martinez et al., 2010; Zhang & Banerji, 2017; Bigdeli et al., 2020; Mont, 2002). One particularly relevant challenge is the complexity of a servitized offering compared to a manufactured product, resulting in enhanced uncertainties which bring significant new risks (Valtakoski, 2017; Zhang & Banerji, 2017). These risks may be environmental, as the business landscape of the firm changes, or internal, as managers in the firm may make mistakes in formulating or executing the firm's strategy (Bernedettini, Neely & Swink, 2015). Environmental risks may originate in market structures: servitizing manufacturing firms may struggle with service markets, which are more customer centric and subject to more numerous and varied rules and regulations (Bernedettini et al., 2015). This is compounded by the fact that companies face wholly new competitors when entering service markets: they may compete with actors from different industries or with actors that had previously been their customers or suppliers. They may even start competing with themselves, as the increased service offering lowers the demand for their material products (Vandermerwe & Rada, 1988). Even when not directly competing with the servitized firm, network partners may obstruct servitization progress. After all, servitized firms are more dependent on network partners than traditional manufacturing firms (Hullova, Laczko & Frishammar, 2019). If the firm's network partners are too product-oriented, they may not be willing or able to support the firm's servitization tradition – this risk is especially relevant since a manufacturing equipment supplier may not profit significantly from service contracts (Hullova et al., 2019).

Yet, Bernedettini et al., (2015) find that the greatest risks facing servitizing firms are not environmental, but internal. These internal risks predominantly stem from a firm's ability to leverage tangible and intangible resources when developing service extensions. Exploiting the potential new, synergistic combinations between products and services requires more complex coordination capabilities, increasing the risk of management mistakes. Misalignment between managerial attention and servitization strategy is a major threat to servitization success: often, transformation plans are initiated by top management, but fail to percolate downwards. Middle managers' attention is focused on supplier and customer demands, meaning that they are more concerned with ad-hoc demands of dominant suppliers than with top management's strategic plans; this then translates into the sales team as an incentive scheme aimed at sales rather than services, as the key performance indicators favour producing quotes and selling machines rather than service targets (Hullova, Laczko & Frishammar, 2019). This disconnection also travels in the opposite direction, as salespeople's customer knowledge may be largely tacit and therefore does not leave the sales team. Thus, middle and upper management lack the necessary knowledge to create service strategies that align with customer demands (Hullova et al., 2019). The sales team may even have concrete incentives to gatekeep this knowledge, as servitization may create competition within the firm. If the service offering is too successful, it can extend the product's useful life, meaning that replacement sales are reduced; conversely, services are less needed for products with higher quality, durability, and user-friendliness, meaning that a servitization strategy may incentivize against product quality increases (Oliva & Kallenberg, 2003). Thus, the disconnect between levels is to some extent structural, making it even harder to overcome.

Servitization challenges can also be described in terms of the boundaries that need to be crossed during the transformation (Bigdeli, Kapoor, Schroeder & Omidvar, 2020). Boundaries can take

different shapes. Efficiency boundaries stem from transaction costs; power boundaries form around power dependencies among actors; competency boundaries are determined by a firm's resources, demarcating areas of expertise; and identity boundaries relate to how employees define their organizations (Bigdeli et al., 2020). These boundaries may occur in two loci: external organizational boundaries and internal boundaries. The former demarcate organizations from their operating environments; thus, they are formative to firm identity. These boundaries protect the firm and its employees from environmental risks, but they may also slow down technology diffusion. Internal boundaries, on the other hand, demarcate across departments, knowledge domains, and practices. They protect vested professional interests, but they also create the disconnection between firm levels described above.

Kohtamäki, Einola and Rabetino (2020) further the analysis on the contradictions of servitization by pointing out that servitization is subject to several paradoxes. Paradoxes are “contradictions that persist over time, impose and reflect back on each other, and develop into seemingly irrational or absurd situation because their continuity creates situations in which options appear mutually exclusive, making choices among them difficult” (Dimitrijeva et al., 2022, p.143). The most widely recognized paradox is the service paradox: despite the substantive investments poured into servitization efforts, many manufacturers do not generate sufficient returns to financially justify their servitization efforts (Dimitrijeva et al., 2022). This paradox is built up of several smaller paradoxes. Besides the abovementioned conflict between customer orientation and engineering mindset, Kohtamäki et al. (2020) identify three others: the paradox between effectiveness in solution customization and efficient product manufacturing; between organizing product-service integration and separated service and product organizations; and between exploratory innovation in solutions and exploitative innovation in product manufacturing. These are paradoxes rather than dilemmas, as resolution between them is not possible. For instance, a servitized firm needs effective solution customization to increase user value, but it also needs to run an industrial level operation if it wants to be successful. The firm cannot choose between these two seemingly contradictory concepts, it can only cope with the paradox. Kohtamäki et al.'s (2020) paradoxes and associated coping mechanisms are represented in Figure 5.

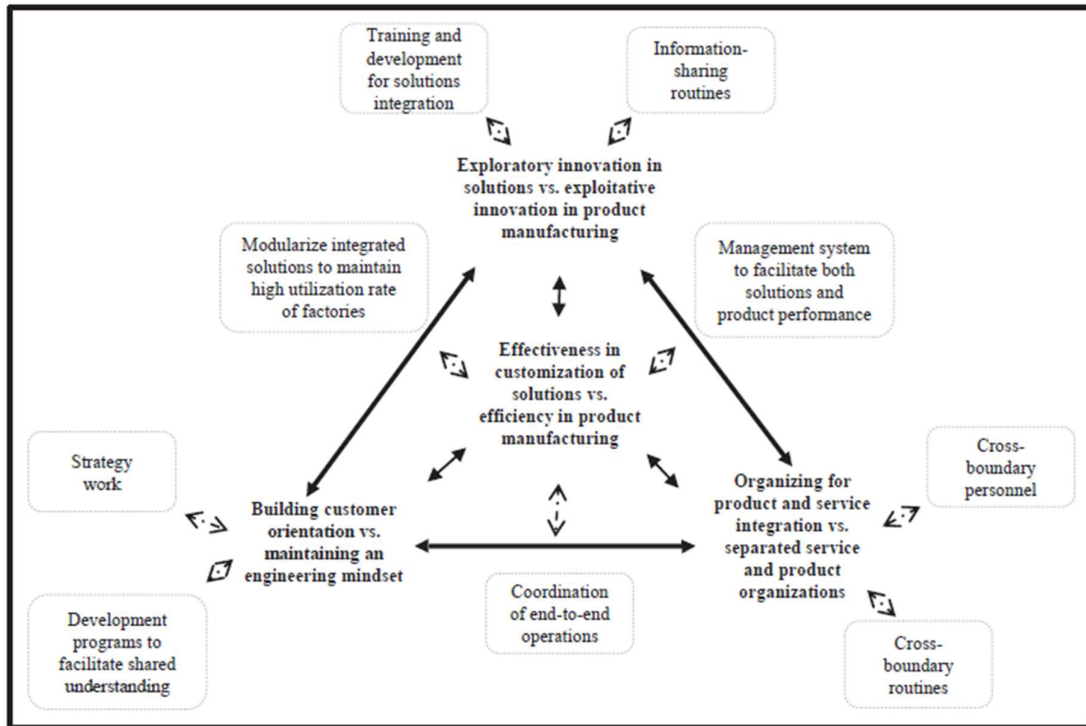


Figure 5: Kohtamäki et al.'s (2020) servitization paradoxes and associated coping practices.

d. The role of data in servitized business models

In recent years, literature on servitization has increasingly recognized the mutual relationship between servitization and digitalization, as digitalization stimulates the offering of smart products and digital services (Favoretto et al., 2022). Although digitalization and servitization are, at their core, two separate concepts which can be pursued independently, they are strongly interconnected. As such, recent literature often refers to digital servitization (DS), a compound concept combining the two. DS is defined as “the transformational process by which a product company changes its product-centered business model to a service-centered business model with the support of digital technologies, enabling the reconfiguration of its business processes, capabilities, products and services to improve the value for customers and increase the company’s non-financial and financial performance” (Favoretto et al., 2022, p.109). Figure 6 shows this explosion of interest in DS by documenting the number of publications on the topic. This figure not only showcases the increased interest in digitalization as a theme in servitization research, but also displays the emergence of DS as a concept: before 2017, digitalization and servitization were treated mostly separately, while post-2017 publications largely discussed DS.

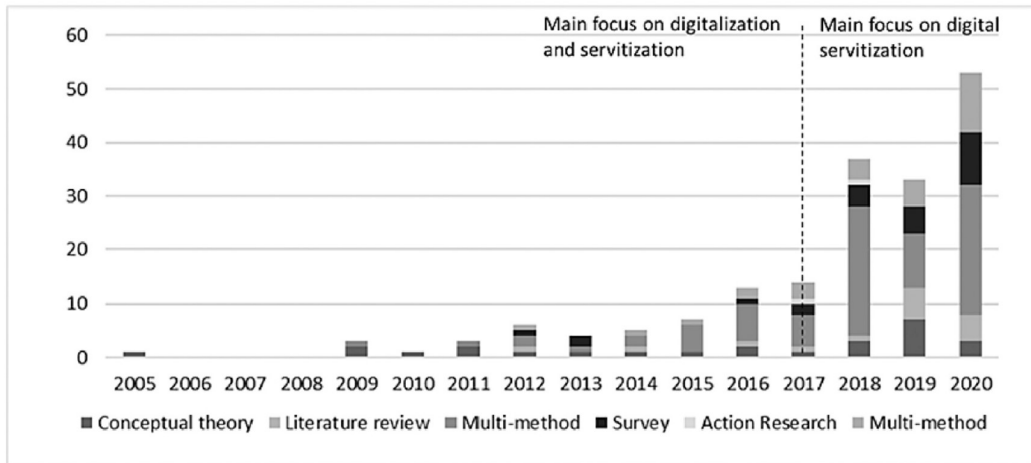


Figure 6: Publications on digitalization, servitization, and digital servitization up to 2020 (Favoretto et al., 2022)

What, then, is the role digital technologies could take in servitization? Bressanelli, Adrodegari, Peroni and Saccani (2018) give some indications. For one, they point out the potential for IoT technologies to operationalize the installed base towards data collection: companies could supply devices with sensors to allow them to communicate and become active participants in the information network. This data can then be used, among others, to improve product design; improve marketing activities; plan preventative and predictive maintenance; and provide their customers with personalized advice with the aim of optimizing usage. The key properties defining data’s usability is volume, variety, velocity, and variety. Data is likely to be large in volume and high in velocity, but also highly varied and unstructured. Moreover, a firm would prefer data that is high-quality and has proven applications (Bressanelli et al., 2018).

