Exploring the governance mechanisms for value co-creation

in PSS business ecosystems

Abstract

This paper explores the governance mechanisms for value co-creation when product–service systems (PSS) providers move into PSS business ecosystems. The PSS providers in our study applied both internal and external governance mechanisms to regulate value co-creation. Internally, they relied on formal organisational setups and informal coordination between product, service and digital divisions. Externally, they had strong relational governance mechanisms supported by appropriate contractual governance mechanisms. As frontline (field) interactions became an important factor for realising value co-creation, PSS providers also attempted to develop individual-based psychological governance to complement group-based relational governance. Our findings reveal five challenges in managing the governance mechanisms: (1) orchestrating all digital resources and capabilities, especially managing the incompatibility and isolation of different digital tools in product and service divisions; (2) managing all relations in one platform that can embrace customer relationship management (CRM), supplier relationship management (SRM) and form relations with emerging actors such as authorities; (3) designing appropriate contractual governance to measure co-created value from economic, societal and environmental perspectives, and govern data ownership and security; (4) managing the interplay between contractual and relational governance mechanisms during PSS agreement implementation; and (5) developing psychological governance for frontline staff. We direct PSS providers towards essential aspects that require attention when developing governance mechanisms by identifying these challenges. Moreover, identifying such challenges will allow policymakers, practitioners, and scholars to jointly develop standards, policies and guidelines in these increasingly prevalent ecosystem business arrangements.

Keywords Contractual governance, Relational governance, Psychological governance, Value co-creation, PSS business ecosystems, Digitalisation

1. Introduction

Since the 1980s, an increasing number of manufacturers have shifted their strategies from selling products to providing integrated systems of products and services (Baines et al., 2007; Gaiardelli et al., 2021; Rabetino et al., 2018). The integrated systems are believed to result in economic, environmental and social benefits (Haber and Fargnoli, 2021; Li and Found, 2017; Reim et al., 2018). This phenomenon is also known as servitisation, or the emergence of product-service systems (PSS) (Rabetino et al., 2021; Vandermerwe and Rada, 1988). In the era of industry 4.0, the evolution of PSS continues by leveraging the advancement of digital technologies such as the Internet of Things (IoT), cloud computing and big data analytics (Gaiardelli et al., 2021; Gebauer et al., 2021a; Rabetino et al., 2021). Consequently, PSS providers, i.e. manufacturers providing integrated products and services systems, are attempting to develop smart PSS business ecosystems. A business ecosystem is an economic community where a group of interacting firms beyond the boundaries of a single industry mutually adapt and co-evolve their capabilities and roles to build a shared vision, set governance rules, and gain sustainable competitive advantage (Adner, 2017; Jacobides et al., 2018; Moore, 1996). For example, John Deere, a global manufacturer of farming equipment, led the development of a smart PSS business ecosystem of farms by linking its agricultural machinery with farms' irrigation systems, meteorological systems and seeding systems from other ecosystem partners (Porter and Heppelmann, 2014).

The development and delivery of PSS business ecosystems require multi-dimensional exchanges, dynamic interactions and capability co-development among various actors such as customers, sub-system integrators and service providers (Gaiardelli et al., 2021; Gebauer et al., 2013; Windahl and Lakemond, 2006). Traditional buyer-supplier relationships should be broadened to more holistic network or ecosystem relationships (Ellram and Murfield, 2019; Kamalaldin et al., 2020) to facilitate such exchanges. Meanwhile, with the rapid digital advancement reshaping traditional industry boundaries and changing supply chain management structures, new actors also emerge from seemingly unrelated industries (Porter and Heppelmann, 2014; Sklyar et al., 2019). As a result, firm boundaries and inter-firm interactions become multiple and dynamic. The network structure can no longer be considered a process of slicing up a pre-defined set and sequence of value-adding tasks but rather a process of embracing value co-creation (Spring and Araujo, 2009). Considering that value co-creation is central to PSS providers (Sjödin et al., 2016), managing PSS in broader ecosystem contexts requires manufacturers to shift their conventional linear chain perspectives towards a more

holistic ecosystem perspective, and from sequential value-adding to value co-creation. This shift also calls for evolving governance mechanisms to regulate value co-creation in PSS business ecosystems from a marketing perspective. Despite a rich literature on PSS, business ecosystems, value co-creation, and governance mechanisms, these important areas continue to be studied mainly in independence. Research on the governance mechanisms for value co-creation in PSS business ecosystems remains rare, particularly in the industrial business to business (B2B) context (Hein et al., 2019; Li et al., 2020a; Sjödin et al., 2019).

Several other research gaps have been reported here. First, PSS providers often encounter significant relational challenges in value co-creation (Li et al., 2020a; Reim et al., 2018; Sjödin et al., 2016). The emerging actors in PSS business ecosystems complicate relational governance, yet the literature does not provide the insights that support the development of relational governance mechanisms. Second, PSS providers also face challenges in configuring appropriate contractual governance mechanisms that can create incentives for value co-creation and are not so complex to reduce trust, hinder the development of relationships, and limit the exploration of new win-win opportunities (Liinamaa et al., 2016; Sjödin et al., 2019, 2016). In addition, value co-creation in PSS business ecosystems becomes more dynamic and context-specific and, therefore, cannot be wholly managed by explicit, rigid contracts (Green et al., 2017; Ng et al., 2009; Sjödin et al., 2016). Consequently, it is imperative to understand the interplay between contractual governance and relational governance and how they jointly impact value co-creation better because purely relying on either is ineffective and even problematic for the whole value co-creation process. Third, the enhanced digital connectivity via 'smart connected products' (Porter and Heppelmann, 2015, 2014) is changing the socialisation process between network actors leading to more decentralised and democratised individual interactions in the industrial B2B contexts. Research has yet to catch up with this trend and provide further insight into psychological governance that guides individual-based interactions and behaviours, and its interplay with relational governance that guides group-based interactions for value co-creation.

In this paper we seek to address the above gaps by answering the following two research questions:

- How do PSS providers develop governance mechanisms to guide value co-creation in PSS business ecosystems?
- What challenges are they facing?

Our findings are based on a multi-case study from three multi-national manufacturing companies that are in the process of transforming to PSS business ecosystems. In our analysis, we investigated the core PSS providers and included the perspectives of their suppliers, customers, end-users (equipment operators), governmental authorities, and other horizontal partners. Moreover, our research design incorporated aspects of Formentini and Taticchi (2016), who examine both internal and external governance mechanisms to gain a holistic investigation. The contributions of our research are twofold. First, we extend and enrich the literature on governance mechanisms for value co-creation in PSS business ecosystems. Specifically, our findings contribute to theory development in the following four aspects: (1) the realisation that internal governance mechanisms should also be considered alongside external governance mechanisms; (2) the realisation that relational governance goes beyond traditional B2B setup and involves more B2A (business to authorities); (3) new lights cast on the emerging psychological governance to guide individual-based frontline interactions and complement the group-based relational governance; and (4) the realisation that contractual, relational and psychological governance mechanisms need to be orchestrated holistically. Second, the challenges revealed in this research can direct PSS providers towards important aspects that require attention when developing holistic governance mechanisms. Identifying such challenges will also allow policymakers, practitioners, and scholars to join efforts to develop policies and guidelines in these increasingly prevalent ecosystem business arrangements.

The remainder of this paper is structured as below. Section 2 reports the result of a literature review. Section 3 outlines the research methodology of a multi-case study design. Section 4 reports the findings and results. Section 5 discusses the findings, followed by Section 6 on the conclusion and future research directions.

2 Literature review

2.1 Research on PSS, business ecosystems and value co-creation

Literature shows that alongside the research growth in PSS, other research streams also shape the research direction of PSS and contribute to the convergence of different research disciplines (e.g., see the work of Rabetino et al. (2021, 2018), Li et al. (2020a), and Kowalkowski et al. (2017)). The digitalisation trend accelerates industry boundary-blurring and PSS business ecosystem growth (Burström et al., 2021; Gaiardelli et al., 2021; Gebauer et al., 2021b; Lenka et al., 2017); research on PSS, business ecosystems and value co-creation start to converge.

Research on PSS

Research on PSS can be divided into three phases (Li et al., 2020a). The first phase (1999-2004) set the foundation for concept development with main concerns on sustainability and related policy. The second phase (2005-2008) was characterised by reflection and adjustment of PSS research directions, such as questions arising from the service paradox (Brax, 2005; Gebauer et al., 2005). The third phase started around 2009 and continues with a growing maturity and broader development areas. This phase is influenced by the 'service-dominant logic' (Vargo et al., 2008; Vargo and Lusch, 2008a, 2008b), 'smart connected products' (Porter and Heppelmann, 2014, 2015), 'smart services' (Kagermann et al., 2014), and 'IoT in servitisation' (Paiola and Gebauer, 2020; Rymaszewska et al., 2017; Suppatvech et al., 2019). The key themes that have emerged in this phase include value co-creation (Hakanen, 2014; Kamalaldin et al., 2020; Lenka et al., 2017; Sjödin et al., 2016), digitisation/digitalisation (Coreynen et al., 2017; Lenka et al., 2017; Lerch and Gotsch, 2015; Vendrell-Herrero et al., 2016), digital servitisation (Coreynen et al., 2020; Gebauer et al., 2021b; Kamalaldin et al., 2020; Paiola and Gebauer, 2020; Paschou et al., 2020; Tronvoll et al., 2020), and PSS networks and ecosystems (Burström et al., 2021; Gaiardelli et al., 2021; Hakanen, 2014; Jaakkola and Hakanen, 2013; Lacoste, 2016; Sklyar et al., 2019). We summarise the main findings from these papers in Table 1.

Table 1 Summary of literature review: main findings and recommended future research

Authors	Research topic	Main findings	Recommended future research (Texts in bold are addressed by this research)
Burström *et al.* (2021)	AI-enabled business-model innovation and transformation in industrial ecosystems	AI business-model innovation should be aligned with ecosystem innovation. In short-term manufacturers may use ecosystem reconfiguration strategy, whereas long-term strategies relate to ecosystem revitalization, and resilience.	• Design studies **reaching beyond the industrial boundaries to include stakeholders such as governments and research institutions and exploring their role in the transformation** of manufacturing business models. • Encourage studies using comprehensive panel data. Looking at both the firm- and industry-level effects of circular economy transformation
Gaiardelli *et al.* (2021)	PSS evolution in the era of Industry 4.0	Identifying the main trajectories that would shape a future scenario in which PSS and Industry 4.0 would merge	• **Transformation of the PSS value chain into a PSS ecosystem** • The transformation inside a single company • The digital transformation of the traditional PSS business model
Gebauer *et al.* (2021a)	Special issue introduction in digital servitisation	Digital servitisation: research in academia and practices in the business world	• Relying on a variety of research strategies and methods • Role of external growth for facilitating digital growth • Competitive arena around IoT platforms
Rabetino *et al.* (2021)	Research streams in servitisation	Seven sub-streams and their thematic trends are identified. **Governance in performance-based contracting is with a low number of publications.**	• Explore sub-streams within other industrial marketing management research domains and **cross-disciplinary topics such as the PSS literature**
Kamalaldin *et al* (2020)	Transforming provider-customer relationships in digital servitisation	Four relational components: complementary digitalisation capabilities, relation-specific digital assets, digitally enabled knowledge-sharing routines, and partnership governance. The development of a relational transformation framework for digital servitisation.	• The contingency perspective concerning relational transformation in digital servitisation • Quantitative studies to measure the transformation and dependent variables related to performance • **Co-creation among different network actors (e.g., providers, service delivery partners, and customers). Network or ecosystem perspectives seem to be particularly pertinent given the increasing speed and complexity of the digital transformation of industry**
Paschou *et al.* (2020)	Review of digital servitisation in manufacturing	Research on digital servitisation is fragmented across different fields. Limited research addresses the cumulative effect of technologies.	• **A more systemic and holistic approach by extending the research scope from a single-firm or dyadic perspective to a network or ecosystem approach** • Develop models and frameworks to support decision-making by practitioners
Tronvoll *et al.* (2020)	Transformational shifts through digital servitisation	To achieve digital service-led growth, a firm and its network need to make three interconnected shifts: (1) from planning to discovery, (2) from scarcity to abundance, and (3) from hierarchy to partnership. Organizational identity, de-materialization, and collaboration play a key role in this transformation.	• **Collect data from additional actors in the network** • Explore whether and how digital maturity within a specific industry relates to the scope of each shift • Intersection of marketing and related disciplines

