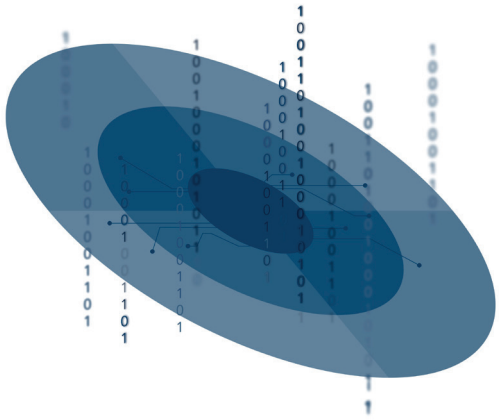
DOCTORAL THESIS

A Relational View on Digital Servitization

Empirical Insights from Industrial Relationships



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Empirical Insights from Industrial Relationships

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To Ebrahim Kamalaldin
and Eman Alkhawaja

إلى إبراهيم كمال الدين
وإيمان الخواجة

Abstract

Background and purpose: Digital technologies are enabling the transformation of manufacturing companies from being a product provider to a service provider, a trend that is referred to as 'digital servitization'. Providers typically adopt a digital servitization strategy to differentiate themselves from competitors, create new revenue streams, and unlock new value creation opportunities for their industrial customers. Though, for realizing the benefits of digital servitization, a key challenge is related to adapting industrial relationships to a state where value is increasingly created by digital rather than physical component. However, current knowledge about this is lacking. More specifically, there is a need to investigate how provider-customer relationships are transformed, as a shift from transactional to relational interaction is needed. A further complicating factor that emerges in digital servitization is that relationships tend to extend beyond provider-customer relationship and spreads across ecosystems of multiple actors, including equipment providers, digitalization partners, besides customers. This creates various challenges, as providers have to secure their roles in an ecosystem where they may have to simultaneously cooperate and compete. Therefore, there is a need to investigate how ecosystem relationships are configured. This thesis adopts the theoretical lens of the relational view (Dyer et al., 2018; Dyer & Singh, 1998) to advance understanding of how industrial relationships develop for digital servitization. More specifically, the purpose is divided into two research questions: 1) How can provider-customer relationships be transformed for digital servitization?, 2) How can a provider configure ecosystem relationships for digital servitization?.

Research methods: A qualitative case study methodology was adopted, and cases were selected based on theoretical sampling. Data was mainly collected through semi-structured interviews with company informants, supplemented by secondary data. Data was analyzed following the method of Gioia et al. (2013).

Findings: The thesis integrates the findings of five papers into a 'relational framework for digital servitization'. The framework draws on the relational view theory, which suggests four determinants of inter-organizational competitive advantage: complementary resources and capabilities, relation-specific assets, knowledge-sharing routines, and effective governance (Dyer et al., 2018; Dyer & Singh, 1998). The four determinants are conceptualized for the context of digital servitization and used as theoretical lens to synthesize the findings into two layers. First, from a provider-customer

perspective, the findings show that it should transform to one that is based on co-creation logic with a long term-perspective, and the framework underlines four principles in this endeavor. From an ecosystem perspective, the findings show that the ecosystem should be centered on a focal value proposition (digital service) targeted at a specific industrial customer, and providers need to align activities for interdependent value creation with other actors. The framework suggests four principles to that end.

Contributions and implications: This thesis contributes to the emerging literature on digital servitization by developing processes and overarching principles for transforming provider-customer relationships. The thesis also contributes to the growing body of literature on innovation ecosystems by demonstrating the central role of ecosystem alignment in digital servitization and suggesting frameworks and principles for configuring ecosystem strategies based on assessing the context. Furthermore, the thesis contributes by emphasizing the interplay between technology development, ecosystem configuration, and business model design in digital servitization. Besides its theoretical contributions, this thesis has implications for managers who are active in digital servitization efforts in manufacturing firms and digital services providers, in addition to managers in firms pursuing the procurement of digital services.

Keywords: Digital Servitization; Digitalization; Industry 4.0; PSS; Relational View; Business Models; Innovation Ecosystems; B2B.

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"Feeling gratitude and not expressing it is like wrapping a present and not giving it."

~William Arthur War

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Anmar Kamalaldin
Luleå, Sweden, August 2021

Appended Papers

Paper 1 **Kamalaldin, A.**, Linde, L., Sjödin, D., & Parida, V. (2020). Transforming provider-customer relationships in digital servitization: A relational view on digitalization. *Industrial Marketing Management*, 89, 306-325. https://doi.org/10.1016/j.indmarman.2020.02.004

Paper 2 Sjödin, D., **Kamalaldin, A.**, Parida, V., & Islam, N. Procurement 4.0: How industrial customers transform procurement processes to capitalize on digital servitization. *(Accepted for publication in IEEE Transactions on Engineering Management)*.

Paper 3 **Kamalaldin, A.**, Sjödin, D., Hullova, D., & Parida, V. (2021). Configuring ecosystem strategies for digitally enabled process innovation: A framework for equipment suppliers in the process industries. *Technovation*, 105, 102250. https://doi.org/10.1016/j.technovation.2021.102250

Paper 4 Thomson, L., **Kamalaldin, A.**, Sjödin, D., & Parida, V. (2021) A maturity framework for autonomous solutions in manufacturing firms: The interplay of technology, ecosystem, and business model. *International Entrepreneurship and Management Journal*. https://doi.org/10.1007/s11365-020-00717-3

Paper 5 **Kamalaldin, A.**, Sjödin, D., Lindberg, P. & Olsson, J. Digitalized PSS for a circular economy: The role of ecosystem alignment. *(R&R in Sustainability)*.

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Part I

1. Introduction

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

1.1. Background

> *"What we have historically done is to buy a finished product with a service agreement, but in this case [of digitalization], it is impossible to do that… We need to do it [i.e., the digital transformation] together with someone, we can never do it ourselves."*
> ~Project leader of an energy and utilities company

Digital technologies such as the Internet of Things (IoT), Artificial Intelligence (AI), and big data analytics are enabling the transformation of manufacturing companies from being a product provider to a service provider (Hasselblatt et al., 2018; Holmström & Partanen, 2014; Kohtamäki et al., 2019; Vendrell-Herrero et al., 2017). This trend is referred to as 'digital servitization', defined as "the transformation in processes, capabilities, and offerings within industrial firms and their associated ecosystems to progressively create, deliver, and capture increased service value arising from a broad range of enabling digital technologies" (Sjödin, Parida, Kohtamäki, et al., 2020), p. 478). An example is ABB's remote optimization service which is offered through its collaborative operations centers for gearless mill drives, capitalizing on the efficiencies of digital technologies. Product providers typically adopt a digital servitization strategy to differentiate themselves from competitors (Opresnik & Taisch, 2015) and create new revenue streams (Scherer et al., 2016). However, despite considerable investment in offering digital services, many providers still struggle to create real customer value, and ultimately fail to secure the desired return on investment (Gebauer et al., 2005; Pagoropoulos et al., 2017; Suarez et al., 2013; Visnjic Kastalli & Van Looy, 2013). For realizing the benefits of digital servitization, a key challenge is related to adapting industrial relationships. More specifically, a provider-customer relationship need to

transform to one that is based on co-creation logic, and ecosystem relationships need to be configured to ensure alignment of partners.

In relation to provider-customer relationships, a key issue is that digital servitization is altering traditional product-centric relationships (Lerch & Gotsch, 2015; Pagoropoulos et al., 2017; Sjödin, Parida, Jovanovic, et al., 2020). This is so because digital services require providers to take on greater responsibility for the core processes of the customer (Lerch & Gotsch, 2015) and a shift from transactional to relational interaction (Reim et al., 2018; Sousa & da Silveira, 2017). Therefore, digital servitization tends to require closer provider-customer relationships characterized by co-creation logic (Sjödin, Parida, Kohtamäki, et al., 2020) with a long-term perspective and greater investment in the relationship. However, this transition is not always easy, as for many companies, this is a step into unknown territory, and they may struggle with numerous relational challenges. These include issues such as how to balance risk and reward (Reim et al., 2018), how to find the appropriate level of customization, and how to share data and integrate digital systems (Coreynen et al., 2017). This stresses the need to investigate and understand how provider-customer relationships can be transformed for digital servitization.

A further complicating factor that emerges in digital servitization is that relationships tend to extend beyond a dyadic provider-customer relationship, but rather spreads across ecosystems of multiple actors, including equipment providers, digitalization partners, besides customers (Linde et al., 2021; Sklyar et al., 2019). More specifically, no single provider has all the necessary expertise and resources to develop and deliver complex digital services required by customers (Kohtamäki et al., 2020; Sklyar et al., 2019). For example, it would be very difficult for an equipment manufacturer like Scania Trucks to build capabilities for developing AI algorithms and cloud platforms. Doing so "would require the company to take on high levels of uncertainty and perform well in a number of different, and often unrelated, product markets" (Visnjic et al., 2016, p. 112). This means that multiple providers need to cooperate within an ecosystem, which is "the alignment structure of the multilateral set of partners that need to interact in order for a focal value proposition to materialize" (Adner, 2017, p. 40). However, digitalization has created great uncertainty among providers, generating strong competition and threatening the potential of alignment, as all parties aim to maximize their profits and many providers

may aim for taking the leading role in an ecosystem. This creates various challenges for a provider, as it has to secure its role in an ecosystem where it may have to simultaneously cooperate and compete with other ecosystem actors. Inability to configure the appropriate ecosystem strategy in approaching the alignment of partners might hinder the exploitation of opportunities and realization of profits from digital servitization. This underscores the need to investigate and understand how a provider can configure ecosystem relationships for digital servitization.

To advance knowledge on how industrial relationships develop for digital servitization, at both provider-customer level and ecosystem level, this thesis adopts the theoretical lens of the relational view. The relational view theory (Dyer et al., 2018; Dyer & Singh, 1998) provides a good lens to study this phenomena, as it focuses on the inter-firm relationship as an important unit of analysis for understanding competitive advantage. The relational view emphasizes that the advantages of an individual firm are connected to the advantages of its network of relationships; it acknowledges that a firm's resources can extend beyond the boundaries of a single firm and can be combined with partners' resources for competitive advantage (Dyer & Singh, 1998). More specifically, the relational view suggests four determinants of inter-organizational competitive advantage: complementary resources and capabilities, relation-specific assets, knowledge-sharing routines, and effective governance (Dyer & Singh, 1998). This thesis argues that these determinants hold significant explanatory potential for understanding how industrial relationships develop for digital servitization.

1.2. Research Problem

Research on digital servitization remains at a nascent stage, and a number of scholars have considered it as a key research priority due to the significant potential for digitalization to radically influence the delivery of services (Parida et al., 2015; Raddats et al., 2019). Despite the increasing focus on this topic, digital servitization research is not yet theoretically mature (Kohtamäki et al., 2019; Raddats et al., 2019). The literature offers only simplistic explanations of the phenomenon, and typically focus on firm-specific practices, overlooking the underlying processes for industrial relationships with customers and the broader ecosystems (Sklyar et al., 2019). Therefore, a holistic

understanding of the relational aspect is needed, and filling knowledge gaps on this could provide a more complete understanding of the transformation that firms undergo for digital servitization. More specifically, four research gaps have been identified.

