

A PLATFORM ECOSYSTEM VIEW OF SERVITIZATION IN MANUFACTURING

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Abstract

This study investigates how the social and technical subsystems of a platform ecosystem change and interact in the advanced services context. An integrated research approach results in the development of an analytical framework accounting for the four perspectives of - technical core, key actors, structural boundaries and tasks of a servitization-based platform ecosystem. This study draws from collective experiences of 14 senior executives from seven manufacturing firms using a multiple case study approach. We find that manufacturers' decision to modularise or standardise affects the range of services they can offer, and while modularity presents challenges of engagement between ecosystem actors, standardisation is harder for manufacturers with intricate products and complex customer settings. We also find that complexities of service transformation can trigger product-biased behaviour of internal actors, risking the success of servitization within the organisation. Additionally, we find that manufacturers can concurrently operate across multiple structural boundaries, and this impacts the mechanisms they adopt to govern and orchestrate their actor networks.

Keywords: Advanced services; platform ecosystems; servitization

1. Introduction

Wide-ranging manufacturers are actively exploring the opportunities of service-focused business models. They take inspiration from successful examples, such as Rolls-Royce's

power by the hour, whereby the firm moved away from providing their gas turbine engines as products to provide thrust as a service proposition. Such a transformation is widely recognised as servitization (Vandermerwe and Rada, 1988), where manufacturers develop business models based on the capabilities enabled from product usage, instead of the sale of their product alone (Baines and Lightfoot, 2013). Servitization literature provides important insights on the diversity of service-focused business models in manufacturing (Baines et al., 2009, Martinez et al., 2010).

There is a well-accepted categorisation of these business models at three levels of service provision - base (product provision), intermediate (product condition) and advanced (performance or outcome) services (Baines et al., 2013, Bustinza et al., 2015). Of the three, the development of advanced services requires significant organisational transformation (Baines et al., 2019), as they involve adoption of new technologies and changes in organisational structures, alongside significant changes in the relationship dynamics involving customers, providers and other partners (Ziaee Bigdeli et al., 2018). In addition, existing research is of the opinion that advanced services are an extremely risky strategic choice for manufacturers, given the issues of resource constraints, misaligned strategic focus, and organisational conflicts (Durugbo, 2014, Josephson et al., 2016, Ziaee Bigdeli et al., 2018).

Advanced services are a complex bundle of product-service offerings involving long-term contractual agreements and cost-down commitments; an example is Xerox delivering pay-per-click scanning, copying and printing of documents (Baines and Lightfoot, 2013). Inherently, manufacturers do not have all the capabilities required for the development of service offerings (Paiola et al., 2013, Story et al., 2017). Advanced services, in particular, necessitate the development of service-related technology and relational capabilities that facilitate co-creation amongst the actors of a network to produce novel value offerings (Baines and Lightfoot, 2013, Brax and Jonsson, 2009, Gebauer et al., 2013). In doing so, manufacturers are increasingly leaning towards the formation of wider, connected *ecosystems*, which are essentially enabled by *platforms* (Eisenmann et al., 2011, Ostrom et al., 2015).

By definition, “*platforms* are products, services, or technologies that are similar in some ways, but provide the foundation upon which outside firms (organized as a “business ecosystem”) can develop their own complementary products, technologies, or services” (Gawer and Cusumano, 2014, p. 418). A *platform ecosystem* (PE) is an assemblage of a platform, the actors and the offerings developed on that platform (Tiwana, 2015a, Eloranta and Turunen, 2016, Goldbach et al., 2018). In the servitization context, manufacturers use their products as the platform, which enables them to extend beyond product offerings to create new usage scenarios, i.e. advanced services, whilst facilitating co-creation and service innovation across key actors in their PEs. In steering strategic opportunities, platforms extend capacities of a product to deliver new outcomes, facilitate information flows, and realise shared benefits (Eloranta et al., 2016). Incorporating platforms as a part of service innovation unlocks immense possibilities (Vargo et al., 2015, Lindhult et al., 2018), and involves facilitating synergistic interactions between multiple actors in a business ecosystem to enable innovation and value delivery (Gawer and Cusumano, 2014, Cenamor et al., 2017, Thomas et al., 2014). Therefore,

a platform always operates/functions in alignment with its ecosystem, and in order to establish a holistic understanding, accounting for the platform with its ecosystem is key.

For instance, commercial truck manufacturer, MAN use their trucks (product) as the platform. They have successfully collaborated with a telematics firm, Microlise (a key actor in their ecosystem), and together developed a tracking unit that is installed on MAN trucks to feedback driver and vehicle performance data. They use such data for improving driver skills and monitoring truck health (advanced service). Successful examples like MAN are evidence that in manufacturing, collaborating with an extended network of actors equipped with service-related capabilities (i.e. ecosystem) can derive benefits of maximum value from investments, as well as result in lasting relationships with customers even after product sales. Despite such potential, existing research has not yet comprehensively analysed servitization, particularly, the development and delivery of advanced services from a PE perspective. This will make for a stimulating research context and help us understand the interplay and management of PEs in servitization. Since we are interested in understanding how these aspects come into play in the development and delivery of advanced services, we account for such actor dynamics from a manufacturer's perspective.

PEs have the potential to account for various actors interacting via diverse means of trade (data, resources) and value creation processes (Schneider, 2018). Existing research (Kuula et al., 2018) suggests the need for investigating platform ecosystems across complex hybrid offerings; a research call suggests, “a fruitful field to explore modularity and platform-based approaches in complex hybrid offerings are the integrated solutions business model and the firms that are engaged in servitization. Thus, it is encouraged that scholars in the servitization and product-service systems fields turn toward research questions on modularity” (Brax et al., 2017, p. 692). There is an obvious overlap in the topics of PEs and servitization, but very little is available in the management literature on how the two topics fit together. There have been some early contributions on the topic; for instance, from a technical perspective, Rajala et al. (2019) refer to modularization, a key characteristic of PEs, as a critical competitive capability for servitizing businesses; they emphasize on the importance of modularity principles in designing solutions. However, studies like Salonen and Jaakkola (2015) and Rajala et al. (2019) investigate such PE aspects in firms relying on external collaborations, but yet, not much is known about how these play out in firms focused on resource internalisation (Rajala et al., 2019). Moreover, a pressing gap in the literature is that existing studies focus more on the technical subsystem and not on the social subsystem of a PE; not many insights on the actor dynamics, i.e. the ecosystem and its orchestration, are available (Breibach et al., 2018, Cenamor et al., 2017). Therefore, the aim of this study is to adopt a *platform ecosystem lens* that will account for both social and technical perspectives in understanding manufacturers' development and delivery of advanced services.

A technical perspective offers insights into how a system meets technical requirements, but fails to account for the relationship dynamics of an organisation and the actors undertaking and supporting its different business processes (Goguen, 1999, Baxter and Sommerville, 2011). For establishing a coherent understanding of how the social system (actors) adjusts goals to support the technical aspects (technical changes and innovations within PEs), a socio-technical (S-T)

approach is seen fit. S-T systems are inherently dynamic and evolve via recursive shaping of technical infrastructure and social constructs, reflected in actions altering entities at the technical, actor, structure and task levels (Dremel et al., 2018).

Technical aspects comprise of an organisation's technical core (Lyytinen and Newman, 2008), including the platform architecture, its components and modules integral for a sustainable PE. *Actors* are the key stakeholders, i.e. leaders, maintainers, developers, and users of a system (Lyytinen and Newman, 2008), who can set forward claims or benefit from its development. *Structure* covers decision-making, authority, and workflow, focussing on both - the normative dimension of role expectation and the behavioural dimension of PE actors in terms of sharing specifications, exercising authority, and operating within an established ecosystem (Lyytinen and Newman, 2008). *Task* describes how an organisation evolves with the environment to ensure work gets done (Lyytinen and Newman, 2008), which includes incentives for encouraging actor participation and their subsequent management reflected in the governance and orchestration criteria established to align actors' interests with the goals of a PE.

We follow a multiple case study approach to investigate the servitization journey of seven large multinational manufacturers. This will broaden our understanding of how PEs add value to a servitization-based business model. In terms of the paper's structure, Section 2 reviews key literature and proposes research questions. Section 3 outlines the methodological approach, and Section 4 builds on findings. Section 5 presents the discussions and focuses on conclusions, implications, limitations and future research.

2. Research background

2.1. Current research on platforms and ecosystems in servitization

The concept of platforms has remained a topic of discussion for over two decades. Several studies have shared fundamental insights on the dynamics of platforms, such as the interfaces and subsystems of a platform, use of common architecture on a platform etc. (Meyer and Lehnerd, 1997, Krishnan and Gupta, 2001, Muffatto and Roveda, 2002). Most of these studies focus on product architecture and product development. Given the rise in service-driven economy, recent studies are moving towards platforms in services, and a few studies are also exploring some aspects of PEs in services (Gawer and Cusumano, 2014, Han et al., 2018). For instance, some investigate the role of platforms in systematising the networking, innovation and operations (Turunen et al., 2018) in services and manufacturing (Eloranta and Turunen, 2016, Brax and Jonsson, 2009), while others focus on the usefulness of platforms in orchestrating industrial ecosystems (Eloranta and Turunen, 2016, Breidbach et al., 2018). Recent studies like Brax et al. (2017) are asking for more research on the topic, with specific focus on platform-based models exploring modularity in hybrid offerings that combine both product and service modules (as in servitization). Frandsen (2017) also identified studies, such as Pekkarinen and Ulkuniemi (2008) and Bask et al. (2010) that showed evidence of platforms in service contexts, and recommended furthering the research on platforms in developing business models for services almost a decade ago. One of the primary gaps emerging from existing research is that, despite such early recognition and repeated calls for research, there is limited evidence on the role of PEs in servitization.