Although several articles already conceptualize digital servitization, relatively few conceptual papers show how prerequisites for DS and the transformation itself differ from that of traditional servitization. Besides the obvious difference of data’s central role, Tronvoll, Sklyar, Sörhammar and Kowalkowski (2020) already show one major discerning factor for digital servitization: it creates a much greater need for an agile mindset, as software and digital infrastructure see uniquely fast development cycles. Moreover, IoT technologies have the potential to vastly alter the servitized business model. Building an offering around IoT may not only improve traditional servitization offerings such as improved maintenance of the installed base but open completely new opportunities around networks of smart, connected products (Paschou, Rapaccini, Adrodegari & Saccani, 2020) As such, digitalization is not simply an ‘add-on’ to a servitized product; it fundamentally changes the way the firm should approach services.

e. The product-service system: servitization in the circular economy

The potential benefits of servitization go beyond the company implementing the strategy: it is widely considered to be a powerful facilitator for the circular economy (Kuhl et al., 2018). Circular economy, here, pertains to a “system restorative and regenerative by design, which aims to maintain products, components and materials at their highest utility and value” (definition by Ellen McArthur Foundation as cited in Bressanelli, Adrodegari, Perona & Saccani, 2018, p2). While a traditional linear economy would see products being disposed at end-of-life, a circular economy attempts to further environmental quality, economic prosperity, and social equity by reducing, reusing, recycling, and recovering materials during the

production, distribution, and consumption processes (Kuhl et al., 2018). The system plays out on three levels: macro (city, region, nation), meso (industries and eco-industrial parks) and micro (product, company, consumer). Especially at the micro level, circular economy is massively enabled by novel business models (Kuhl et al., 2018). Business models for circularity are a central concept within the circular economy. A strong business model is crucial to generating growth and profit for the firm, but if circular economy considerations are neglected this very success can encourage over-consumption and waste (Han et al., 2020). This, then, reflects the key challenge of sustainable business models: they must be designed in such a way that the firm can capture economic value through delivering social or environmental benefits (Bocken, Short, Rana & Evans, 2014).

Within the literature on circular business models, servitization often manifests in the form of product-service systems (PSSs). PSSs are systems “consisting of tangible products and intangible services designed and combined so that they jointly are capable of fulfilling specific customer needs” (Tukker, 2004, pp.246). They are a key example of a business model delivering functionality rather than ownership, one of Bocken et al.’s (2014) core circular business models, and as such place among the most widely cited applications of circular business models in practice (Kuhl et al., 2018). Although PSS and servitization as concepts follow the same core logic, the PSS literature emerged from environmental considerations while servitization stems from commercial and strategic considerations (Kuhl et al., 2018). Thus, while servitization is a way of differentiating products by integrating them with services to satisfy consumer demand and achieve competitive advantage, PSSs have sustainable development as an explicit goal, creating systems with a lower environmental impact than traditional models (Doni, Corvino & Bianchi Martini, 2019). In contemporary literature, the relationship between the two bodies of literature is very interesting. On the one hand, many articles use “servitized offering” and “PSS” as interchangeable terms (Doni et al., 2019). Yet, on the other hand, articles analyzing both servitization’s strategic and sustainability potential are few and far between (Kuhl et al., 2018).

Yet, servitization has excellent potential to combine circular and strategic logic, as it moves away from existing product concepts and focuses on the final need, demand or function that needs to be fulfilled (Tukker & Tischner, 2006). Its circularity potential is predicated on the idea that business incentives change, since the company now receives reliable income throughout the product’s lifetime, rather than only at the point of sale (Tukker, 2015). As a result, many servitizing companies start offering technical assistance and maintenance services that extend the product’s lifespan (Bressanelli et al., 2018). This is especially true for DS. Digital technologies greatly enrich the sustainable potential of a servitized offering: through internet-of-things (IoT) technology, the firm can gather vast amounts of usage data as well as monitor the products’ condition, status, location, and usage in real-time. These capacities have many applications: for instance, they may deter careless use behavior, facilitate end-of-life collection and recycling, and support optimization of product maintenance and improvement (Bressanelli et al., 2018; Kuhl et al., 2018). Moreover, it makes sharing business models more attractive as the consumer can access real-time information about the product’s use history and current state (Bressanelli et al., 2018). Han et al. (2020) present one particularly ambitious case, where the firm in question used IoT to create a network of smart connected products, thus increasing the products’ usability in various industries. As such, use of digitalized technologies is a key facilitator for attractive sustainable servitized business models.

Broadly, literature on PSSs differentiates between three types of PSSs: product-oriented, use-oriented, and result-oriented PSSs (Tukker, 2004; Tukker, 2015). These main categories as well as the archetypes in which they can be subdivided are represented in Figure 7. Broadly, the

categories are reminiscent of the servitization concepts SSP and SSC, with the addition of category C: result-oriented business models.

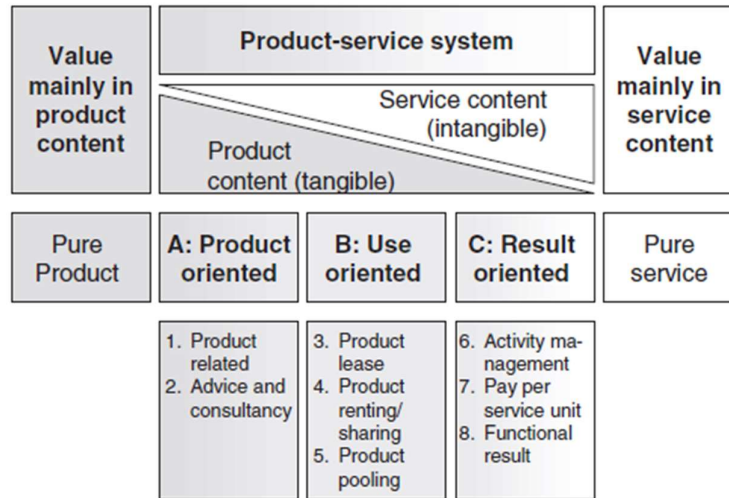


Figure 1. Main and subcategories of PSS

Figure 7: Three categories of PSS, subdivided in eight archetypes (Tukker, 2004).

According to Tukker (2004), most of these archetypes have positive environmental benefits, except for those that reduce the user’s responsibility for the product; however, improvements may be incremental at best. This reflects the need for creating a dialogue between “PSS theory” and “servitization theory”. On the one hand, research on servitized businesses provides a basis for optimism: servitized businesses tend to emit less carbon (Hao, Yiding & Zhu, 2022), and servitization correlates negatively with energy consumption (Doni et al., 2019). Yet, servitization is rarely a predictor of sustainable behavior, sustainability reporting, or sustainability policies, suggesting that servitized firms are not more sustainable because they prioritize sustainability, but because servitized business models are simply more efficient (Doni et al., 2019). This initial evidence is promising, as it suggests that servitization is a viable way to turn a competitive advantage into a sustainability advantage; however, it also proves that there is still much room for improvement. To truly live up to its sustainable potential, the PSS should have the explicit goal to minimize the environmental impact of consumption by closing material cycles, reducing consumption through alternative scenarios of product use, increasing overall resource productivity, and striving for dematerialization, and striving for optimally efficient integration of system elements (Mont, 2002).

Laumann Kjaer et al. (2018) argue that, to qualify as a CE strategy, a PSS should at least result in relative resource reduction but ideally lead to absolute resource decoupling. Yet, many purpose-designed sustainable PSSs fail to achieve commanding market positions while successful PSSs fail to provide a coherent interpretation of their sustainability goals, resulting in relative decoupling at best. For instance, product-oriented PSS strategies such as advice and consultancy tend to be the least intrusive for companies to introduce; however, these strategies have relatively little environmental impact, as they do not change the system but merely make it more efficient. Meanwhile, the most environmentally promising business models, such as the result-oriented functional result archetype, require a large radical transformation within the business model (Tukker, 2004). This effect is amplified as the value proposition for a PSS is often more complex than that of a traditional product. For instance, transaction costs may be higher as the value chain tends to be more complicated; and, while PSS tends to present a market

value than competing products, it lacks intangible values such as permanent access, status, and autonomy that come with a customer's acquisition of pure products (Tukker, 2015).

To bridge the gap between relative and absolute resource decoupling, Laumann Kjaer et al. (2018) propose a framework, depicted in Figure 8. They suggest three primary requirements to achieve this transition. First, to ensure net resource reduction: that is, the avoided resources should exceed the induced resources. Second, burden shifting between life cycle stages should be avoided; optimizing one life cycle stage should not lead to increased resource consumption in another life cycle stage. Third and finally, rebound effects should be mitigated. As discussed above, part of the servitized value proposition is its lower cost compared to pure services: this may mean that the consumer has more services overall. They can then use these remaining resources to consume other, potentially less sustainable, goods and services.