First, prior studies on digital servitization have placed dominant focus on the provider perspective, without adequate attention to the relational aspect (Parida, Sjödin, et al., 2019; Raddats et al., 2019; Rönnberg Sjödin et al., 2016, 2017). There are limited insights in literature on how provider and customer firms must work closely to adapt and, thus, derive benefits from digital technologies (Pagoropoulos et al., 2017). Digital servitization requires engagement and intensive collaboration between the provider and customer (Story et al., 2017; Valtakoski, 2017), so, it is important to understand the requirements of both sides in the relationship. For example, procuring a digital service, such as site management, requires a completely different evaluation process where the value parameter places emphasis on outcome guarantees rather than product features (Ziaee Bigdeli et al., 2018). Therefore, it is necessary to include the less-studied customer perspective in order to understand the new relational requirements that emerge in digital servitization (Coreynen et al., 2017; Holmlund et al., 2016; Tuli et al., 2007; Valtakoski, 2017).

Second, there is a lack of knowledge concerning how provider-customer relationships transform and evolve through digital servitization. Whilst the significance of digital transformation is well established (Ardolino et al., 2018; Porter & Heppelmann, 2015), only a few studies have addressed it from a dynamic relational perspective. Lerch and Gotsch (2015) have stressed that attempts to offer models dealing with the transformation to advanced digital services have been few. In response, they developed a model that encompasses four generic stages of a company's transformation path from manufacturer to provider of digitalized product–service systems (Lerch & Gotsch, 2015). However, their model highlights only the provider's transformation journey. A need, therefore, remains to study the transformation of the provider–customer relationship as a whole, so that the key activities and the dynamics between them are better understood (Bharadwaj et al., 2013). Arguably, the dynamics in these types of relationship are very different from traditional provider-customer relationships and, therefore, many unforeseen relational challenges can be expected (Reim et al., 2018). However, the change in relational

dynamics between providers and customers remains an under-researched topic in the servitization literature – a deficiency that is increasingly acknowledged (Huang & Chiu, 2018; Reim et al., 2018; Rönnberg Sjödin et al., 2016; Schuh et al., 2008; Sundin et al., 2010).

Third, although prior literature has highlighted the need for greater ecosystem collaboration for digital servitization (e.g. Kohtamäki et al., 2019; Parida et al., 2019), it provides little guidance on how a provider configure strategies to work within an ecosystem of multiple actors (Parida, Burström, et al., 2019; Sjödin, 2019). It seems plausible to argue that providers which devise conscious relational strategies for involving ecosystem partners and integrate their resources in a distinctive way may secure greater advantage compared to competing firms unable or unwilling to do so (Dyer et al., 2018; Dyer & Singh, 1998). However, a provider may face multiple challenges when working in an ecosystem where they may have to cooperate with competitors. The literature on ecosystems recognizes the need to balance the tensions between competition and cooperation (Hannah & Eisenhardt, 2018) and offers some insights into defining ecosystem roles (Iansiti & Levien, 2004). However, a research gap remains in our understanding of the intersection between these aspects. Therefore, there is a need to understand how providers exercising different roles in an ecosystem, such as leader or follower, configure and apply different ecosystem strategies, and what tactics are employed to balance appropriate levels of cooperation and competition.

Fourth, research on ecosystems has largely focused on collaborative approaches in generic ecosystems of affiliated actors rather than studying ecosystem strategies applied to a concrete value proposition (Adner, 2017), such as a digital service targeted at specific industrial customer. For example, Iansiti & Levien (2004) identified three ecosystem strategies (keystone, dominator, and niche) for ecosystems of affiliated actors, but they gave little consideration to how the industry's and customer's context would impact these strategies. Though, in industrial context, it is imperative to customize ecosystems for the value proposition in line with the customer's idiosyncratic design requirements for technologies and existing equipment, for example (Robertson et al., 2012; Rönnberg-Sjödin, 2013). For instance, at a specific site of a mining company, equipment providers may already have established positions and relationships within the ecosystem depending

on the core technologies and objectives in focus. Additionally, the customer might demand advanced technology development for autonomous operations, which requires a more open and transparent approach to data sharing amongst ecosystem actors in order to enable system-level innovation (Sjödin et al., 2018). This can create tensions and strongly impact the ecosystem strategy to be applied by a provider in its relationships with other providers. Yet, this research domain is still very much underexplored (Lager & Frishammar, 2012; Sjödin, 2019), and it is not clear how ecosystem configuration adapts with higher maturity levels of digital services and autonomous solutions.

1.3. Research Purpose

To address these gaps, the purpose of this thesis is *to advance understanding of how industrial relationships develop for digital servitization*. More specifically, the stated purpose is divided into two research questions (RQs):

RQ1. *How can provider-customer relationships be transformed for digital servitization?*

RQ2. *How can a provider configure ecosystem relationships for digital servitization?*

RQ1 is mainly addressed in Papers 1-2, which focus on provider-customer relationships, whereas RQ2 is mainly addressed in Papers 3-5, as they investigate ecosystem relationships. Naturally, there are overlaps, as some insights from the papers have contributed to both RQs. For example, whilst Paper 2 concentrates on provider-customer relationships from a customer's perspective, it does emphasize the importance of cross-fertilization within the ecosystem to foster digital innovation. On the other hand, although Paper 4 discusses ecosystem configuration in alignment with technology development and business model design, it underlines that an equipment provider should consider the digital maturity of the customer, i.e., a consideration for provider-customer relationships.

2. Theoretical Background

This chapter provides the theoretical background for this thesis. First, an overview of the digital servitization research field is presented. Then a discussion on industrial relationships in digital servitization is provided, discussing both provider-customer relationships and ecosystem relationships. This is followed by an overview of the relational view theory, which represents the theoretical lens of this thesis. All sections also present existing gaps in the literature and how they contribute to the development of a relational framework for digital servitization.

2.1. Digital Servitization

Research has demonstrated a strong interconnection between digitalization and servitization (Gago & Rubalcaba, 2007; Kohtamäki et al., 2020; Lerch & Gotsch, 2015; Parida et al., 2015; Sklyar et al., 2019). The usage of digital technologies empowers various types of servitization and service innovation (Gago & Rubalcaba, 2007). Digitalization has actually stimulated companies to move from product-centric models to digital service-oriented offerings (Adrodegari & Saccani, 2017; Ardolino et al., 2018; Rust & Huang, 2014). Iansiti and Lakhani (2014) argue that digital transformation changes the customer's value proposition; it changes how a company creates and captures value since digitalization principally involves the provision of services. The opportunities to expand services increase when companies synchronize digitalization, connectivity, and data analytics (Luz Martín-Peña et al., 2018).

A research sub-stream in the servitization literature has been named 'digital servitization'. Its principal focus has been on the provision of digital services that are dependent on the digital components embedded in physical products (Holmström & Partanen, 2014; Vendrell-Herrero et al., 2017). A comprehensive definition was suggested by (Sjödin, Parida, Kohtamäki, et al., 2020), who define digital servitization as "the transformation in processes, capabilities, and offerings within industrial firms and their associated ecosystems to progressively create, deliver, and capture increased service value arising from a broad range of enabling digital technologies such as the Internet of Things (IoT), big data, artificial intelligence (AI), and cloud computing" (p. 478). Alternatively, digital

servitization can be defined as "the transition toward smart product-service-software systems that enable value creation and capture through monitoring, control, optimization, and autonomous function" (Kohtamäki et al., 2019, p. 383). Both definitions emphasize the transformational nature of digital servitization, and that it alters the traditional idea of standalone products.

Indeed, digital servitization involves the utilization of digital tools for transforming a product-centric business model to a service-centric logic (Sklyar et al., 2019). This owes to the evolution of 'smart, connected products' – a combination of hardware, software, sensors, data storage, and connectivity – which have transformed manufacturing companies (Porter & Heppelmann, 2014, 2015). An example of digital services is remote monitoring, which is considered a key enabler of servitization since it is vital to remotely monitor the product's location, condition, and use (Lightfoot et al., 2013; Ulaga & Reinartz, 2011). Through remote monitoring and diagnostics, the company can pre-emptively repair a machine prior to failure, rather than reactively mend it after it has shut down (Allmendinger & Lombreglia, 2005). Through connecting digital and physical systems, remote services create the opportunity to provide availability guarantees, for example (Lerch & Gotsch, 2015). Hence, this helps in meeting the evolving needs of industrial customers (Iansiti & Lakhani, 2014; Lenka et al., 2017), and in creating new revenue streams for providers (Scherer et al., 2016). Nonetheless, digital servitization creates both opportunities and challenges for companies thus engaged, as it requires revising industrial relationships.

2.2. Industrial Relationships in Digital Servitization

Digital opportunities arise at a speed that many companies are unable to cope with expeditiously. Industrial customers typically seek to involve their providers in operations that fall outside their own core competences (Sjödin et al., 2018) and to benefit from their digitalization capabilities. Simultaneously, the scope of ecosystem relationships are expanding for providers as they need to secure additional digital capabilities through partnerships and increasingly collaborate with complementing actors to meet the customers' evolving digital requirements. Accordingly, both *provider-customer*

relationships as well as *ecosystem relationships* need to adapt for digital servitization as detailed in the following sections.

First, digital servitization requires a change in *provider-customer relationships* whereby new and innovative approaches need to be adopted for creating value (Iansiti & Lakhani, 2014). Research has shown that value is co-created by providers and customers through integrating their resources and exploiting their shared competences (Grönroos & Voima, 2013). This is particularly true for digital services, which are typically an outcome of an interaction and close engagement between the provider and customer, rather than simple transactional exchanges. This is so because the characteristics of digital services are such that they cannot be a priori stipulated in detail (Story et al., 2017), rather, they need to be co-created by the provider and customer in an iterative way (Sjödin, Parida, Kohtamäki, et al., 2020). However, this can be challenging. Literature offers only limited insights on how provider-customer relationships can be transformed for digital servitization in a way that ensures long-term success and value maximization for all parties.

Whilst there are previous studies that have offered transformation models for providers moving to digital servitization (e.g., Iansiti & Lakhani, 2014; Lerch & Gotsch, 2015), they have largely focused on the provider's transformation rather than the provider-customer relationship as a whole. For example, Iansiti & Lakhani, 2014 note that a transformation journey can go through three phases in the search for increased value. First, it starts as a transactional relationship between provider and customer. Second, it evolves into a contractual relationship, where the risk is shared and the total cost of ownership is reduced. Third, the relationship develops further with expanded customer outcomes as assets and operations are optimized using data and analytics (Iansiti & Lakhani, 2014). However, knowledge is lacking on how to achieve the objectives of each phase, and how to move from one phase to the next. There is a need for a better understanding of what aspects ought to be considered throughout relational transformation in order to attain high relational value. This provides the primary motivation for studying digital servitization from a relational view.

Second, although there is an implicit evolution in the literature from a provider-centric to multi-actor perspective, more research is needed on the relational aspect within *ecosystem*

relationships. This is especially because digital servitization tends to extend beyond dyadic provider-customer relationships to involve value co-creation within an extended ecosystem of multiple actors (Raddats et al., 2019; Sklyar et al., 2019). The term 'ecosystem' has gained great interest in academia and industry over the last few years (Adner, 2017; Jacobides et al., 2018; Laczko et al., 2019; Oh et al., 2016). Although ecosystems are considered the usual context for doing business in industries such as software and communication technologies (Muegge, 2013), research on ecosystems in general is underdeveloped and undertheorized (Spigel, 2017). Adner (2017) argues that the lack of clarity on how exactly an ecosystem view adds value has hindered its usability as a concept. In response, he makes a distinction between two views of ecosystems; 'ecosystem-as-affiliation' and 'ecosystem-as-structure'.