Additionally, the scope of the few studies available on PEs in servitization is quite fragmented and narrow. Much of the servitization literature suggests that platforms stimulate value creation and help alleviate/manage the servitization paradox (i.e. the challenge of enhancing value propositions by adding services to the business, whilst keeping costs low), and organisational and network complexities in service businesses (Eloranta et al., 2016, Cenamor et al., 2017, Ardolino et al., 2018, Wei et al., 2019). A significant part of such research adopts a business model perspective focused largely on the platform owner (key actor in the PE who owns the platform) revealing their underlying strategies and best practices (Gawer and Cusumano, 2008, Tiwana et al., 2010, Karhu et al., 2018). On the other hand, some studies concentrate on the worth of digital components, highlighting the value of information in successfully transitioning towards advanced services (Baines and Lightfoot, 2013, Baines and W. Lightfoot, 2013, Cenamor et al., 2017). They focus on the fact that manufacturers are increasingly exploring and incorporating digital capabilities and internet technologies in instilling flexibility and reconfiguration skills, i.e. modularity into their production systems (Savastano et al., 2019).

Modularity is another topic of interest, which is discussed at length in servitization-related studies; it implies breaking up the complicated production process into modules split across different producers using the same components to produce different offerings for differing target markets (Kuula et al., 2018). In a manufacturing setting, product offerings can be modularised to be broken down into different services associated with product spares, preventive maintenance, fleet management, and so on, allowing manufacturing firms to configure multiple service offerings using different module combinations (Gawer, 2014, Cenamor et al., 2017). While Löfberg and Åkesson (2018) consider the modular characteristic of platforms extremely effective in controlling organisational complexity and improving customer orientation, Zheng et al. (2018) find most studies vouch for the modular architecture of platforms in product-service innovation as an effective strategy for overcoming the servitization paradox. This reveals yet another gap in the literature, where most research is either tunnel focused or fragmented across issues of modularity, servitization paradox, organisational complexity and platform owners.

It is equally important to note that the studies that focus on both platforms and ecosystems in servitization tend to separate the investigation of the technical aspects of a platform from its ecosystem. Numerous studies are mostly interested in the technical features of a platform, investigating the various aspects of platform architecture, and in the role of its core components, complements and other tangible resources (Tiwana et al., 2010, De Reuver et al., 2018, Rolland et al., 2018). For instance, Visnjic et al. (2017) focus on complementarity as a value driver for outcome-based contracts, and Birkel et al. (2019) focus on platforms as business models for solution-based offerings, i.e. the technical side.

There are, on the other hand, studies that mainly focus on the social aspects. For instance, Ziaee Bigdeli et al. (2018) analyse the underlying risks of strategic partnerships in the servitization context, Breidbach et al. (2018) pay attention to network orchestration and value co-creation in delivering services, and Tao et al. (2017) focus on key actors in a manufacturing-based service platform, i.e. the social side. As well as accounting for the new technical capabilities

essential for service provision, servitization also facilitates interaction between multiple actors who share expertise and enable knowledge integration, making PEs as much of a social challenge as they are a technical challenge. These social and technical aspects are essentially complementing each other, suggesting that they need to be investigated in an integrated way in order to identify the mechanisms underlying the ecosystems and explain their successes and failures (Walrave et al., 2018). This suggests a third gap in the literature, whereby an integrated investigatory approach that accounts for both technical and social aspects of PEs as a whole is missing in current research.

PEs are essentially visualised as a structured alignment of multilateral set of partners, who maintain sufficient interaction between each other with an aim to materialise a focal value proposition (Adner, 2016). Therefore, neglecting social aspects (ecosystem) and focusing only on technical aspects (of a platform) in silos, or vice versa, risks misunderstanding the wide-ranging and complex technical and social interdependencies of a PE.

2.2. A socio-technical view of platform ecosystems

To address the aforementioned gaps and take a holistic view of PEs in servitization, this study undertakes an integrated research approach and conceptualises PEs as socio-technical (S-T) systems. At its core, S-T systems theory builds on the idea that the design and performance of an organisational system can be understood only when the social and technical aspects are considered in conjunction, and treated as interdependent elements of a complex system (Hughes et al., 2017). Several authors link the S-T systems theory to the resource based view of a firm (e.g. Wong et al., 2014, Xu et al., 2014, Wang et al., 2016), with its focus on the firm's internal strengths as source of its competitive advantage. By adopting such a view, researchers consider a wide array of socio-technical resources (e.g. assets, capabilities, relationships) and their complementary attributes to explain the firm's performance (Rouse and Daellenbach, 2002, Chisholm and Nielsen, 2009).

Although the S-T view has its origin in information systems research, it has since been used to guide the analysis of resources enabling core operational or strategic issues of firms, supply chains and production networks (e.g. Panebianco and Pahl-Wostl, 2006, Kemper and Ballantine, 2017, Grover et al., 2018, Lee et al., 2020). Similarly, this study draws on the S-T systems theory, not to explain an individual firm's performance, but as a framework to develop a holistic view of the PE: to identify diverse resources and their interactions that characterise and enable an advanced services PE. Hence, following Lyytinen and Newman (2008) and Dremel et al. (2018), we apply the S-T system notion and consider the four perspectives of - *technical core*, *key actors*, *structural boundaries* and *tasks* as the key domains to investigate the S-T nature of an advanced services PE.

The platform itself accounts for the technical aspects encompassing principles of *modularity* and *standardisation* (Tiwana et al., 2010, De Reuver et al., 2018), which allows manufacturing firms to conceive and devise modularised service offerings. Modularity refers to the process of dividing the design of a product/service into fragmented modules (Kuula et al., 2018). Modularity principles are focused on the need for each module to be fairly independent to enable a specific function per module (scalability catering to diverse needs),

and at the same time, also be compatible with standardised interfaces to enable integration between modules (Broekhuis et al., 2017). Standardisation refers to the commonality of components (Salonen et al., 2018), with standardisation principles focusing on repetitive tasks (repeatability of operating procedures) that can reduce complexity and increase overall efficiency of a system (Kuula et al., 2018). Platforms designate core (stable components that cannot be changed) and peripheral (variable components that can be changed) components for delivering flexible solutions (Gawer and Cusumano, 2014, Salonen et al., 2018) that can accommodate future changes to meet varying customer needs for services. These core and peripheral components allow for scalability and repeatability on a platform (Ardolino et al., 2018). However, research suggests there is little evidence in the literature of such capabilities supporting servitization; academics (Brax et al., 2017, Cenamor et al., 2017, Story et al., 2017) are particularly encouraging peers to build research questions (RQ) centred on modularity and related capabilities. We therefore ask:

RQ1: How do manufacturers employ modularity and standardisation principles in the development and delivery of advanced services?

In addition to modularity and standardisation, resource integration between actors in a PE is central to value co-creation, where they dynamically create and change value propositions (Löfberg and Åkesson, 2018, West et al., 2018). The key actors here are the platform owners, complementors and end users. *Platform owners* assume the role of an architect, and are accountable for designing, managing, and continuously changing PEs as the network intricacies evolve with time (Perks et al., 2017, Helfat and Raubitschek, 2018). *Complementors* are developers of complementary or ancillary offerings (complements), and *end users* are consumers/subscribers of such complements (Tao et al., 2017). In a PE, tight cooperation between network actors is paramount (Immonen et al., 2016). It is, therefore, critical to define the roles of key actors, and establish their unique contributions (based on their individual capabilities) towards the overall value co-creation process. We thus ask:

RQ2: How do manufacturers define the roles of key actors, essential for the development and delivery of advanced services?

Platform owners define structural boundaries for their platforms to determine whether the development and delivery of advanced service should be undertaken internally, along the supply chain and/or externally. Platforms restricted to an internal structure (closed interface) rely on assets organised in a common structure employed by a single firm to develop and produce a selection of derivative offerings (Gawer and Cusumano, 2014). Platforms operating along a supply chain have a selectively open interface, where interface sharing occurs exclusively within the supply chain (Gawer and Cusumano, 2014). Those operating externally (open interface) support platforms that bring together multiple firms that are not necessarily transacting with each other, but that are interdependent and must operate together as a part of a technological system (Gawer and Cusumano, 2014). There is no evidence in the existing literature suggesting whether manufacturers operate across a single structural boundary or whether they choose to operate across multiple types during their services lifecycle. Since such

understanding can explain which structural configuration best supports a manufacturer’s servitization journey, we set out to understand:

RQ3: How do manufacturers define the structural boundaries of their platforms for supporting the development & delivery of advanced services?

An ecosystem with multiple actors is constantly subject to changing actor roles, which can complicate industry structures and power structures in a market; this makes the task-level actions of effective governance and the resulting network orchestration a topic of concern (Eloranta and Turunen, 2016). Here, platform coordination revolves around ecosystem governance (Gawer and Cusumano, 2014, Den Hartigh et al., 2016). Network orchestration is defined as a process that manages an inter-organisational network to support tasks that are beyond a manufacturer’s own capabilities (Wei et al., 2019). In reviewing service operation literature, Breidbach et al. (2018) identify orchestration as a critical theme, very typical of a constantly evolving ecosystem that supports services. Researchers (Ardolino et al., 2018, Wareham et al., 2014) consider orchestration and governance as very critical aspects of PE management, given the resource interdependencies of its many actors. We therefore ask:

RQ4: How do manufacturers manage task-level actions related to the governance and orchestration of their PEs in supporting the development and delivery of advanced services?

We structure the aforementioned insights into a framework (Table 1) for analysing the case studies for this research.

