International Journal of Production Economics 192 (2017) 54–65

Contents lists available at ScienceDirect

Int. J. Production Economics

journal homepage: www.elsevier.com/locate/ijpe

Adopting a platform approach in servitization: Leveraging the value of digitalization

J. Cenamor[a,*], D. Rönnberg Sjödin[a], V. Parida[a,b]

[a] Entrepreneurship and Innovation, Luleå University of Technology, 97187 Luleå, Sweden
[b] Department of Marketing, University of Vaasa, Finland

ARTICLE INFO

Keywords:
Servitization
Platform
Information module
Modularity
Digitalization

ABSTRACT

This study explores how a platform approach facilitates the implementation of advanced service offerings in manufacturing firms. Understanding servitization through a platform approach is important because many manufacturing firms fail to manage the service paradox, that is, the challenge of simultaneously enriching the value proposition by adding services while maintaining cost levels. This study focuses on how adopting a platform approach leverages the value of digital and information technologies (e.g., smart and connected machines) for advanced service offerings. It is argued that a platform approach based on a modular architecture can enable manufacturers to pursue both customization and operational efficiency. Based on multiple case studies, the findings highlight the importance of information modules replacing product and service modules as the core modules for successful servitization. More specifically, the findings illustrate the journeys of manufacturing firms as they leverage value from information modules to facilitate the orchestrating role of back-end units and the builder role of front-end units.

1. Introduction

Manufacturing firms have progressively shifted their focus from exclusively delivering industrial products to providing combined product and service offerings; this is known as servitization (Beuren et al., 2013; Vandermerwe and Rada, 1988). Competitive pressure and the need to differentiate have driven manufacturers to adapt their offerings to meet increasingly more heterogeneous needs, while exploiting scale economies from high-volume production (Baines and Lightfoot, 2013; Hart, 1995; Parida et al., 2015). Specifically, manufacturing firms are increasingly focusing on advanced services, which are defined as "a capability delivered through product performance and often featuring; relationship over extended life-cycle, extended responsibilities and regular revenue payments" (Baines and Lightfoot, 2014, p. 22). Manufacturing firms offering advanced services claim that because they have the capabilities to develop the products, they know how to keep those products operational and to manage performance. Based on this notion, servitized manufacturers are gradually offering advanced services as performance or outcomes-based contracts (e.g., customer support agreements, risk and reward sharing), where customers hire the provider firms to improve internal operations.

The present study focuses on advanced product–service offerings; indeed, they represent an important firm transformation due to increased complexity. This transition requires manufacturing firms to provide unique offerings with competitive cost structures (de Blok et al., 2010). Fulfilling customers' specialized service needs usually results in higher development and delivery costs (Reim et al., 2015) which needs to be offset by increased revenues. However, successfully organizing the development, configuration and delivery of advanced service offerings towards diverse global customers represents a major challenge for servitizing firms. Thus, the service paradox, that is, increased revenues from services leading to reduced profits (Gebauer et al., 2005), often occurs. Indeed, many firms have found that substantial investment in extending the service business leads to increased service offerings and higher costs, but does not generate the expected correspondingly higher returns (Benedettini et al., 2016; Gebauer et al., 2005).

Prior studies have suggested that manufacturing firms can overcome the servitization paradox by leveraging a platform approach (Jha et al., 2016; Marion et al., 2015). A platform approach is the core of a modular architecture that enables the firm to develop a wide portfolio characterized by easily interchanged modules (Meyer and Lehnerd, 1997). In this sense, a platform approach can be viewed as an organizational business perspective for leveraging the value of digital technologies based on modularity and IT-enabled interactions (Thomas et al., 2014). The literature has analyzed how a platform approach

* Corresponding author.
E-mail addresses: javier.cenamor@ltu.se (J. Cenamor), david.ronnberg.sjodin@ltu.se (D. Rönnberg Sjödin), vinit.parida@ltu.se (V. Parida).

http://dx.doi.org/10.1016/j.ijpe.2016.12.033
Received 27 November 2015; Received in revised form 15 November 2016; Accepted 31 December 2016
Available online 02 January 2017

allows organizations to achieve flexibility through modularity and allocating responsibility (Gawer and Cusumano, 2014; Thomas et al., 2014). Product platforms have traditionally enabled manufacturing firms to exploit efficiency and customization through product modularity (Bask et al., 2010). For example, manufacturers in the automotive and electronic industries have developed families of products based on a common internal platform. Similarly, servitized manufacturers have extended product platform modularity logic into expanding their services business (Pekkarinen and Ulkuniemi, 2008). The intangible nature of services and the hybrid architecture of product and service modules, however, increase the complexity of exploiting the benefits of a platform approach and can result in high costs.