The ecosystem-as-affiliation view sees an ecosystem as a community of associated actors affiliated in a network or platform, and it focuses on interdependence and the breakdown of traditional industry boundaries (Adner, 2017). For example, Iansiti & Levien (2004) adopt this view in considering business networks as ecosystems "characterized by a large number of loosely interconnected participants who depend on each other for their mutual effectiveness and survival" (p. 8). Accordingly, Iansiti & Levien (2004) distinguish between three strategies: 'keystone', which aims to improve connections between actors and the overall ecosystem productivity; 'dominator', which aims to take over and eliminate others; and 'niche', which aims to develop specialized capabilities that differentiate them. Although these strategies distinguish between the roles of a leader (keystone or dominator) and a follower (niche), they see the ecosystem as organized around a central actor rather than a value proposition. Arguably these strategies may fit for providers engaged in digital servitization, however, it is unclear how and in what context they applicable. From a strategy point of view, this ecosystem-as-affiliation perspective "tends to focus on general governance and community enhancements, with limited insights into the specifics of value creation" (Adner, 2017, p. 41).

In contrast, the ecosystem-as-structure perspective focuses on interdependent value creation because it "starts with a value proposition and seeks to identify the set of actors that need to interact in order for the proposition to come about" (Adner, 2017, p. 41). Adopting the ecosystem-as-structure view, Adner (2017) defines an ecosystem as "the

alignment structure of the multilateral set of partners that need to interact in order for a focal value proposition to materialize" (p. 40). He contends that partner alignment is a vital strategic challenge that underlies a more actionable perspective on interdependence between partners. Thus, this perspective is most relevant in the context of digital servitization since actors need to align activities in order to arrive at a focal value proposition, i.e., the digital service(s) to the customer. For example, providing digital site optimization services may require the involvement of equipment suppliers, local service delivery partners, besides technology and connectivity partners.

Building on the definition of an ecosystem-as-structure, Adner (2017) defines an ecosystem strategy as "the way in which a focal firm approaches the alignment of partners and secures its role in a competitive ecosystem" (p. 47). He pinpoints four implications arising from this definition. First, "a focal firm approach" stresses that each firm develops its own ecosystem strategy even though the ecosystem consists of multiple actors. It is important to stress that 'focal firm' means the firm in focus, i.e., the firm from whose perspective the analysis is conducted, which can either be a leader or a follower in the ecosystem. Second, "the alignment of partners" sees alignment in terms of the focal firm's ability to bring other partners along with it according to the positions and roles that its own ecosystem strategy envisions. Third, "secures its role" stresses that undertaking the role of leader or follower depends on the aspiration of the focal firm as well as the agreement of its partners. Fourth, "in a competitive ecosystem" underlines the fact that concern about competitiveness guides the ecosystem strategy. Thus, a key management issue in an ecosystem is setting the right balance between a shared vision and the self-interest of the actors involved to influence, facilitate, and motivate their actions (Adner, 2006; Laczko et al., 2019). However, we continue to lack insights into how ecosystem strategies can be configured in digital servitization, where multiple providers need to establish a complex balance between cooperation and competition. For example, part of this complexity is related to data sharing between providers, which may be required for maximizing the value of digital services to customers. Providers consider their data-driven knowledge as a competitive resource that they hold, and they would be unwilling to share it with other providers unless they gained something in return, which underlines the tensions between cooperation and competition.

Hannah and Eisenhardt (2018) distinguish three ecosystem strategies by which firms balance cooperation and competition. They define cooperation as "firms jointly pursuing mutual interests and common benefits" and competition as "firms pursuing their own interests at the expense of others" (Hannah & Eisenhardt, 2018, p. 3164), consistent with (Das & Teng, 2000). Hannah and Eisenhardt (2018) argue that prior research has generally focused on either cooperation and value creation (Adner & Kapoor, 2010; Ozcan & Eisenhardt, 2009), or competition and value capture (Jacobides et al., 2006). Hannah and Eisenhardt (2018) bring these research streams together and provide insights into how firms balance cooperation and competition. They identify three ecosystem strategies; the 'component' strategy that favors cooperative behavior, the 'system' strategy that favors competitive behavior, and the 'bottleneck strategy' that exhibits a dialectic tension between cooperation and competition (Hannah & Eisenhardt, 2018). Whilst this distinction is useful in explaining the interplay of cooperation and competition, it does not take into account the actor's role in the ecosystem. Since the 'leader' of the ecosystem would apply different strategy and tactics than an actor exercising a 'follower' role, the actor's role in the ecosystem is no less important. For example, a leader may want to establish a digital architecture for providing digital services to the customer (such as predictive maintenance and process optimization), whilst a follower might only seek to integrate its equipment into that digital architecture of the leader. Therefore, there is a need for further research bringing the two aspects together, i.e., actors' roles and the balance between cooperation and competition. Given that firms' dependence on each other is increased in digital servitization, a critical factor for any individual provider's success is considering ecosystem-level relational issues, such as value co-creation and interaction with other partners (Pellikka & Ali-Vehmas, 2016). However, research on how firms collaborate within an ecosystem is scarce. This reemphasizes the significance of studying digital servitization from a relational view.

2.3. The Relational View

The key theoretical lens for this thesis is the relational view (Dyer et al., 2018; Dyer & Singh, 1998). It argues that competitive advantage is a result of mutually adapted inter-firm relations and the joint input of partners (Dyer & Singh, 1998; Lavie, 2006). Although competition between companies might still be the general rule, firms that integrate their

resources in a distinctive way may secure greater advantage compared to competing firms unable or unwilling to do so (Dyer & Singh, 1998). The importance of a relational view is particularly relevant in the context of digital servitization (Cenamor et al., 2017; Eloranta & Turunen, 2015) due to the high need for involving customers and ecosystem partners in value co-creation (Parida, Sjödin, et al., 2019; Rönnberg Sjödin et al., 2016; Visnjic et al., 2016). For example, the implementation of integrated products and services can only succeed when both provider and customer deploy them, and not simply because a provider delivers them (Tuli et al., 2007). Also, delivering such digital services usually involves an extended ecosystem that includes multiple providers. Therefore, a major issue in digital servitization is the quality of interaction between involved actors so that customized and comprehensive solutions and services that offer real value are provided (Kohtamäki et al., 2013; Lerch & Gotsch, 2015; Reim et al., 2015; Viljakainen & Toivonen, 2014). A key question to consider is how firms develop their industrial relationships in digital servitization to realize competitive advantage.

Dyer and Singh (1998) suggest four determinants of inter-organizational competitive advantage: *complementary resources and capabilities, relation-specific assets, knowledge-sharing routines, and effective governance*. These determinants can generate relational rents, defined as the "supernormal profit jointly generated in an exchange relationship that cannot be generated by either company in isolation and can only be created through the joint idiosyncratic contributions of the specific alliance partners" (Dyer & Singh, 1998, p. 662). The following paragraphs describe these four determinants and how they may be conceptualized in the context of digital servitization.

First, Dyer et al. (2018) argue that access to *complementary resources and capabilities* is considered the initial rationale in forming a partnership. In this case, the marginal return on a partner's resources increases in the presence of resources from the other partner (Hess & Rothaermel, 2011; Milgrom & Roberts, 1995). Dyer and Singh argue that "the greater the proportion is of synergy-sensitive resources owned by alliance partners that, when combined, increase the degree to which the resources are valuable, rare, and difficult to imitate, the greater the potential will be to generate relational rents" (1998, p. 667). Having competences and experience is essential in implementing digital technologies (Ardolino et al., 2018; Cenamor et al., 2017). So, when companies do not

have the necessary capabilities or resources, they tend to fill the gap by partnering with other companies. For example, Sandvik (mining equipment provider) is extending their internal capabilities by partnering with IBM (AI analytics) and Newtrax (positioning technology) to deliver digitally optimized and automated underground mining solutions. However, there is limited research on how a company's capabilities complement its partners' capacities and resources within digital servitization (Pagoropoulos et al., 2017), and how firms align incentives with complementing actors.

Second, Dyer and Singh argue that "the greater the alliance partners' investment is in *relation-specific assets*, the greater the potential will be for relational rents" (1998, p. 664). These assets are usually specialized and are considered to be of strategic importance for the relationship (Amit & Schoemaker, 1993). In terms of digital servitization, the more digital intensity increases within a company's business strategy, the more likely its scaling options will be based on partnership with other companies by means of shared digital assets (Bharadwaj et al., 2013). For example, offering availability guarantees for machines and plants requires linking customer plants to the provider's digital architecture through a compatible communication network (Lerch & Gotsch, 2015). Clearly, complexity is increased if this involves multiple providers that need to be connected. However, further research is needed to investigate how relation-specific digital assets evolve throughout an industrial relationship and when it is applicable to make such investment.

Third, Dyer and Singh emphasize that "the greater the alliance partners' investment is in inter-firm *knowledge-sharing routines*, the greater the potential will be for relational rents" (1998, p. 665). They define knowledge-sharing routines as a regular pattern of interactions between companies that allow specialized knowledge to be transferred, recombined, or created (Grant, 1996). In the digital era, technologies allow companies to easily communicate and share in-depth information and knowledge through digital means (Gago & Rubalcaba, 2007; Luz Martín-Peña et al., 2018). Digitalization lays the foundation for translating digital data into knowledge, and leads to improved transparency and better-informed decision making (Ness et al., 2015). This is enabled by digital services that depend on 'machine intelligence' where data are automatically gathered, validated, stored, and turned into information that can be acted on (Allmendinger &

Lombreglia, 2005). However, if the customer uses machinery of various competing providers, issues such as data access and knowledge sharing versus knowledge protection, can arise. Hence, research is needed to understand how partners can work together in this endeavor.

Fourth, the *effective governance* of relationships is regarded as the key differentiator, as governance is the safeguard used by partners to enforce what they have agreed, and it is intimately connected to all other determinants of relational rents (Dyer et al., 2018; Dyer & Singh, 1998). Dyer and Singh suggest that "the greater the alliance partners' ability to align transactions with governance structures in a discriminating (transaction cost minimizing and value maximizing) way, the greater the potential will be for relational rents" (1998, p. 669). In the context of digital servitization, Svahn et al. (2017) argue that a key paradox experienced by companies relates to governance – that is, achieving balance between control versus flexibility during the transformation process. As digital servitization is largely based on innovation, there is a major need to balance new opportunities and established practices. Hence, governance mechanisms should enable exploration of digital opportunities and incentivize co-creating digital services with partners (Svahn et al., 2017), while maintaining acceptable control over value appropriation (Boudreau, 2010). Although the literature underscores the importance of maintaining a balance between control and flexibility in governing digital servitization partnerships, there is scant knowledge on how this balance should be fostered as the relationship evolves over time.