Table 1 Summary of literature review: main findings and recommended future research (continued)

Authors	Research topic	Main findings	Recommended future research (Texts in bold are addressed by this research)
Sklyar *et al.* (2019)	Digital servitisation and service ecosystem	Within-firm centralization and integration play a key role in the capacity to organise for digital servitisation.	• Interdisciplinary and transdisciplinary research • **Study multiple actors in the ecosystem** • Assess the interplay between various ecosystem characteristics and digital servitisation initiatives
Sjödin *et al.* (2019)	Relational governance strategies for advanced service provision in manufacturing companies	The research identifies three alternative governance strategies to profit from service provision: innovation, relational, and market-based governance strategies. Relational governance strategy locks customers into longer relationships by high perceived switching costs and low level of explicit contracts. Relying on high trust and openness between provider and customer for value co-creation.	• Adopt a relational view both at the relational and **ecosystem levels** to study service interactions, knowledge processing, value-creating processes and performance in ecosystems.
Rabetino *et al.* (2018)	Review on servitisation-related research	Three servitisation-related communities are identified: product-service systems, solution business, and service science.	• **Increase the use of well-established theories from adjacent mature fields** • **Borrow ideas from different communities to stimulate knowledge accumulation within and across communities** • Reduce the level of description while increasing the number of confirmatory, quantitative, and longitudinal research designs
Lenka *et al.* (2017)	Digitalisation capabilities as enablers of value co-Creation in servitizing firms	Three underlying digitalisation capabilities: intelligence capability, connect capability, and analytic capability.	• Understand the digitalisation capability development process and the antecedents to digitalization capabilities • Examine the level and extent of the influence of the digitalisation capabilities on the value co-creation process
Kowalkowski *et al.* (2017)	Review on service growth in product firms	The evolution of the research on service growth can be grouped into two phases: (1) setting the boundaries of the research domain, and (2) emergence of the conceptual foundation. While research on service growth has a well-established tradition in terms of output, theoretically it is still largely in a 'nascent' phase.	• Assess empirical evidence of the impact of service growth on firm performance • Study the role of merger & acquisitions in service growth strategy • Explore single/multiple positions along the transition line • Study the process of adding or removing services • Expand the context of service growth beyond product manufacturing firms
Sjödin *et al.* (2016)	Relational coping strategies for value co-creation process in integrated product-services	Three types of role ambiguities (vague role expectations, unclear role descriptions and uncertain role scripts) often serve as barriers to value co-creation, which requires different relational response strategies (role clarification, role redefinition and role adaption).	• Consider cultural differences for studying relational coping strategies • **Examine roles at multiple levels, such as the organizational, relational, and individual levels** • **Investigate value co-creation from a network perspective**

Business ecosystems

In their study on ecosystems, Jacobides et al. (2018) identified three streams: a 'business ecosystem' stream, an 'innovation ecosystem' stream, and a 'platform ecosystem'. In this paper, our focus is on the business ecosystem. A business ecosystem is an economic community where a group of interacting firms create, maintain and evolve a specific structure of relationships and alignment to find mutually supportive roles to create value or materialise the focal value proposition (Jacobides et al., 2018; Moore, 1996; Rong et al., 2015). Over time, the members 'co-evolve their capabilities and roles and tend to align themselves with the direction set by one or more central companies' (Moore, 1996, p. 26). The central companies (i.e., the PSS providers in this paper) are ecosystem leaders who define the ecosystem visions, set governance rules, and orchestrate various product and service offerings from other complementors. Leadership position can change as a project matures in the ecosystem (Kumar et al., 2022). In a few cases, the leadership position can be shared among several actors in the ecosystem. For example, Cisco and Philips share the lead in smart city lighting (Adner, 2017).

As was stated at the outset of this section, PSS providers continue to innovate and grow by taking advantage of digital technologies in the era of industry 4.0. The competition shifts from the functionality of a discrete product or service to the performance of broader ecosystems by offering a package of connected equipment and related services that optimise overall results (Porter and Heppelmann, 2014). Thus, PSS providers must engage more actors to integrate related products, services, resources and capabilities into system offerings, leading to broader PSS business ecosystems. The actors in PSS business ecosystems can include PSS providers, customers, components manufacturers, sub-system integrators, service providers, complementary partners, asset owners, operators, end-users, research institutes, governmental authorities (agencies), and standards organisations (Gaiardelli et al., 2021; Gebauer et al., 2013; Sklyar et al., 2019; Ulaga and Reinartz, 2011; Windahl and Lakemond, 2006).

Value co-creation

The concept of value co-creation (co-production in Ramírez's words) was first introduced by Ramírez (1999). Socio-technical advancements transformed the role of human actors from being in a linear and sequential industrial mode of value creation to considering value creation as a synchronic and interactive process, in which value is not simply 'added' but mutually 'created' (Ramírez 1999). Thus, compared to the traditional industrial view, this co-production view includes several key characteristics:

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1. Co-production is rendering boundaries that are more permeable and overlapping.
2. Firms require radical decentralisation, distributed leadership, intense interdependence, transparent performance measurement, and reciprocity.
3. Firms' connection with external partners is becoming at least as necessary as the interaction among their organisations.
4. Digital frameworks support co-production.

We believe this co-production view is instrumental to studying value co-creation in PSS business ecosystems, particularly when it converges with the digitalisation trend in manufacturing industries. Vargo and Lusch (2008b) and Vargo et al. (2008) proposed in their service-dominant logic (SDL) that value is co-created by the actors through resource integrations in the network. Research on value co-creation has been centred on the user side or use stage, the so-called 'value in use'. However, in the PSS context, value co-creation can occur during the three phases of requirement definition, offering customisation and implementation (Sjödin et al., 2016), and throughout the product lifecycle from design to production and use (Grönroos et al., 2010; Martinez et al., 2010). In this paper, value co-creation is defined as below:

Value co-creation is a particular case of collaboration, where actors integrate resources and capabilities and work together interactively to meet a need and unleash the potential value, both tangibly and intangibly, throughout the product lifecycle.

As introduced in Section 2.1, in the third phase of research on PSS, industry boundaries expand beyond product systems to PSS networks and ecosystems (Burström et al., 2021; Gaiardelli et al., 2021). The development and delivery of PSS business ecosystems require multi-dimensional exchanges and dynamic interactions among many actors. During these interactions, the network structure should not be considered a process of slicing up a pre-defined set and sequence of value-adding tasks between the actors but also potentially as a process of genuinely embracing the opportunities for value co-creation (Spring and Araujo, 2009). When PSS providers do not have the necessary capabilities or resources, they co-create with other partners by integrating resources and competence (Kamalaldin et al., 2020).

A fair amount of research comprises efforts toward exploring value co-creation in the PSS context. Most studies take either a predominantly technical perspective, such as digital technologies and capabilities (Gaiardelli et al., 2021; Lenka et al., 2017; Li and Found, 2017) or a relational view (Gaiardelli et al., 2021; Kamalaldin et al., 2020; Ng et al., 2013; Sjödin et

al., 2019, 2016). For example, in the latter, Sjödin et al. (2016) identified three role ambiguities (vague role expectations, unclear role descriptions and uncertain role scripts) as barriers to value co-creation. Kamalaldin et al. (2020) revealed four relational components for digital servitisation: 1) complementary digitalisation capabilities, 2) relation-specific digital assets, 3) digitally-enabled knowledge-sharing routines, and 4) partnership governance. Gaiardelli et al. (2021) revealed the value creation interactions continuum, where the 'symbiotic relationships' represent the innovative step to co-create solutions. While these studies enrich our understanding of value co-creation and PSS, the nature of PSS business ecosystems means the integration of multiple actors. It therefore requires the shift of attention away from a single-firm or dyadic relationship perspective. Scholars have pointed out that investigating value co-creation should extend from dyadic relationships to network or ecosystem relationships (Gaiardelli et al., 2021; Kamalaldin et al., 2020; Paschou et al., 2020; Sjödin et al., 2016; Sklyar et al., 2019; Tronvoll et al., 2020) (see Table 1). Moreover, ecosystem relationships indicate challenges when PSS providers need to coordinate with multiple partners. Effective governance is thus required to maximise value co-creation in the ecosystem (Kamalaldin et al., 2020; Li et al., 2020b; Sjödin et al., 2016)

2.2 The governance mechanisms for value co-creation in PSS business ecosystems

Governance mechanisms are considered one key factor of value co-creation between PSS partners (Kamalaldin et al., 2020; Sjödin et al., 2019, 2016) because appropriate governance mechanisms are critical to governing complex and dynamic interactions and exchanges (Gaiardelli et al., 2021; Li et al., 2020a; Sklyar et al., 2019).

Contractual governance and relational governance are two types of governance mechanisms frequently discussed in marketing and supply chain management. Contractual governance is based on detailed, formal binding agreements that specify the roles and obligations of both parties. Relational governance, in contrast, is associated with trust-based social ties characterised by shared norms and values (Bastl et al., 2012; Cannon and Perreault, 1999; Poppo and Zenger, 2002). Contractual governance and relational governance can complement each other (Bastl et al., 2012; Liinamaa et al., 2016; Poppo and Zenger, 2002; Wacker et al., 2016). This complementarity is because well-specified contracts can promote more cooperative, long-term, trusting relationships by narrowing the severity of the risk to which exchange is exposed and increasing the penalties (costs) to leaving an exchange relationship. Relational governance may safeguard against poorly protected hazards by the contract and result in a bilateral commitment to 'keep-on-with-it' despite unexpected conflicts

(Poppo and Zenger, 2002). Scholars also identified another type of governance - psychological contract. Grounded in social exchange theory, Rousseau (1989) developed the concept of psychological contract through her work on psychological bonding between employees and employers. Psychological contracts 'are individual beliefs in a reciprocal obligation between the individual and the organisation' (Rousseau, 1989, p. 121). The main difference between relational governance and the psychological contract is that the former deals with generally held, group-based behaviours, whereas the latter resides in the individual's mind (Kingshott, 2006).