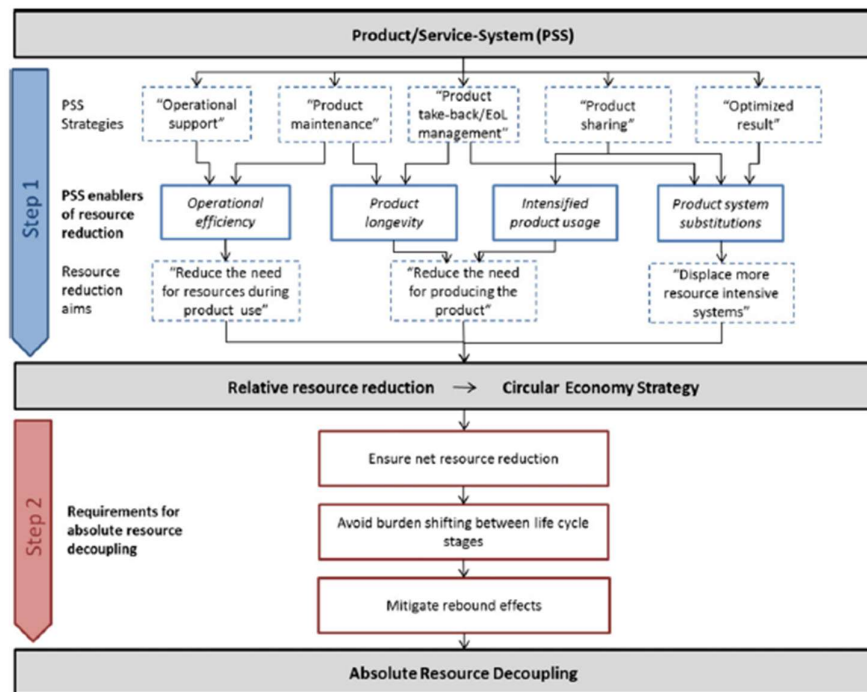


Figure 8: A two-step framework from PSS to circular economy strategy to absolute resource decoupling (Laumann Kjaer et al., 2018)

What is notable about the three steps described by Laumann Kjaer et al. (2018), though, is that they ostensibly concern the resource side of the equation. As such, it fails to circumvent the effect that Tukker (2015) warned for, inadvertently proving that steps towards strong circularity are often hard to justify from a business perspective. Indeed, many servitizing firms hesitate to add environmental considerations to their product development cycle, as it is seen as lengthening the time to market (Mont, 2002). Moreover, sustainable servitization also presents a paradox of its own: as services are less needed for products with higher quality, durability and user-friendliness, a heavily service-focused strategy may incentivize against increasing product quality, nullifying servitization's positive effect on product lifespan. This is compounded by the fact that lifespan improvements from servitization decrease replacement sales, thereby further decreasing the incentive to invest large sums into product quality (Oliva & Kallenberg, 2003). The servitizing manufacturer must tread a fine balance between product quality and service provision in any case, but this tradeoff becomes especially pernicious when including circularity considerations.

3. Methodology

a. Research approach

To achieve its goal of creating an overview of extant literature, this study uses a systematic literature review of case studies researching digital servitization. By pursuing this approach, the study can be expected to find a comprehensive overview of empirical research on digital servitization success. To synthesize this wealth of knowledge into a comprehensible framework, the study uses an inductive content analysis of the papers: this is the best way to recognize themes that emerge from the literature while maintaining a structured approach to the content (Elo & Kyngäs, 2007). Sections 4b and 4c below go into more depth about the approach to data collection and data analysis, respectively.

b. Data collection

The unit of analysis for this study is peer-reviewed case studies documenting success factors and challenges for the development and implementation of a digital servitization strategy. The study collected its articles primarily from Scopus, as this database offers a very wide range of material within the management sciences (Tukker, 2015). In the search, the papers were held to three primary standards:

1. Servitization must be the core focus of the paper
2. The paper must specifically consider digital servitization
3. The paper needs to describe a single or multiple case study as its primary data collection method

For each of these criteria, the study devised a set of keywords based predominantly on Fernandes et al. (2019), Favoretto et al. (2022), and Rabetino et al. (2017). The keyword set was adjusted over the course of several searches to achieve a set that represented the study’s purposes. This yielded the following search terms:

Criterion	Search terms	Reference
Servitization	"from products to services" OR "integrated product-services" OR "product service syste*" OR "product/service syste*" OR "product-service offerings" OR "product-service syste*" OR "service infusion" OR "service transition" OR "servicification" OR "servicisation" OR "serviti*" OR "solution business model"	Fernandes et al. (2019), Favoretto et al. (2022), Rabetino et al. (2017)
Digitalization	Digital* OR digiti*ation OR “emerging technologies” OR “ICT” OR “big data” OR “cloud computing” OR “Internet of Things” OR “IoT” OR “remote control” OR “remote monitoring” OR “digital manufacturing” OR “digital technology*” OR “digital transformation” OR “Industry 4.0” OR “predictive analytic*” OR technolog* OR “augmented reality” OR “virtual reality” OR simulation OR “cybersecurity” OR “cyberphysical system*” OR “3D printing” OR smart*	Favoretto et al. (2022)
Case research	"case stud*" OR "case research"	Fernandes et al. (2019)

Papers were only considered if at least one keyword from every group appeared in the papers title, abstract or keywords. To ensure quality and relevance of the articles, the results were limited to papers within the field of business, management, and accounting; papers in the English language; papers from peer-reviewed journals; and papers that were available online in full. The study acknowledges that this sampling method may exclude some relevant papers. For instance, some relevant papers may not be included in the Scopus database; they may not be labeled as business, management and accounting; or they may not (yet) have been published in peer-reviewed journals. This thesis invites any follow-up studies to be attentive to these potential shortcomings and adjust these criteria if deemed worthwhile.

The initial search yielded 71 results, which were scanned for relevance by reviewing the abstracts (Rabetino et al., 2017). During this step, papers that did not comply with the three primary criteria were excluded; also excluded were papers that did not describe the process of servitization (e.g., papers that described its outcomes or environmental impacts, instead). This generated a sample of 29 papers. Appendix A provides an overview of all papers included in the final sample.

c. Data analysis

The 29 selected papers were analyzed using an content analysis as described by Elo & Kyngäs (2007). Although prior literature has made calls for more quantitative meta-studies of servitization case research (e.g. Tukker, 2015), most articles in the sample followed a qualitative approach, meaning that the study found insufficient data to base a quantitative analysis on. Of course, the qualitative nature of the analysis means that it is subject to the researcher's bias, a risk that is compounded by the fact that this study was executed by only one researcher (Hesse-Biber & Leavy, 2002). This risk is somewhat mitigated by the nature of the source material: scientific language is more objective than, for instance, the colloquial language that may be used in an interview. Insofar as the risk of bias persists, it is worth taking within the context of this study. Because qualitative content analysis offers unique opportunities for creating rich insights into source material, it is uniquely suitable for creating holistic, nuanced insights into a field as new as DS success (Elo & Kyngäs, 2007).

The study pursued an inductive strategy to its analysis. Inductive analysis is uniquely suitable for studying a phenomenon about which knowledge is scarce or fragmented (Elo & Kyngäs, 2007). As digital servitization is a relatively new field, the papers do not display a high level of theoretical consistency yet. Therefore, an inductive analysis was deemed more appropriate than a deductive analysis because deductive analysis requires a higher level of theoretical consistency. Insofar as this knowledge base exists for traditional servitization the study deemed it insufficient for a deductive analysis of DS for two primary reasons. Firstly, even among the more comprehensive theories of servitization success, too little consensus exists between authors to justify basing the analysis on one or few of these theories. Secondly, this paper assumes that, while the two concepts are related, servitization and digital servitization are likely subject to different effects, and there are insufficient compelling reasons to believe that theories of servitization success also apply to DS.

To start off the analysis, the papers were read through for familiarization. The findings sections of the papers were coded in NVivo through an open coding approach: any topics that were presented as relevant were marked, where necessary with connections and themes attached to them (Elo & Kyngäs, 2007). Only the findings sections were analysed to avoid interference from other studies. The codes were then grouped together and subsequently categorized. These

categories formed the basis for higher-level abstractions, which were then translated into the framework presented by this paper (Elo & Kyngäs, 2007). As such, the paper uses inductive content analysis to recognize emergent themes in the extant empirical literature on digital servitization. The coding structure is presented in Appendix B.

4. Results

Based on the coding process, the study identified six aggregate themes in the literature: organizational factors, the role of network partners, customer relations, digitalization and data, and the DS value proposition.

a. Organizational factors

The structure of a servitizing firm plays an essential role in its DS success – or lack thereof. As such, it should come as no surprise that the organizational factors code is one of the richest, hosting a large quantity and variety of codes. Some organizational factors are relatively static, akin to properties or goals to achieve; others are dynamic, pertaining to the processes playing out at the firm as the transition unfolds. Since many static and dynamic processes are intertwined, this section will not explicitly distinguish between the two; however, it does acknowledge that the two are different in nature, and this may change the way they affect the DS process.

i. The transformation process

The first code presents an inherently dynamic factor. After all, a servitizing company is a company in flux, and the nature of this transition affects its outcome. The question, then, is what the nature of the transition should be. Several papers describe an idealised development model, usually consisting of three to five stages. Throughout these stages, the service and digitalization strategy co-evolve rather than develop separate from one another. In many of the models, the first phase is a strategic one: during this phase, the company builds its understanding of the customer's needs and digital opportunities and starts defining its goals accordingly. The second phase is usually one of development: during this phase, the studied case firms start developing their value proposition and build a network of digitalization partners. Some papers recognise a third step where the service offering and the associated contracts are (co-)developed, but several papers directly moved on to the next phase. This phase is an implementation phase, where the firm rolls out the DS offering and promotes it to customers.

In some models, the final step is reserved for learning, reflection, and evaluation. During this phase, the process and its outcomes are evaluated, and potential improvements for the next cycle are assessed. Even papers that did not map out a development process recognised the importance of organizational learning through approaches such as participative workshops where employees collaboratively review and revise their strategies. Since the organization is largely unexperienced with its new strategy, conscious learning is essential to understand which tactics work and develop those further. Such learning most organically takes place at the end of a creation cycle, but it can also be more pervasive. A firm can reflect on their progress at any point in the process. In fact, such learning by doing is desirable, as it helps the firm constantly improve their process rather than limiting learning moments to the end of the cycle.