In short, the relational view can be considered a very useful theoretical lens to study industrial relationships in the context of digital servitization. Given the speed of development in the digital era, it is clear that no company can keep pace on its own (Bogers et al., 2018). Hence, the relationships between different actors are important in examining value creation and profit maximization (Dyer & Singh, 1998) in digital servitization.

3. Research Methods

This chapter presents and discusses the methods used in this thesis. The chapter starts with a brief description of the research background and research project. This is followed by an explanation of the research approach and the rationale for using qualitative case study methodology. Subsequently, a more detailed description of case selection, data collection, and data analysis is presented. Finally, quality aspects of the research are discussed.

3.1. Research Background

My research journey started in September 2017, when I joined Luleå University of Technology (LTU) as a PhD candidate in Entrepreneurship and Innovation Group. I have taken part in a research project titled 'Digital Innovation of Business Models in Industrial Ecosystems' (DigIn). The project is conducted in close collaboration with more than 40 companies from different industries, such as mining, forestry, pulp and paper, telecom, and energy. DigIn project aims to develop, test, and disseminate methods for digital business model innovations in Swedish and global industrial ecosystems. Essentially, these business models relate to digital servitization offerings, and involve a change in industrial relationships from transactional product-centric models to relational service-oriented engagements. Thus, understanding the relational aspect is key.

In order to gain familiarity with the literature and investigate the gaps that need further research, I started my research process with a literature review on the topics of digitalization and servitization. Though, literature review was conducted on a continuous and iterative manner throughout the research process, and additional reading was done for each paper as required. While familiarizing myself with the literature, the empirical work for DigIn project had also started. Initial meetings with partner companies and interviews with key informants provided practical insights into the challenges that they encounter with digital servitization, as well as possible solutions and attempts to address them. A key strength of DigIn project's consortia is that it includes providers engaged in digital servitization, industrial customers looking to procure these offerings to increase

their operating performance, as well as other ecosystem actors such as technology and service delivery partners. In my first year, I collected empirical data from partner companies to gain insights into their challenges. These insights, together with research gaps in literature, informed the initial research purpose of this thesis, motivating a qualitative case study research approach.

3.2. Research Approach

Despite the transformational role of digitalization in servitization literature and industrial management practice, theoretically, the research on digital servitization in is still at a nascent stage (Coreynen et al., 2020; Raddats et al., 2019; Sjödin et al., 2020; Sklyar et al., 2019; Tronvoll et al., 2020). There are many open questions relating to transforming provider-customer relationships and configuring ecosystem relationships for digital servitization. Therefore, this thesis follows a qualitative approach, based on open-ended research questions and data collection primarily through interviews, to build theoretical perspectives and invite further research on the topic (Edmondson & Mcmanus, 2007). Because of the scarce theory on industrial relationships in digital servitization, a qualitative approach provides rich, detailed, and meaningful insights to further our understanding of the phenomenon (Edmondson & Mcmanus, 2007).

Qualitative case study methodology was adopted, as it is best suited to the study of topics where little theory exists, and where gathering rich information from cases is expected to identify new aspects of a phenomenon (Eisenhardt, 1989; Voss et al., 2002). Case studies are also suitable for 'what' and 'how' questions that are designed to unearth the richness and complexity of a phenomenon (Eisenhardt, 1989; Miles & Huberman, 1994). Case studies also help provide a better understanding of the underlying dynamics and relationships of the subject (Eisenhardt, 1989) – in this case, provider-customer relationships and ecosystem relationships in digital servitization.

A multiple qualitative case study approach was adopted for Papers 1-4. This approach provides opportunities to seek patterns across cases to verify the existence of the phenomenon whilst strengthening the basis for analysis (Eisenhardt, 1989; Ozcan & Eisenhardt, 2009). For Paper 5, however, a single qualitative case study approach was

chosen in order to allow for more in-depth analysis of specific problems. Though, the case study involved investigating the views of multiple actors in an ecosystem. Overall, the qualitative case studies answer the specific research questions of the papers, relating to issues surrounding provider-customer relationships and ecosystem relationships in digital servitization. Table 1 provides a methodological overview of the appended papers.

Table 1: *An overview of the research methods of appended papers*

Paper	Research purpose	Research approach	Data collection	Data analysis
Paper 1 Transforming provider-customer relationships in digital servitization: A relational view on digitalization	To investigate how providers and customers transform their relationships in digital servitization	Qualitative; Multiple case studies of 4 provider-customer relationships (7 companies)	40 semi-structured interviews; documents; websites	Gioia
Paper 2 Procurement 4.0: How industrial customers transform procurement processes to capitalize on digital servitization	To investigate how procurement process models can be adapted to address the opportunities and challenges of digital servitization for industrial customers	Qualitative; Multiple case studies of 11 customer firms (besides 8 of their suppliers)	75 semi-structured interviews; documents	Gioia
Paper 3 Configuring ecosystem strategies for digitally enabled process innovation: A framework for equipment suppliers in the process industries	To investigate how equipment suppliers configure appropriate ecosystem strategies to realize digitally enabled process innovation in various industrial customer contexts	Qualitative; Multiple case studies of 6 equipment suppliers (besides 12 other ecosystem actors)	80 Semi-structured interviews; workshop; documents; websites	Gioia
Paper 4 A maturity framework for autonomous solutions in manufacturing firms: The interplay of technology, ecosystem, and business model	To investigate how industrial equipment manufacturers can align the development of technology, business models, and ecosystem relationships for the advancement of autonomous solutions	Qualitative; Multiple case studies of 4 equipment manufacturers (besides 3 digitalization partners and 3 customers)	32 Semi-structured interviews	Gioia
Paper 5 Digitalized PSS for a circular economy: The role of ecosystem alignment	To develop understanding on how ecosystem alignment affects the sustainability potential of digitalized PSS offerings, and how this is influenced by the contextual characteristics of the product and industry	Qualitative; Single case study of a PSS ecosystem in the PC industry (5 companies)	16 Semi-structured interviews; workshops; documents	Gioia

3.3. Case Selection

Since this research was initiated as part of a research project (DigIn), the project's partner companies formed the main pool of which case studies were selected for this thesis. This offered several advantages to the research, as the case companies had already committed to be part of the project. The good contacts that had been established with company informants enabled rich data collection, and facilitated access to additional data from other companies (e.g., their customers and/or suppliers). Furthermore, given that the case companies and their informants are actively involved in digital servitization, interview time was used efficiently to focus on discussing the relevant issues, without the need for detailed explanation of the concept. Whilst the initial phase of the project was of an exploratory nature, later phases focused on selecting specific cases for in-depth study.

The cases for each of the appended papers were selected from the set of project partner companies based on theoretical sampling (Eisenhardt, 1989; Eisenhardt & Graebner, 2007; Glaser & Strauss, 1967). Accordingly, the case selection criteria were informed by the research question addressed in each paper, and the criteria were explicitly stated and explained in the methods section of the papers. Overall, cases were selected where the phenomenon of enquiry was evident and would most likely offer rich information for theorizing (Gioia et al., 2013).

3.4. Data Collection

Data was mainly collected through semi-structured interviews with company informants. Interviews were initially conducted with key informants of the selected cases, i.e., individuals who were closely involved with the subject of enquiry of each paper. Additional informants were identified through snowballing technique where informants were asked to recommend other people who could provide additional insights. In order to gain a multifaceted view and an understanding from different perspectives, interviews were conducted with informants exercising various functional roles and seniority levels in different companies. This also helped reducing bias (Eisenhardt & Graebner, 2007).

Informants were asked open-ended questions with the support of interview guides. The guides were developed based on overarching themes about digital servitization and the

specific settings and purpose of each study. Follow-up questions were often asked for clarification and to obtain further details, which allowed further exploration of interesting relevant themes and cases. What is more, the interview guides were revised continuously as new insights were derived from collected data (Eisenhardt, 1989), thus, increasing relevance and deepening understanding (Miles & Huberman, 1994). Commonly, several researchers joined the interviews, which facilitated understanding and analysis of the cases.

With the permission of informants, interviews were recorded and transcribed, and transcripts provided the key basis for data analysis. These were supplemented by data from secondary sources such as company websites and documents (e.g., annual reports, agreements, project documents, Power Point presentations). This enabled empirical triangulation (Jick, 1979) and increased construct validity by using multiple sources of evidence (Yin, 2018) – i.e., both different informants and different secondary sources. Furthermore, in order to increase reliability and enhance transparency, as well as the possibility of replications, case-study protocols highlighting field procedures and interview questions were constructed for each study. This was along with case-study database which included physical and digital material such as case-study notes, documents, and analysis. The aim was to keep track of the process and allow multiple researchers to collect and analyze data.

3.5. Data Analysis

A similar approach of data analysis was used for all the five papers, following a thematic analysis to identify relevant themes and patterns (Braun & Clarke, 2006). To be specific, a three-step process was followed, guided by the suggestions of Gioia and colleagues (Gioia et al., 2013). For each paper, data was coded into first-order categories, which were then clustered into second-order themes, which in turn were converted into aggregate dimensions (Gioia et al., 2013). These steps are further detailed below.

The first step in data analysis focused on an in-depth analysis of raw data (e.g., interview transcripts). It involved a thorough reading of interview transcripts and marking relevant phrases and passages related to the research purpose. By coding common words, phrases,

terms, and labels, it was possible to identify codes which express the views of the informants. This was facilitated by MAXQDA software and resulted in first-order categories. The second step of the analysis involved identifying links and patterns within the first-order categories using an iterative process. This led to the formation of second-order themes that were on a higher level of abstraction than the first-order categories. In accordance with validity claims in the literature, the themes were further refined based on insights from prior literature as well as data from interviews and secondary sources (Kumar et al., 1993). This step was conducted conjointly by authors, facilitated by comprehensive discussions of the data structure. This led to the third step, which involved the formation of aggregate dimensions that were on an even higher level of abstraction. Following the approach of Gioia et al. (2013), insights from the literature were used to guide the development of labeling that is both theoretically and empirically grounded.

This approach helped in building a data structure for each paper, which may be seen as a visual illustration of the progression from raw data to identified themes. This demonstrates the analytical rigor of this qualitative research (Gioia et al., 2013; Tracy, 2010). Overall, the data analysis process was iterative and involved constant moving back and forth between the raw data, first-order categories, second-order themes, and aggregate dimensions, in parallel to engaging with literature for support (Eisenhardt, 1989; Gioia et al., 2013).

3.6. Research Quality

Several measures were taken to enhance the research quality of this thesis. To elaborate and reflect on this in detail, the 'Case Study Evaluation Template' (CASET) developed by Goffin et al. (2019) is used to evaluate the quality of this research against ten criteria, as shown in Table 2. The template was specifically developed for evaluating case study research in innovation management (Goffin et al., 2019). Thus, it serves as a good tool for discussing the quality of this research.