In the PSS literature, PSS providers develop advanced, customised contracts such as procuring complex performance (PCP) arrangements, outcome-based contracts (OBC) and performance-based logistics (PBL) (Liinamaa et al., 2016; Ng et al., 2013; Rabetino et al., 2021; Roehrich and Lewis, 2014) to lock in customers, clarify roles and responsibilities, mitigate risks and co-create value in the long term. However, advanced PSS contracts are also characterised by complex exchanges and uncertainties. They are often deployed defensively to safeguard their own interests, and legal-technical contract design issues are an important barrier to PSS success (Liinamaa et al., 2016). Contracts are also impossible to anticipate every possible scenario during contract execution (Kamalaldin et al., 2020). Moreover, relying on contractual agreements that are too detailed or with tight controls could even hinder innovation, relationship adaption and continuous improvement (Kamalaldin et al., 2020; Roehrich and Lewis, 2014; Sjödin et al., 2019). Contractual governance may provide little flexibility and opportunities for both parties seeking to co-create value by constantly improving the underlying processes and activities (Sjödin et al., 2019, 2016). Thus, they are challenging, ineffective, and costly to implement (Sjödin et al., 2019).

Research suggests that PSS providers adapt and enhance their relational governance strategies because 'managers tend to employ greater levels of relational norms as their contracts become increasingly customised' (Poppo and Zenger, 2002, p. 721). Appropriate relational governance can also facilitate co-capability development and value co-creation (Batista et al., 2017; Kamalaldin et al., 2020; Sjödin et al., 2019). However, PSS providers often encounter significant relational challenges (Reim et al., 2018; Sjödin et al., 2016). For example, PSS providers and customers encounter three types of role ambiguities: vague role expectations, unclear role descriptions, and uncertain role scripts across different phases of value co-creation. The role ambiguities inhibit value co-creation and require different relational response strategies (role clarification, role redefinition and role adaption) to govern responsibilities and

interactions (Sjödin et al., 2016). With 'smart connected products' reshaping industry boundaries (Porter and Heppelmann, 2014), new actors also emerge from the same or other industries to co-create value (Sklyar et al., 2019), which complicates relational governance in PSS business ecosystems and calls for a holistic exploration.

As inter-organisational interactions in PSS are becoming more dynamic and context-specific (Green et al., 2017; Ng et al., 2009; Sjödin et al., 2016), they cannot be wholly managed by explicit, rigid contracts and call for complementary relational governance mechanisms. Research shows that the better performing PSS providers combine contractual governance with relational governance because the latter can facilitate inter-personal trust leading to increased information sharing and joint problem solving (Roehrich and Lewis, 2014). In their study on digital servitisation, Kamalaldin et al. (2020) reveal a three-phase partnership evolution of governance mechanisms: starting from contractual governance, then developing into transitional governance, and eventually on to relational governance. At the start of the relationship, partners initiate contractual governance with a high level of control to safeguard interests. Since the contracts cannot anticipate all possible scenarios, they establish transitional governance to revise the contract and realign incentives. As the relationship matures, partners set up relational governance based on trust to focus on mutually beneficial improvements (Kamalaldin et al., 2020). Their framework provides novel insights into the middle way between contractual governance and relational governance, i.e., transitional governance, filling a significant gap where most related research merely focuses on comparing relational governance and contractual governance. Yet their research does not consider the interplay between contractual governance and relational governance for value co-creation. A better understanding of their interplay is imperative because purely relying on either is ineffective and even problematic during the whole process of value co-creation. For example, complex and strict contractual governance mechanisms can clarify roles and obligations, minimise risks and guarantee the desired outcome. However, they can also hinder relationship development and co-creation opportunity identification (Liinamaa et al., 2016; Sjödin et al., 2019, 2016). Relational governance mechanisms are more fluid and allow for flexibility and adaptation to changes (Ng et al., 2013; Roehrich and Lewis, 2014), but they are insufficient for governing obligations and mitigate risks.

Psychological and relational governance stems directly from the same socialisation process (Kingshott, 2006). The enhanced connectivity via 'smart connected products' (Porter and Heppelmann, 2015, 2014) is changing the socialisation process with more decentralised

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and democratised individual interactions in the industrial B2B contexts, leading to the blurring boundaries between B2B and B2C. Similar to the B2C context, individuals (e.g., operators and maintenance people) in the B2B became more informed, connected, empowered and increasingly active in value co-creation (Prahalad and Ramaswamy, 2004). Consequently, individual interactions (e.g., between frontline/field workers) are becoming as important as, if not more than, the group-based interactions for value co-creation. For example, when moving into PSS business ecosystems that favour value-based selling and co-creation, PSS providers need psychological and cultural adaptations to an individual's mindset compared with price-centric selling (Keränen et al., 2021). Thus, value co-creation in PSS business ecosystems can be studied at multiple levels, such as the organisational and individual levels (Sjödin et al., 2016). However, individual-based psychological governance is under-researched, mainly when individuals conduct contextual and dynamic interactions to realise value co-creation.

2.3 The research gaps and a theoretical framework

Despite rich literature in each field of PSS, business ecosystems, value co-creation, and governance mechanisms, two important gaps are identified in understanding value co-creation in PSS business ecosystems.

First, as Table 1 illustrates, several studies call for future research to extend the investigation of value co-creation in PSS from dyadic relationships to network or ecosystem relationships (Gaiardelli et al., 2021; Kamalaldin et al., 2020; Paschou et al., 2020; Sjödin et al., 2016; Sklyar et al., 2019; Tronvoll et al., 2020).

Second, although there are many studies on value co-creation in PSS which either uses relational or contractual governance mechanisms (Gaiardelli et al., 2021; Kamalaldin et al., 2020; Ng et al., 2013; Sjödin et al., 2016), explicit explorations of both governance mechanisms and their interplay for value co-creation remain rare. This specific gap comprises four important aspects:

1. Considering that PSS providers are suggested to manage relationships with many actors that influence and contribute to the development and delivery of PSS ecosystems, holistic explorations of relational governance are required to capture the full complexity and scope of the arrangements.

2. While explicit contracts can reduce uncertainties and risks in governance relationships by providing formal rules and procedures, relying on complex and tightly controlled contractual agreements could hinder innovation and relationship

adaptation. A gap remains in our understanding of how PSS providers configure appropriate contractual governance to stimulate the correct behaviour for value co-creation.

3. At present, limited research is dedicated to exploring the interplay between contractual governance and relational governance and how the interplay impacts value co-creation. Yet, a thorough understanding of this interplay is fundamental for the success of PSS business ecosystems.

4. Although Sjödin et al., (2016) recommend examining roles for value co-creation at organisational and individual levels, research on value co-creation in PSS still focuses on group-based relational governance and neglects individual-based psychological governance. The latter becomes prominent in the emerging era of industry 4.0, when contextual and dynamic interactions are conducted among individuals for value co-creation.

To guide further research, a theoretical framework (see Figure 1) is constructed based on the arguments outlined above. As the framework shows, PSS providers interact and exchange with other actors for value co-creation in PSS business ecosystems. Contractual, relational and psychological governance mechanisms jointly regulate value co-creation.
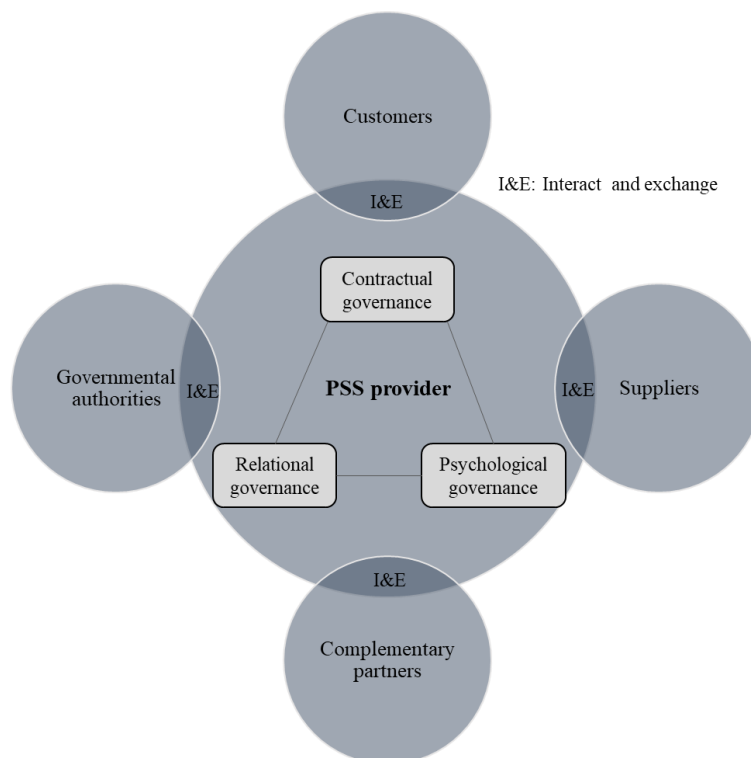

Figure 1 A theoretical framework for value co-creation in PSS business ecosystems

3 Methodology

This paper uses a theory elaboration approach as the context studied is still evolving and it isn't easy to obtain sufficiently detailed premises from the literature (Ketokivi and Choi, 2014; Lee et al., 1999). The theory elaboration approach results in adopting an exploratory, qualitative multi-case study design. We not only investigated PSS providers but also included the views of their suppliers, customers, horizontal partners and governmental authorities. The principle of purposeful sampling guided the selection of cases (Bastl et al., 2012; Eisenhardt, 1989; Lenka et al., 2018). The three main criteria for the case selection included: first, the case companies were from Western, developed countries because of the high maturity of PSS; second, they were large multi-national corporations (MNCs) in the manufacturing industry; and third, they should position themselves as a leader of PSS in their respective industries and had been developing PSS business ecosystems. An initial list of 20 MNCs was drafted. Then they were approached in several ways, including introductions, sending request emails, and attending industry exhibitions. Finally, the list included an aircraft engine manufacturer, a ship engine manufacturer, and a truck manufacturer. The three case companies are summarised in Table 2.

Table 2 The profile of the three case companies

Case No.	Core products	Advanced service agreements	PSS business ecosystems
Case 1	Aircraft engines	Customised service agreement (CSA)	Smart airport
Case 2	Ship Engines	Performance-based agreement (PBA)	Smart port
Case 3	Trucks	Comprehensive repair and maintenance (R&M) agreement	Smart city

The unit of analysis in this research was the PSS provider, i.e., the lead coordinator of PSS ecosystems. The research also studied PSS providers' suppliers, horizontal partners, and customers because value co-creation cannot be realised without interacting with other actors. The case study was conducted during 2017-2020, mainly through semi-structured interviews supplemented by non-participant observations and documentation. As the research was highly related to business strategy, it was decided that the main interviewees should be senior executives and management team members with various positions, including sales, services,

supply chain, engineering, digital development, and manufacturing. This decision is because: (1) interviewees did not represent a random sample of employees but rather a sample of individuals across the organisation with roles of making significant contributions to bringing PSS policies to life (Johnstone et al., 2009); (2) the range of positions added diversity to the sample to capture alternative views during the value co-creation processes (Sjödin et al., 2016). Then the interviewees were asked to identify key business partners with whom they thought they had value co-creation initiatives. After cross-checking with each interviewee, these partners were finalised, and introductions were made.