The development processes above explain how a firm can roll out its transformation, but it says little about the nature of the innovation. This was a significant theme in the literature. From the analysis, a debate emerged about the desirability of incremental and radical change. Most articles viewed an incremental approach as necessary or even desirable. For one, many firms do not possess the necessary resources to orchestrate a radical shift, and employees need to ease into the changes. Moreover, several papers pointed out that incrementalism allowed their case firms to build on existing capabilities, making the transformation much smoother and allowing

the firm to draw on their unique pre-existing manufacturing capabilities. The only paper explicitly advocating *against* incremental pointed out that incremental change increased confusion: “The slow, unsure extension of functionalities, professional figures, tools and procedures in service, generated confusion and resistances, revealing information asymmetries between functions.” (Galvani & Bocconcelli, 2022, p.6).

Radical change is much less widely advocated within the sample. Some articles see it as a necessary evil, suggesting that an overturning of the business model is near-inevitable to achieve a true transformation. However, even those papers suggest that too much novelty may confuse the customer and generate too much uncertainty due to the lack of an established framework for value assessment. Two papers, therefore, suggest that a servitizing firm must be able to simultaneously manage radical and incremental change, a paradox that cannot be avoided but only managed. For instance, the firm could ease the conflict through solutions-oriented training and strong internal information sharing routines.

Although more salient for radical transformations, resource availability is a challenge for any form of DS transformation, as upfront investments are usually required to build the necessary IT functionalities. Development resources are all too often deprioritized, hindering progress, so companies must go about allocation of their scarce resources strategically. To some extent, a firm can draw upon existing resources, but these may be limited. Therefore, the firm may have to negotiate with suppliers, who typically have greater R&D budgets, to take an active role in driving the innovation process. Since the firm may not always be able to negotiate this with their supplier, they may draw upon partners such as banks to acquire the necessary resources. This challenge is compounded by the fact that the customer may also need to make investments to be able to use the DS offering, so it needs to be abundantly clear to the customer what the benefits of the offering are. Thus, the need for upfront investment can create challenges across every step in the value chain.

ii. Company culture

Numerous articles noted the importance of the ‘company culture’ being conducive to the DS transformation. However, ‘culture’ is a vague concept, and the literature is relatively vague on what constitutes a desirable company culture. Some articles mention specific pointers. For instance, a few articles encourage cultivating an error culture where mistakes are used as a learning opportunity. Some others emphasise having a holistic perspective over the firm’s entire business network and the entire set of DS tools and competences that the firm has to its disposal. However, these suggestions only provide parts of the puzzle. Perhaps the most agreed upon conceptualisation of desirable company culture is that services rather than products are the norm at the company. Although this may seem obvious, several case companies still clung onto a product-oriented engineering mindset, where technological solutions to issues are prioritized. This is logical, considering that most case companies had their roots in manufacturing, and the engineering mindset is certainly not always negative: after all, it contributes to delivering high-quality, cutting-edge technology. However, more often than not the engineering mindset was described as hindering the transformation, as personnel at the company may concentrate on technical improvements to the product rather than expanding the DS business model.

Because of this, a cultural shift is widely deemed necessary. One paper suggests that this shift has the biggest chance of success if it builds on the company’s history rather than completely subverting the company’s identity. Thus, the company would use the engineering mindset as a starting point for developing a service-oriented mindset. Another study even pointed out that their case company perceived servitization rather as a return to its roots than as a new step, as the firm had started out by producing customized goods. It is important to frame the cultural

shift in terms that are familiar to the company, since employees may reject the transformation if it is framed as a great departure from the company's values.

One often-used strategy in orchestrating a change in culture is to revise the metrics for success. Many articles stress the importance of adapting the logic of the key performance indicators to suit servitization goals, rather than the sales-oriented KPIs that the engineering mindset dictates. To optimize organizational learning and ensure that the KPIs match the company's DS goals, the firm should regularly review and revise its DS goals. This, then, is one concrete tactic for shifting the company's focus towards service provision.

iii. Roles within the firm

The firm consists of its employees: the transformation is orchestrated by its employees, and company culture is fostered by employees. As such, it should come as no surprise that employees and their role in the transformation are amply mentioned within the sample. Numerous papers argue that employees should be actively involved in the change process, for instance through participative workshops. This is important for several reasons: first, the employees are the ones that should implement the strategy, so they have to feel comfortable with it. Second, the employees possess unique knowledge that can be utilised when designing the change process. One article warns that, in their case study, one employee group quickly became the dominant voice in the discussion, meaning that their needs and input were much more heard than that of their coworkers. In these situations, it is up to the transition managers to moderate the process in such a way that several groups' voices are heard. For this to be truly constructive, employees and managers must share a common vision. Everyone in the firm should be aware of what this vision is. To some extent the responsibility for this lies with the employees themselves: ideally, they approach the change process with an open mindset. Lack of willingness from employees is regularly described as a major challenge, as it can lock the firm within an engineering mindset. The manager can help foster an open mindset, though, through a strong understanding of the employees' respective backgrounds and goals which can be operationalized through open communication within the firm. A more straightforward approach that some successful firms pursued is to adjust the incentive and bonus structures in line with the DS strategy, as many manufacturing firms inherit sales-oriented target systems which motivate the employee to cling onto their engineering mindset. An ideal approach would do both, combining a soft approach with an appropriate incentive structure.

The above suggests that managers have an important role to play, and indeed numerous papers pointed out the crucial role of managerial commitment. Although an open mindset is essential on each level of the organization, change is often driven top-down. One article even found that, in one of their case companies, a bottom-up change became messy and poorly coordinated. Before the different levels of organization can adopt a shared vision, the management levels must clearly formulate and communicate this vision. This does not stop at top management, as disconnect between top management and the rest of the organization severely hinders the transformation. Thus, there is a need for individuals that act as boundary spanners. Some papers suggested that project managers can be such boundary spanners, translating top management visions into project strategies. However, it is very possible that the firm does not yet possess the competences to bridge the gap between sales, services and IT. In such a situation, the firm may have to hire or train employees who can fill this role.

More broadly, DS requires a wholly new set of versatile digital and service skills that may not yet be available for the firm. This shift can prove challenging to the firm, as it requires a process of "implementing solutions, reflecting on the outcomes, and learning from operational experience to progressively develop digital service delivery skills, user capabilities, and

procedural knowledge” (Sjödín et al., 2020, p.488). Besides external partnerships, which are described in section 4c.ii, the sample described two primary strategies for achieving this. Firstly, the firm may invest in employee training: many successful case firms rolled out training programmes or workshops. These allow employees to take on new responsibilities and cast off old responsibilities that have become obsolete. Secondly, the firm may choose to bring in individuals who already possess the desired skills. This must be handled carefully, though: being faced with personnel shifts may instil in employees a fear of layoffs, which is bound to demotivate them. Some articles therefore described the need for clear roles for different entities within the organization. These roles should not create rigidity as much as present a continuous bridging effort which simultaneously ensures continuity and enables discontinuity.

iv. Organizational structure

Aforementioned elements such as company culture and personnel form an overarching emergent organizational structure, and this structure needs to be conducive to DS also. Arguably the most important property of a servitizing firm is agility. A large majority of articles mentioned agile organization as a cornerstone to DS. This approach allows for a continuous assessment of new options and functions, which in turn creates greater adaptability towards customer needs. This is necessary in the face of rapidly changing technology and customer needs. The novelty of a DS offering makes it hard for customer and firm alike to comprehend the best approach upfront, so firms need to constantly update their value proposition, adding new requirements, changing existing ones, or even removing certain parts altogether. If they fail to do so, they run the risk of becoming uncompetitive following initial misestimations. As such, agility contributes not only to the quality of the product but also to the firm’s relationship with the customer and the firm’s ability to learn. Processes in traditional manufacturing firms tend to be rather rigid: it is therefore crucial that the firm consciously develops an agile mindset.

While the literature widely agrees on agility, other aspects of the desired organizational structure are debated upon. Many papers argue for cross-functional organizational structures, with short lines of communication between different teams and structures. Ideally, this allows back-end units to clearly define and communicate the core modules of the offering, the insights generated through IoT technology, and their range of possibilities to the front-end in regular face-to-face meetings or digital communication. In the cross-functional organization, the front-end can use this information to craft final offerings in conjunction with the customer, communicating their existing configuration challenges to back-end units. Thus, different units in the cross-functional organizations can collaboratively navigate the DS process, but the strategy’s success fully depends on frequent and open communication and active support from management. Only then can key functions such as procurement, R&D and operations be aligned to support cross-functional interactions. On the other hand, some articles document successful case firms that foster separate servitization-oriented business units. Some firms even obtained new service capabilities by acquiring start-ups or branches of other firms, which enables them to obtain service competences much more rapidly than if they were to develop them internally. While this leads to a less integrated organization, it may be more fool-proof. Thus, while all articles agree on the importance of agility, several organizational structures may be conducive to DS.

b. Customer relations

A cornerstone of DS is customer-oriented value. This relates back to the full-solution nature of servitized businesses: the firm is not only making and selling a product but working with and for its customer. As such, it is important to take the customer’s perspective into account from the very first step of the process. This necessarily includes a much higher degree of customer

value co-creation then one would find in traditional manufacturing firms: a small majority of analyzed papers acknowledge this factor. Here, customer value co-creation could for instance take the shape of jointly identifying customer needs, involving lead customers in design and testing phases, joint resource deployment, or iterative development processes where customers are included in the different steps of the process. This is desirable, in large part to ensure reciprocity between the firm and the customer. After all, it is hard to fully estimate customer demand up front. Moreover, sharing risks and payoffs in such a way is highly recommended: it means that the customer has a high stake in the solution's success, without feeling like the company is holding them hostage or depriving them of value.

Essential to value co-creation is to carefully consider customer feedback, which the firm can use to discover unmet customer needs and in turn improve their offering. This, too, was widely mentioned. Feedback collection is facilitated by digital technologies, as customers can use digital platforms to deliver feedback. The firm can even capitalize on IoT technologies to collect customer data, thereby decreasing the need for constant customer involvement and streamlining the process. Communication with customers also fosters relationships, which builds indispensable trust and loyalty between the customer and the firm. Servitizing firms must showcase their commitment to the DS partnership throughout every step of the process through means such as regular check-ins and common funds. Moreover, they must consistently offer high-quality products: desirable customized solutions at high speed and low cost can convince a customer that the servitized offering is preferable over any others. There is also a very important role for front-end employees, here, as they are the ones combining and communicating the offer. They must be flexible in their engagement with customers, adopting a role not just as a salesperson but as a trusted advisor. After all, customer management in a DS offering does not end with the contract. Some papers therefore emphasised the need for longitudinal contract management, warning that the firm should not see the signing of the contract as a done deal. Writing and managing a watertight contract is moreover helpful to prevent opportunistic behaviour, and to protect the firm from any unforeseen risks.