Table 1: Analytical framework

Components	Subcomponents (Theory-driven Codes)	Description	References
Technical Core	- Modularity - Standardisation	Representative of all elements that build the technological core of a PE	Amit and Zott (2001), Gawer (2014), Gawer and Cusumano (2014), (Acquier et al., 2017), Brax et al. (2017), Cenamor et al. (2017), Visnjic et al. (2017), Story et al. (2017), Ardolino et al. (2018), Kuula et al. (2018), Salonen et al. (2018), West et al. (2018), Meyer and Lehnerd (1997)
Key Actors	- Platform leader - Complementor - End user	Major stakeholders undertaking and influencing work in PEs. They set forward claims or benefit from system development	Cusumano and Gawer (2002), Lusch and Nambisan (2015), Immonen et al. (2016), Eloranta and Turunen (2016), Cenamor et al. (2017), Perks et al. (2017), Tao et al. (2017), Sussan and Acs (2017), Löfberg and Åkesson (2018), West et al. (2018)
Structural Boundaries	- Internal - Supply chain - External	Account for workflow, issues of decision-making, interface sharing and actors operating across different architectures	Gawer and Cusumano (2014), Den Hartigh et al. (2016), Eloranta and Turunen (2016), Facin et al. (2016), Brown et al. (2017), Wei et al. (2019)
Tasks	- Governance - Orchestration	Account for mechanisms of authority and orchestration, which together ensure the alignment of goals of multiple stakeholders participating in a PE	Cusumano and Gawer (2002), Tanriverdi and Chi-Hyon (2008), Zhu and Iansiti (2012), Cennamo and Santalo (2013), Koh and Fichman (2014), Thomas et al. (2014), Wareham et al. (2014), Tiwana (2015b), Eloranta and Turunen (2016), Ardolino et al. (2018), Breidbach et al. (2018), Karhu et al. (2018), Huotari et al.

		(2017), Helfat and Raubitschek (2018), Rietveld and Eggers (2018)
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In summary, as manufacturers can offer a range of outcomes focused on product performance (Baines and Lightfoot, 2013), principles of modularity and standardisation become fundamental in supporting the development of heterogeneous advanced services (RQ1). Manufacturers adopt new technologies, change organisational structures, and also bring about changes in their relationships with other ecosystem actors to align with the service focus (Ardolino et al., 2018). This not only warrants redefining the product-dominant actor roles to fit the new service-focus (RQ2), but also leads to changes in structural boundaries (RQ3). For instance, a servitizing firm could opt for an open approach to encourage complementor involvement, and explore the option of a closed approach to prevent interface sharing between certain ecosystem actors (Wei et al., 2019). Furthermore, servitization impacts management of network relationships (Ziaee Bigdeli et al., 2018), which affects governance strategies, and can result in orchestration complexities (RQ4). Therefore, with these four RQs, we attempt to address issues that manufacturers are most likely to encounter in their servitization journey.

3. Methodology

3.1. Research method

With the intent of understanding manufacturers' servitization journey through a PE lens and given the insufficient understanding of the topic, we adopt a qualitative research method (Miles et al., 1994). Case study methods have produced reliable results in investigating new service development (Aaboen et al., 2012, Story et al., 2017). This study thus applies a multiple case study approach to enable in-depth understanding of PEs (Wei et al., 2019).

3.2. Case selection

In undertaking this investigation, we used a purposive sampling technique (Matthyssens and Vandembemt, 2010, Cenamor et al., 2017) to identify manufacturing firms. These firms are traditionally product-focused, and are in the early stages of exploring, developing and/or delivering advanced services. The search and selection process involved multiple techniques, such as web searches for businesses associated with advanced service-type contracts, monitoring attendees at field service networking events, using LinkedIn for networking, and so on. Through these searches, we found 20 globally operating multinational firms that were engaged with advanced service-type contracts; we directly contacted them to further assess their suitability for this research. This led us to shortlisting firms that are (i) manufacturers involved in development and delivery of advanced services (not pure service providers), (ii) willing to divulge information on their interactions and collaborations with the varied stakeholders of their service ecosystem, and (iii) willing to provide access to middle/senior management for data collection purposes. Following this process, seven firms were selected to take part in this study. The selected seven cases were all at different levels of organisational maturity and development with respect to servitization, accounting for the many different stakeholders of a manufacturer's service ecosystem. This provided the research team with a

comprehensive view of manufacturers' development and delivery of advanced services from a PE perspective and allowed for generalisability of the findings.

Moving from product offerings to service offerings involves significant transformations within an organisation. For instance, one of our case firms (Case A) moved from selling equipment to setting up call centres and appointing engineers for offering improved services directly to customers. Others (like Case B) underwent a complete redevelopment process to incorporate new capabilities, such as automation and cloud services to develop new divisions for service offerings. We included cases demonstrating such transformation, including evidence of - change management, creation of new roles and opportunities, redevelopment to tear away from traditional methods, and changes in business infrastructure to aid service provision. Terms of data access and confidentiality were agreed, and thus, the names of these manufacturing organisations are withheld herein (Table 2).

Table 2: Case firms and interviewee information

Case Firms	Employees/ Revenue	Product Offering	Service Offering	Interviewees
Case A	6,400/ \$1.99B	Commercial water and space heating systems	Connected solutions; Protection plans	Customer Insight Manager; Innovation Delivery Manager
Case B	2,800/ \$155M	Digital printing products	Remote monitoring and cloud capability; Extended warranties	Director of Channel Development; Director of Product Management
Case C	15,000/ \$3.1B	Powered industrial forklift trucks	Connected maintenance via remote monitoring	Director of Design Research; Relationship Manager for Advanced Services
Case D	3,564/ \$1.08B	Weighing, inspection and packing products	Service contract offerings involving remote monitoring	EMEA Business Manager for Advanced Services; Director of Services
Case E	2,305/ \$47.5M	Industrial air filtration systems	Remote support for air filtration units	Vice President Business Development; Relationship Manager for Advanced Services
Case F	74,200/ \$49.33B	Networking and telecommunications equipment	Digitised customer experience	Senior Manager for Workforce and Staffing; Managing Director for Advanced Services
Case G	101,500/ \$54.7B	Construction machinery and equipment	Leasing, renting & extended warranty; total maintenance & repair; remote monitoring; consulting	Head of Business Model Transformation in Services, Marketing and Digital; Director of Services Design

3.3. Data collection

We gathered data using semi-structured interviews (face-to-face and telephonic) over a two-month period. All respondents belonged to one of the following categories - (a) directly involved in development and delivery of advanced services, (b) having extensive experience and knowledge of a breadth of key functions supporting service offerings, (c) a subject matter expert previously/currently working for the manufacturing firm. Given the high-profile roles of our interviewees, we applied an elite interviewing approach (Welch et al., 2002), which allowed the assimilation of data from key players across the shortlisted manufacturing firms.

The interview questions were a reflection of the research questions, designed to guide the conversation towards servitization initiatives, focusing on the process and contextual forces

affecting the development and delivery of servitization-based offerings. Questions were on - advanced services, actors, service-enabling capabilities, standardisation, modularity, network dynamics and governance functions. At least two researchers were present for the interviews. All interviews lasted 45 minutes to an hour, and were audio recorded. Written transcripts were prepared for all interviews. We conducted 14 interviews, with two senior executives per case firm, resulting in over 400 minutes of total recorded material. Triangulation (Jick, 1979) was adopted to verify responses, and we included supplementary data, such as observation notes, and crosschecked responses from interviewees.

3.4. Data analysis

A thematic analysis procedure was deemed suitable for this study to generate an in-depth analysis of the gathered data (Miles and Huberman, 1994). Thematic analysis (TA) follows an iterative series of steps to identify themes in qualitative data, capable of producing an empirically sound framework (Cenamora et al., 2017). To maintain focus on the raised research questions, and avoid a needlessly descriptive account of interview data, studies adopt the codebook technique for steering their discussions in the intended direction (Braun and Clarke, 2006). Advocates of the codebook technique suggest that it allows for the expansion, reconceptualization, and transformation of data in examining the degree to which such data supports/contradicts the theory guiding a research (DeCuir-Gunby et al., 2011).

Therefore, we followed a codebook TA approach, which allowed us to determine some themes in advance that were then conceptualised as domain summaries (Braun et al., 2018). We created the codebook using a combination of theory-driven and data-driven codes, as suggested by Boyatzis (1998). We arrived at theory-driven codes by exploring the theoretical concepts underlying platform ecosystems in the services context, resulting in the development of an analytical framework (Table 2). The subsequent steps for arriving at data-driven codes involved repeated readings of full transcripts to identify patterns, key phrases and sentences. Interesting words and text segments, and any other important relationships (Saldaña, 2015) were captured.

To ensure reliability and construct validity, the data was coded by two independent researchers, and different interpretations of the data (code classification into conceptual categories) were generated to arrive at consensual coding (King et al., 2004). As coding is an iterative process, the researchers revisited both theory and data-driven codes to ensure their utility and to account for inconsistencies in the coding protocol. The coding structure was finalised when further analysis by the researchers did not reveal any new codes or relationships, meaning the point of theoretical saturation was reached (Bryman, 2016). In addition, agreement between the two researchers was calculated using Cohen's Kappa and an almost perfect agreement score (>0.81) was achieved, confirming reliability and consensus in the coding process (Braun et al., 2018).

Cross-case analysis was undertaken by summarising data from each case and building displays to reveal cross-case patterns to make comparisons. Validity was further enhanced by identifying commonalities across cases, and comparing cases with different servitization-based offerings (Yin, 2003). Overall, such application of the codebook technique allowed us to establish new links between concepts, and led to us reconsidering some of the causal theoretical connotations for this study, whilst supporting the translation of data from multiple

manufacturers into measurable units. The next section reports findings for each of the proposed research questions.

4. Findings

The findings show evidence of all four aspects of a PE – technical core, key actors, structural boundaries and tasks across all servitizing manufacturers shortlisted for this study.