A total of 33 interviews were conducted, with an average of one hour for each interview. The software NVivo 11 was chosen to build the database and manage the analysis. Interview transcripts and other supplementary documents such as reports and white papers were imported into NVivo for coding because it helps researchers identify common themes (Miles et al., 2013). Aligned with the theory elaboration approach (Lee et al., 1999), the themes emerged both deductively from literature and inductively from data. An initial list of codes was created from the literature review. The coding framework evolved as new themes emerged from data analysis. For example, the codes of contractual governance and measuring performance were derived from the literature. During data analysis, following the three-step coding methods of Lenka et al. (2018), the emerging data was labelled and grouped into sub-categories, categories, and themes. For example, the common words and phrases that the interviewees used, such as ambiguous terms and data ownership, were labelled as a sub-category code. They were further linked to the category labelled 'challenges of designing appropriate contracts'. Table 3 illustrates the coding process. A case report was drafted and validated by interviewees either by sending emails or presenting the findings for each case study.

Table 3 An example of the coding process

Item	Codes from Literature	Codes emerging from data
Sub-category	Measuring performance, aligning incentives, guarantee, and penalty	Ambiguous terms, grey area and data ownership
Category	Advanced agreements	Challenges of designing appropriate contracts
Theme	Contractual governance	Contractual governance

4 Findings

4.1 The development of PSS business ecosystems

Our findings show that the three PSS providers we studied developed their PSS business ecosystems through a growth path of first enhancing their core products, then adding adjacent products or services, and subsequently including peripheral products or services. For example, Case 1 started enhancing its core products (aircraft engines) through modernisation and digitalisation. It added adjacent aircraft control systems and digital services that positively impacted flight punctuality and fuel efficiency. Subsequently, Case 1 moved to peripheral fleet management services by integrating weather forecast, flight plan, navigation, and R&M scheduling. Finally, Case 1 established a PSS business ecosystem for a smart airport, in which aircraft, fleets, pilots, airports, key suppliers, and customers were connected for value co-creation through its digital platform. More details of the growth path are summarised in Table 4.

Table 4 The growth path of PSS business ecosystems

Case No.	Core products	Adjacent products/services	Periphery products/services	PSS business ecosystems
Case 1	Aircraft engines	Own aircraft control systems and digital services such as engine health monitoring	Fleet management solutions (integrating weather forecast, flight plan, R&M scheduling, navigation, etc.) and finance services	Smart airport
Case 2	Ship Engines	Own engine exhaust gas cleaning systems and digital services such as remote monitoring	Fleet management solutions (integrating shipping plan, sea chart, navigation, weather forecast, etc.)	Smart port
Case 3	Trucks	Bodywork (e.g., freezer body, tail lift and crane) and telematic via partners	Fleet management solutions (integrating traffic, logistic planning, city parking, R&M scheduling, etc.) and finance services	Smart city

4.2 The governance mechanisms for value co-creation in PSS business ecosystems

Our findings reveal that PSS providers applied internal and external governance mechanisms to govern value co-creation. Internal governance mechanisms included formal organisational

setups and informal coordination between product, service and digital divisions. External governance mechanisms comprised contractual governance and relational governance. To co-create value, PSS providers had strong relational governance first and then developed appropriate contractual governance for aligning incentives. Relational governance involved PSS providers and customers and other actors such as governmental authorities, horizontal partners, and end-users (equipment operators in the customer's organisation). As end-users increasingly impacted value co-creation, psychological governance emerged to guide frontline interactions, for example, between PSS providers' remote monitoring experts and field service technicians and customers' pilots, ship crew, and drivers.

More details about how PSS providers managed the governance mechanisms are provided in the following sub-sections. They are not listed in order of importance but in the sequence of emergence that aroused PSS providers' attention along the journey of nourishing the governance mechanisms.

4.2.1 Governing internal integrations of products, services, and digital tools

We found that product and service units were separate business divisions in all three cases with their own reporting lines and profit–loss responsibilities (see Table 5). Although the separation of product and service divisions brought benefits such as revenue increase and service culture cultivation, it also led to several issues for integrated PSS offerings.

First, product and service sales overlapped, especially when they proposed ecosystem offerings. They either competed on order intake or disputed revenue allocation from selling systems. Second, there were multi-point contacts with the same customers and suppliers, which often caused confusion and complaints from customers and other partners. Third, they established digital functions both at the corporate level and within product and service business divisions, which complicated internal relationships leading to further overlapping or ambiguous roles and responsibilities. For example, in Case 1 and Case 2, there were automation departments in product divisions, remote monitoring centres in service divisions, and software departments in all digital functions.

When the corporate strategy shifted to PSS ecosystems, the organisational setup was insufficient and ineffective to support internal integrations of products, services, and digital tools and value co-creation with customers and other actors. As a result, PSS providers established various formal mechanisms (something like 'contractual governance') and informal mechanisms ('relational governance') to improve internal synergies. For example,

Case 2 established a supply chain management (SCM) committee led by a vice president to govern corporate sourcing and purchasing policies and ensure the synergy between product and service divisions. It also set up an informal product lifecycle revenue committee involving sales and finance representatives from product and service divisions to evaluate the sales model and co-creation initiatives holistically. More details are provided in Table 5.

Table 5 Internal governance mechanisms in the three case companies

Case No.	Organisation setup	Internal governance mechanisms	
		Formal mechanisms ('contractual governance')	Informal mechanisms ('relational governance')
Case 1	**For all the three cases:** - Product and service divisions are separate, with profit–loss responsibility - Digital organisation exists in both the corporate level and product and service divisions	• Corporate SCM • Transformation office • Product office • Integrated systems unit • Lean Six Sigma	• Joint review meetings • Joint visit of customers • Lessons learnt forum
Case 2		• Chief transformation officer • SCM committee • Integration unit • Operational excellence	• Product lifecycle revenue committee • Best practice sharing forums • Joint visit of customers
Case 3		• Business planning unit • HR cross-functional leadership program	• Joint review meetings • Joint visit of customers • Drop-in coffee talk

4.2.2 Managing emerging actors that complicate relational governance

Moving along the growth path to PSS business ecosystems, PSS providers dealt with internal integrations and orchestrated external integrations involving various actors from vertical and horizontal dimensions. These actors included suppliers, complementary partners, customers, authorities, and even end-users (i.e., equipment operators in customers' organisations such as airline pilots, ship crews, and truck drivers), as summarised in Table 6.

Table 6 Actors we studied in the three cases

Case No.	Vertical supplier	Customer & their operators	Horizontal partner	Other actors
Case 1	A supplier for turbo blades	An airline and its pilots	A digital partner and a joint venture	Aviation administration authorities and airport authorities
Case 2	A supplier for turbochargers	A shipping company and its crew	A supplier for fuel supply systems and two digital partners	International Maritime Organisation, classification societies, finance associations, and port authorities
Case 3	A supplier for truck engines	A wastes management company and its drivers	A dealer, a supplier for telematics and a bodybuilder	Governments, municipal authorities and labour unions

Consequently, relational governance in PSS business ecosystems went beyond the traditional B2B setup and involved more policymakers, including governmental authorities, agencies, and administrations (B2A). In PSS business ecosystems, they play an increasingly important role in drafting, approving, and governing new standards and ways of working (e.g., in digitalisation, information security, safety and environment compliance). For example, the new digital offerings such as analytics-based maintenance crucial to value co-creation in Case 1 and Case 2 need to be approved by aviation administration authorities and classification societies. As a result, PSS providers spent more time and effort enhancing the B2A relations by adding additional resources, improving communication and engaging them early for new offering development.

4.2.3 *Designing appropriate contractual governance to align incentives, measure and share the co-created value, and govern data ownership and security*

When PSS providers shifted from the cost-based transactional model into a value-based co-creation model, they developed formal contracts to align incentives for value co-creation (make the pie bigger together), as illustrated in Figure 2.

1. Traditional relationship
Conflicting incentives

2. Performance-based relationship
Aligned incentives

Supplier

Customer

Spares/repairs (Cost based)

Wants to increase the pie (selling more)

Wants to reduce the pie (buying less)

Supplier

Customer

Performance/ Outcome (Value based)

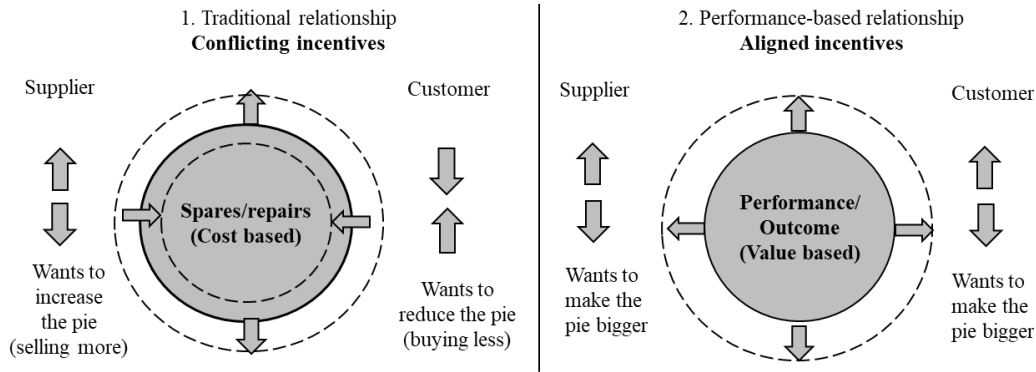Wants to make the pie bigger

Wants to make the pie bigger

Figure 2 The change of incentives: adapted from Reiskin *et al.*(1999)

For example, Case 1 and Case 2 spent years developing advanced agreements that guaranteed engine availability, and customers paid a fixed price based on engine running hours. As they took over all repair and maintenance activities, they were incentivised to extend the interval between repairs or part change safely through advanced digital tools such as remote monitoring to save cost. However, this approach might deteriorate fuel performance, which would not be in the best interest of airlines and ship owners, respectively. This can be seen from the quotes below.

We charge a fixed rate per flying hour. Our incentives are to extend the service interval through engine health monitoring: if we can extend that, it is our benefit. We must be cost-effective to perform the agreement. – Head of engineering, Case 1

Case 2 is more likely to extend maintenance intervals and wait for a considerable interval safely because of the condition-based monitoring. They can save maintenance costs and thus make more profits because we pay a fixed price. As a result, it will not be incentivised to replace the essential parts such as turbochargers and fuel injectors to make the engine fuel-efficient within that interval. – Head of operations, Customer of Case 2

Considering that customers' expectations continue to grow, PSS providers must be innovative in remaining competitive. For example, Case 2 co-developed the offering further with its customer by adding fuel efficiency to the existing engine availability guarantee. If Case 2 fails to improve fuel efficiency, it must compensate the customer. Conversely, if it achieves the target, the customer would share fuel savings benefits. Thus, their incentives were aligned, and both parties were committed to helping and supporting each other to save more fuels. Case 2 also considered the network effect of contractual governance to ensure aligned incentives with other key partners in the ecosystem. For example, Case 2 signed a special agreement with

its supplier of turbochargers (a key component impacting fuel efficiency) to develop advanced solutions for increasing fuel efficiency jointly.

As a counterexample, Case 3 often included telematics in their repair & maintenance offerings accompanying the sale of new trucks. However, some customers were not incentivised to use this telematics because they had already installed other telematics to their existing fleets from other brands. Thus, there were inter-operability issues as the two telematics were not connected, which inhibited both Case 3 and customers from having a holistic view of the performance of vehicles and drivers. Moreover, the network effect of contractual governance did not work as its dealer worried about making less money, as shown in the quotes below.