Table 2: *Evaluation of research quality based on the CASET template* (Goffin et al., 2019)

	Evaluation criteria	Reflection on this research with examples from the papers
Research Design	**Theoretical foundation:** Was a clear explanation given of why the case method was the most appropriate method to adopt?	All five papers explain why case study method was the most suitable method to apply, highlighting that case study approach is particularly useful for exploratory research (Yin, 2018). It helps to develop new insights into theoretically novel phenomena, such as digital servitization, which has not yet been adequately explained by existing theory (Edmondson & Mcmanus, 2007; Eisenhardt & Graebner, 2007). For example, Paper 5 explains the choice of applying a single case study approach "as it allows for in-depth analysis of specific problems. Although single case study approach endures the difficulty of generalizing the finding outside the specific context of the case, the study aims to understand the general problems rather than the specific causality".
	Pilot study: Was there a pilot study proceeding the main study?	Piloting interviews were conducted prior to the main studies for all papers in order to test the interview instrument and revise it. The interview guide for all papers were revised continuously as new insights were derived from the interviews and secondary data, thus increasing relevance and understanding, and ensuring valid data collection (Miles & Huberman, 1994). For example, when piloting interviews were conducted for Paper 3, informants were asked about knowledge sharing. As they emphasized that this is very much data driven, questions on this theme were extended to specifically address data exchange between ecosystem actors.
	Theoretical sampling: Was an explanation provided of which case(s) were chosen and why?	Cases were selected based on theoretical sampling (Eisenhardt, 1989; Eisenhardt & Graebner, 2007; Glaser & Strauss, 1967) for all five papers. The case selection criteria were informed by the research question of each study, and explicitly explained. For example, the selection criteria of Paper 4 was informed by the study's research question: How can industrial equipment manufacturers align the development of technology, business models and ecosystem relationships for the advancement of autonomous solutions?. Accordingly, three case selection criteria were used. First, we selected industrial equipment manufacturers with which we had established good contacts, as well as access to data of other ecosystem actors. Second, we selected cases where the equipment manufacturer is actively involved in the provision of industrial solutions as opposed to solely providing products to enable exploring different business models. Third, we selected manufacturers that are either developing, testing and/or implementing a range of autonomous solutions at different levels of technology development and maturity.
Data Collection	**Triangulation:** Was the research based on multiple sources of data?	Multiple sources of data have been used in all five papers. Besides enabling triangulation (Jick, 1979), different sources of data can also generate different insights (Gibbert & Ruigrok, 2010). Whilst semi-structured interviews were the main source of data collection, these were supplemented by data from secondary sources. For example, in Paper 2, secondary sources of data included documents such as company reports, agreements, project documents, and Power Point presentations.
	Review and validation of evidence: Was the evidence reviewed and validated by external parties?	The evidence for different studies have been reviewed and validated by company informants. This is to ensure "giving voice to participants" (Bluhm et al., 2011), and to "help avoid researcher bias and subsequent misinterpretations" (Goffin et al., 2019). This was done in different ways. For instance, for Paper 5, workshops were conducted with informants to validate findings and obtain further insights, whereas for Paper 2, this was done via correspondence and follow-up discussions with informants.

	Transparency of data collection: Was it made clear how the data collection process was conducted?	The process of data collection was clearly explained in the methods section of each of the five papers to enable an understanding of the logic and purpose of the procedures (Leonard-Barton, 1990). This included stating the sources of data and number of interviews, for example. Furthermore, a table was included in each paper to provide an overview of the case companies and the job titles of the interviewees. The overarching open-ended interview questions were also included. For example, interview questions for Paper 1 were listed in its appendix.
Data Analysis	**Inter-coder agreement:** Were the data coded by multiple investigators?	For each paper, at least two authors were involved in data coding and categorizing in order to increase rigor and confidence to the research findings (Benbasat et al., 1987; Eisenhardt, 1989). For example, the process of inter-coder agreement was explained in Paper 3, stating "Each researcher independently classified the case equipment suppliers into the different ecosystem strategies distinguished. The purpose was to check the accuracy of the classification. There was considerable agreement between researchers on the classification, and discrepancies were overcome through comprehensive discussions leading to ultimate agreement".
	Case presentation: Were findings and empirical evidence presented in a way that made it clear how the author(s) reach their conclusions?	The data structure resulted from data analysis (Gioia et al., 2013) was presented in a figure in each paper, showing a systematic process of analysis and reporting. This is to ensure that readers understand how conclusions were reached (Miles & Huberman, 1994). Furthermore, representative quotations of informants were provided as empirical evidence throughout the reporting of findings. For example, in Paper 1, a table was included to present a summarized overview of a systematic cross-case analysis, showing the progression of provider-customer relationships within each case and how they relate to the identified themes and dimensions. This was supported by a table in the appendix showing representative quotations from each case for each first-order category.
	Case interpretation: Did the case analysis move beyond description and conceptual ordering?	Whilst condensing data into patterns and categories was a step in data analysis, all five papers moved beyond that toward theorizing (Yin, 2018). This was done through activities such as abstracting, generalizing, relating, explaining, and synthesizing (Weick, 1995), leading to the development of frameworks and models. To exemplify, the framework for commercialization of autonomous solutions developed in Paper 4 was based on synthesizing the insights emerged from data analysis. "The framework visualizes the three key dimensions (technology development, ecosystem configuration, business model design), evolving across the three autonomous solution maturity levels and interconnecting with the three overarching principles". Similarly, the framework developed in this thesis (Chapter 5) is based on synthesizing insights from the five papers through the theoretical lens of the relational view (Dyer et al., 2018; Dyer & Singh, 1998), thus, relating research outcomes to extant literature (Goffin et al., 2019).
Post-hoc	**Reflecting on validity and reliability:** Was there a discussion about the quality of the research?	This table can be considered as an overall reflection on the quality and rigor of this research. Also, the papers include sections that acknowledge the limitations and reflect on the validity and reliability of research. For example, Paper 1 states "By using multiple sources of evidence – i.e. both different informants and different secondary sources – we were able to increase construct validity [(Yin, 2018)]… The initial results of the study were presented to a number of informants… to increase validity… Furthermore, to increase reliability and… the possibility of replication, a case-study protocol with emphasis on field procedures and case-study questions was constructed along with a case-study database".

4. Summaries of Appended Papers

This chapter summarizes the five appended papers. Together, the findings of the five papers contribute to fulfil the overall purpose of the thesis. The chapter briefly presents the research gaps and the resulting purpose of each paper. Furthermore, the applied research method and key findings are presented.

4.1. Paper 1

Kamalaldin, A., Linde, L., Sjödin, D., & Parida, V. (2020). Transforming provider-customer relationships in digital servitization: A relational view on digitalization. *Industrial Marketing Management*, 89, 306-325.

Digitalization is viewed as a source of future competitiveness due to its potential for unlocking new value-creation and revenue-generation opportunities. To profit from digitalization, providers and customers tend to move away from transactional product-centric model to relational service-oriented engagement. This relational transformation is brought about through digital servitization. However, current knowledge about how providers and customers transform their relationship to achieve benefits from digital servitization is lacking.

Accordingly, this paper targets two research gaps. First, prior studies have placed the dominant focus on the provider perspective, with limited insights into the relational aspect and how industrial customers must work closely with providers to adapt and, thus, derive benefits from digital technologies. Therefore, it is necessary to include the less-studied customer perspective to understand the relational requirements. Second, there is a lack of knowledge concerning how provider-customer relationships transform and evolve through digital servitization. A need remains to study the change in relational dynamics and activities between providers and customers in this transformation. This study targets these research gaps by applying the relational view theory to increase understanding of *how providers and customers transform their relationships in digital servitization*. It

builds on the case studies of four dyadic provider-customer relationships engaged in digital servitization.

The results provide evidence for four relational components (complementary digitalization capabilities, relation-specific digital assets, digitally enabled knowledge-sharing routines, and partnership governance) that enable providers and customers to profit from digital servitization. A key contribution is the development of a relational transformation framework for digital servitization that provides an overview of how the four relational components evolve as the relationship progresses across three phases (foundational, intermediate, and advanced), where each phase builds on the other. The framework emphasizes that complementary digitalization capabilities are the main trigger for initiating and preserving a digital servitization relationship, thus, complementarity is the foundation for partnership. In order to move this partnership forward, partners must continue to invest in relation-specific digital assets, and enhance digitally enabled knowledge-sharing routines, in order to maximize the potential of their relationship. What is more, partnership governance must be gradually transformed to a relational trust-based approach to fully leverage digitalization potential. Thus, this paper contributes to the emerging digital servitization literature by offering key relational insights into the interdependence of activities throughout the transformation phases of provider-customer relationships. By adopting a novel theoretical lens (the relational view), this paper also addresses the call to include and develop relevant theoretical perspectives when studying servitization.

4.2. Paper 2

Sjödin, D., **Kamalaldin, A.**, Parida, V., & Islam, N. Procurement 4.0: How industrial customers transform procurement processes to capitalize on digital servitization. *(Accepted for publication in IEEE Transactions on Engineering Management).*

This paper focuses on the customer's perspective of digital servitization relationships. Whilst the procurement and application of digital solutions can revolutionize companies' operations, it is essential for industrial customers to refine their internal processes to exploit the potential of digital servitization. In this transition, the procurement

organization is pivotal in orchestrating relationships between internal functions and supplier ecosystems. Yet, traditional procurement processes are poorly suited to the evaluation and procurement of digital solutions, hampering value co-creation between suppliers and customers. However, research on this area remains scarce.

Hence, this paper targets two research gaps. First, there is a need to understand the challenges of procurement in digital servitization, as there is lack of insights into the causes of these challenges relating to internal processes. Second, there is a need to understand how industrial customers can structure their procurement processes to capitalize on digital servitization. Research on digital servitization has widely focused on the supplier's perspective with little insights into the key phases and activities that guide industrial customers in procuring digital solutions. In targeting these gaps, the purpose of this paper is to investigate *how procurement process models can be adapted to address the opportunities and challenges of digital servitization for industrial customers*. To fulfil this purpose, this study draws on the rich case-study data from eleven industrial customers and eight suppliers that are leading adopters of digital servitization in their industries.

The paper's findings offer several contributions to theory and practice. First, the paper identifies three key industrial customer challenges related to procuring digital services: 1) evaluating value of digital solutions, 2) prioritizing digital investment across organizational silos, and 3) incentivizing supplier-driven digital innovation. Second, the study suggests a blueprint of a revised process model for Procurement 4.0 in digital servitization, highlighting four phases: 1) mapping digital opportunities, 2) selecting digitalization partners, 3) co-developing digital solution contracts, and 4) promoting continuous digital innovation. The paper underlines the key activities and key questions for each phase. Third, the paper also defines three overarching principles for capturing business value from digital innovation: 1) nurture digital ecosystem generativity, 2) orchestrate cross-functional integration, and 3) leverage supplier capabilities through agile co-creation. Finally, although the focus of this paper is the internal processes of the industrial customer, it underlines the relational dynamics between the customer and provider, and underscores the importance of an ecosystem perspective, emphasizing that digital servitization extends beyond dyadic relationships and involves a multilateral set of actors.

4.3. Paper 3

Kamalaldin, A., Sjödin, D., Hullova, D., & Parida, V. (2021). Configuring ecosystem strategies for digitally enabled process innovation: A framework for equipment suppliers in the process industries. *Technovation*, 105, 102250.

Digitalization offers new opportunities for equipment suppliers to support the competitiveness of process industry firms through participating in digitally enabled process-innovation initiatives. However, doing so is not without challenges, as it requires equipment suppliers to align with multiple actors within an extended ecosystem to deliver complex product-service software systems as embodied sources of process innovation. This creates various challenges for the equipment supplier because it has to secure its role in an ecosystem where it must simultaneously cooperate and compete with other ecosystem actors (i.e., coopetition). Therefore, it needs to consciously determine what ecosystem strategy to apply. However, literature provides little guidance on this.