Opportunistic behaviour is a real concern, as the customers are bound to change their behaviour as the business model changes. Opportunistic behaviour is perhaps the greatest risk, as the customer may display a tendency to exploit the increased service responsibility of the provider through opportunistic behaviour. The company has to account for this in the revenue model. Even when customers do not blatantly exploit the firm's service responsibilities, the firm may struggle to keep up with fickle customer demands in the value co-creation process. Thus, DS can result in greater operational management and maintenance costs than the firm expected, either to keep up with changing customer demands or due to faster wear and tear.

Moreover, it is even possible that the firm must abandon current customer segments and reach out to new customer segments altogether. This is especially challenging as the company may compete over these new customer bases with suppliers or pre-existing customers, who had previously been supplying to these new customers. For instance, some firms decided to move downstream in the value chain, wishing to sell services more effectively by being closer to the end customer. However, these firms often faced resistance from their pre-existing customer base, who currently served as distributors to the end customer. Even when this competition does not exist, finding and acquiring new customer bases is an intensive process, and it can prove rather challenging for servitizing companies.

c. The role of network partners

A firm never operates fully alone, and this is especially true for a servitizing firm. Many of the analysed papers described the interplay between the firm and its business environment as well as the crucial role that network partners play in servitization success.

i. Suppliers

Since servitized offerings are structured differently from traditional manufactured products, their supply chain is bound to be structured differently as well. For instance, the customization that is common to servitized offerings creates more volatile procurement processes, where high inventories are a burden that create an inert backlog and make it harder to meet customer requirements. As a result, suppliers become a core group of ecosystem partners. Close relationships to external suppliers facilitate access to new specialised competences, but also reduce control over the process: several papers point out that dependency on non-agile, product-oriented suppliers is a major barrier to servitization. Of course, a firm has limited power over what their suppliers do; however, they can to some extent influence this factor by diversifying their supply base, thereby decreasing dependencies and suppliers' bargaining power.

To create favourable supplier relations, the firm must adjust its procurement processes to prioritize DS. Sjödin et al. (2021) sketch such an updated process by providing a model for DS procurement, consisting of four phases: mapping digital opportunities, selecting digitalization partners, codeveloping digital solution contracts, and promoting continuous digital innovation. Several articles contribute that digital capabilities can greatly smoothen this process. For instance, firms can use digital platforms to connect with suppliers in real-time and co-regulate supplier inventories. Some case firms within the body of literature even made such digital tools an explicit requirement for their suppliers. However, suppliers may not always have access to the necessary digital capabilities to enable this synergy. In these cases, a firm may choose to support their suppliers in the learning process. Alternatively, the firm can choose to seek new suppliers that either have the capabilities available, or display willingness to acquire the necessary skills. However, this is also notably difficult, and several case firms failed to do this. This, then, proves that it is impossible to fully neutralize the supplier's power, which underscores the importance of strong bonds of trust between the supplier and the firm.

ii. Other network partners

During the DS process, a firm is likely to build a network of new key partners. For instance, some case companies shared a digital platform not only with their distributors, but also with third-party service providers and regional units. Other new key partners include banks, insurance providers, universities, information technology service providers, and consultancies. These new partners can provide necessary knowledge and insights to facilitate the transition, complementing the knowledge and competences already present in the company. Such partnerships must be approached with caution, though, as new partnerships may generate inefficiencies in the absent of sufficient digital technologies to create interfaces between the company and its partners. Thus, when selecting partners, the firm must be critical: who can help the firm digitalize and improve overtime?

The prospect of potential inefficiencies may tempt a firm to prioritize suppliers and customers, thereby neglecting other network partners, but this is highly inadvisable. In fact, the firm must actively cultivate bonds of trust with its partners. This can be achieved through actions such as systematically verifying data security aspects and setting and subsequently achieving small, realizable goals. Many papers describe these relationships as 'mutually profitable connections', in a form of cross-company networking. However, the articles also recognise that many

servitizing firms are operating within highly competitive environments, and interdependencies may not be viewed positively as they enhance uncertainty and risk. As such, some papers even found that their case companies hardly pursued a cross-company network, although these papers were in the minority compared to papers that did describe a cross-company network. However, despite being rather thorough on the nature of bilateral partnerships, the sample remained rather superficial on the structure, functioning and benefits of the networks, limiting itself to vague terms such as ‘data and competence sharing’.

One group that remains curiously underdeveloped is the shareholder group. Only a few papers mentioned shareholder commitment as an essential factor to servitization success, but those that did considered it a crucial factor. One paper named continuous profit pressures from stock owners and investors as a major challenge while exploring service options. Conversely, another article suggested that committed shareholders can play an essential and very positive role in stabilizing the DS firm’s revenue.

d. Digitalization and data

Claims on data-related factors within the literature can largely be divided into two questions: what kind of data sets can be used and how this data can be used. This section first discusses the former question, describing desirable qualities of data sets for DS, and then elaborates on data use competences.

Not many papers in the sample elaborate on the data’s desirable qualities. Although the need for high-quality data is widely alluded to, it remains vague what quality data is. One matter that several articles agreed on is that, when it comes to data, more is better. Vast sets of data are especially important when making intensive use of AI algorithms, as the algorithms need high quantities of data for creating insights such as the identification of potential problem areas. As such, the case companies also use a wide range of data sources in their operations. However, leveraging these vast amounts of data can prove challenging, so many firms do not make optimal use of the data that is available to them. The question of who should own these data, however, is one that found less consensus. Most importantly, there is disagreement between papers on how important exclusive data ownership is. Some papers suggest that firms find a competitive advantage by having exclusive access to data, being able to use it as a unique resource. Other papers, however, do not perceive this as very important: they suggest that it is more important to have access to as much data as possible and gain a competitive advantage by using this data in innovative ways. Interestingly, many papers point out the importance of data sharing. For instance, several papers perceive data as the customer’s property, suggesting that the firm should create salient incentives for the customers to share their data. Thus, it is acceptable that the firm does not have access to the data: as long as the firm can offer unique and desirable applications of the data, the consumers are probably willing to share it anyway. Furthermore, studied firms are prone to share data with partners such as suppliers, to facilitate co-creation and avoid incompatibility between the firms’ digital infrastructures. This wide sharing of customer data, then, does greatly increase the importance of data security. Proving to your customers that you are keeping their data safe is an essential part of maintaining their trust; indeed, one paper pointed out that their successful case firms all use state of the art security solutions.

With these pointers on data properties in mind, the question becomes how data should be used. All papers agreed that having a clear vision is essential to successfully pursuing a digitalization trajectory, as this helps steering the organization in a unified direction and building trust among the customers. Thus, the starting point of most DS process models is to assess digitalization opportunities and formulate digitalization goals. The other matter that most articles agree on is

that data has a unique role in DS companies; several papers described that, while product- and service- modules are relatively interchangeable, the information modules are unique enablers to the servitized business modules. Data therefore plays an irreplaceable role in every step of the process, from strategizing to customer engagement to evaluation. Among others, it is a unique enabler of trust between company and their customer, as it allows for great amounts of transparency and information sharing. Yet, one paper does point out that strong data capabilities alone are not sufficient; they are merely a facilitator to the DS journey.

To exploit this unique facilitator, the firm requires a sufficient set of data analysis competences and tools. Such skills include connecting cloud servers, developing software, applications and analytical tools, using information modules to collect critical data and identify customer trends, leveraging data to identify unmet customer needs and new business opportunities, and defining the right criteria for evaluating digitalization success. A firm may also create a feedback loop, where data-generated insights are used to define trainings that in turn strengthen other competences, which can create massive advantages as many traditional manufacturing firms initially lack digital affinity in their workforce. To build such capabilities, the firm needs appropriate tools: it requires access to IoT-, cloud-, and (big) data analysis-tools, data warehouses and data monitoring centres, and processes for data use. Finding the right tools is a challenge, though, and acquiring them may be even harder. This is especially true for smaller companies with fewer resources, who may need to call upon network partners for them.

Simply having access to the right capabilities and tools does not suffice, though; nearly all papers that explicitly mention data use also discuss the importance of successfully monetizing data. This does not need to be complicated: for instance, data use can simply be a way to make the offering more efficient, increasing the firm's adaptability, or ensuring smoother and more far-reaching communication. Similarly, potential for future revenues can be identified through data analysis. However, more intricate digitalised business models are possible: for instance, some firms choose to license their software rather than selling their product, creating consistent long-term revenue. Special attention, here, needs to go to the concept of the digital platform, which is widely recognised as a deeply promising method for utilizing data. A platform approach is seen as a way to "leverage flexible ways of configuring advanced service offerings enabled by combining product modules, service modules, and information modules" (Cenamore, Rönnberg, Sjödin & Parida, 2017, p.58). The platform is a very suitable way to exploit the firm's digital competences, as it is an easy way to coordinate different functions and connect in real time with suppliers and customers. As such, the digital platform may provide the company with a reliable source of data, or the customer with an easy way to share feedback. Some articles even proposed selling the 'platform as a service', offering the customer a subscription to the platform based on a regular fee.

A common pitfall, though, is to overzealously develop an overly complex digital business model, which may alienate the customer by unnecessarily driving up prices and complicating the offering. It is crucial that the digitalizing firm is mindful of its business context and its customers' wishes: even when a tool may appear unambiguously helpful, it is only desirable if the customer also understands it and sees its value.

e. The DS value proposition

Being a business model innovation, DS requires a firm to vastly change its value proposition and delivery to suit digital services. Thus, the sample proposes various options for a renewed business model. This section summarises these suggestions and discusses how a DS firm can define value.

i. The structure of the DS value proposition

One of the most widely mentioned appeals of a servitized business model is customization, the ability to tailor the offering to the customer's specific need. Customization greatly raises customer value and, with it, customer loyalty. Effective customization requires access to specific customer data, a close relationship to the customer, and flexibility in value delivery from the firm. A unique benefit of DS, specifically, in pursuing these strategies is the remote support that a digitalized firm can offer. Firms can use the data gathered from machines or separate sensor technology to understand how customers use the firm's products and even predict potential malfunctions. They can then tailor their services accordingly. A major benefit of this approach is that the offering is no longer location bound, allowing the firm to act faster and serve a larger market. Several firms decided to offer such digital services as a contract-based service, showcasing a compelling DS value proposition.