> *We are looking at our telematics from an engineering point of view, such as engine performance, but the customers cannot see that. The customers run their telematics, and we cannot see the driving styles. – Key account manager, Case 3*

> *For Case 3, an R&M contract that includes telematics means a stable monthly fee, but there is no stability for us because we are still paid based on the per-job base… When you sell a truck, you try to promote that the truck is reliable, and the maintenance cost is low. But when it comes to service, you wish they are not so reliable. – Service manager, Dealer of Case 3*

Regarding the measurement of the co-created value, we observed different maturity levels among the three cases. Case 2 was the most advanced because it set up a joint measuring system with its customer, in which they owned the same digital platform and data. However, the system was not accessible to other partners in the ecosystem. In contrast, Case 3 encountered more challenges due to ambiguous terms and conditions in the agreement, as shown in the quotes below.

> *It is not a case that we measure them, they measure us, and we argue with each other who is right. We do it together, and we measure it together. – Global development director, Case 2*

> *Though we promise customers we can achieve a certain fuel-saving benefits; there is no agreement on the start point and benchmark point. – Fleet sales manager, Case 3*

4.2.4 Managing the interplay of contractual governance and relational governance

Our findings show that PSS providers had strong relational governance first and then developed appropriate contractual governance for value co-creation. Contractual governance and relational governance co-evolved in three stages of value co-creation: initiation stage, implementation stage, and summary stage, as illustrated in Figure 3.

At the initiation stage, relational governance played a leading role in co-developing the PSS offerings (matching 'what you need' and 'what I can offer') and co-defining terms and conditions in the contracts to govern value co-creation. During this process, PSS providers, customers, suppliers, or partners might not know the best offering and how they could collectively utilise existing capabilities or develop complementary capabilities. Therefore, all the involved actors stressed openness and trust by frequently meeting each other to clarify and redefine their roles due to role ambiguity or uncertainty, which eventually led to the formation of contractual governance.

Interestingly, our findings also indicate that more aligned terms and conditions were written into the agreements along the way to co-developing advanced PSS agreements (ranging from a few months in Case 3 to 2 years in Case 1). Enhancing the relational governance between the parties, in turn, accelerated value co-creation. For example, the draft of PSS agreements defined terms for dealing with conflicts and disputes. Although they were not officially released, each party considered them contractual guidance for practice.

At the agreement summary stage, contractual governance played a leading role in securing benefits allocation as specified in the PSS agreements, enhancing future relational governance. For example, in Case 1 and Case 2, when their customers and partners received the benefits, they expressed a willingness to extend collaboration to other fleets and deepen co-creation on a broader scope. Case 1 and Case 2 also invested more in product and service development to achieve higher performance because of the 'bonus' received from customers. They described their relationships with customers as a 'marriage'. The enhanced relational governance also made it easier for both parties to refine the PSS agreements when they saw 'surprises' or unpredicted scenarios.

At the agreement implementation stage, although advanced agreements developed at the initiation stage included many terms and conditions, they could not predict all possible scenarios, regulate contextual interactions, and facilitate role adaption in the fields, so that

potential or latent value was sensed and co-created. Therefore, PSS providers and customers applied relational governance to complement contractual governance.

On-wing check is different to situations in which the engine is removed for inspection. If they send engineers to our base, they will use our facilities, tools and work with our technicians. This is not in the contract. – Deputy head of engine management, Customer of Case 1

According to the agreement, Case 2 is monitoring the engine conditions. But, again, we are on the ship every day. If there is a condition on the ship that is considered irregular, we will inform them, and they will listen to the ship. – Head of operations, Customer of Case 2
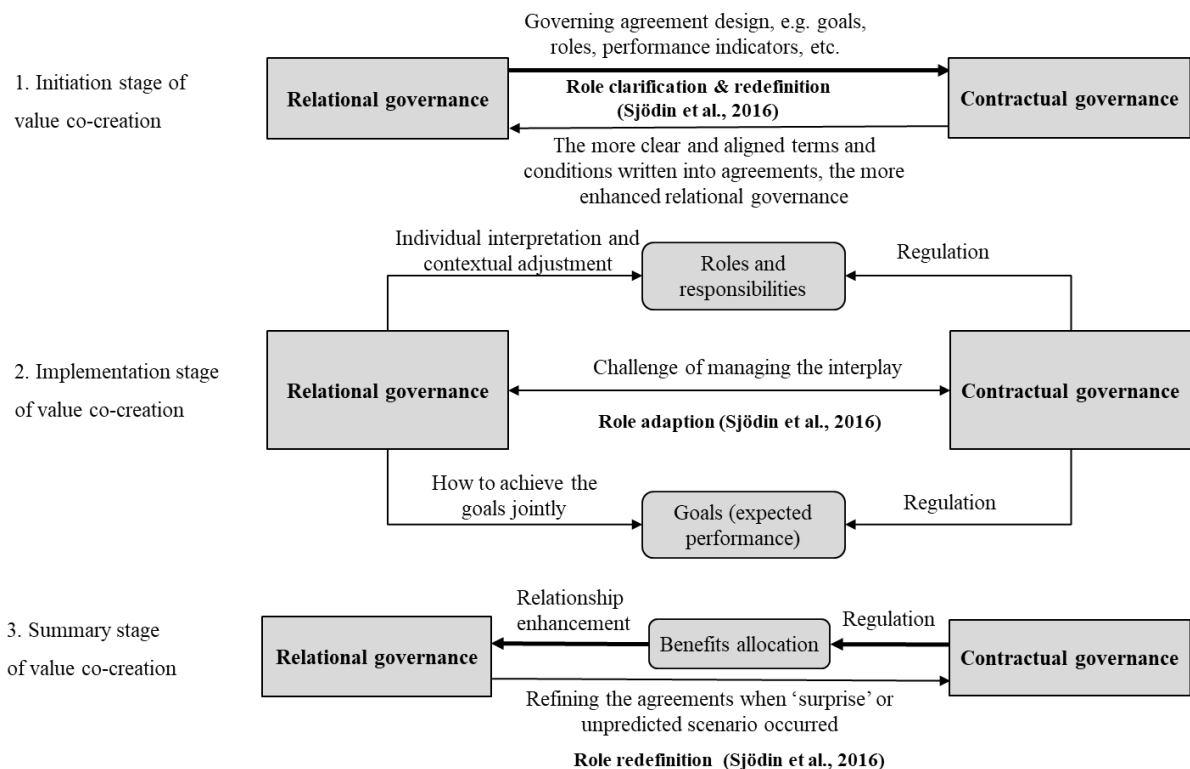

Figure 3 The co-evolution of contractual governance and relational governance

4.2.5 Developing psychological governance for guiding individual-based co-creation

Our findings reveal that frontline staff such as end-users (equipment operators), remote monitoring experts and maintenance technicians played a crucial role in realising value co-creation. Their prominent role in the process emerged because the success of PSS and value co-creation was not only determined by PSS providers' products and digital technologies but relied on contextual interactions between customers and PSS providers. The interactions

mainly were conducted between individuals, such as a field service technician or a remote monitoring expert from the PSS provider and an equipment operator or maintenance staff in the customer's organisation. Although advanced agreements between Case 1, Case 2 and Case 3, and their customers defined specific terms on frontline collaboration such as 'who does what and when', these rules were generic and mainly dealt with a group of people such as crew team and maintenance department. Thus, group-based contractual governance and relational governance could not govern individual interactions in the aspects of individual attitude, motivation and behaviour. Consequently, PSS providers realised the importance of psychological governance:

> *In the past, pilots were eager to see their flight data and the impact of their operations, but they did not have access to the data and have a dialogue with our expert. – Head of customer operations, Case 1*

> *I think if you are a crew member, the incentive for you in this agreement is that you get smarter and more skills through the training from and interaction with Case 2. – Head of operations, Customer of Case 2*

> *Can we help their drivers? Every time when the drivers go into a Cafe, can he get an extra discount? Or should we set up several motorway Cafes across the country? The drivers have good feelings, and they will be happy. They will drive in a good way and interact with us well, for example, to realise fuel savings through the telematics we provide. – Parts Director, Case 3*

With digitalisation in the three case companies, traditional organisation hierarchy and boundaries with their customers and partners were broken down, allowing for direct and instant individual interactions. More and more activities for value co-creation, such as remote monitoring and augmented reality, could be done remotely through one-to-one interactions, which complemented or even replaced the traditional group-based on-site interactions. Consequently, field visits were becoming the primary human touchpoint, and emotional conversations between PSS provider's field service staff and customer's operations staff determined customer experience and potential sales opportunities. Such individual-based human interactions, both online and infield, required appropriate psychological guidance to enhance the customer experience for value co-creation. The three cases also reported that good psychological governance practices led to improved relational governance:

> *The field service engineer may go and see the customer [maintenance people in the*

airports] every day. He may say to the customer, 'Hey, is there anything I can do for you'? or 'For your technical worries, let me help you with that'… Such dialogues not only help the maintenance people out but lead to more co-creation opportunities and improved customer relationship. – Head of customer operations, Case 1

The good relationship between our company and our customer set up a friendly atmosphere which can ease frontline employees' worry and free their minds for collective co-creation. In turn, the sum of many good individual interactions can enhance our company relationship with customers. – Parts Director, Case 3

4.3   The challenges on governance mechanisms for value co-creation

Despite significant efforts PSS providers had made, they also encountered five challenges.

The first challenge is orchestrating all digital resources and capabilities (both internal and external). PSS providers attempted to leverage digital technologies to enhance internal governance by simplifying layers and processes of communication and synchronising information flow. However, managing the incompatibility and isolation of different digital tools at various locations in both product and service divisions was challenging, as shown in the quotes below:

There are multiple versions of the same information. Many digital tools focus on one site alone. They do not talk to each other… We think we got the big picture, but we got lots of surprise. – Digital leader, Case 1

Product and service divisions use different tools that are difficult to share data. This slows down our decision-making process for PSS integrations. – Manufacturing Director, Case 2

The challenge was caused by the co-existence of new and old business models and unclear digital integration strategies at the corporate level. PSS providers were not well prepared when they faced the emerging and unprecedented opportunities brought in by smart PSS ecosystems. Each organisation in the product, service and digital divisions saw the potential of digital tools, and each just wanted to invest for its own benefit. The silo thinking and practice resulted in digital incompatibility and isolation when opportunities for PSS ecosystem integrations came.

The second challenge we observed relates to managing relational governance in two aspects. First, PSS providers used to have customer relationship management (CRM) and

supplier relationship management (SRM) separately. With the move into PSS business ecosystems for value co-creation and considering the relations with other emerging actors such as authorities and end-users, the traditional relationship management practice became inefficient and ineffective. On the one hand, they expected one platform where all actors could exchange data and interact with each other. On the other hand, PSS providers were worried about data leakage and potential competition. This dilemma slowed down their decision making. Second, PSS providers faced a challenge in dealing with additional layers of relational governance in customers' organisations. Although PSS providers had contractual and relational governance mechanisms in place with customers, they did not govern their influence on some groups of people that emerged as a new factor impacting value co-creation. These people included end-users (i.e., pilots, crews, and drivers) and maintenance people. They were essential to realising value co-creation through their dynamic, contextual interactions with PSS providers' frontline staff, such as field service technicians and data experts working remotely in their monitoring centres.