Consequently, this study addresses two research gaps. First, there is a need to advance understanding on the conditions influencing ecosystem strategy configuration. Although prior literature has contended that the tension between cooperation and competition must be balanced, a research gap remains in understanding the intersection between this balance and actors' roles in the ecosystem. Second, there is a need for a contingency perspective on appropriate ecosystem strategies based on the industrial customer's context from the standpoint of an equipment supplier. Prior contributions have largely focused on collaborative approaches in generic ecosystems of affiliated actors rather than studying ecosystem strategies applied to a concrete value proposition targeted at a specific industrial customer. Therefore, the purpose of this study is to investigate *how equipment suppliers configure appropriate ecosystem strategies to realize digitally enabled process innovation in various industrial customer contexts*. It builds on six case studies involving equipment suppliers and their ecosystem partners in diverse customer sites.

The study distinguishes four archetypical ecosystem strategies (orchestrator, dominator, complementor, and protector), and explores the conditions in which they are applicable. The core insights are converted into a decision tree framework to guide equipment

suppliers in configuring the appropriate ecosystem strategy based on the industrial customer context. Key contingency considerations include determining an appropriate role in the ecosystem (leader or follower) and a suitable coopetitive approach (cooperation dominated or competition dominated). Consequently, the study contributes to the literatures on process innovation and ecosystems by projecting a contingency perspective and affirming that different contexts require different ecosystem strategies.

4.4. Paper 4

Thomson, L., **Kamalaldin, A.**, Sjödin, D., & Parida, V. (2021) A maturity framework for autonomous solutions in manufacturing firms: The interplay of technology, ecosystem, and business model. *International Entrepreneurship and Management Journal*.

Significant advancements in digitalization and automation have enabled the development, testing, and implementation of increasingly advanced autonomous solutions. Current examples of industrial automation promise significant economic and sustainability-oriented benefits for industrial customers. Yet, implemented autonomous solutions have rarely advanced beyond 'islands of autonomy'. Although enabling initial improvements in the efficiency and effectiveness of operations, they have not led to the systemic process improvements that fully integrated site-wide solutions can achieve. It is becoming increasingly clear that the major challenges in this shift extend beyond technology to focus on business transformation and ecosystem relationships. Yet, extant research offers few insights into these domains.

Specifically, three research gaps are identified. First, there is a need to consider the business model elements for advancing levels of autonomous solution maturity. Although prior research has acknowledged that more advanced digital solutions will likely require a move to outcome-based contracts, gaps in understanding remain as to how revenue model develops in relation to autonomous solution maturity. Second, there is a need to extend the understanding of autonomous solutions beyond the boundaries of a single firm to incorporate an ecosystem perspective. Previous studies have highlighted the need for greater ecosystem collaboration in support of the transition to delivering more advanced automation. However, it is not clear how the ecosystem configuration advances with the

level of autonomous solution maturity. Third, there is a need for a maturity framework to advance understanding of how firms can successfully develop and commercialize autonomous solutions, taking into consideration the importance of alignment between technological, ecosystem, and business model perspectives. Current classifications of autonomous solutions in digital servitization literature fail to capture the significant nuances between solutions at varying levels of technical complexity, with only abstract classifications stating that autonomous solutions exist at the higher end of digitalization capability scale. To address these gaps, this paper investigates *how industrial equipment manufacturers can align the development of technology, business models and ecosystem relationships for the advancement of autonomous solutions*. The paper builds on case studies that include 32 interviews from four industrial equipment manufacturers and their extended ecosystems of partners and customers.

The findings are captured into a three-level maturity framework for industrial autonomous solutions. It shows that key activities are split across three dimensions of technology development, ecosystem configuration, and business model design that evolve over three maturity levels of autonomous solutions (level 1: operator assistance, level 2: semi-autonomous operation, level 3: fully autonomous operation). This is complemented by three overarching principles for the successful commercialization of autonomous solutions: 1) adapting technology to ecosystem maturity, 2) aligning partner revenue flows, and 3) identifying technological value generators. Therefore, the paper develops the existing digital servitization literature with a specific focus on exploring the context of autonomous solutions, and advances understanding of the interplay between technology, ecosystem, and business model for commercializing autonomous solutions.

4.5. Paper 5

Kamalaldin, A., Sjödin, D., Lindberg, P. & Olsson, J. Digitalized PSS for a circular economy: The role of ecosystem alignment. *(R&R in Sustainability)*.

Digitalized Product-Service Systems (DPSS) are seen as a means to achieve a circular economy. However, DPSS does not automatically lead to resource efficiency and a circular economy. PSS literature emphasizes the need for taking a holistic ecosystem

perspective to realize the sustainability potential, but it also acknowledges that this is not easy. Challenges include the complexity of managing relationships between multiple ecosystem actors, the difficulty in aligning incentives and interests of actors with different objectives, and the fear of information leakage. Hence, overcoming the challenges of ecosystem alignment is necessary, especially in the case of DPSS, as digitalization requires combining diverse capabilities of multiple actors. However, knowledge gaps remain in prior literature in relation to ecosystem alignment.

First, there is a lack of knowledge regarding how ecosystem alignment applies in relation to realizing the sustainability potential of DPSS. Although several studies have problematized the ecosystem perspective, a research gap remains in understanding the practical issues with DPSS ecosystem alignment. Second, there is a lack of knowledge on the effect of the contextual characteristics of product and industry on the DPSS ecosystem and sustainability potential. More specifically, little is known on whether a DPSS can achieve sustainability benefits in an industry with short product life-cycles such as the PC industry, which is characterized by a fast product development pace. To address these gaps, the purpose of this study is to develop understanding on *how ecosystem alignment affects the sustainability potential of DPSS offerings, and how this is influenced by the contextual characteristics of the product and industry*. The paper builds on an exploratory single case study of a DPSS ecosystem within the PC industry, through investigating the views of multiple ecosystem actors.

Remarkably, the results show that none of the involved actors has incentives to enhance the sustainability impact of the DPSS offering. This is due to two reasons: 1) contextual factors of the PC industry make long-term product use economically unfavorable, and 2) the complexity and features of DPSS, such as incentive dilution and service and product decoupling, make the sustainability impact potential hard to achieve. This paper contributes to PSS and digital servitization literature by putting the ecosystem perspective in focus in the transition towards a circular economy. The study highlights the importance of enhancing and aligning incentives to all ecosystem actors for improving the sustainability potential of DPSS. In addition, it sheds light on the role of industry related factors in this regard.

5. Towards a Relational Framework for Digital Servitization

This chapter integrates the findings of the appended papers and synthesizes them into a relational framework for digital servitization. Drawing on the conclusions of the appended papers and the insights obtained from the empirical setting, this proposed framework guides the development of industrial relationships at two layers: provider-customer relationship layer, and ecosystem relationships layer. The overall framework and the two layers are explained in detail.

5.1. Introduction to the Framework

The purpose of this thesis is to advance understanding of how industrial relationships develop for digital servitization, targeting two research question; how can provider-customer relationships be transformed, and how can a provider configure ecosystem relationships for digital servitization?. The findings of the five appended papers contribute to the thesis' purpose and research questions. This chapter integrates the findings of the papers and builds on them to develop new theoretical understanding (Weick, 1995). To this end, the following sections outline an emerging relational framework for digital servitization. The framework is the result of sense making concerning the results in the different papers and how they fit together (Weick, 1989). Indeed, Eisenhardt (1989) noted that theorizing processes are often inspired by case study research, stating that "In-depth case research encourages theory building by allowing the constructs, their definitions or measurements, and relationships among constructs to emerge from the process rather than being specified at the outset" (p. 542).

The framework primarily draws on the influential relational view theory and the determinants of inter-organizational competitive advantage: complementary resources and capabilities, relation-specific assets, knowledge-sharing routines, and effective governance (Dyer et al., 2018; Dyer & Singh, 1998). The four determinants are conceptualized for the context of digital servitization, and used as theoretical lens to synthesize the findings from the appended papers into two layers: provider-customer relationship, and ecosystem relationships. Figure 1 illustrates the developed relational framework for digital servitization, which is followed by detailed explanation.

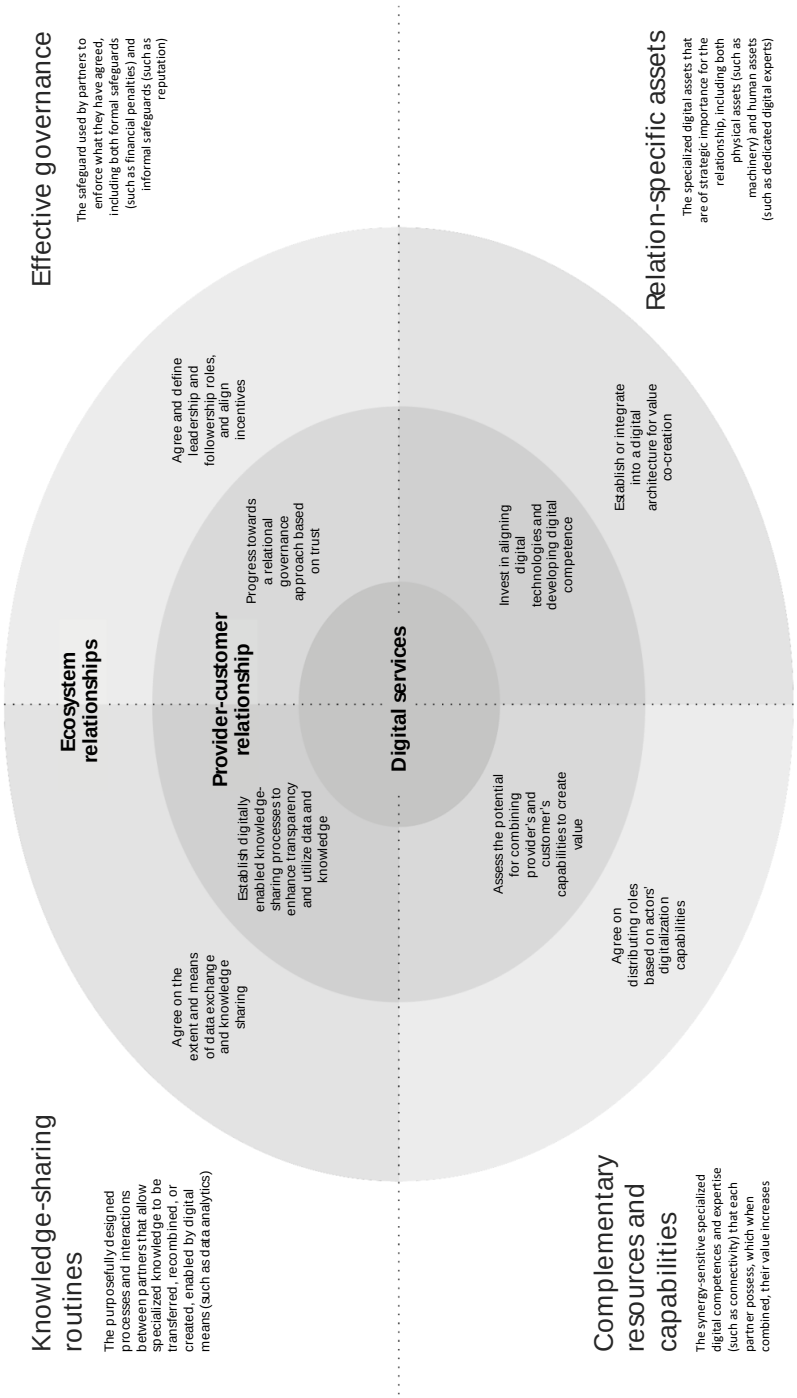

Figure 1: *A relational framework for digital servitization*

5.2. Transforming Provider-Customer Relationship: Towards Co-Creation Logic

From a provider-customer relationship perspective, digital servitization necessitates a closer collaboration, as digital services require providers to undertake larger responsibility for the customer's core processes. The findings show that provider-customer relationship should transform to one that is based on co-creation logic with a long-term perspective (Papers 1-2), and four principles are underlined in this endeavor.