Unfortunately, though customized offerings are harder to manufacture and deliver on a large scale, potentially making the value delivery less efficient and more expensive. The trade-off between customization and scalability or standardization was one of the most-discussed conflicts within those papers in the sample that discussed the value proposition. To some extent, firms can counter this issue by implementing modularity or microservices, where microservices are focused DS functionality which perform one narrow task very well. Individual modules are much easier to standardize, so building the solution around modules or microservices can reduce its complexity. It also allows the firm to add new functionalities more easily to the offering. Some papers pointed towards other aspects of the business model that may be standardized for greater efficiency, such as data collection processes, infrastructures, or communication plans. These papers tended to understand the risk of standardization, but view it rather positively. Still, most papers argue that standardization must be approached with caution as it counters customization ideals. The company is therefore threading a fine balance between standardization and customization, and where this balance lies remains unresolved within the literature.

The sample pointed towards several other challenges specific to DS. For instance, the firm may struggle to assess the value of the DS offering, making it hard to appropriately estimate the customer's demand and willingness to pay for certain offerings. For instance, an overly complex solution may be disproportionate to the customer's need. This can culminate in a servitization paradox as the firm finds it had overestimated DS revenue streams. Even when the DS offering is successful, revenue may fall short as the service offering may compete with the product offering, meaning that overall firm revenue stagnates or falls.

The sample provides little analysis on how to combat these risks. Some papers argue that the company must have an intimate understanding of the business context: firms need to understand the customer's willingness to pay and account for the risks of misestimating revenues. However, for an offering as new as DS, even the customers themselves may not be entirely sure what they need; little indications exist in the sample of how risk can be managed in this environment of uncertainty.

ii. Value metrics for DS

Perhaps one of the most important challenges in developing a DS value proposition is how to assess and communicate the value of the DS. Especially proving the concept is essential for an offering as new as DS, as customers may otherwise be hesitant to opt in: several papers point out the importance of doing so, but they also admit that this can be difficult to achieve. One tactic employed to overcome this challenge is to develop new service-oriented routines that the

firm can leverage to showcase its ability to handle servitized offerings professionally. Transparent communication of said routines is essential to make the (potential) customer understand and appreciate the company's competence.

One important difference between DS offerings and traditional product offerings is the timeline for value delivery. Several papers indicate that the value delivered in DS offerings is of a more long-term nature than that delivered in a traditional manufacturing firm, as the firm is much more responsible for the offering throughout its lifetime. As such, longitudinal life cycle thinking is described as an essential approach to servitized offerings. The firm must calculate close cooperation with the customer throughout the useful life of the product into its value metrics from the very start to accurately capture the value of the offering. Firms must keep their lead-times low, offering customers fast response times throughout the sales process and product life cycle. When done well, low lead times can be a unique benefit of DS over traditional products since the firm has a pre-existing relationship with the customer and digital technologies allow for fast communication. However, this is also a crucial point of transformation: as pointed out above, traditional manufacturing firms are often non-agile with rigid development cycles.

The elephant in the room, however, is cost. Although there are clear benefits to proven quality and high response times, most articles acknowledged that the costs of the DS offering as well as the transition itself are the key factor motivating both the customer and the firm itself. Some articles described that the DS offering would be more financially attractive than its competitors due to factors such as greater material efficiency or higher efficiency of modular offerings compared to standardized products.

However, a firm may encounter unexpected costs. These costs mostly arise within the domain of greater operational management, delivery, and maintenance costs. This may fuel a digitalization paradox, as the firm may struggle to account for these costs in its business model while remaining attractive. Especially for highly customized offerings, the DS product runs the risk of being more expensive than its competitors. This is especially salient as, even in a servitized firm, many KPIs are financially oriented, and keeping costs down is an essential customer retention strategy. Some papers in the sample suggested approaches to lowering costs: for instance, firms would bundle individual modules or microservices into (pseudo-)standardized total solutions; attempt to keep the complexity of the total solution at a minimum; create relationships with suppliers to lower transaction costs; or by increasing supply volumes. Interestingly, some of these suggestions contradict claims that were discussed in earlier sections: for instance, increasing supply volumes may help keep costs low, it has also been warned for as creating an unwieldy backlog that renders the firm unagile. Similarly, the suggestion to bundle modules is reminiscent of the earlier discussion between customization and standardization. As such, this section raises an important debate on the desirable balance between strategies for servitization success.

5. Discussion

a. A conceptual framework for digital servitization success

Based on the results described in chapter 4 and its understanding of foundational servitization theory, the study can fulfil its purpose of designing a conceptual framework that maps servitization success as described by empirical studies on the topic. This framework is depicted in **Error! Reference source not found.**

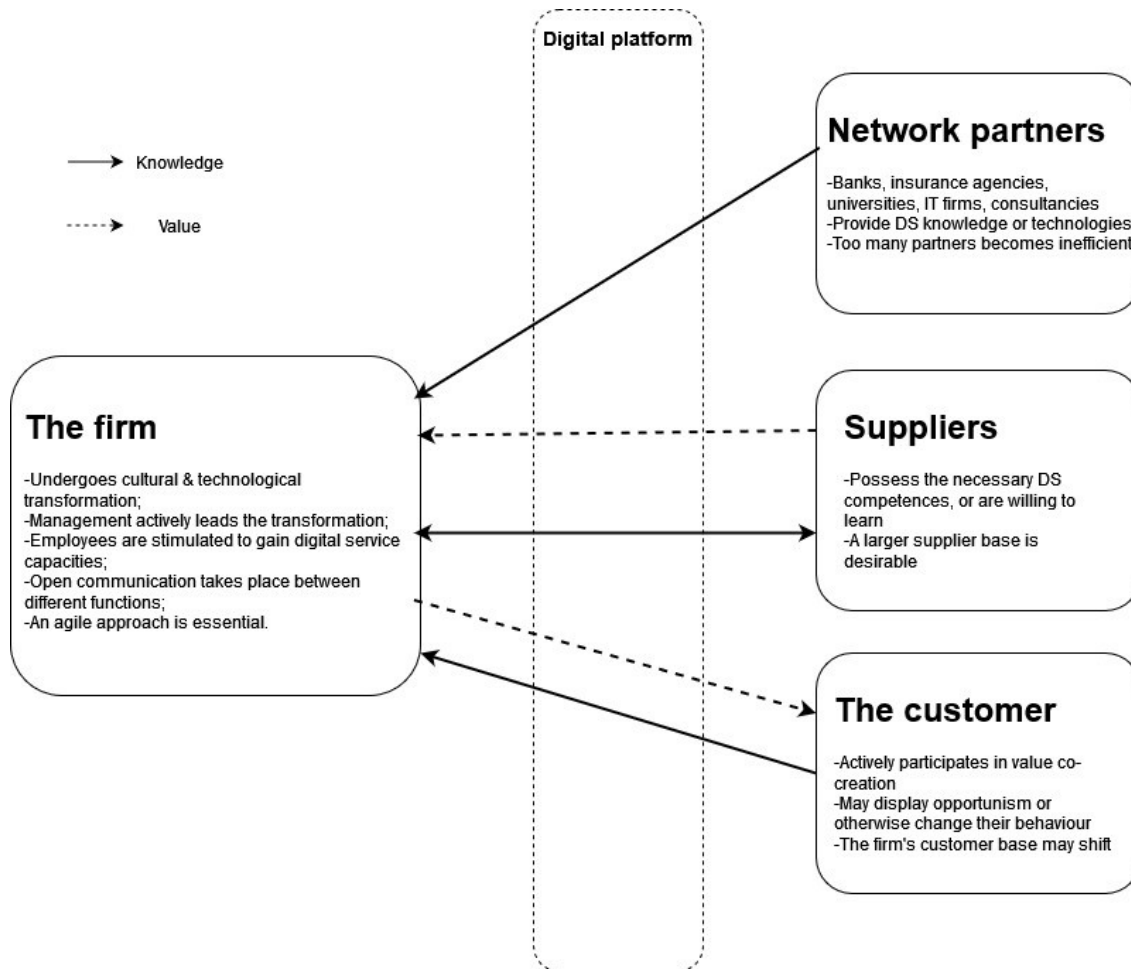


Figure 9: A conceptual framework for successful digital servitization.

At the core of this model is the firm itself, one of the most-mentioned entities both in the sample and in the literature review – and with good reason, as the firm is the entity initiating and undergoing the DS transformation. Although external factors may affect the way the transformation develops, sometimes in ways that are outside the firm’s control, it is ultimately the firm’s responsibility to make the process run smoothly. This understanding of the transformation was already suggested by Bernedettini et al (2015), who proposed that internal risks are a much more significant factor to the success or failure of a servitized offering than external risks.

The analysis reveals that the firm must undergo a dual transformation: a technical business model innovation, but also a cultural shift. In DS this transformation is even more complex than for traditional servitization. While in traditional servitization, the shift is oriented on one primary variable, that being service infusion (e.g. Oliva & Kallenberg, 2003; Martinez et al.,

2010), DS adds the element of digitalization to the mix. This increases the number of new capabilities and resources that the firm needs to develop even further. Doing so poses a major challenge that must be handled thoughtfully. The consensus in the sample is that this role is mostly for management, who must be committed to guiding the transition. They need to stimulate the firm's employees to gain the necessary capabilities through workshops, training, and open communication; decide how the firm defines servitization success and adjust KPIs and incentive structures accordingly; and bring in new competences where needed. For this process to turn out successfully, short lines of communication need to exist between the different functions in the firm and the firm must operate in an agile way. Agility is an essential part of DS. Although it did not come up much in the literature on traditional servitization, Tronvoll et al. (2020) already indicated the importance of agility when digitalization enters the mix, and nearly every paper in the sample agreed with this idea.