4.1. Technical core of a servitization-based platform ecosystem

To comprehend components that build the technological core of a servitization-based PE, we asked, *RQ1: How do manufacturers employ modularity and standardisation principles in the development and delivery of advanced services?* We identify evidence for modularity and standardisation across all seven case firms (Table 3) to make the following deductions.

Our findings reveal that uniqueness of products implies data is stored differently for different products. For instance, Case A use the data transmitted between different boilers and remote monitoring devices in different ways to meet varied customer needs. Here, modularity allows adaptation of components (customisation) and reduces technical complexities. Modularity introduces flexibility in such PEs to enable varied functionalities to meet changing customer requirements, suggesting modular components can be changed on a needs basis making them the peripheral components. Some firms (Case A, G) evaluate the market – if there are direct benefits associated with commercial customisation, they introduce flexible processes to offer varied services. Data from other case firms (Cases A, D, F) suggests flexibility is imperative for catering to multiple customer segments, so unique service value propositions can be developed based on unique customer requirements. The Business Manager of Case D shares:

Our customers have very different requirements, although they have relatively common equipment, the applications drive different demands from the equipment.

We also evaluate standardisation, which refers to common components that manufacturers use to ensure service offerings complement their product offerings; this suggests the standardised components are stable and cannot change, making up the core components of a PE (Section 2.2). Our data shows that standardisation becomes prominent in handling data requirements and hardware specifications. In some cases (Case B), a firm's internal policies and process limitations prevent them from being flexible, making standardisation of service offerings an only option for them. The Director of Product Management from Case B explains:

We provide a single access interface for every customer out there. If somebody else wants something different, it's not really possible to do it at the moment.

Some case firms (Cases B, D) find putting standardisation over modularity has allowed them to mass-produce and gain quicker adoption of services. Most case firms acknowledge not all their products are service-compatible, specifically those sold prior to their decision to servitize. Head of Business Transformation at Case G explains, their older customers are now demanding service offerings, but lack of standard components (for supporting services) in their older products is preventing them from catering to their customers' new service needs.

Table 3: Technical core

Case Firms	Modularity (Peripheral)	Standardisation (Core)
Case A	Design processes, both internally and with the agencies including capability-based flexible offerings for different customers	Hardware, GPRS for connecting to the cloud, and other remote monitoring components
Case B	Bare minimum – customers can customise parameter-view on dashboards	Off-the-shelf dashboards, cloud-enabled printers, and other remote monitoring components
Case C	No traces of modularity found – still in exploratory stages of understanding how much data customers want, and its value to them	Telematics box and associated remote monitoring components
Case D	Bare minimum – in exploratory phase of offering customer segment-based customisation	Regular payment service plan, and remote monitoring components
Case E	Customised reporting with specific machine alerts based on customer requests for parameters not available via the standard dashboard	Dial in, SIM card and associated remote monitoring components
Case F	Based on complexity of the offering, flexibility in resources and customer support	Remote monitoring components
Case G	Dealers undertake commercial customisation only in cases of substantial market potential	Telematics box, sensors and associated remote monitoring components

In summary, our findings suggest that manufacturers with a portfolio of diverse product and service offerings, and diverse customer segments will place more emphasis on the modularity principles. Additionally, manufacturers with increasing customer demand for services, specifically targeting faster, widespread installation of parts and components at customer sites to support advanced services will place more emphasis on the standardisation principles.

4.2. Key actors of a servitization-based platform ecosystem

To gain insights into the platform owners, complementors and users of a servitization-based PE, we asked, *RQ2: How do manufacturers define the roles of key actors, essential for the development and delivery of advanced services?* Here, our case firms are the platform owners as they design and manage service offerings. We list key personnel, who assume ownership of such servitization-based PEs across the seven case firms in Table 4.

Table 4: Platform owners across case firms

Platform Owner	Roles	Responsibility
Case A	Key leadership	Leading service directives throughout the organisation
	Group services director	Driving services vision and identifying future services prospects
Case B	Head of global services	Centre of excellence for services
	Product manager	Service development
Case C	Director of product-service	Design research; strategies for service sales
	Vice president customer support	Champion for service-based offerings
Case D	Board of directors	Facilitating service objectives internally
	Managing director	Lead sponsor for services
Case E	CEO & management team	Establish service culture, direction and effective communication
Case F	Vice president	Leadership mandate and creation of governance structures
	Head of sales	Support service sales and customer experience function
Case G	Project managers	Identifying service projects, define scope and monitor progress
	Dealer & customer advisories	Assess value of service outcomes to the organisation and users

Our data suggests, management teams lead service sales and coordination between product management and service delivery teams is the backbone of service development. All cases

concur it is imperative for service directives to come from the managing directors, particularly when the service business is in its early stages. The Business Manager for Case D shares:

Because services are an immature part of our business, to generate buy-in from sales, the Managing Director has to lead and get this implemented within the business.

Complementors can be internal or external to an organisation. Internal complementors mostly drive research and innovation and focus on developing efficient products, dashboards to support services, handle service sales and support customer sites. External complementors are partners/third parties, mostly software developers and design agencies which develop IoT platforms, remote monitoring analytics and interfaces (Table 5).

Table 5: Complementors across case firms

Case Firms	Complementors	Responsibility
Case A	R&D team	Efficient, cost-effective product & service delivery
	Hardware partners	Developing connected devices to support remote monitoring
	Growth & sales team	Selling services
	Innovation team	Developing concepts, processes & opportunities
Case B	Hardware developer	Third party for developing cloud-based functionality
	Technical support	Remote monitoring
	Field service teams	Collection of local sales & service subsidiaries/distribution
Case C	IT team	Supporting remote monitoring team with technical updates
	Product development team	Supporting connected devices & telematics solutions
	Internal & external dealers	Distributing products supporting service offerings
Case D	Internal/field service support	Managing actual service delivery
	Internal Software & control	Enabling service delivery and uptime maintenance contracts
Case E	Knowledge team	Technology enabler for sales team in the delivery of IS/AS
	Subcontractors	Code development & programming
Case F	Partners & resellers	Stocking & selling
	Engineering	Product & service development based on customer feedback
Case G	Technology partners & IT group	Analytics & infrastructure (hardware and software) management
	Dealers	Data analysis, customer communication, execution & feedback
	Software partners	Software development

All case firms cater to distinct customer segments (Table 6), and engage with customers in different ways. Cases D and E have invested in customer engagement to experiment advanced services in their customers' operations. Some manufacturers rely on customer feedback for piloting/testing, and others depend on customers for releasing asset data for inspection and assessment purposes. Some firms (Case G) use such data for incremental improvements in their next generation products/services, and others (Cases A, F) create user stories to capture key insights and run review processes with customers to formulate service requirements.

Table 6: User segments for case firms

Case Firms	Users
Case A	Engineers, plumbers, small businesses, social housing associations, new builds, industrial units
Case B	Fast-moving consumer goods, life sciences, pharmaceutical
Case C	Warehousing and manufacturing, retail
Case D	Farmers, small firms with farm environment, large single turnkey projects
Case E	Foundries, car manufacturers, wood industries, glass fibre industries
Case F	Automotive, banking, education, healthcare
Case G	Process industry (repeated process), project industry (non-repetitive)

In summary, top management act as platform owners to generate internal buy-ins, ensure organisation-wide service implementation, and ascertain customer engagement (crucial before and after service development and delivery). While internal complementors either upgrade their product-oriented skills or acquire new skills to support such service implementation, external complementors are mostly experts with digital resources and competencies, augmenting manufacturers’ product platforms to develop complementary service offerings.

4.3. Structural boundaries of a servitization-based platform ecosystem

In understanding boundaries and the consequent collaborative patterns that servitization-based PEs undertake, we ask, *RQ3: How do manufacturers define the structural boundaries of their platforms for supporting the development & delivery of advanced services?* Our case firms display varied collaborative patterns in developing service offerings (Table 7).

Some case firms (Cases A, B, G) operate across all three boundaries. Case A opts for a combination of internal development and external collaboration with heavy supply chain involvement in provision of IoT and planning and purchasing. Their internal expertise supports development and testing of hardware, and they collaborate with external partners to co-develop software for their smart devices. The Innovation Delivery Manager for Case A explains:

We are used to developing products rather than services. Developing software is new. They [external partners] are top experts, and can turn around things quickly.

For Case G, most services-related development, if a source of strategic competitive differentiation, is undertaken internally. They rely on dealers for customer engagement (supply chain) and collaborate with external technology giants for custom-built software. Case B use third parties for developing some hardware/software components (external). They prefer hiring personnel with capabilities (that they lack internally) on a permanent basis (internal). However, they do rely on distributors in catering for international consumers (supply chain).

We also found case firms (Cases C, E, F) that operate only within internal and supply chain boundaries. Case C identify themselves as a vertically integrated organisation, with a high degree of internal collaboration; remote monitoring, connected maintenance, and telematics are developed internally, but they are dependent on dealers for distribution purposes. Case F focuses on buying unavailable expertise (customer relationship management, business solutions), or acquiring it over co-developing with external collaborators. Case E operates across internal boundaries with limited supply chain involvement with some contractors, but most of their remote monitoring-related development occurs internally.

Case D is the only firm operating solely within internal boundaries. They have developed their own internal system, a proprietary product that offers certain benefits of control and IP. However, they acknowledge potential collaboration with external experts for security and with suppliers for developing specific software and controls for their large turnkey projects.

Table 7: Structural boundaries for case firms

Case Firms	Internal Structure	Supply Chain Structure	External Structure
Case A	✓	✓	✓

Case B	✓	✓	✓
Case C	✓	✓	✗
Case D	✓	✗	✗
Case E	✓	✓	✗
Case F	✓	✓	✗
Case G	✓	✓	✓

In summary, we find that organisational policies and the inherent structure of a manufacturing organisation, to a large extent, influence the choice of structural boundaries for servitization. Vertically integrated case firms tend to operate within a restricted structure and rely on internal resources and expertise, while others are more open to collaboration with external partners.