> *As a significant variable is a driver, we would not guarantee an improvement [of safety and fuel efficiency] but advise that an improvement could be gained if x and y are put into place. – Sales director, Case 3*

The third challenge relates to designing appropriate contractual governance mechanisms. Moving into broader PSS business ecosystems also required considering value from environmental and societal perspectives, particularly with increasing legitimate pressures on decarbonisation, sustainability and environmental compliance. However, all the three PSS providers faced a challenge in quantifying and measuring environmental and societal value, although they claimed that their ecosystem-based offerings could generate environmental and societal benefits. Moreover, as more actors were added to their digital platforms, PSS providers faced another challenge in governing data ownership and cybersecurity. While PSS providers worried about data leakage to partners, particularly to suppliers, their customers were also reluctant to share their operational data. PSS providers struggled to design win-win terms for data sharing in the contracts. For example, Case 1 offered a reduced agreement rate to its airline customers in exchange for accessing engine data so that Case 1 could use the airline's operating data for engine health monitoring. The worry about data leakage can be seen from the quotes below.

> *We quite worry about what kind of data to share with suppliers. It is a big risk. – Digital leader, Case 1*

Today we are very afraid of sharing data, whatever the data means. You do not need open digital access to everyone, but partners should get a certain piece of information to fulfil their responsibility for value co-creation. We should be more open. – Business control director, Case 2

The fourth challenge is managing the interplay between contractual governance and relational governance during the PSS agreement implementation stage. Frontline staff faced a challenge in deciding to which degree they could use contractual governance, and at which point to apply relational governance. People who designed and negotiated the contracts (at the initial stage) were typically senior executives and managers. People responsible for the agreement implementation were usually frontline staff who were not always fully aware of the terms and conditions defined in the contracts. As other partners provided some services in the ecosystem (e.g., through back-to-back agreements in cases 1, 2 and 3), frontline staff found it more challenging to communicate and execute the contracts.

In some cases, complex contracts were not well 'interpreted' into operational language. As a result, procedures were not available for frontline staff to follow or decide at their discretion. Consequently, frontline staff's inability to interpret and execute complex contracts caused role ambiguities and waiting times that worsened relationships. The ambiguities and waiting also caused both parties to miss the capture of new opportunities and contextual interactions for co-creating value at the right time.

The last challenge relates to the emerging psychological governance. Although there was raising awareness of psychological governance in PSS business ecosystems, the awareness was sporadically distributed in organisations and stagnated at a 'conceptual' stage. None of the three cases we studied had allocated resources or set a strategic agenda to systematically develop psychological governance. A common reason was that they focused too much on contractual (and technical) development and group-based relational governance. The psychological governance among individuals was too abstract, invisible, and challenging for organisations to link it to commercial practices and tangible results.

Our data experts and monitoring staff have daily dialogues with customers' counterparts. To capture value co-creation opportunities and make them happen, a good level of psychological interaction is a key factor, particularly in a virtual environment. However, to systematically evaluate and develop it remains a challenge. – Digital leader, Case 1

5   Discussion

The findings enrich our understanding of internal and external governance mechanisms for value co-creation in PSS business ecosystems and reveal five emerging challenges PSS providers face in establishing effective governance mechanisms.

First, the literature recommends creating a separate organisation with profit–loss responsibility to handle the service offering (Davies et al., 2006; Gebauer et al., 2005; Oliva and Kallenberg, 2003; Salonen, 2011). While this may work well for manufacturing companies that want to increase service revenues, separate organisations also increase the risks of internal tensions caused by new and old business models (Porter and Heppelmann, 2015) and conflicting product and service orientations (Lenka et al., 2018). As a result, PSS providers established many formal and informal mechanisms to govern internal synergies for value co-creation with external actors. Moreover, the process of digital transformation that facilitates PSS integration often causes functional roles to overlap and boundaries to blur. The classic 'contingency model' of differentiation and integration (Lawrence and Lorsch, 1967) requires more coordination in PSS business ecosystems because *"periodic handoffs no longer suffice. Intense, ongoing coordination becomes necessary across multiple functions"* (Porter and Heppelmann, 2015, p. 109). Although PSS providers applied many digital technologies and tools to facilitate internal integration and coordination, the challenge of incompatibility and isolation among the tools obstructed PSS providers from achieving the expected effect. This challenge calls for a unified, clear strategy among product, service and digital divisions, especially when different strategies of servitisation, digitalisation, decarbonisation and the combined digital servitisation or decarbonisation are in place. Digital integration also requires a socio-technical fitness between the social and technical elements (Li *et al*., 2020a).

Second, more actors emerged when PSS providers moved into broader PSS business ecosystems, adding complexity to relational governance. Our findings indicate that PSS providers extended relational governance from traditional B2B setup to more B2A contexts due to the increasing influence from governmental and regulatory authorities (e.g., on decarbonisation and sustainability). Our findings thus extend the work of Windahl and Lakemond (2006) and Sklyar et al. (2019) by revealing new actors in PSS business ecosystems and the work of Sjödin et al. (2016) and Kamalaldin et al. (2020) by considering other relations beyond dyadic relationships for value co-creation. Moreover, our findings report the challenges PSS providers encountered in managing relational governance in PSS business ecosystems. For example, it was challenging for them to establish one platform that could connect CRM,

SRM and B2A relationship management. They also faced the challenge of dealing with additional layers of relational governance within customers' organisations that were more individual based. The challenge in managing these individual-based interactions also indicates the necessity of psychological governance, rarely discussed in academia.

Third, with the shift from conflicting incentives in the cost-based transactional model to aligned incentives in the value-based co-creation model, PSS providers explicitly defined terms and conditions such as performance measurement, gains sharing, and risk-taking (Holmbom et al., 2014; Kamalaldin et al., 2020; Ng et al., 2013; Rabetino et al., 2021). Defining terms and conditions clearly are imperative because value co-creation is associated with uncertainties and risks, which requires the functioning of contractual governance. However, in line with Liinamaa et al. (2016), our findings indicate that contracts should not be designed and deployed defensively to safeguard their own interests and be treated like 'plumbing' (visible and relevant only when it fails). Instead, effective contracts should be co-designed to prevent profit slippage and proactively capture new business and value creation opportunities (Liinamaa et al., 2016). Regarding the challenge of measuring the co-created value from social and environmental aspects, although the literature indicates that some value cannot be measured or monetised (Almquist et al., 2016; Ramírez, 1999), PSS providers, together with academic institutions and governmental authorities, are advised to find ways together to quantify these benefits. As decarbonisation and sustainability are on the agenda of businesses, governments and the public, metrics to measure this is necessary.

With digitalisation, data is collected, stored, and converted into information to support the decision making processes underlying value co-creation (Porter and Heppelmann, 2015, 2014; Sklyar et al., 2019). However, we observed that PSS providers faced an emerging challenge to specify data ownership because PSS ecosystems comprise multiple parts, modules, and sub-systems, many provided by different suppliers and partners. Each of these actors generates, transmits, stores, and analyses data. Moreover, customers also contribute to the generation of operational data. The resulting ambiguity and disputes on data ownership require joint work from academia, industry, and regulatory authorities, for example, to design standards and guidelines. All involved actors have to overcome the challenge of performance measurement by shifting the 'fighting attitude' ('you measure me, I measure you, and we argue with each other') toward constructive thinking in terms of co-creation of value ('we measure together'). This attitude illustrates that the challenges are technical (that can be addressed by

designing appropriate contracts) and social (and that must consider organisational behaviours), which calls for a socio-technical systems approach (Li et al., 2020b).

Fourth, literature shows that governance mechanisms evolve when interfirm dependencies change and relationships progress (Gulati and Kletter, 2005; Kamalaldin et al., 2020; Mahapatra et al., 2019). An essential factor in evolution is trust. When trust grows between partners, governance mechanisms are more likely to be based on relationships and less reliant on formal contractual arrangements (Gulati and Kletter, 2005; Kamalaldin et al., 2020). We observed different levels of interactions within the organisation hierarchy, which resulted in information asymmetry and misalignment, harming the trust-building. PSS providers and customers often had to clarify and redefine their roles during the initial stage of PSS agreements due to role ambiguity for value co-creation. This information asymmetry is in line with the findings of Sjödin et al. (2016). However, during the implementation stage, the frontline staff that implemented the contracts experienced challenges in deciding to which degree they could use contractual governance and at which point to apply relational governance. This confusion is because: first, there is a lack of communication of the contracts in a format accessible and understandable to non-lawyers such as frontline staff (Liinamaa et al., 2016); and second, if frontline people rely too much on contractual agreements, it may even hinder trust building and relationship development in the fields (Kamalaldin et al., 2020; Sjödin et al., 2019). As a result, the interplay process requires dynamic and constant role adaption (Sjödin et al., 2016). Therefore, our findings extend the work of Kamalaldin et al. (2020) by revealing the interplay between contractual governance and relational governance in each phase of value co-creation (see Figure 3). Our findings also echo the recommendation of Liinamaa et al. (2016) that future contracting research should centre on coordination (facilitating cooperation) and adaptation (adapting to changed circumstances) functions. Thus, future research can lead to embedded elements of relational governance in contractual governance because the latter provides opportunities for parties to manipulate each other and affect organisational interfaces, mindsets, and even ethics (Liinamaa et al., 2016).

Lastly, our findings suggest that psychological governance emerged with increasing interactions with frontline staff to complement and enhance relational governance for value co-creation. This complementarity is because the actual performance of PSS was not only determined by the product component (including the digital technologies such as remote monitoring) itself but also relied on the direct and indirect human interactions. Thus, psychological governance became an 'invisible hand' to govern and harmonise behaviours

among different actors. These findings extend the work of Rousseau (1989) and Kingshott and Pecotich's (2007) work in the context of value co-creation and in the B2B setting, where the group-based relational governance and individual-based psychological governance prove necessary.

6 Conclusion and research agenda

Our findings provide evidence that PSS providers developed internal and external governance mechanisms to govern value co-creation in PSS business ecosystems. Internally, PSS providers relied on formal setups and informal coordination between product, service and digital divisions. Externally, they developed relationships with suppliers, customers, end-users, complementary partners, and governmental authorities. They had strong relational governance first and then developed appropriate contractual governance that coevolved with relational governance. They also saw the emergence of psychological governance to guide individual-based interactions. Good relational governance sets up a friendly atmosphere for conducting psychological governance, and in turn, excellent psychological governance practice can enhance group-based relational governance. The findings are summarised in Figure 4.
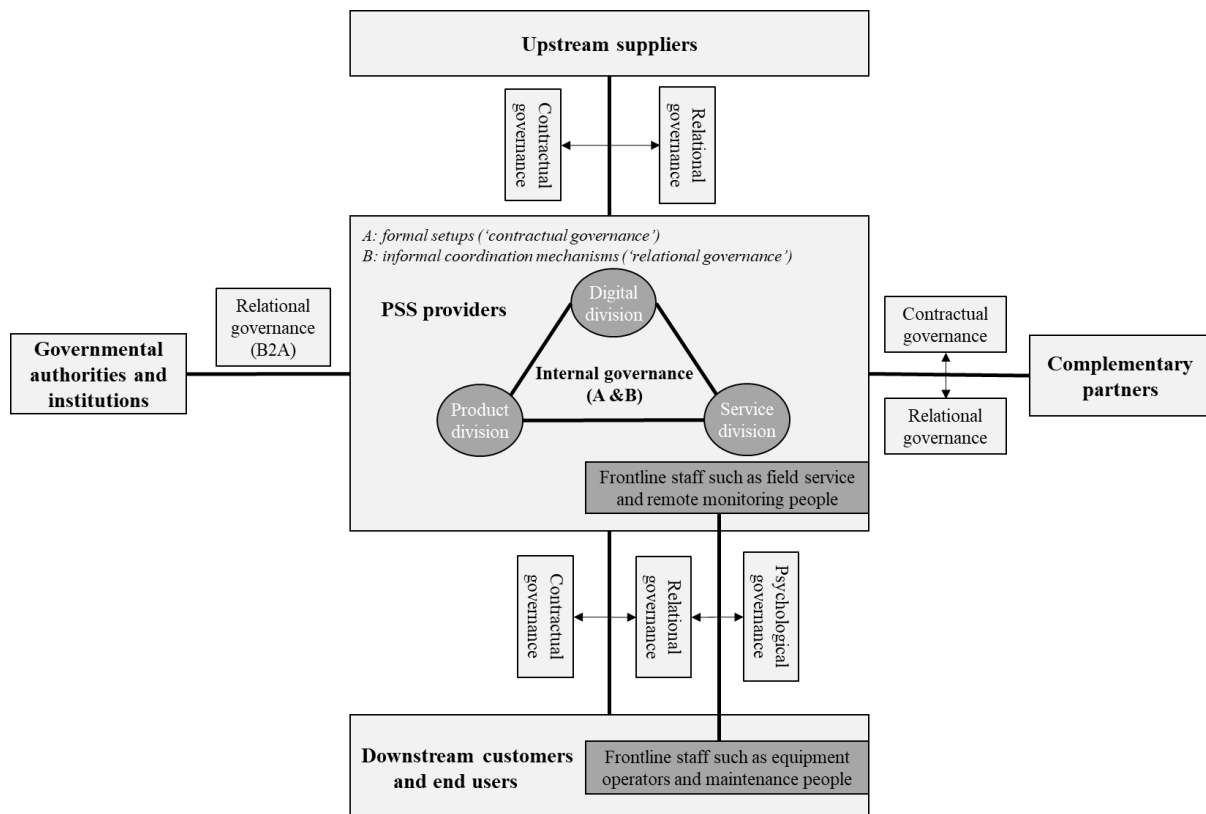