The firm relates to three groups of stakeholders, with whom they exchange value in the form of goods and services and knowledge in the form of data and competences. Each group may contribute to the firm's DS success in a different manner, meaning that different traits are required from each group. Although these stakeholder groups are of course external to the firm, the firm can still exert some influence over them: most notably, they may set certain standards for their network, maintain close relationships to their network, offer training and capacity development, or simply change the composition of their network to fit their new strategy. In DS, interaction between the firm and these three groups is moreover heavily facilitated by digital technology, often in the form of a digital platform, which allows customers to provide easy feedback to the firm and share data in real-time. Data-sharing was generally highly advised (although several papers warned for data security). Here, the thesis corroborates Bressanelli et al.'s (2018) four v's for data and digitalization: volume, variety, velocity and veracity; however the SLA also warned against overcomplicating the digital structure to a point where it is incomprehensible to employees and the firm network alike. The digital aspect of the business model should be as simple as possible for maintaining a useful offering.

A notable new feature of a DS firm's customer base is its active participation in value co-creation. In the diagram, this is visualized as a full arrow symbolizing the feedback and data that the customer provides to improve the value delivery (dashed arrow) that the firm offers to the customer. The customer is therefore generally a trusted partner who has a close relationship with the firm, which is corroborated by the theoretical framework (e.g. Martinez et al., 2010; Vargo & Lusch, 2004; Baines et al., 2020). The firm may strengthen their relationship to existing customers, or seek out new customer segments altogether. However, the results of the SLA displayed an alarming rebound effect that was not recognised in the theoretical framework: the customer may also take advantage of the increased manufacturer responsibility that comes from servitization. As such, the original idea of a DS firm cultivating a close relationship with their customer may be a romanticised one.

Next, a digitally servitized firm generally wants to cultivate a close relationship with their suppliers, but avoid dependencies so as to limit the suppliers' power over the DS transformation. One popular approach to guarantee this was to ensure a diverse supplier base. If the manufacturer has too much power, they may hinder the shift away from an engineering mindset (see also Hullova et al., 2019); if the firm has more power, they can demand higher levels of DS competence from the supplier. To this end, a lot of knowledge transfer takes place between the firm and its supplier, as already suggested by Valtakoski (2017). Next to supplying value in the form of physical products, the supplier shares product and inventory data with the firm; and, where needed, the firm shares knowledge with the suppliers in the form of new DS capabilities to help the supplier adapt to the firm's digital service offerings.

The third and final group that the firm engages with are network partners. This group consists of banks, insurance agencies, universities, IT firms, consultancies, and potential other stakeholders, although not necessarily all of those – a too large network becomes inefficient and is therefore inadvisable. This network mostly provides guidance, technology, and resources when the firm cannot acquire these themselves: for instance, universities and consultancies may help the firm develop its digital and servitized competences, and IT firms may be a valuable outsourcing partner if the firm cannot develop the necessary digital capabilities internally. As a result, the model depicts this relationship mostly as a one-sided knowledge transfer from the network partners to the firm. In reality, this relationship is not completely one-sided: for instance, a firm may provide universities with an opportunity to do research or reimburse IT firms and consultancies for their work. However, as these transfers are not directly related to the servitization process, they are outside the scope of the model.

The network interactions above, then, ultimately culminate in the value offering from the firm to its customer, represented in the diagram by a dashed arrow from the firm to the customer. Although most DS success factors described in the model pertain to properties of or actions performed by the different actors in the network, the business model itself is perhaps the most important determiner of servitization success. After all, the very purpose of the network is to build an attractive value offering. The SLA's results on the nature of the value proposition leave some questions open. The analysis suggests cost, lead time and quality of the overall service relationship as important factors for a successful DS business model, and the articles generally agree that modularity and customization are effective ways to achieve this. However, the literature does not offer explicit characterization of potential DS business models in the same way that some literature on traditional servitization has done (e.g. Tukker, 2004; Oliva & Kallenberg, 2003; Storbacka, 2011). This is especially unfortunate considering that the SLA does uncover the paradox between effective customization and efficient industrial-scale manufacturing that was already problematized by Kohtamäki et al. (2020) and Dimitrijeva et al. (2022). Thus, the nature of the DS value proposition is still up for debate.

b. Successful digital servitization in the circular economy

The analysis conducted in this study vindicated the intuition developed in section The product-service system: servitization in the circular economy: circularity is not a salient topic in literature on DS success. Not a single paper within the sample positioned their study within the domain of circular economy. This does not have to mean that no bridging efforts between strategic and sustainable PSS exist at all. What it does suggest is that there is a severe lack of research on commercial success for sustainable DS business models, despite the dire need for such research. After all, many purpose-designed sustainable PSSs fail or underperform (Laumann Kjaer et al., 2018). The findings also echoed Tukker's (2015) warning that the most popular servitized business model innovations are the ones that require the least restructuring of the business. The literature clearly preferred incremental innovations and product-oriented business model innovations, such as customized offerings and product maintenance, were by far the most explored in the sample. However, especially for the relatively unexplored niche of DS, it is unclear how sustainable such product-oriented business models truly are. Meanwhile, use- or result-oriented business model innovations, such as platform as a service, are mentioned favourably but hardly developed, despite their high circularity and service potential.

As a result of the above, topics that were considered essential to sustainable PSS were largely neglected in the studied sample. Matters such as the management of the end-of-life phase and the target of net resource reduction must be considered in a truly sustainable servitization strategy (e.g. Mont, 2002; Laumann Kjaer et al., 2018). These topics are not named at all within

the sample, despite their central role within sustainability literature. This is unsurprising: while central for developing circular business models, there is not always a clear business case for them. The challenge lies in finding areas where the business case and the sustainability case overlap: for instance, strategies that combat opportunistic behaviour may also mitigate rebound effects. Meanwhile, factors that were identified as crucial to the business success of DS, such as short lead times, are harder to achieve when pursuing an explicitly sustainable offering (Mont, 2002). These factors are seemingly difficult to reconcile – as such, it intuitively appears that commercial success and circularity success undermine one another. Further research combining the two is desperately needed before servitization can live up to its full sustainability potential.

The news is not all bad, though: many applications of DS that were laid out in this thesis also facilitate a sustainable transition. For instance, the remote support offerings that were suggested repeatedly in the sample align very well with the sustainable applications of IoT suggested by authors such as Bressanelli et al. (2018) and Kuhl et al. (2018). This proves that there is certainly a commercial potential for sustainable servitization. Data and digitalization can be a powerful facilitator to achieve this goal, which can make a real impact with further work on the overlap between digitalization, servitization, and circular economy.

c. Directions for future research

From the SLA, an image emerges of DS success as a field that is taking shape, but still exists in an early phase of development. This leaves many questions to be answered; for some of these, DS scholars can look towards evidence on traditional servitization, but due to the complexity contributed by the additional dimension of digital technologies one must be cautious in extrapolating lessons from traditional servitization to DS. As such, the thesis proposes that additional research be conducted in the following areas:

1. *Business models for digital servitization*: Most articles in the sample agreed on individual elements of the business model, but no clear concept of the DS business model emerged from the study. While these typologies abound in literature on non-digital servitization (e.g. Ulaga & Reinartz, 2011; Lexutt, 2020; Brax et al., 2021), no such thing was found in the analysis. This is direly needed, considering that the business model is ultimately the firm's key to transforming their DS capacities into customer value (Han et al., 2020). Moreover, no clear solution for relevant business model challenges emerged: for instance, the literature does not provide a clear solution as to how the firm can prevent internal competition between the service branch and the product branch, even though this is a problem that was mentioned in the sample as well as the servitization literature (e.g. Vandermerwe & Rada, 1988; Oliva & Kallenberg, 2003). Similarly, the sample does not offer feasible approaches to radical service innovation, even though this is usually much more effective for achieving circular economy purposes (Tukker, 2004). Moreover, this focus on incremental innovation excludes many highly promising business models, such as IoT-based networks of smart, connected products (Paschou et al., 2020). Thus, the thesis proposes (i) working towards a typology or conceptualisation for DS business models; (ii) devising solutions for self-competition challenges; (iii) designing feasible approaches to radical innovation.
2. *Digital servitization in the circular economy*: Prior literature agrees that DS has great potential to contribute to circular economy (e.g. Han et al., 2020). Yet, the sample made no notable mention of sustainability or circularity concerns, suggesting that it is not a topic that is considered when conceptualising servitization success. This is concerning,

since a DS offering must be designed with circularity in mind for it to truly live up to its sustainability potential; it cannot be an afterthought (Laumann Kjaer et al., 2018). Thus, this thesis proposes (i) to make an active bridging effort between commercially- and sustainability-oriented DS research; (ii) to study if crucial circularity concerns such as end-of-life resource management can be implemented in a way that furthers DS competitiveness.