4.4. Task aspects of a servitization-based platform ecosystem

To better comprehend the governance mechanisms of a servitization-based PE, we asked, *RQ4: How do manufacturers govern and orchestrate their PEs in supporting the development and delivery of advanced services?* This could occur in the form of *lead organisation-governed networks* and *participant-governed networks*; in lead organisation-governed networks (centralised with asymmetrical power), a single participating member acting as a lead organisation (Provan and Kenis, 2008) coordinates all major network-level activities and decisions. With participant-governed networks (decentralised with shared power), governance is achieved either formally or informally via actors (Provan and Kenis, 2008), who have a stake in the success of a PE. We gather evidence for governance and network orchestration across all seven case firms in Table 8.

With multiple actors in a servitization-based ecosystem, our case firms reveal governance poses control issues. Case D suggests IP protection and information sharing become challenging when collaborating with larger firms, which if operating in the same sector, overpower manufacturers despite contracts and non-disclosure agreements. However, some cases also suggest that if customers choose which third parties the manufacturer should collaborate with, there is even balance of power, because it is instantaneously recognised that both parties have to work together to meet customer needs. For manufacturers still in their early stages of service development, control becomes a problem, because they lack the required knowledge (Cases A, B). As a result, external parties take more control, despite manufacturers being platform owners. The Customer Insight Manager for Case A explains:

If you say I want this and someone else says, as a bad example that it will take 5 days, unless you know how much work goes into that requirement, it is hard to dispute that.

For network orchestration, most case firms adopt a lead organisation-governed network. For instance, a top-down structure is evident in Case E, where top management sets the services culture and manages all service-led operations. Case C also follows a top-down structure, where they have full ownership of manufacturing and distribution units, with the exception of some dealers that are not company owned. Few case firms are participant-governed networks, mostly having multiple facilities/plants that use different execution and reporting systems. For

instance, key leadership for Case A makes services-related decisions from a group perspective across every country. They have separate manufacturing and technology competency centres. While their connected devices are developed in competency centres in Holland at group level, customers and data are the responsibility of the customer support centre in the UK.

Table 8: Task aspects

Case Firms	Governed Network	Task-related Quotes from Interviewees
Case A	Participant-governed network	“We go from daily operations into senior leadership, and then we go into the group stream where we have our key leadership, from an entire group perspective, across every country.”
Case B	Participant-governed network	“From a CEO to all the way down. How do we take your service developed locally in China/Germany, and how do we productise that in an agile way that does not take three or four years to do.”
Case C	Lead-organisation governed network	“We are a complex structure and cannot pinpoint the governance structures, but apart from some dealers that are not company owned, we are a vertically integrated organisation.”
Case D	Lead-organisation governed network	“From a governance perspective, it’s fairly tight. Maybe too tight, because it makes things quite slow moving, sometimes.”
Case E	Lead-organisation governed network	“Our CEO gives directions, and we are the instrumentation and control division, so we are the only technology enabler for service outputs. It is a bit too much of silo working.
Case F	Lead-organisation governed network	“Company X was acquired, because they do servitization really well. Company Y was also acquired for their expertise, so there is more acquisition/buying when it comes to servitization.”
Case G	Participant-governed network	“Project manager ensures service-related projects are identified, scope is defined, and progress is fine. They meet monthly, set timelines, and project management supervises the execution.”

In summary, network orchestration becomes extremely challenging with servitization, as manufacturers’ operations can become distributed, particularly in cases where processes are outsourced, or where certain partners choose to operate autonomously. In lead organisation-governed networks, network governance reflects asymmetrical power, and in participant-governed networks, there is increased actor interaction and shared decision making.

4.5. Emergent themes: engagement, product-biased behaviour and service strategy

In undertaking cross-case analysis, we were able to derive some data-driven codes, revealing three emerging themes - *engagement*, *product-biased behaviour* and *service strategy* (Table 9).

Firstly, we recognise that transformation towards services is a slow and diplomatic process that compels our case firms to tackle issues of *engagement*. Most firms perceive it to be *change management*, involving creation of new roles and opportunities, and a redevelopment to pull away from traditional methods. They introduce changes in their business infrastructure by upgrading old designs or expanding existing functions to aid service provision. While most cases vouch for such transformation to be a positive learning experience, they also confirm that it is an extremely turbulent phase. For instance, significant changes occurred at the managerial levels for Cases G and F at the expense of some key personnel losing their jobs. Failure on the part of management to support such transitions prevents personnel from gauging positive outcomes from such changes, risking lack of *internal commitment*.

Secondly, *product-biased behaviour* becomes evident in the *mindset* and *company culture* of our case firms that traditionally belong to a product-focused background. Servitization is an enormous cultural change for manufacturing firms. For instance, a common challenge across our case firms is the struggle faced by their frontline sales teams, who are not familiar with proactively selling services, making internal buy-in from such teams an issue. In addition, some cases (Cases E, C) reveal that they are not necessarily generating noteworthy revenues from service offerings. Instead, they are using services as a tool in the early stages of their servitization journey to change their organisational mindset in building themselves as service organisations with the hope of gradually generating revenue from advanced services.

Thirdly, our case firms divulge information on their *services strategies* in tackling a multitude of servitization challenges. Some case firms are juggling with decisions of how much to develop internally and how much to outsource. Our findings suggest it is imperative for manufacturers to evaluate their strengths in comparison to the other actors in their PE, i.e. *strategic differentiation*, which they can then use to set precedence of control in managing service offerings. This will help them gain more control over finances, design, and scale of services. Another challenge comes with some case firms being indecisive about how far they want to go with services; most case firms reveal that they do not envision advanced services to be their ultimate goal (Case C), and instead align their transition into services with their customers' needs and experiences. Therefore, there appears to be a trend of *controlled growth* or transition of our product-focused firms into services in line with their customers' service expectations. In a parallel vein, *customer buy-in* can pose problems for some firms (Case D), where they can become so invested in developing a relationship with their customers that they provide service offerings as a part of goodwill and relationship building, resulting in failure on their part to capitalise on such service offerings (meaning, having received these services free of charge, customers may not be willing to pay for advanced services as a new service package).

Table 9: Data-driven codes

Quotes	Data-driven Codes	Emergent Themes
“There has to be a golden thread from sales, so understanding why customers make the purchase decision, ensuring the sale is fit for purpose and then having that translate from sales into services.” (Case F)	Internal commitment	Engagement
“So, maybe we’re at 10% of the change we need, because the big mass and some of the management are not moving, and if they’re not moving, their personnel is not moving.” (Case E)	Change management	
“It’s a big shift for a lot of people and that creates churn and attrition...positive changes in terms of cross-silo working, collaboration; but still to get anything done was a lot of effort” (Case F)	Mindset	Product-biased behaviour
“That’s been a long-term process, to change the makeup of the business, so that the business actually thinks we are in a position to do this” (Case D)	Company culture	
“We don’t always do everything ourselves, only things crucial to the company” (Case G)	Strategic differentiation	Service strategy
“If customer need can be fulfilled by an advanced service then we are certainly open to that direction; but, if they are being fulfilled by our intermediate service, then that is probably where we’ll stay” (Case C)	Controlled growth	
“So, while we’ve developed stickiness with the customer, we’ve not necessarily sold bundled service contracts...we’ve done it as part of goodwill and relationship building with the customer” (Case D)	Customer buy-in	

5. Discussions, implications, and future research

5.1. Theoretical implications

We adopt a PE lens to understand manufacturers' development and delivery of advanced services. By bringing together existing research on PEs and servitization with empirical evidence gathered from seven manufacturers, this study makes five main contributions.

First, this study contributes to literature on service modularity (Brax et al., 2017, Rajala et al., 2019) by showing that the range of advanced services a manufacturer can offer is determined by their decision to modularise/standardise the service components. We supplement the work of Salonen et al. (2018) by investigating applicability of modular solutions, and establish that most manufacturers keep modularisation to a bare minimum. Manufacturers consider services as an ancillary revenue source and despite market demand for diverse services, their organisational policies restrict incorporation of extensive modularity, limiting their services portfolio. In addition, we demonstrate that standardisation becomes vital when manufacturers develop and experiment with advanced services. Integrating standard components (hardware to support technological enhancements like sensors etc.) with the existing products allows manufacturers to update, i.e. retrofit their install base without the need to install new service-compatible products at customer sites (time and cost savings). Here, we qualify studies on product-service innovation in industrial settings (Cenamor et al., 2017, West et al., 2018) by validating that absence of standards can risk connectivity and integration capabilities required for supporting servitization.

Second, we qualify research on platform types (Gawer, 2009) by demonstrating that servitizing firms do not operate in a single fixed structural boundary, and instead alternate between different boundary types (from internal to a supply chain, or from a supply chain to external, or even from internal to an external structural boundary) to support advanced services. Our study supplements the work of Gawer (2014) by applying the classification of technological platforms in a servitization context to show that manufacturers, depending on where they are in their servitization journey (i.e. how close they are to delivering advanced services), shift boundaries throughout their services lifecycle to concurrently operate across multiple boundaries. Our findings add to the research on territorial servitization (Kamp and Alcalde, 2014, Lafuente et al., 2017, Gomes et al., 2019) by shedding insights on the interaction and reliance of the manufacturing sector on the service sector via an external structural boundary approach in a bid to implement the service element in their business models. We respond to research calls on platform evolution (Gawer, 2009, Thomas et al., 2014, Tiwana, 2015a) to understand the shifts in structural boundaries that reveals a prominent contribution of our study – we find that servitizing firms are more likely to operate across a structural combination of *internal and supply chain boundaries*, which potentially represents the best structural configuration for supporting manufacturers' development and delivery of advanced services.