Emerging studies on service platforms provide novel insights into the importance of managing digital components that capture the value of information as a key driver of success in the transition toward advanced services (Baines and Lightfoot, 2014; Opresnik and Taisch, 2015). In fact, providing services is increasingly relying on digital technologies and represents a fruitful sub-stream of research, known as digital servitization (Lerch and Gotsch, 2015; Vendrell-Herrero et al., 2016). These studies provide an exploratory view on the increasing importance of information as a source of value through data flows and analysis. Nevertheless, understanding information compared to products and services in enabling servitization is still limited.

Recent research has also highlighted the importance of managing connections among different partners (Eloranta and Turunen, 2016). Indeed, platforms enable activities to be coordinated among different actors in a way that leverages value co-creation (Thomas et al., 2014). More specifically, platforms facilitate interactions and allow firms to distribute responsibilities based on the competitive strengths of each participant. In servitized manufacturers, the coordination between the back-end (e.g., R & D unit) and the front-end (e.g., market and sales unit) represents a key aspect in implementing services (Silvestro and Lustrato, 2015). Nevertheless, how the roles are revised to leverage the value of platforms and digital technologies to assure a successful servitization remain unclear. Thus, although a platform approach may enable customization and operational efficiency (Simpson et al., 2005), it is not as simple as acquiring a new digital technology. Arguably, adopting platforms represents a significant transformational journey and requires designing new roles for the back-end and the front-end to leverage the platform architecture's value. However, the current literature offers little insight into how firms adopt and leverage the value of platforms for servitization. Thus, understanding how a platform approach allows manufacturing firms to overcome the service paradox and successfully undertake servitization needs further investigation.

More specifically, there is a need to better understand how IT and digital platforms can be leveraged to support developing and selling advanced service offerings. Accordingly, *the purpose of the present study is to advance understanding regarding how a platform approach facilitates the implementation of advanced service offerings in manufacturing firms*. To achieve this purpose, the present study is based on multiple case study methods featuring four leading multinational firms. The analysis focused on illustrating the journeys of manufacturing firms as they leverage value from information through a platform approach. In particular, the results examine how a platform approach can leverage the value of digital technologies to help distribute key activities between the back-end and the front-end.

The present paper contributes to the servitization literature by explaining how a platform approach may lead to overcoming the service paradox. Our findings illustrates the journey taken in adopting a platform approach and that information modules are becoming the foundation for servitized manufacturers' value proposition. Moreover, our results reveal that a platform approach enables the back-end to act as an orchestrator and the front-end to act as builder. Finally, the present paper adds to the literature on platforms by combining insights from product platforms and intermediary platforms.

2. Theoretical background

2.1. Implementing services and a platform approach

The servitization literature has focused on the predominant underlying assumption of a unidirectional product-to-service continuum (Baines et al., 2009; Kohtamäki et al., 2013; Oliva and Kallenberg, 2003; Paiola et al., 2013). Specifically, the literature purports that product manufacturers turn into service providers by simply adding services. However, more and more customers want manufacturers to provide a full continuum of products and services (Baines and Lightfoot, 2014). The resulting offering refers to product and service combinations that play a key role in customers' core operations. In this respect, customers hire advanced services adapted to their specific needs, which may differ considerably from one customer to another. As such, servitization is a complex process, and there are multiple paths to successfully accomplishing what all customers need (Turunen and Finne, 2014).