3. *Customer relations in digital servitization*: Customer-oriented value is at the core of a DS offering, and the servitizing firm is expected to actively engage its customers in the design of its offering. However, the dynamics of the customer relation remain underexplored. Valtakoski (2017) already noted that customers' motives for servitization as well as the collaboration and division of labour between the solution provider and the customer remained underexplored in the contemporary servitization literature. This study's sample does not expand on these themes, even though they are central to designing the customer relationship. Thus, the thesis proposes researching themes such as (i) the structure of collaboration between customers and firms within DS; (ii) how to engage customers in the change process in such a way that they are invested in the idea of DS; (iii) how exactly data and digital technologies can be utilised to facilitate constructive relations between the solution provider and the customer.
4. *The structure of the network*: Much like close customer relations, a close network of new DS partners is generally perceived as a good thing, but it is unclear how this network should be approached to make the most of DS. Besides the above-mentioned paradox between cross-functional integration and employing external competences (1.iv), this study proposes further research into: (i) how a firm should find and select partners; (ii) how a firm can use digital technologies to connect and maintain a diverse network; (iii) how different organizations can use DS networks to develop mutually beneficent resource-sharing strategies.
5. *Coping with paradoxes of digital servitization*: Several paradoxes of traditional servitization (e.g. Kohtamäki et al., 2020; Dimitrijeva et al., 2022) can also be recognized in the literature on DS, either as explicitly described conflicts or as unresolved contradiction between articles. However, little to no evidence exists on coping strategies for these paradoxes in DS. The most notable conflicts persist between (i) customization v. scalability of the offering; (ii) agility in designing the offering v. creating routines for perceived reliability; (iii) data sharing v. data protection; (iv) cross-functional integration v. employing external competences.
6. *Risk management and uncertainty*: Servitization occurs in markets with high relational complexity, low substitutability, and high contextuality (Valtakoski, 2017). This means that servitizing firms face higher risk than traditional manufacturing firms (Zhang & Banerji, 2017; Bernedettini et al., 2015). The SLA shows how this risk is amplified by the sheer newness and technological volatility of DS, as the topic of risk was at least mentioned in passing in every aggregate theme. Yet, explicit explorations of risk and how to handle it within DS are scarce. Thus, this thesis suggests (i) further exploring the new levels of complexity in a DS value network; (ii) researching strategies for risk mitigation in DS value networks.

6. Conclusion

The purpose of this thesis was to map which challenges and success factors can hinder or support a manufacturing firm's digital servitization trajectory. It specifically aimed to distinguish factors that are common in the literature from those that are still contentious so as to provide directions for future research, and to understand how commercial success factors interact with servitization's sustainability potential. To achieve these goals the thesis has synthesized existing literature on digital servitization into a conceptual model of DS success. It built its original understanding of servitization on the field of traditional servitization, but understands that the inclusion of digital strategies in the servitization transformation adds new dimensions to the process, which expand the scope of necessary components to a successful strategy. Therefore, the thesis departs from classical servitization literature by specifically focusing on DS.

The systematic literature analysis yielded an image of DS as a process that is internal to the firm, and therefore subject to the firm's corporate culture and structure as well as the level of commitment of different employee groups within the firm. However, it also made the importance of context abundantly clear, especially highlighting the position of customers, suppliers, and network partners in DS value creation. The thesis then shows how the actors within this value network exchange knowledge and value as the firm co-creates the DS value proposition. However, due to the novelty remains unclear. This unfortunately includes the strategies a firm can use to achieve the DS offering's sustainability potential, which was left undiscussed by the analysed papers. To further the understanding of DS success, the thesis suggests further research into the topics of business models for DS; digital servitization in the circular economy; customer relations for DS; the structure of the value network; DS paradoxes; and risk management for DS.

The study's main contributions are fourfold. Firstly, it creates an overview of case studies on success factors and challenges for DS, thereby helping scholars understand the current state of the empirical evidence in the field. Secondly, it created a conceptual model for a successful DS value network, thereby providing practitioners and scholars alike with a comprehensible overview of success factors and challenges for servitization. Thirdly, it compared empirical evidence on servitization success to literature on sustainable PSS, thereby generating awareness of the large untapped potential for further exploration between the two domains. Finally, it provides six categories of themes that should be further explored to create a more comprehensive and actionable understanding of the road to successful DS.

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Appendix A

Papers included in the sample for the content analysis

Author(s)	Year	Title	Journal
Cenamor, Rönnerberg, Sjödin & Parida	2017	Adopting a Platform Approach in Servitization: Leveraging the Value of Digitalization	International Journal of Production Economics
Chen, Visnjic, Parida & Zhang	2021	On the Road to Digital Servitization – The (Dis)Continuous Interplay between Business Model and Digital Technology	International Journal of Operations and Production Management
Chester Goduscheit & Faullant	2018	Paths Toward radical Service Innovation in Manufacturing Companies – A Service-Dominant Logic Perspective	Journal of Product Innovation Management
Coreynen, Matthyssens & Van Bockhaven	2017	Boosting Servitization Through Digitization: Pathways and Dynamic Resource Configurations for Manufacturers	Industrial Marketing Management
Ferreira Junior, Scur & Nunes	2022	Preparing for Smart Product-Service-System (PSS) Implementation: An Investigation into the Daimler Group	Production Planning and Control
Frandsen, Raja & Neufang	2022	Moving Towards Autonomous Solutions: Exploring the Spatial and Temporal Dimensions of Business Ecosystems	Industrial Marketing Management
Galvani & Bocconcelli	2022	Intra- and Inter-Organizational Tensions of a Digital Servitization Strategy. Evidence from the Mechatronic Sector in Italy	Journal of Business and Industrial Marketing
Grandinetti, Ciasullo, Paiola & Schiavone	2020	Fourth Industrial Revolution, Digital Servitization and Relationship Quality in Italian B2B Manufacturing Firms. An Exploratory Study	TQM Journal
Harris & Wonglimpiyarat	2020	Strategic Foresight of Xerox Servitization: Look Back and Look Forward	Foresight
Huikkola, Kohtamäki, Rabetino, Makkonen & Holtkamp	2022	Unfolding the Simple Heuristics of Smart Solution Development	Journal of Service Management
Huikkola, Kohtamäki, Rabetino, Makkonen & Holtkamp	2021	Overcoming the Challenges of Smart Solution Development: Co-Alignment of Processes, Routines, and Practices to Manage Product, Service and Software Integration	Technovation
Huikkola, Rabetino, Kohtamäki & Gebauer	2020	Firm Boundaries in Servitization: Interplay and Repositioning Practices	Industrial Marketing Management
Kohtamäki, Rabetino, Einola, Parida & Patel	2021	Unfolding the Digital Servitization Path from Products to Product-Service-Software Service: Practicing Change through Intentional Narratives	Journal of Business Research
Linde, Frishammar & Parida,	2021	Revenue Models for Digital Servitization: A Value Capture Framework for Designing, Developing, and Scaling Digital Services	IEEE Transactions on Engineering Management

Linde, Sjödin, Parida & Gebauer	2020	Evaluation of Digital Business Model Opportunities: A Framework for Avoiding Digitalization Traps	Research Technology Management
Mosch, Schweikl, Obermaier	2021	Trapped in the Supply Chain? Digital Servitization Strategies and Power Relations in the Case of an Industrial Technology Supplier	International Journal of Production economics
Münch, Marx, Benz, Hartmann & Matzner	2022	Capabilities of Digital Servitization: Evidence from the Socio-Technical Systems Theory	Technological Forecasting and Social Change
Rajala, Brax, Virtanen & Salonen	2019	The Next Phase in Servitization: Transforming Integrated Solutions into Modular Solutions	International Journal of Operations and Production Management
Rudnick, Riezebos, Powell & Hauptvogel	2020	Effective After-sales Services Through the Lean Servitization Canvas	International Journal of Lean Six Sigma
Rymaszewska, Helo & Gunasekaran	2017	IoT Powered Servitization of Manufacturing – an Exploratory Case Study	International Journal of Production Economics
Sjödin, Parida, Palmié & Wincent	2021	How AI Capabilities Enable Business Model Innovation: Scaling AI Through Co-evolutionary Processes and Feedback Loops	Journal of Business Research
Sjödin, Kamalaldin, Parida & Islam	2021	Procurement 4.0: How Industrial Customers transform Procurement Processes to Capitalize on Digital Servitization	IEEE Transactions on Engineering Management
Sjödin, Parida, Kohtamäki & Wincent	2020	An Agile Co-Creation Process for Digital Servitization: A Micro-Service Innovation Approach	Journal of Business Research
Struyf, Galvani, Matthyssens & Bocconcelli,	2021	Toward a Multilevel Perspective on Digital Servitization	International Journal of Operations and Production Management
Sun & Zhang	2022	How Can Dynamic Capabilities Make Sense in Avoiding Value Co-creation Traps?	Management Decision
Thomson, Kamalaldin, Sjödin & Parida	2022	A Maturity Framework for Autonomous Solutions in Manufacturing Firms: The Interplay of Technology, Ecosystem, and Business Model	International Entrepreneurship and Management Journal
Turunen, Eloranta & Hakanen	2018	Contemporary Perspectives on the Strategic Role of Information in Internet of Things-driven Industrial Services	Journal of Business and Industrial Marketing
Zabala, Campos & Narvaiza	2022	Moving from a Goods- to a Service-oriented Organization: a Perspective on the Role of Corporate Culture and Human Resource Management	Journal of Business and Industrial Marketing

Appendix B

Codes developed through the inductive analysis

Aggregate dimension	Coding categories	Code
Customer relations	Customer changes	Change in customer behaviour
		New customer segments
	Customer relations	Contract management
		Customer feedback
		Customer loyalty-trust
		Customer-oriented value
Customer value co-creation		
Digitalization and data	Properties of the data	Data quality
		Data security
		Data volume
		Data ownership
	Approaches to data use	Data monetization
		Defining digitalization goals
		Data analytic skills
		Data analytics tools
		Unique role of data
		Digital affinity
Digital platform		
Network partners	Network partners	Cross-company networking
		Stakeholder commitment
		New key partners
	Suppliers	Procurement process
		Role of suppliers
		Supplier learning
	Shareholders	Shareholder commitment
Organizational factors	Company culture	Cultural shift
		Engineering mindset
		Error culture
		Holistic perspective
		Target system based on the KPIs / Logic of the KPIs
	Factors related to personnel	Employee training
		Employees should be actively involved in the change process
		Incentivization of employees
		Competence shift
		Open mindset among the workforce
		Boundary spanners
Need for clear roles		

	The transformation process	Management commitment
		Personnel change
		Development process
		Radical change
		Incrementalism
	Organizational learning	
	Organizational structure	Front-end
		Back-end
		Agility
		Internal communication
Cross-functional organizational structure		
Separate servitized business unit		
Value proposition	Cost focus	Prioritizing development resources
		Resource availability
		Unexpected costs
	Types of offering	Customization
		Scaleability
		Servitized business model
		Remote support
		Modules
		Standardization
	Value metrics	Lead time
		Long term value
		Proof of concept
	Business model challenges	Challenges assessing value
		Revenue model misaligned with customer
		Cannibalizing existing business model



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