Third, this study contributes to existing calls for further research on platform actors roles (Cenamor et al., 2017). We qualify Helfat and Raubitschek (2018) by demonstrating that only a few executives within servitizing firms exhibit integrative capabilities and act as pivot points

i.e. platform owners of servitization directives to ensure resource integration, buy-in and reciprocity between all complementors (internal and external). The biggest challenge for platform owners is gaining internal engagement, as their employees (a) do not see the value from services, and (b) lack the skills to support service development and delivery. The issue is that the employees are skilled in optimising product systems, not in changing them into product-service systems. Building on existing research on complementors (Cusumano and Gawer, 2002, Cenamor et al., 2017, Sussan and Acs, 2017), we demonstrate that manufacturers first explore their supply chains to locate missing competencies. If unavailable, they venture externally to engage with the likes of IoT and digital experts, who are innately not a part of the manufacturers' traditional supply chain. Furthermore, this study extends insights from Immonen et al. (2016) and Tao et al. (2017) by demonstrating that customers are highly valued actors of a servitization-based PE, and their involvement goes beyond product ownership to their commitment post service-delivery; without customer cooperation and feedback, access to equipment data is at stake, jeopardising the success of servitization initiatives in entirety.

Fourth, this study answers calls for research on multi-actor perspectives in investigating the orchestration strategies (Sjödín et al., 2020a). Network perspectives focusing on co-creation amongst multiple actors can have significant implications for efficient management of ecosystem actors. This study contributes to the literature on PE governance and orchestration (Wareham et al., 2014, Ardolino et al., 2018) by demonstrating that servitizing firms are likely to follow either a participant-governed structure or a lead-organisation governed structure for managing actors, who support tasks related to advanced services. Managing actor networks is particularly complex for servitizing manufacturers as they have to coordinate these mechanisms for both their product and service divisions, and the control mechanisms depend on the structural boundaries within which the platform is operating. We supplement literature on ecosystem governance (Den Hartigh et al., 2016, Wei et al., 2019) and network orchestration (Eloranta and Turunen, 2016, Breidbach et al., 2018) by adding another contribution to suggest - servitizing firms operating across a combination of internal and supply chain boundaries are likely to follow a more centralised lead-organisation governance structure, while those choosing to operate across an external boundary are leaning towards the more collaborative, participant-governed structures.

Fifth, this study identifies and explains the emergent themes of engagement, product-biased behaviour and service strategy commonly observed within servitizing firms. Here, we contribute to calls for research on engagement challenges associated with servitization and knowledge-intensive services (Sjödín et al., 2020b). We qualify Sjödín et al. (2020a) by offering insights that suggest the turbulent transformation towards services can be better managed by effective engagement aimed at aligning the value perceptions of all participating stakeholders and clearly defining the value creation and capture mechanisms. Furthermore, our findings complement the work of Kohtamäki et al. (2020) and Tronvoll et al. (2020) revealing the struggles of product-biased mindset; this triggers the subsequent need for accommodating a service-oriented customer mindset across internal workforce to progress the servitization agenda within manufacturing firms. Our study also responds to calls for research on ecosystem perspectives involving multiple actors (Kamalaldin et al., 2020) by divulging insights on the direct impact that relational engagement with customers has on a firm's service strategies; these

directly influence manufacturers' decisions related to the expansion of service competencies, and the extent of service provision.

5.2. Managerial implications

This study has several managerial implications for managers (and executives) directly engaged with advanced services. Firstly, we demonstrate that incorporating modularity in developing services requires extensive engagement between the manufacturers, customers, and other ecosystem actors to assess flexibility requirements. Furthermore, our findings suggest that the ability to standardise depends on the complexity of manufacturers' products and resulting services. Standardisation can become harder for manufacturers with intricate products, complex customer settings, or customer segments with wide-ranging service needs. Thus, this study recommends that managers conduct a thorough initial evaluation of the market/customer needs against their internal capabilities and servitization goals to create an adept scenario of value creation for the customers and value capture for the manufacturers. Flexibility becomes vital in serving customers situated in different geographical proximities. Here, managers should prepare for changes in culture and customer relationships across countries, triggering changes in their design processes and dynamics of internal agencies, etc. Moreover, flexibility enabled by modularity further comes into play when manufacturers change their service strategy (emergent theme) to scale up their service business, which is a big challenge in itself. We advise managers to account for the management and planning complexities that often multiply with large scale service deliveries and alter their service strategy to cushion risks to business, as these actions will have a spiralling impact on customer satisfaction.

Secondly, we see product-dominant roles being carefully restructured to fit the new service-focus across all case firms. Service transformation is complex, and our findings show that employees, particularly in the inception phase, exhibit product-biased behaviour (emergent theme). This is because employees are faced with an entirely new notion of services, opposed to their prior product-dominant experiences. We thus recommend managers to prepare for initial setbacks, as very few personnel understand servitization until brought to a pivot point by someone with a mandate taking reins to change company culture and mindset that reconfigures focus on services. Based on criticality of some of the new service roles, we also recommend that managers work towards coherent integration of product management and service teams, as successful service delivery appears to be deeply rooted in the effective communication of these teams. Additionally, frequent advisory panels with partners/customers to discuss hurdles/developments are advised, and executive committees should follow-up any new emerging requirements with the relevant business units. We also find that the front-end sales teams now face the arduous task of proactively selling services. To make the sales team adept, we recommend managers build service contracts in a format that they become a product, involving an element of business as an aftersales offer and service capability.

Thirdly, in defining structural boundaries, our case firms take different approaches for collaborating with internal, supply chain, and external partners. Based on evidences emerging from our findings, we recommend managers to explicitly find partners with capabilities that fit their firm's servitization vision, and not partner up with firms just because they have a strong

service reputation. Rigorous two-way communication to ensure partners' understanding of the manufacturer's business and expected outcomes should follow this; this will also allow the partners to feedback opportunities and ideas for further developing manufacturers' service offerings (new features, enhancements, etc.).

Finally, we find that if the governance structures are too tight in managing actor networks, they inhibit development within the organisation. Co-development weakens and fails, if value for each party from such collaboration (be it financial, technical or other) is not clearly established. Therefore, we recommend that managers emphasise on developing a clear understanding of the end goal by developing a service framework that not only specifies clearly-defined processes, but also shows which stakeholders owns these processes to prevent fragmentation, and to facilitate the necessary co-development between multiple actors in a servitization-based PE.

5.3. Limitations and future work

Having put together the theoretical and practical implications, we identify some limitations of this study. Our findings are based on the data gathered exclusively from multiple multinational manufacturing firms, and are, thereby, more concentrated in the business context. Digitally-enabled interactions (remote monitoring in servitization) can be significantly different in the user contexts (Cenamor et al., 2017), and as the end users are key actors of a PE, future research can expand this investigation to include data from the consumer perspective in analysing PEs in servitization. The same applies to complementors, and future research can broaden the overall investigation to account for data from complementors present in manufacturers' supply chains and other external partner organisations. Additionally, we see the opportunity to explore the local manufacturer-complementor networks to unravel localised economies of scale across different structural boundaries to understand the role of PEs in furthering territorial servitization. Next, in shortlisting the case firms, we focused on manufacturers showing evidence of transactions with a range of different stakeholders, in line with the scope of this study. However, firms interacting with fewer stakeholders could reveal different implications for the governance and orchestration strategies in a PE setting. Therefore, another prospective avenue for future research would be to study PEs in the context of firms pursuing servitization activities with fewer stakeholders. Another avenue for future research is to study the interdependencies of the four socio-technical PE components in the context of advanced services. This could potentially lead to patterns of relationship between the components, which could reveal insightful implications for manufacturers.

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REFERENCES

- AABOEN, L., DUBOIS, A. & LIND, F. 2012. Capturing processes in longitudinal multiple case studies. *Industrial Marketing Management*, 41, 235-246.
- ACQUIER, A., DAUDIGEOS, T. & PINKSE, J. 2017. Promises and paradoxes of the sharing economy: An organizing framework. *Technological Forecasting and Social Change*, 125, 1-10.