Manufacturing firms implement services to increase their revenues and enhance customer satisfaction (Parida et al., 2014). Specifically, additional services may enable manufacturing firms to access new business opportunities (Oliva and Kallenberg, 2003), improve efficiency (Eggert et al., 2014), and enhance the offering differentiation (Kohtamäki et al., 2013) and customer relationships (Reinartz and Ulaga, 2008). However, the literature has highlighted that servitization does not automatically increase performance; in fact, it may increase the likelihood of bankruptcy because some obstacles may diminish performance (Benedettini et al., 2016). In this respect, expanding the portfolio by adding services may leave manufacturing firms facing an ambiguous business focus, more complex interactions, and a more uncertain future. This represents a major challenge in servitization, which leads many firms to increase revenues while reducing profits, also known as the service paradox (Gebauer et al., 2005).

Paradoxes include underlying tensions that emerge when contradictory yet interrelated elements that seem logical separately turn inconsistent when they are considered together (Eisenhardt, 2000; Luscher et al., 2006; Smith and Lewis, 2011). Specifically, the service paradox entails adding services to increase revenues but subsequently becoming stuck in unprofitable cycles. Thus, many manufacturing firms have failed to accomplish successful servitization because they are unable to manage the associated tensions. Recent research on paradoxes highlights the importance of simultaneously managing interrelated elements to overcome paradoxical tensions (Cunha et al., 2016; Smith et al., 2010). Thus, manufacturers need efficient mechanisms to exploit the benefits of servitization by delivering adapted product and services offerings with a clear strategy and competitive prices (Settanni et al., 2014). In other words, servitized manufacturing firms should develop implementation mechanisms that assure competitive levels of both customization and organizational efficiency (Silvestro and Lustrato, 2015).

The servitization literature has suggested that a digitalization enabled platform approach may allow manufacturers to overcome the service paradox (Eloranta and Turunen, 2016; Pekkarinen and Ulkuniemi, 2008). Digital servitization may help manufacturing firms add services to their offerings (Coreynen et al., 2016; Vendrell-Herrero et al., 2016). Digital technologies enable firms to improve service quality and reduce operational costs (Kindström and Kowalkowski, 2014). For example, Rönnberg Sjödin et al. (2016) found that digitalization capabilities are a key facilitator for advanced service offerings. Thus, a platform approach that leverages the value of digital technologies may be particularly beneficial in the context of advanced service implementation that facilitates both customization and efficiency (Bask et al., 2010; Silvestro and Lustrato, 2015; Tuunanen and Cassab, 2011; Voss and Hsuan, 2009; Wareham et al., 2014). Platforms are technological infrastructures that allow firms to develop, configure, and deliver advanced services efficiently at an unprecedented scale

(Franco et al., 2009; Ransbotham and Kane, 2011; Yoo et al., 2012). In this way, digital technologies enable manufacturing firms to either give away services or offer them below cost (Suárez et al., 2013) and to exploit complementarities and substitution effects (Cusumano et al., 2015).

The literature has analyzed product platforms as a modular structure consisting of a set of physical components (Mikkola, 2006; Salvador, 2007; Zhang, 2015). The design of modules consists of identifying the elements with functionalities that have as much in common as possible and creating a loose coupling (Hyötyläinen and Möller, 2007). Based on this view, research on service platforms decomposes the service architecture into several service modules (Voss and Hsuan, 2009). For example, manufactures of heavy machines can break down their offerings into services related to spare parts, preventive maintenance, or fleet management. Moreover, firms can use platforms to reorganize the allocation of responsibilities and change how value is created (Gawer, 2014; Thomas et al., 2014). Thus, the platform literature explains how different actors can create value within the organization using platforms. In sum, a platform approach is grounded in the modularity of offerings and the cooperative distribution of activities.

2.2. Platform modularity and servitization

Research on servitization has analyzed extensively how modular architectures have been used to solve the service paradox (Bask et al., 2011; Marion et al., 2015; Pekkarinen and Ulkuniemi, 2008; Raddats, 2011; Rahikka et al., 2011; Vähätalo and Juhani Kallio, 2015). Modular architectures comprise a set of reusable core elements with easily interchangeable elements (Baldwin and Woodard, 2009; Henderson and Clark, 1990). The benefits of a modular architecture can be described generally as a flexibility that supports the simultaneous exploitation of scale and scope (Simpson et al., 2005; Thomas et al., 2014). The servitization research has examined different advantages of platform modularity in implementing services. A modular architecture may allow manufacturing firms to optimize investments by using certain product and service modules in many different offerings (Meyer et al., 2007). Moreover, a modular architecture may help the firm configure several offerings using different combinations of modules (Bask et al., 2010). In addition, a modular architecture establishes the fundamentals that all the modules should follow. In this respect, modularity may reduce the complexity of some offerings and facilitate communication regarding the offered value (Böttcher and Klingner, 2011). Thus, breaking down offerings into modules may enable efficient use of resources in servitization.