First, if a digital servitization relationship is to be initiated, it is key to assess the potential for combining provider's and customer's capabilities for value co-creation (Papers 1-2). Industrial customers tend to fill digitalization capabilities gap by partnering with providers, thus provider's possession of complementary digitalization capabilities (e.g., data analytics) is the trigger for a digital servitization relationship (Paper 1). Therefore, a thorough formulation and evaluation of how digitalization capabilities improve the customer's business and fill operational needs is of significant importance (Paper 2). Accordingly, the findings reveal that an important activity is to continuously evaluate the benefits of combining the provider's digital expertise with the customer's operational business knowledge, since the rapid development of digital technologies necessitates continuous monitoring of complementarity (Paper 1).

Second, when complementarity is present, the provider and customer should invest in relation-specific digital assets through aligning digital technologies and developing digital competence (Paper 1). This includes building the required digital systems for providing the digital services, enabled by installing sensors and connecting a fleet of machines, for example. The provider and customer may consider developing a digital platform tailored to customer's needs to facilitate the implementation of digital services across functions; such as customer's operations checking equipment performance, and provider's account managers identifying operational problems and solutions (Paper 1). Hence, a digital platform can become an enabler for further optimization, efficiency improvements, and offer customization, which can increase value creation. Also, the findings show that assigning dedicated staff from the provider's team for managing the digital services to the customer is highly appreciated by the customers' firms, as it ensures

closer collaboration (Paper 1). Similarly, a helpful practice is to assign dedicated staff from the customer's firm to take ownership of each project and steer discussions with the provider (Paper 2). Furthermore, the provider and customer may consider forming a joint team, including experts from both sides, in order to manage joint operations and develop digital competence (Paper 1).

Third, besides investing in relation specific digital assets, it is critical for the provider and customer to establish digitally enabled knowledge-sharing processes in order to enhance transparency and utilize data and knowledge (Paper 1). Accumulating and connecting data from multiple sources can enable analysis and optimization. For example, through smart hardware and analytical software, real-time data from the whole fleet of machines and from the entire process can be automatically generated, collected, and analyzed. This can help in identifying bottlenecks, hidden operational problems, as well as new opportunities (Papers 1-2). Needless to say, data and knowledge has little value if not utilized and acted upon. Therefore, the provider and customer should find structured ways to maximize value from the data collected and knowledge exchanged. The findings show that a common practice is to set up regular joint meetings at both managerial and operational level to assess and implement new opportunities based on data analytics, enabling continuous improvement and innovation (Papers 1-2). These interactions may be facilitated through forming a joint Research and Development (R&D) team that analyze new solutions and decide on priorities (Paper 1).

Fourth, the findings demonstrate the necessity for provider and customer to nurture mutual trust and progress towards a relational governance approach in order for both parties to fully benefit from digital servitization (Paper 1). To improve governance efficiency, the balance between control and flexibility needs to be adjusted over time, since the latter is necessary for innovation and exploiting new digital opportunities (Papers 1-2). As the relationship develops, the provider and customer may consider revising the contract and adding contractual incentives, such as reward-penalty mechanism, to enable a transition to a partnership of trust (Paper 1). Given that mutual trust grows over time, the governance mechanisms may then progress to a more relational approach, where the focus is placed on mutually beneficial improvements and continuous innovation rather than on monitoring partner's behavior (Papers 1-2).

5.3. Configuring Ecosystem Relationships: Towards Alignment of Partners

From an ecosystem perspective, adopting the ecosystem-as-structure view is needed for digital servitization (Papers 3-5) – viewing an ecosystem as "the alignment structure of the multilateral set of partners that need to interact in order for a focal value proposition to materialize" (Adner, 2017, p. 41). Accordingly, the ecosystem is centered on a concrete value proposition (digital service) targeted at a specific industrial customer, and ecosystem actors need to align activities for interdependent value creation. The findings emphasize four principles to that end.

First, it is essential that ecosystem roles are distributed based on the digitalization capabilities of the different actors (Paper 3-4). Thus, a provider should assess their internal capabilities and identify the gaps that need to be filled by partnerships in order to achieve the focal value proposition through ecosystem collaboration (Papers 3-5). Although the provider might strive to take the leading role in the ecosystem, the findings stress that this should be subject to having the required maturity and capabilities that enable it to assume such a leading role (Papers 3). This may vary depending on the scope and technology in focus. For example, leading a large-scale digitalization initiative is subject to the provider's possession of the necessary expertise, customer knowledge, local sales and distribution capabilities, and existing resources and staff to drive the implementation (Paper 3). Therefore, it is important for the provider to agree with other ecosystem actors on who will lead the ecosystem and who will accept follower role, in a way that combines each other's resources and capabilities for developing and delivering the digital service(s) to the customer (Paper 3).

Second, the findings emphasize the value of establishing or integrating into a digital architecture for value co-creation (Papers 3-4). For instance, a digital platform can be helpful for handling mixed fleets of equipment, and implementing standard interfaces can increase the potential for platform consolidation and connecting digital assets (Paper 4). Hereby, if the provider is taking a leader role, it should assess the desired extent of openness of the digital architecture based on the customer's context and requirements, as

the customer might specifically demand open systems that enable efficient integration between equipment of multiple providers (Paper 3).

Third, the findings stress the cruciality of agreeing on the extent and means of data exchange and knowledge sharing between ecosystem actors, and seeking to incentivize transparency (Papers 3-4). A provider would need to evaluate the benefits versus risks of data exchange with other actors. For example, the potential to capture greater value and gain higher profits can incentivize a more open exchange of data and knowledge. However, a certain level of risks tends to be associated with sharing knowledge or data with competing providers, especially if these are linked to intellectual property. Therefore, a provider might be willing to exchange data and knowledge only if the anticipated benefits outweigh the potential risks, or if the risks can be mitigated (Paper 3). Accordingly, ecosystem actors can identify and agree on what data and business knowledge are to be shared or protected.

Fourth, in governing the relationships with other ecosystem actors, it is important to agree and define leadership and followership roles, and align incentives for collaboration (Papers 3-5). The involvement of numerous actors in the ecosystem, which may include competing providers, may require them to simultaneously cooperate and compete. Naturally, the provider would compete to maximize its own interests, as it seeks to increase the value captured. At the same time, the provider need to cooperate with other ecosystem actors to achieve the common goal of the customer (Paper 3). Therefore, in governing such relationships, it is critical to consider governance mechanisms that enable aligning the interests of ecosystem actors. This can be through outcome-based contracting or risk/reward sharing arrangements (Papers 4-5).

In conclusion, in order to realize the benefits from digital servitization, a careful consideration of industrial relationships is needed. To that end, the relational framework for digital servitization provides guidance to managers in firms engaged in digital services. The first layer of the framework recommends four overarching principles for transforming provider-customer relationships, whilst the second layer suggests principles for configuring relationships at an ecosystem level that involves multiple actors.

6. Discussion

This chapter presents the main theoretical contributions of this thesis as well as its managerial implications. To conclude, research limitations are stated, and directions for future research are suggested.

6.1. Theoretical Contributions

The purpose of this thesis is to advance understanding of how industrial relationships develop for digital servitization. Thus, this research overlaps into two management domains; innovation management and industrial marketing, as it explores business-to-business relationships in the context of digitalization. The relational framework proposed in Chapter 5, together with the five appended papers, contribute to the emerging literature on digital servitization. The thesis provides novel insights on how provider-customer relationships can be transformed, and how a provider can configure ecosystem relationships for digital servitization. In doing so, this thesis offers theoretical contributions in the following specific ways.

First, the thesis contributes by *developing a process and overarching principles for transforming provider-customer relationships in digital servitization*. Servitization and digitalization literature recognizes that digital servitization is a process, but in-depth insights of how the transformation unfolds has been lacking (Bharadwaj et al., 2013; Lerch & Gotsch, 2015). Whilst there are previous studies that have offered transformation models for providers (e.g., Iansiti & Lakhani, 2014; Lerch & Gotsch, 2015), Paper 1 provides a novel transformation model for the provider-customer relationship as a whole, showing the interdependence of activities at foundational, intermediate, and advanced phases of the relationship. The findings illustrate that each phase builds on the proceeding one as firms make joint investments and build stronger relationships over time. Hence, this research provides direction on which order to perform certain activities to handle relational complexities, as well as overarching principles that guide provider-customer relational progress.

Second, the thesis contributes to digital servitization literature by *viewing customers as active agents in shaping the value proposition in the context of digital servitization*. This contrasts with earlier studies that have tended to view customers as receivers of a value proposition (e.g., Iansiti & Levien, 2004; Teece, 2007). This thesis builds on value co-creation logic (Grönroos & Voima, 2013) and considers both provider and customer as partners who jointly co-create value through interdependent activities. This acknowledges that customer's requirements and operational contexts need to be considered, and hence, customers may exert considerable influence on the value proposition and contribute their own resources from an early stage. In particular, as paper 3 illustrates, the industrial customer's context may hold significant role in shaping not only the key value propositions, but also the appropriate ecosystem strategies of providers.

Third, the thesis contributes by *developing a process model for procuring digital services*. Prior studies on servitization have presented several process models to co-create services and service innovation from the provider's perspective (Rönnberg Sjödin et al., 2016; Sjödin et al., 2021; Sjödin, Parida, Kohtamäki, et al., 2020). However, to the best of our knowledge, no study has yet to investigate the view of industrial customer's procurement process. This thesis advances understanding of the challenges faced by traditional procurement approaches in digital servitization. Failing to address these challenges can explain failure on the part of both providers and customers to achieve a financial return on investment in the fast-changing digital world (Sjödin, Parida, Kohtamäki, et al., 2020), as standard procurement models (e.g., Van Weele, 2005) are not well suited to digital services. Hence, Procurement 4.0 model developed in Paper 2 provides an alternative approach that is built on iterative refinement of specifications and service solutions. The model emphasizes that industrial customers need to develop a digital mindset that is built on agility and relational engagement with providers and associated ecosystems.

Fourth, the thesis contributes to the growing body of literature on innovation ecosystems (Jacobides et al., 2018) by *demonstrating the central role of ecosystem collaboration in digital servitization and suggesting overarching principles for configuring ecosystem relationships*. Prior research has highlighted the need for an ecosystem perspective in digital servitization, and provided some insights into defining ecosystem roles (Iansiti & Levien, 2004) and balancing competition and cooperation (Hannah & Eisenhardt, 2018).