- ADNER, R. 2016. Ecosystem as Structure: An Actionable Construct for Strategy. *Journal of Management*, 43, 39-58.
- AMIT, R. & ZOTT, C. 2001. Value creation in e-business. *Strategic management journal*, 22, 493-520.
- ARDOLINO, M., SACCANI, N. & ELORANTA, V. 2018. Complexity Management in Service Businesses through Platform Adoption. *IFAC-PapersOnLine*, 51, 1329-1334.
- BAINES, T. & LIGHTFOOT, H. 2013. Made to serve: how manufacturers can compete through servitization and product service systems. Wiley Press.
- BAINES, T., LIGHTFOOT, H., BENEDETTINI, O. & KAY, J. M. 2009. The servitization of manufacturing: A review of literature and reflection on future challenges. *Journal of Manufacturing Technology Management*, 20, 547-567.
- BAINES, T., LIGHTFOOT, H., SMART, P. & FLETCHER, S. 2013. Servitization of manufacture: Exploring the deployment and skills of people critical to the delivery of advanced services. *Journal of Manufacturing Technology Management*, 24, 637-646.
- BAINES, T. & W. LIGHTFOOT, H. 2013. Servitization of the manufacturing firm: Exploring the operations practices and technologies that deliver advanced services. *International Journal of Operations & Production Management*, 34, 2-35.
- BAINES, T., ZIAEE BIGDELI, A., SOUSA, R. & SCHROEDER, A. 2019. Framing the servitization transformation process: A model to understand and facilitate the servitization journey. *International Journal of Production Economics*.
- BASK, A., LIPPONEN, M., RAJAHONKA, M. & TINNILÄ, M. 2010. The concept of modularity: diffusion from manufacturing to service production. *Journal of Manufacturing Technology Management*, 21, 355-375.
- BAXTER, G. & SOMMERVILLE, I. 2011. Socio-technical systems: From design methods to systems engineering. *Interacting with computers*, 23, 4-17.
- BIRKEL, H. S., VEILE, J. W., MÜLLER, J. M., HARTMANN, E. & VOIGT, K.-I. 2019. Development of a risk framework for Industry 4.0 in the context of sustainability for established manufacturers. *Sustainability*, 11, 384.
- BOYATZIS, R. E. 1998. *Transforming qualitative information: Thematic analysis and code development*, sage.
- BRAUN, V. & CLARKE, V. 2006. Using thematic analysis in psychology. *Qualitative research in psychology*, 3, 77-101.
- BRAUN, V., CLARKE, V., HAYFIELD, N. & TERRY, G. 2018. Thematic analysis. *Handbook of research methods in health social sciences*, 1-18.
- BRAX, S. A., BASK, A., HSUAN, J. & VOSS, C. 2017. Service modularity and architecture—an overview and research agenda. *International Journal of Operations & Production Management*, 37, 686-702.
- BRAX, S. A. & JONSSON, K. 2009. Developing integrated solution offerings for remote diagnostics: a comparative case study of two manufacturers. *International Journal of Operations & Production Management*, 29, 539-560.
- BREIDBACH, C., CHOI, S., ELLWAY, B., KEATING, B. W., KORMUSHEVA, K., KOWALKOWSKI, C., LIM, C. & MAGLIO, P. 2018. Operating without operations: how is technology changing the role of the firm? *Journal of Service Management*, 29, 809-833.
- BROEKHUIS, M., VAN OFFENBEEK, M. & EISENS-VAN DER LAAN, M. 2017. What professionals consider when designing a modular service architecture? *International Journal of Operations & Production Management*.
- BROWN, A., FISHENDEN, J., THOMPSON, M. & VENTERS, W. 2017. Appraising the impact and role of platform models and Government as a Platform (GaaP) in UK Government public service reform: Towards a Platform Assessment Framework (PAF). *Government Information Quarterly*, 34, 167-182.
- BRYMAN, A. 2016. *Social research methods*, Oxford university press.

- BUSTINZA, O. F., BIGDELI, A. Z., BAINES, T. & ELLIOT, C. 2015. Servitization and competitive advantage: the importance of organizational structure and value chain position. *Research-Technology Management*, 58, 53-60.
- CENAMOR, J., SJÖDIN, D. R. & PARIDA, V. 2017. Adopting a platform approach in servitization: Leveraging the value of digitalization. *International Journal of Production Economics*, 192, 54-65.
- CENNAMO, C. & SANTALO, J. 2013. Platform competition: Strategic trade-offs in platform markets. *Strategic Management Journal*, 34, 1331-1350.
- CHISHOLM, A. M. & NIELSEN, K. 2009. Social capital and the resource-based view of the firm. *International Studies of Management & Organization*, 39, 7-32.
- CUSUMANO, M. A. & GAWER, A. 2002. The elements of platform leadership. *MIT Sloan Management Review*, 43, 51-58.
- DE REUVER, M., SØRENSEN, C. & BASOLE, R. C. 2018. The digital platform: A research agenda. *Journal of Information Technology*, 33, 124-135.
- DECUIR-GUNBY, J. T., MARSHALL, P. L. & MCCULLOCH, A. W. 2011. Developing and using a codebook for the analysis of interview data: An example from a professional development research project. *Field methods*, 23, 136-155.
- DEN HARTIGH, E., ORTT, J. R., VAN DE KAA, G. & STOLWIJK, C. C. M. 2016. Platform control during battles for market dominance: The case of Apple versus IBM in the early personal computer industry. *Technovation*, 48-49, 4-12.
- DREMEL, C., HERTERICH, M. M., WULF, J. & VOM BROCKE, J. 2018. Actualizing Big Data Analytics Affordances: A Revelatory Case Study. *Information & Management*.
- DURUGBO, C. 2014. Strategic framework for industrial product-service co-design: findings from the microsystems industry. *International Journal of Production Research*, 52, 2881-2900.
- EISENMANN, T., PARKER, G. & VAN ALSTYNE, M. 2011. Platform envelopment. *Strategic Management Journal*, 32, 1270-1285.
- ELORANTA, V., ORKONEVA, L., HAKANEN, E. & TURUNEN, T. 2016. Using platforms to pursue strategic opportunities in service-driven manufacturing. *Service Science*, 8, 344-357.
- ELORANTA, V. & TURUNEN, T. 2016. Platforms in service-driven manufacturing: Leveraging complexity by connecting, sharing, and integrating. *Industrial Marketing Management*, 55, 178-186.
- FACIN, A. L. F., DE VASCONCELOS GOMES, L. A., DE MESQUITA SPINOLA, M. & SALERNO, M. S. 2016. The Evolution of the Platform Concept: A Systematic Review. *IEEE Transactions on Engineering Management*, 63, 475-488.
- FRANSEN, T. 2017. Evolution of modularity literature: a 25-year bibliometric analysis. *International Journal of Operations & Production Management*, 37, 703-747.
- GAWER, A. 2009. Platform dynamics and strategies: from products to services. *Platforms, markets and innovation*, 45, 57.
- GAWER, A. 2014. Bridging differing perspectives on technological platforms: Toward an integrative framework. *Research policy*, 43, 1239-1249.
- GAWER, A. & CUSUMANO, M. A. 2008. How companies become platform leaders. *MIT Sloan Management Review*, 49, 28-35.
- GAWER, A. & CUSUMANO, M. A. 2014. Industry platforms and ecosystem innovation. *Journal of Product Innovation Management*, 31, 417-433.
- GEBAUER, H., PAIOLA, M. & SACCANI, N. 2013. Characterizing service networks for moving from products to solutions. *Industrial Marketing Management*, 42, 31-46.
- GOGUEN, J. 1999. Tossing algebraic flowers down the great divide. Springer, New York.
- GOLDBACH, T., BENLIAN, A. & BUXMANN, P. 2018. Differential effects of formal and self-control in mobile platform ecosystems: Multi-method findings on third-party developers' continuance intentions and application quality. *Information and Management*, 55, 271-284.

- GOMES, E., BUSTINZA, O. F., TARBA, S., KHAN, Z. & AHAMMAD, M. 2019. Antecedents and implications of territorial servitization. *Regional Studies*, 53, 410-423.
- GROVER, P., KAR, A. K. & DAVIES, G. 2018. "Technology enabled Health"—Insights from twitter analytics with a socio-technical perspective. *International Journal of Information Management*, 43, 85-97.
- HAN, X., MARTINEZ, V. & NEELY, A. 2018. Service in the Platform Context: A Review of the State of the Art and Future Research. *Collaborative Value Co-creation in the Platform Economy*. Springer.
- HELFAT, C. E. & RAUBITSCHKE, R. S. 2018. Dynamic and integrative capabilities for profiting from innovation in digital platform-based ecosystems. *Research Policy*, 47, 1391-1399.
- HUGHES, H. P., CLEGG, C. W., BOLTON, L. E. & MACHON, L. C. 2017. Systems scenarios: A tool for facilitating the socio-technical design of work systems. *Ergonomics*, 60, 1319-1335.
- HUOTARI, P., JÄRVI, K., KORTELAJINEN, S. & HUHTAMÄKI, J. 2017. Winner does not take all: Selective attention and local bias in platform-based markets. *Technological Forecasting and Social Change*, 114, 313-326.
- IMMONEN, A., OVASKA, E., KALAOJA, J. & PAKKALA, D. 2016. A service requirements engineering method for a digital service ecosystem. *Service Oriented Computing and Applications*, 10, 151-172.
- JOSEPHSON, B. W., JOHNSON, J. L., MARIADOSS, B. J. & CULLEN, J. 2016. Service transition strategies in manufacturing: Implications for firm risk. *Journal of Service Research*, 19, 142-157.
- KAMALALDIN, A., LINDE, L., SJÖDIN, D. & PARIDA, V. 2020. Transforming provider-customer relationships in digital servitization: A relational view on digitalization. *Industrial Marketing Management*.
- KAMP, B. & ALCALDE, H. 2014. Servitization in the basque economy. *Strategic Change*, 23, 359-374.
- KARHU, K., GUSTAFSSON, R. & LYTTINEN, K. 2018. Exploiting and defending open digital platforms with boundary resources: Android's five platform forks. *Information Systems Research*, 29, 479-497.
- KEMPER, J. A. & BALLANTINE, P. W. 2017. Socio-technical transitions and institutional change: Addressing obesity through macro-social marketing. *Journal of Macromarketing*, 37, 381-392.
- KING, N., CASSELL, C. & SYMON, G. 2004. Using templates in the thematic analysis of text. *Essential guide to qualitative methods in organizational research*, 2, 256-70.
- KOH, T. K. & FICHMAN, M. 2014. Multi-Homing Users' Preferences for Two-Sided Exchange Networks. *MIS Quarterly: Management Information Systems*, 38, 977-996.
- KOHTAMÄKI, M., EINOLA, S. & RABETINO, R. 2020. Exploring servitization through the paradox lens: Coping practices in servitization. *International Journal of Production Economics*, 107619.
- KRISHNAN, V. & GUPTA, S. 2001. Appropriateness and impact of platform-based product development. *Management Science*, 47, 52-68.
- KUULA, S., HAAPASALO, H. & TOLONEN, A. 2018. Cost-efficient co-creation of knowledge intensive business services. *Service Business*, 12, 779-808.
- LAFUENTE, E., VAILLANT, Y. & VENDRELL-HERRERO, F. 2017. Territorial servitization: Exploring the virtuous circle connecting knowledge-intensive services and new manufacturing businesses. *International Journal of Production Economics*, 192, 19-28.
- LEE, J., KIM, J., KIM, H. & HWANG, J. 2020. Sustainability of ride-hailing services in China's mobility market: A simulation model of socio-technical system transition. *Telematics and Informatics*, 101435.
- LINDHULT, E., CHIRUMALLA, K., OGHAZI, P. & PARIDA, V. 2018. Value logics for service innovation: practice-driven implications for service-dominant logic. *Service Business*, 1-25.
- LÖFBERG, N. & ÅKESSON, M. 2018. Creating a service platform—how to co-create value in a remote service context. *Journal of Business & Industrial Marketing*, 33, 768-780.