Figure 4 The governance mechanisms for value co-creation in PSS business ecosystems

Our findings further reveal five emerging challenges that PSS providers faced in establishing effective governance mechanisms for value co-creation:

1. Orchestrating all digital resources and capabilities, especially managing the incompatibility and isolation of different digital tools in product and service divisions;

2. Managing all relations in one platform that can embrace CRM, SRM and B2A relations with governmental authorities;

3. Designing appropriate contractual governance to measure the co-created value from economic, societal and environmental perspectives and govern data ownership and security;

4. Managing the interplay between contractual and relational governance mechanisms during agreement implementation;

5. Developing psychological governance for frontline staff.

Our paper, through a theory elaboration approach, adds new knowledge to the literature by providing a holistic view of the governance mechanisms for value co-creation in PSS ecosystems. First, our research answers the call for extending the relationship in SCM beyond the buyer and supplier (Ellram and Murfield, 2019) and the call for investigating PSS from network or ecosystem perspectives (Gaiardelli et al., 2021; Kamalaldin et al., 2020; Paschou et al., 2020; Sjödin et al., 2016; Sklyar et al., 2019; Tronvoll et al., 2020). Second, our findings provide a comprehensive view of governance mechanisms from both internal and external perspectives (Formentini and Taticchi, 2016). Third, our findings cast new light on the structure of relational governance that goes beyond traditional B2B setups and involves more B2A arrangements (Burström et al., 2021). Fourth, our identification of the role of psychological governance for value co-creation in the B2B context extends the work of Rousseau (1989) on psychological bonding between employees and employers. Lastly, contractual, relational and psychological governance should be orchestrated holistically to govern value co-creation in PSS ecosystems. The five challenges revealed in this research provide practitioners with a better insight into developing effective governance mechanisms. The challenges will also direct policymakers, practitioners and scholars to join efforts to develop standards, policies and guidelines.

Like many other pieces of research, our paper is not without limitations. First, we only focus on economic value and related governance mechanisms. As PSS providers move into ecosystems and the meaning of value evolves from predominantly monetary considerations to a broader concept that concomitantly considers economic, environmental and social aspects

(Li and Found, 2017), research on value co-creation should also study broader governance mechanisms. Second, a qualitative case study approach was adopted for this research, which enabled a meaningful exploration of value co-creation. However, quantitative methodologies are yet to be applied to validate and enrich our findings and supplement the verification of findings on governance mechanisms (e.g., to quantify the intensity of governance). Third, we do not investigate detailed factors for each governance mechanism. Lastly, the variety of actors interviewed for this study - though already much broader than previous studies in this area – remains limited when considering a range of actors involved in PSS ecosystems typically.

Our findings are based on in-depth studies of three case companies operating in manufacturing industries that integrate services into products (via servitisation) by leveraging digital development. The three cases share several standard features: (1) they are large multinational corporations (MNCs); (2) they are mature in PSS development and; (3) they take advantage of digitalisation for integrating more products and services. Thus, the findings are primarily applicable to business ecosystems characterised by similar conditions. Different findings are possible if the research context were different. For example, studies on smart PSS business ecosystems initiated by other large MNCs through productisation (i.e., adding physical products to their service offerings, e.g., Smart Home/City by Amazon and Google) will probably lead to additional findings.

The above limitations do point to several fascinating research opportunities. First, future research on governance mechanisms in ecosystems should consider the economic, environmental, and social aspects of value. Second, applying more quantitative or blended research methodologies, such as repertory grids studies (Goffin et al., 2012), could provide a more in-depth understanding of the breadth and depth of governance mechanisms in the PSS context. Third, exciting opportunities exist to explore further the detailed factors for internal governance and external governance mechanisms. For example, the three types of trust (Sako, 1992) - contractual trust, competence trust and goodwill trust will provide a suitable theoretical lens for future research to explain the interplay of contractual governance and relational governance. Fourth, including a broader range of actors would facilitate a deeper understanding of B2A governance and emerging psychological governance. Thus, it is also recommended to do a systematic study on the interplay of contractual, relational, and psychological governance and their collective impact on value co-creation. Fifth, further research on how specific digital technologies impact governance mechanisms for value co-creation will provide new insight into understanding PSS business ecosystems in the industry 4.0 age, mainly when the emerging

digital servitisation is considered (Gebauer et al., 2021a; Rabetino et al., 2021). Sixth, we think the findings will be different if other actors (esp. from the downstream such as airports) initiate the ecosystems. This kind of ecosystem might be different from the PSS business ecosystems and can be at a higher level like a 'platform ecosystem' as grouped by Jacobides et al. (2018). As our study centres on manufacturers that lead their domain of PSS business ecosystems, we do not have evidence to show the differences, which lead to an exciting future research area. Moreover, research also shows there are situations where shared leadership can be possible. For example, Cisco and Philips claim leadership in smart city lighting (Adner 2017). Exploring how each ecosystem leader develops their business ecosystems under shared leadership will also be interesting. Finally, comparing studies on PSS business ecosystems developed from a productisation growth path (e.g., Smart Home/City by Amazon and Google) with studies on a servitisation path are exciting research areas.

References

Adner, R., 2017. Ecosystem as Structure: An Actionable Construct for Strategy. J. Manage. 43, 39–58.

Almquist, E., Senior, J., Bloch, N., 2016. The elements of value: Measuring and delivering what consumers really want. Harv. Bus. Rev. 46–53.

Baines, T., Lightfoot, H., Steve, E., Neely, A., Greenough, R., Peppard, J., Roy, R., Shehab, E., Braganza, A., Tiwari, A., Alcock, J., Angus, J., Bastl, M., Cousens, A., Irving, P., Johnson, M., Kingston, J., Lockett, H., Martinez, V., Michele, P., Tranfield, D., Walton, I., Wilson, H., 2007. State-of-the-art in product service-systems. Proc. Inst. Mech. Eng. Part B J. Eng. Manuf. 221, 1543–1552.

Bastl, M., Johnson, M., Lightfoot, H., Evans, S., 2012. Buyer-supplier relationships in a servitized environment:an examination with Cannon and Perreault's framework. Int. J. Oper. Prod. Manag. 32, 650–675.

Batista, L., Davis-Poynter, S., Ng, I., Maull, R., 2017. Servitization through outcome-based contract – A systems perspective from the defence industry. Int. J. Prod. Econ. 192, 133–143.

Brax, S., 2005. A manufacturer becoming service provider – challenges and a paradox. Manag. Serv. Qual. An Int. J. 15, 142–155.

Burström, T., Parida, V., Lahti, T., Wincent, J., 2021. AI-enabled business-model innovation and transformation in industrial ecosystems: A framework, model and outline for further research. J. Bus. Res. 127, 85–95.

Cannon, J.P., Perreault, W.D., 1999. Buyer-Seller Relationships in Business Markets. J. Mark. Res. 36, 439–460.

Coreynen, W., Matthyssens, P., Van Bockhaven, W., 2017. Boosting servitization through digitization: Pathways and dynamic resource configurations for manufacturers. Ind. Mark. Manag. 60, 42–53.

Coreynen, W., Matthyssens, P., Vanderstraeten, J., van Witteloostuijn, A., 2020. Unravelling the internal and external drivers of digital servitization: A dynamic capabilities and contingency perspective on firm strategy. Ind. Mark. Manag. 89, 265–277.

Davies, A., Brady, T., Hobday, M., 2006. Charting a path toward integrated solutions. MIT Sloan Manag. Rev. 43, 39–48.

Eisenhardt, K.M., 1989. Building theories from case study research. Acad. Manag. Rev. 14, 532–550.

Ellram, L.M., Murfield, M.L.U., 2019. Supply chain management in industrial marketing–Relationships matter. Ind. Mark. Manag. 79, 36–45.

Formentini, M., Taticchi, P., 2016. Corporate sustainability approaches and governance mechanisms in sustainable supply chain management. J. Clean. Prod. 112, 1920–1933.

Gaiardelli, P., Pezzotta, G., Rondini, A., Romero, D., Jarrahi, F., Bertoni, M., Wiesner, S., Wuest, T., Larsson, T., Zaki, M., Jussen, P., Boucher, X., Bigdeli, A.Z., Cavalieri, S., 2021. Product-service systems evolution in the era of Industry 4.0. Serv. Bus. 15, 177–207.

Gebauer, H., Fleisch, E., Friedli, T., 2005. Overcoming the service paradox in manufacturing companies. Eur. Manag. J. 23, 14–26.

Gebauer, H., Paiola, M., Saccani, N., 2013. Characterizing service networks for moving from products to solutions. Ind. Mark. Manag. 42, 31–46.

Gebauer, H., Paiola, M., Saccani, N., Rapaccini, M., 2021a. Digital servitization: Crossing the perspectives of digitization and servitization. Ind. Mark. Manag. 93, 382–388.

Gebauer, H., Paiola, M., Saccani, N., Rapaccini, M., 2021b. Digital servitization: Crossing the perspectives of digitization and servitization. Ind. Mark. Manag. 93, 382–388.

Goffin, K., Raja, J.Z., Claes, B., Szwejczewski, M., Martinez, V., 2012. Rigor in qualitative supply chain management research: Lessons from applying repertory grid technique. Int. J. Phys. Distrib. Logist. Manag. 42, 804–827.

Green, M.H., Davies, P., Ng, I.C.L., 2017. Two strands of servitization: A thematic analysis of traditional and customer co-created servitization and future research directions. Int. J. Prod. Econ. 192, 40–53.