However, these aspects have not been integrated into a common framework. Paper 3 contributes to filling this gap by developing a framework for providers to configure appropriate ecosystem strategies and suggesting a contingency perspective, recognizing that different contexts require different ecosystem strategies. To conceptualize ecosystem strategy, this research builds on the less-studied 'ecosystem-as-structure' view (Adner, 2017). It supports the proposition that this view offers a "more actionable perspective on interdependence", since it highlights partner alignment as a key strategic challenge. This thesis responds to the call of Adner (2017) to identify and explain ecosystem strategy – "the way in which a focal firm approaches the alignment of partners and secures its role in a competitive ecosystem" (p. 47). Specifically, Paper 3 proposes four archetypes of such ecosystem strategies (orchestrator, dominator, complementor, and protector), the underlying tactics manifested in each, and under what conditions these strategies are most applicable. In this way, this thesis contributes to ongoing efforts to develop an empirically grounded theory of innovation ecosystems.

Fifth, the thesis contributes by *emphasizing the interplay between technology development, ecosystem configuration, and business model design in digital servitization.* Previous work has highlighted the need for greater collaboration in progressing to more technologically advanced solutions (e.g., Kohtamäki et al., 2019; Leminen et al., 2018). The findings of Paper 4 support this need, however, it establishes a more direct connection to autonomous solutions (e.g., autonomous wheel loader) by highlighting aspects such as data sharing and digital platforms that must be considered when configuring the ecosystem. The paper highlights the importance of adapting technology to ecosystem maturity when developing digital services and autonomous solutions. It also underlines the need for alignment between the complexity of the solution and the capability of ecosystem partners and customer to manage that complexity. This is also linked to the second contribution, stressing that the industrial customer should be at the focus and actively involved. In relation to business model design, prior studies have highlighted the expected transition to performance or outcome-based business models as a direct consequence of higher levels of autonomy (Lerch & Gotsch, 2015; Parida, Sjödin, et al., 2019). Paper 4 supports this work, but has also identified activities and steps that enables this transition. The maturity framework for autonomous solutions developed in Paper 4

provides a comprehensive perspective, capturing the dimensions of technology development, ecosystem configuration, and business model design across three levels of maturity (level 1: operator assistance, level 2: semi-autonomous operation, level 3: fully autonomous operation).

Sixth, the thesis contributes by *underlining the contextual issues with ecosystem alignment for digital servitization*. Paper 5 emphasizes the need for enhancing and aligning incentives and interests of all involved ecosystem actors in order to achieve a common goal, such as improving the sustainability potential of the offering. It also shows that ecosystem alignment is greatly influenced by the contextual characteristics of the product and industry. For example, an industry with short product life-cycles such as the PC industry, which is characterized by a fast product development pace, would make long-term product use economically unfavorable, and hence reducing the desired sustainability potential. In contrast, the other papers in the thesis focus on more complex product-service-software solutions characterized by high capital costs and long asset lifecycles, which underlines the sustainability potential in such setting. Thus, this research highlights that contextual factors should be taken into consideration. What is more, for aligning the incentives for ecosystem actors, Paper 4 emphasizes the need for aligning partner revenue flows to ensure win-win scenarios. This is achieved by ensuring that the business model incentivizes the desired behaviors. For example, a shift to autonomous solutions could conflict with the incentives of local delivery organizations that are structured for more traditional equipment sales. Therefore, there is a need to consider how incentives are structured and partner revenue flows are aligned, given that autonomous solutions will require risks and responsibility to be shared, and outcomes co-owned.

Finally, the thesis contributes by *adopting a novel theoretical lens (the relational view) in studying digital servitization*. Servitization studies have been criticized for being largely phenomena driven and lacking theoretical application (Rabetino et al., 2018). This thesis addresses this shortcoming by applying a well-established theoretical perspective, the relational view (Dyer et al., 2018; Dyer & Singh, 1998). In doing so, the thesis responds to the call to include and develop relevant theoretical perspectives when studying servitization (Kowalkowski et al., 2017; Rabetino et al., 2018). While there are both benefits and drawbacks to the application of any theoretical perspective (Van de

Ven, 1989), this thesis contends that the relational view helps to shed light on important relational aspects that need to be investigated and understood for advancing the literature on digital servitization. Given the rapid development in digital technologies, it is clear that no single firm can keep pace on its own (Bogers et al., 2018). Thus, this thesis underscores that the relationships between different actors are important unit of analysis in examining value creation and profit maximization (Dyer & Singh, 1998) in digital servitization.

6.2. Managerial Implications

Besides its theoretical contributions, this thesis has several implications for managers who are active in digital servitization efforts in manufacturing companies and digital services providers, as well as managers in companies pursuing the procurement of digital services. More specifically, this thesis offers the following managerial recommendations.

First, this thesis recommends to *adopt a stepwise transformation process of provider-customer relationships in digital servitization*. Digitalization is speeding up the business climate, and placing new requirements on provider–customer relationships to be based on co-creation logic. However, the shift from transactional to relational interaction may not be easy, and hence, a gradual transformation process is recommended. Paper 1 offers a three-phases framework for transforming provider-customer relationships in digital servitization. Drawing on the relational view (Dyer et al., 2018; Dyer & Singh, 1998) and empirical insights, Paper 1 identifies four relational components that are important in digital servitization; complementary digitalization capabilities, relation-specific digital assets, digitally enabled knowledge-sharing routines, and partnership governance. The transformation framework developed in the paper shows how these components evolve, and highlights what to focus on at different phases of the relationship. Hence, it can help managers to prioritize resources and make more informed decisions. The thesis also recommends taking all four relational components into consideration when discussing and negotiating how to move forward with digital servitization, as focusing on one component to the neglect of the other might hinder the generation of the intended value.

Second, the thesis recommends to *progress towards a relational governance approach in governing provider-customer relationships in digital servitization*. The relational

transformation framework developed in Paper 1 shows that different governance mechanisms are needed in different maturity phases of the relationship. It illustrates that development in governance approaches is a process, which can take time to progress. Managers from both sides are recommended to continuously evaluate and revise their governance approach in order to make it more efficient, based on the lessons learned. It is worth mentioning that the pace of progressing from highly contractual to highly relational governance might be subject to a number of factors. These include, for example, existing collaborations between the companies, personal relationships between managers of both parties, and the market reputation of the companies. Managers, thus, should take all these factors into consideration when discussing governance mechanisms.

Third, the thesis recommends industrial customers *to revise procurement processes for procuring digital services*, as traditional procurement processes are not well suited for co-creating value with providers. Paper 2 offers a Procurement 4.0 process model for procuring digital services, highlighting the phases and key activities, and providing practical insights for a new procurement logic. This research recommends that the procurement function plays a central role as an orchestrator of digital transformation and collaboration internally and within ecosystems. In addition, it recommends managers to benefit from digital transparency through new business models focused on customer's outcomes, to automate recurring processes to enable procurement function to focus on orchestrating strategic partnerships, and to ensure cross-fertilization and pollination within suppliers ecosystems. It is, thus, sensible for industrial customers to extend supplier evaluation to include an ecosystem perspective, as complex solutions including product, service, and software components (e.g. sensors, connectivity, and analytics) are typically reliant on cooperation amongst multiple interdependent ecosystem actors. Managers are therefore recommended to map their suppliers in ecosystems and evaluate their ecosystem strategies, which can serve to promote a better understanding of how to foster mutual collaborations. The ecosystem strategies framework developed in Paper 3 can provide a complementary view and guide industrial customers in understanding how their suppliers can work together.

Fourth, the thesis recommends providers to *assess the customer's context and accordingly configure the appropriate ecosystem strategy to approach the alignment of partners in a*

digital service(s) ecosystem. The framework developed in Paper 3 can guide managers in shaping their company's strategy when working in an ecosystem of multiple actors, based on assessing the specific industrial customer context. By identifying the appropriate ecosystem strategy, the provider can better understand its appropriate role (leader or follower) and the suitable balance of cooperation and competition in relation to other ecosystem actors. Hence, it can be better able to organize value creation and delivery in order to secure the benefits of the digital services. In particular, this thesis recommends managers to acknowledge that providers may need to simultaneously compete and cooperate in an ecosystem. Competition is often a driver of innovation and an enabler of finding novel configurations of collaborating actors. Acknowledging this reality would help providers to keep an open mind concerning cooperation with competitors and, consequently, to make decisions regarding issues such as knowledge sharing and knowledge protection. This is especially important for more advanced autonomous solutions, as collaborative research and development activities may be needed between providers to integrate their capabilities for achieving fully autonomous operation.

Finally, the thesis recommends to *align the interests and incentives for all ecosystem actors to achieve the common goals of the digital service(s)*. Papers 4 and 5 explore some practical and contextual issues with ecosystem alignment in digital servitization, and a number of recommendations to managers are drawn. As close cooperation throughout the ecosystem is needed for digital servitization, this needs to be supported by a business model that reflects risk/reward sharing arrangements complemented by high data transparency for auditability and trust. The business model should align partners revenue flows and ensure win-win scenarios to incentivize all actors to cooperate. However, managers should also consider the contextual barriers of the industry and product, such as product's longevity. For example, managers of manufacturers of products with relatively short life-cycles, may consider promoting products with relatively longer life-cycles if they are aiming to enhance the sustainability potential through digital servitization. Governmental and societal pressure to move towards a circular economy is increasing, and thus, equipment manufacturers are recommended to look into promoting long-term product use. Without aligning the interests of all involved ecosystem actors and a consideration to the contextual factors, the sustainability potential of digital services may be hindered.

6.3. Limitations and Suggestions for Future Research

Although it provides several contributions to the emerging digital servitization literature, the present thesis has some limitations that should be considered when interpreting the results. Accordingly, the limitations provide a starting point for future research.

First, this research was based on qualitative case studies, so, the generalizability of the findings might be limited to similar contexts. Hence, further quantitative research is suggested to assist in the generalization of findings and theory building. For example, quantitative studies using time lag to measure the transformation of digital servitization provider-customer relationships and dependent variables related to performance could provide valuable insights on the correlation. Another suggestion is conducting a quantitative research to study the success of a particular ecosystem strategy in specific conditions, or the extent to which certain dependent variables affect the applicability of an ecosystem strategy in digital servitization context.

Second, this research was mainly based on large companies in Sweden. The results could be different in other settings, contingent on firm-, industry- or country-level differences. For example, SMEs may require a different procurement process than the one suggested in this thesis. Also, disparities in culture and regulations between countries may influence industrial relationships. Consequently, further research is suggested on this aspect exploring the significance of such factors.

Third, this research focused on B2B setting of digital servitization. Further research on B2C setting of digital services is suggested, since scale, complexity, and risks are likely to be different. These differences might, for example, influence ecosystem configuration and how ecosystem actors approach the alignment of partners for delivering digital services to individual consumers, as opposed to industrial customers. So, studying B2C context can provide additional insights into ecosystem strategies for digital servitization.

Finally, digital servitization literature could benefit from research taking the ecosystem-as-coevolution view, recently suggested by Hou and Shi (2021), which emphasizes continuous evolution and innovation. This opens up interesting issues for digital servitization research, such as how an ecosystem evolve, and how the dynamics between ecosystem actors change over time.

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