- LUSCH, R. F. & NAMBISAN, S. 2015. Service innovation: A service-dominant logic perspective. *MIS Quarterly: Management Information Systems*, 39, 155-175.
- LYYTINEN, K. & NEWMAN, M. 2008. Explaining information systems change: a punctuated socio-technical change model. *European Journal of Information Systems*, 17, 589-613.
- MARTINEZ, V., BASTL, M., KINGSTON, J. & EVANS, S. 2010. Challenges in transforming manufacturing organisations into product-service providers. *Journal of Manufacturing Technology Management*, 21, 449-469.
- MATTHYSSENS, P. & VANDENBEMPT, K. 2010. Service addition as business market strategy: identification of transition trajectories. *Journal of service management*, 21, 693-714.
- MEYER, M. H. & LEHNERD, A. P. 1997. *The power of product platforms*, Simon and Schuster.
- MILES, M. B. & HUBERMAN, A. M. 1994. *Qualitative data analysis: An expanded sourcebook*, sage.
- MILES, M. B., HUBERMAN, A. M., HUBERMAN, M. A. & HUBERMAN, M. 1994. *Qualitative data analysis: An expanded sourcebook*, sage.
- MUFFATTO, M. & ROVEDA, M. 2002. Product architecture and platforms: a conceptual framework. *International Journal of Technology Management*, 24, 1-16.
- OSTROM, A. L., PARASURAMAN, A., BOWEN, D. E., PATRÍCIO, L. & VOSS, C. A. 2015. Service research priorities in a rapidly changing context. *Journal of Service Research*, 18, 127-159.
- PAIOLA, M., SACCANI, N., PERONA, M. & GEBAUER, H. 2013. Moving from products to solutions: Strategic approaches for developing capabilities. *European Management Journal*, 31, 390-409.
- PANEBIANCO, S. & PAHL-WOSTL, C. 2006. Modelling socio-technical transformations in wastewater treatment—a methodological proposal. *Technovation*, 26, 1090-1100.
- PEKKARINEN, S. & ULKUNIEMI, P. 2008. Modularity in developing business services by platform approach. *The International Journal of Logistics Management*, 19, 84-103.
- PERKS, H., KOWALKOWSKI, C., WITTELL, L. & GUSTAFSSON, A. 2017. Network orchestration for value platform development. *Industrial Marketing Management*, 67, 106-121.
- PROVAN, K. G. & KENIS, P. 2008. Modes of network governance: Structure, management, and effectiveness. *Journal of public administration research and theory*, 18, 229-252.
- RAJALA, R., BRAX, S. A., VIRTANEN, A. & SALONEN, A. 2019. The next phase in servitization: transforming integrated solutions into modular solutions. *International Journal of Operations & Production Management*.
- RIETVELD, J. & EGGERS, J. P. 2018. Demand heterogeneity in platform markets: Implications for complementors. *Organization Science*, 29, 304-322.
- ROLLAND, K. H., MATHIASSEN, L. & RAI, A. 2018. Managing digital platforms in user organizations: The interactions between digital options and digital debt. *Information Systems Research*, 29, 419-443.
- ROUSE, M. J. & DAELLENBACH, U. S. 2002. More thinking on research methods for the resource-based perspective. *Strategic management journal*, 23, 963-967.
- SALDAÑA, J. 2015. *The coding manual for qualitative researchers*, Sage.
- SALONEN, A. & JAAKKOLA, E. 2015. Firm boundary decisions in solution business: Examining internal vs. external resource integration. *Industrial Marketing Management*, 51, 171-183.
- SALONEN, A., RAJALA, R. & VIRTANEN, A. 2018. Leveraging the benefits of modularity in the provision of integrated solutions: A strategic learning perspective. *Industrial Marketing Management*, 68, 13-24.
- SAVASTANO, M., AMENDOLA, C., BELLINI, F. & D'ASCENZO, F. 2019. Contextual Impacts on Industrial Processes Brought by the Digital Transformation of Manufacturing: A Systematic Review. *Sustainability*, 11, 891.
- SCHNEIDER, P. 2018. Managerial challenges of Industry 4.0: an empirically backed research agenda for a nascent field. *Review of Managerial Science*, 12, 803-848.

- SJÖDIN, D., PARIDA, V., JOVANOVIĆ, M. & VISNJIĆ, I. 2020a. Value creation and value capture alignment in business model innovation: A process view on outcome-based business models. *Journal of Product Innovation Management*, 37, 158-183.
- SJÖDIN, D., PARIDA, V., KOHTAMÄKI, M. & WINCENT, J. 2020b. An agile co-creation process for digital servitization: A micro-service innovation approach. *Journal of Business Research*.
- STORY, V. M., RADDATS, C., BURTON, J., ZOLKIEWSKI, J. & BAINES, T. 2017. Capabilities for advanced services: A multi-actor perspective. *Industrial Marketing Management*, 60, 54-68.
- SUSSAN, F. & ACS, Z. J. 2017. The digital entrepreneurial ecosystem. *Small Business Economics*, 49, 55-73.
- TANRIVERDI, H. & CHI-HYON, L. 2008. Within-industry diversification and firm performance in the presence of network externalities: Evidence from the software industry. *Academy of Management Journal*, 51, 381-397.
- TAO, F., CHENG, Y., ZHANG, L. & NEE, A. Y. 2017. Advanced manufacturing systems: socialization characteristics and trends. *Journal of Intelligent Manufacturing*, 28, 1079-1094.
- THOMAS, L. D., AUTIO, E. & GANN, D. M. 2014. Architectural leverage: putting platforms in context. *Academy of management perspectives*, 28, 198-219.
- TIWANA, A. 2015a. Evolutionary competition in platform ecosystems. *Information Systems Research*, 26, 266-281.
- TIWANA, A. 2015b. Platform desertion by app developers. *Journal of Management Information Systems*, 32, 40-77.
- TIWANA, A., KONSZYNSKI, B. & BUSH, A. A. 2010. Platform evolution: Coevolution of platform architecture, governance, and environmental dynamics. *Information Systems Research*, 21, 675-687.
- TRONVOLL, B., SKLYAR, A., SÖRHAMMAR, D. & KOWALKOWSKI, C. 2020. Transformational shifts through digital servitization. *Industrial Marketing Management*.
- TURUNEN, T., ELORANTA, V. & HAKANEN, E. 2018. Contemporary perspectives on the strategic role of information in internet of things-driven industrial services. *Journal of Business & Industrial Marketing*, 33, 837-845.
- VANDERMERWE, S. & RADA, J. 1988. Servitization of business: adding value by adding services. *European Management Journal*, 6, 314-324.
- VARGO, S. L., WIELAND, H. & AKAKA, M. A. 2015. Innovation through institutionalization: A service ecosystems perspective. *Industrial Marketing Management*, 44, 63-72.
- VISNJIĆ, I., JOVANOVIĆ, M., NEELY, A. & ENGWALL, M. 2017. What brings the value to outcome-based contract providers? Value drivers in outcome business models. *International Journal of Production Economics*, 192, 169-181.
- WALRAVE, B., TALMAR, M., PODOYNYTSYNA, K. S., ROMME, A. G. L. & VERBONG, G. P. 2018. A multi-level perspective on innovation ecosystems for path-breaking innovation. *Technological Forecasting and Social Change*, 136, 103-113.
- WANG, Z., HUO, B., QI, Y. & ZHAO, X. 2016. A resource-based view on enablers of supplier integration: evidence from China. *Industrial Management & Data Systems*.
- WAREHAM, J., FOX, P. B. & GINER, J. L. C. 2014. Technology ecosystem governance. *Organization Science*, 25, 1195-1215.
- WEI, R., GEIGER, S. & VIZE, R. 2019. A platform approach in solution business: How platform openness can be used to control solution networks. *Industrial Marketing Management*.
- WELCH, C., MARSCHAN-PIEKKARI, R., PENTTINEN, H. & TAHVANAINEN, M. 2002. Corporate elites as informants in qualitative international business research. *International Business Review*, 11, 611-628.
- WEST, S., GAIARDELLI, P. & RAPACCINI, M. 2018. Exploring technology-driven service innovation in manufacturing firms through the lens of Service Dominant logic. *IFAC-PapersOnLine*, 51, 1317-1322.

- WONG, W. P., IGNATIUS, J. & SOH, K. L. 2014. What is the leanness level of your organisation in lean transformation implementation? An integrated lean index using ANP approach. *Production Planning & Control*, 25, 273-287.
- XU, D., HUO, B. & SUN, L. 2014. Relationships between intra-organizational resources, supply chain integration and business performance. *Industrial Management & Data Systems*.
- ZHENG, P., LIN, T.-J., CHEN, C.-H. & XU, X. 2018. A systematic design approach for service innovation of smart product-service systems. *Journal of cleaner production*, 201, 657-667.
- ZHU, F. & IANSITI, M. 2012. Entry into platform-based markets. *Strategic Management Journal*, 33, 88-106.
- ZIAEE BIGDELI, A., BUSTINZA, O. F., VENDRELL-HERRERO, F. & BAINES, T. 2018. Network positioning and risk perception in servitization: evidence from the UK road transport industry. *International Journal of Production Research*, 56, 2169-2183.