Grönroos, C., Helle, P., Gronroos, C., Helle, P., 2010. Adopting a service logic in manufacturing: Conceptual foundation and metrics for mutual value creation. J. Serv. Manag. 21, 564–590.

Gulati, R., Kletter, D., 2005. Shrinking core, expanding periphery: The relational architecture of high-performing organizations. Calif. Manage. Rev. 47, 77–105.

Haber, N., Fargnoli, M., 2021. Sustainable Product-Service Systems Customization: A Case Study Research in the Medical Equipment Sector. Sustainability 13, 6624.

Hakanen, T., 2014. Co-creating integrated solutions within business networks:The KAM team as knowledge integrator. Ind. Mark. Manag. 43, 1195–1203.

Hein, A., Weking, J., Schreieck, M., Wiesche, M., Böhm, M., Krcmar, H., 2019. Value co-creation practices in business-to-business platform ecosystems. Electron. Mark. 29, 503–518.

Holmbom, M., Bergquist, B., Vanhatalo, E., 2014. Performance-based logistics – an illusive panacea or a concept for the future? J. Manuf. Technol. Manag. 25, 958–979.

Jaakkola, E., Hakanen, T., 2013. Value co-creation in solution networks. Ind. Mark. Manag. 42, 47–58.

Jacobides, M.G., Cennamo, C., Gawer, A., 2018. Towards a theory of ecosystems. Strateg. Manag. J. 39, 2255–2276.

Johnstone, S., Dainty, A., Wilkinson, A., 2009. Integrating products and services through life: an aerospace experience. Int. J. Oper. Prod. Manag. 29, 520–538.

Kagermann, H., Riemensperger, F., Hoke, D., Helbig, J., Stocksmeier, D., Wahlster, W., Scheer, A.-W., Schweer, D., 2014. Smart Service Welt:Recommendations for the Strategic Initiative Web-based Services for Businesses. Berlin.

Kamalaldin, A., Linde, L., Sjödin, D., Parida, V., 2020. Transforming provider-customer relationships in digital servitization: A relational view on digitalization. Ind. Mark. Manag. 89, 306–325.

Keränen, J., Terho, H., Saurama, A., 2021. Three Ways to Sell Value in B2B Markets. MIT Sloan Manag. Rev. September.

Ketokivi, M., Choi, T., 2014. Renaissance of case research as a scientific method. J. Oper. Manag. 32, 232–240.

Kingshott, R.P., Pecotich, A., 2007. The impact of psychological contracts on trust and commitment in supplier-distributor relationships. Eur. J. Mark. 41, 1053–1072.

Kingshott, R.P.J., 2006. The impact of psychological contracts upon trust and commitment within buyer-supplier relationships: A social exchange view. Ind. Mark. Manag. 35, 724−739.

Kowalkowski, C., Gebauer, H., Oliva, R., 2017. Service growth in product firms: Past, present, and future. Ind. Mark. Manag. 60, 82–88.

Kumar, M., Pullman, M., Bouzdine-Chameeva, T., Sanchez Rodrigues, V., 2022. The role of the hub-firm in developing innovation capabilities: considering the French wine industry cluster from a resource orchestration lens. Int. J. Oper. Prod. Manag. 42, 526–551.

Lacoste, S., 2016. Sustainable value co-creation in business networks. Ind. Mark. Manag. 52, 151–162.

Lawrence, P.R., Lorsch, J.W., 1967. Differentiation and Integration in Complex Organizations. Adm. Sci. Q. 12, 1–47.

Lee, T.W., Mitchell, T.R., Sablynski, C.J., 1999. Qualitative Research in Organizational and Vocational Psychology, 1979–1999. J. Vocat. Behav. 55, 161–187.

Lenka, S., Parida, V., Sjödin, D.R., Wincent, J., 2018. Towards a multi-level servitization framework: Conceptualizing ambivalence in manufacturing firms. Int. J. Oper. Prod. Manag. 38, 810–827.

Lenka, S., Parida, V., Wincent, J., 2017. Digitalization Capabilities as Enablers of Value Co-Creation in Servitizing Firms. Psychol. Mark. 34, 92–100.

Lerch, C., Gotsch, M., 2015. Digitalized Product-Service Systems in Manufacturing Firms. Res. Manag. 58, 45–52.

Li, A.Q., Found, P., 2017. Towards Sustainability: PSS, Digital Technology and Value Co-creation. Procedia CIRP 64, 79–84.

Li, A.Q., Kumar, M., Claes, B., Found, P., 2020a. The state-of-the-art of the theory on Product-Service Systems. Int. J. Prod. Econ. 222.

Li, A.Q., Rich, N., Found, P., Kumar, M., Brown, S., 2020b. Exploring product-service systems in the digital era: a socio-technical systems perspective. TQM J. 32, 897–913.

Liinamaa, J., Viljanen, M., Hurmerinta, A., Ivanova-Gongne, M., Luotola, H., Gustafsson, M., 2016. Performance-based and functional contracting in value-based solution selling. Ind. Mark. Manag. 59, 37–49.

Mahapatra, S.K., Narasimhan, R., Barbieri, P., 2019. A contingent assessment of the structural and governance characteristics of interconnected dyads in multitier supply chains. Int. J. Oper. Prod. Manag. 39, 714–738.

Martinez, V., Bastl, M., Kingston, J., Evans, S., 2010. Challenges in transforming manufacturing organisations into product-service providers. J. Manuf. Technol. Manag. 21, 449–469.

Miles, M.B., Huberman, A.M., Saldaña, J., 2013. Qualitative Data Analysis: A Methods Sourcebook, 3rd ed. SAGE Publications, Inc., Thousand Oaks, CA.

Moore, J.F., 1996. The Death of Competition: Leadership and Strategy in the Age of Business Ecosystems. NY: HarperCollins, New York.

Ng, I.C., Ding, X., Yip, N., 2013. Outcome-based contracts as new business model: The role of partnership and value-driven relational assets. Ind. Mark. Manag. 42, 730–743.

Ng, I.C., Maull, R., Yip, N., 2009. Outcome-based Contracts as a driver for Systems thinking and Service-Dominant Logic in Service Science: Evidence from the Defence industry. Eur. Manag. J. 27, 377–387.

Oliva, R., Kallenberg, R., 2003. Managing the transition from products to services. Int. J. Serv. Ind. Manag. 14, 160–172.

Paiola, M., Gebauer, H., 2020. Internet of things technologies, digital servitization and business model innovation in BtoB manufacturing firms. Ind. Mark. Manag. 89, 245–264.

Paschou, T., Rapaccini, M., Adrodegari, F., Saccani, N., 2020. Digital servitization in manufacturing: A systematic literature review and research agenda. Ind. Mark. Manag. 89, 278–292.

Poppo, L., Zenger, T., 2002. Do formal contracts and relational governance function as substitutes or complements? Strateg. Manag. J. 23, 707–725.

Porter, M., Heppelmann, J., 2014. How Smart, Connected Products Are Transforming Competition. Harv. Bus. Rev. 92, 65–88.

Porter, M., Heppelmann, J., 2015. How Smart, Connected Products Are Transforming Companies. Harv. Bus. Rev. 97–114.

Rabetino, R., Harmsen, W., Kohtamäki, M., Sihvonen, J., 2018. Structuring servitization-related research. Int. J. Oper. Prod. Manag. 38, 350–371.

Rabetino, R., Kohtamäki, M., Brax, S.A., Sihvonen, J., 2021. The tribes in the field of servitization: Discovering latent streams across 30 years of research. Ind. Mark. Manag. 95, 70–84.

Ramírez, R., 1999. Value co-production: Intellectual origins and implications for practice and research. Strateg. Manag. J. 20, 49–65.

Reim, W., Sjödin, D., Parida, V., 2018. Mitigating adverse customer behaviour for product-service system provision: An agency theory perspective. Ind. Mark. Manag. 74, 150–161.

Reiskin, E.D., White, A.L., Johnson, J.K., Votta, T.J., 1999. Servicizing the chemical supply chain. J. Ind. Ecol. 3, 19–31.

Roehrich, J., Lewis, M., 2014. Procuring complex performance: Implications for exchange governance complexity. Int. J. Oper. Prod. Manag. 34, 221–241.

Rong, K., Hu, G., Lin, Y., Shi, Y., Guo, L., 2015. Understanding business ecosystem using a 6C framework in Internet-of-Things-based sectors. Int. J. Prod. Econ. 159, 41–55.

Rousseau, D.M., 1989. Psychological and implied contracts in organizations. Empl. Responsib. Rights J. 2, 121–139.

Rymaszewska, A., Helo, P., Gunasekaran, A., 2017. IoT powered servitization of manufacturing – an exploratory case study. Int. J. Prod. Econ. 192, 92–105.

Sako, M., 1992. Price, Quality, And Trust: Inter-Firm Relations in Britain and Japan. Cambridge University Press, Cambridge.

Salonen, A., 2011. Service transition strategies of industrial manufacturers. Ind. Mark. Manag. 40, 683–690.

Sjödin, D., Parida, V., Kohtamäki, M., 2019. Relational governance strategies for advanced service

provision: Multiple paths to superior financial performance in servitization. J. Bus. Res. 101, 906–915.

Sjödin, D., Parida, V., Wincent, J., 2016. Value co-creation process of integrated product-services : Effect of role ambiguities and relational coping strategies. Ind. Mark. Manag. 56, 108–119.

Sklyar, A., Kowalkowski, C., Tronvoll, B., Sörhammar, D., 2019. Organizing for digital servitization: A service ecosystem perspective. J. Bus. Res. 104, 450–460.

Spring, M., Araujo, L., 2009. Service, services and products: rethinking operations strategy. Int. J. Oper. Prod. Manag. 29, 444–467.

Suppatvech, C., Godsell, J., Day, S., 2019. The roles of internet of things technology in enabling servitized business models: A systematic literature review. Ind. Mark. Manag. 82, 70–86.

Tronvoll, B., Sklyar, A., Sörhammar, D., Kowalkowski, C., 2020. Transformational shifts through digital servitization. Ind. Mark. Manag. 89, 293–305.

Ulaga, W., Reinartz, W.J., 2011. Hybrid Offerings: How Manufacturing Firms Combine Goods and Services Successfully. J. Mark. 75, 5–23.

Vandermerwe, S., Rada, J., 1988. Servitization of Business: Adding Value by Adding Services. Eur. Manag. J. 6, 314–324.

Vargo, S.L., Lusch, R.F., 2008a. Service-dominant logic: Continuing the evolution. J. Acad. Mark. Sci. 36, 1–10.

Vargo, S.L., Lusch, R.F., 2008b. From goods to service(s): Divergences and convergences of logics. Ind. Mark. Manag. 37, 254–259.

Vargo, S.L., Maglio, P.P., Akaka, M.A., 2008. On value and value co-creation: A service systems and service logic perspective. Eur. Manag. J. 26, 145–152.

Vendrell-Herrero, F., Bustinza, O.F., Parry, G., Georgantzis, N., 2016. Servitization, digitization and supply chain interdependency. Ind. Mark. Manag. 1–13.

Wacker, J.G., Yang, C., Sheu, C., 2016. A transaction cost economics model for estimating performance effectiveness of relational and contractual governance: Theory and statistical results. Int. J. Oper. Prod. Manag. 36, 1551–1575.

Windahl, C., Lakemond, N., 2006. Developing integrated solutions: The importance of relationships within the network. Ind. Mark. Manag. 35, 806–818.