The literature describes the potential to offer various customized products or services by attaching interchangeable modules to core modules (Pekkarinen and Ulkuniemi, 2008), but also highlights that modularity does not always lead to customization and operational efficiency (Bask et al., 2011). Specifically, an increasingly greater heterogeneity of products and services makes the architecture design a difficult process (Bask et al., 2010; Voss and Hsuan, 2009). Some researchers have focused on the characteristics of the services that facilitate the design of service modules (Böttcher and Klingner, 2011; Lin and Pekkarinen, 2011; Voss and Hsuan, 2009). Recent research has taken a more holistic view by adding information modules as a source of value, while recognizing the importance of product and service modules as key components in the offerings (Opresnik and Taisch, 2015). An implicit assumption, however, is that product and service modules represent the main source of value, and information modules are complementary. Recent research, however, has highlighted that information modules are a key element that explain the success of advanced service implementation (Baines and Lightfoot, 2014), but is unclear what modules constitute the core. Thus, the position of information modules in the architecture provided by servitized manufacturers remains unclear.

2.3. Platform roles and servitization

A platform approach entails an organizational perspective that facilitates interaction and value creation among different actors (Thomas et al., 2014). Compatibility among modules thus helps different actors easily change combinations and content contributions (Chaturvedi et al., 2011). Platforms, therefore, can be helpful in coordinating actors as they develop service offerings (Gebauer et al., 2013). The literature generally distinguishes between two main actors in servitization, that is, the back-end and the front-end units (Gebauer and Fleisch, 2007; Oliva and Kallenberg, 2003). Traditionally, research on servitization has defined the role of the back-end unit as a central integrator involved in designing, developing, and manufacturing and the front-end unit as being responsible for offering delivery (Grönroos, 2011). However, the lack of fluent communication between the back- and front-end units represents an important challenge for servitized manufacturers (Parida et al., 2015). Thus, this organizational separation is a key challenge for advanced service offerings, and more coordinated organizational structures are needed to exploit the interdependencies among the product and service divisions (Windahl and Lakemond, 2006).

A platform approach may help guide redefining new roles in manufacturing firms that offer advanced services. Specifically, there are typically two platform roles: the orchestrators and the offering builders (Bask et al., 2011; Eloranta and Turunen, 2016; Thomas et al., 2014). Research has highlighted that the orchestrator role coordinates relationships within networks of firms. Specifically, a platform orchestrator designs and provides the platform and creates the architecture for the offering builders to participate in co-creating value. Thus, recent research has highlighted that a platform approach enables some degree of organizational integration and reciprocity among different actors (Eloranta and Turunen, 2016; Kowalkowski et al., 2011). Research on platform roles, however, has considered the firm as an entire entity that participates in a network of firms. Thus, understanding the platform roles of the back- and front-end units remains limited.

3. Methods

3.1. Research approach and case selection

The literature on servitization has expanded significantly in the last decade (Baines and Lightfoot, 2014; Opresnik and Taisch, 2015). Nevertheless, current research still lack an understanding regarding how a platform approach facilitates advanced service implementation. Therefore, the present study applies case study methods to collect qualitative, complex phenomenological data and address the “how” questions (Eisenhardt and Graebner, 2007; Yin, 2013). This methodological choice is appropriate when the aim is to examine and articulate processes of implementation (Bryman, 2012; Pratt, 2009), which is aligned with the focus on the present study to advance understanding of research phenomena.

This study is based upon multiple case studies with four multinational business-to-business (B2B) manufacturing firms (Table 1). Like Matthyssen and Vandenbempt (2010), a purposive sampling technique was applied to select four large manufacturing firms for the present study. These firms are henceforth referenced to as Alfa, Beta, Delta, and Gamma. Purposive sampling allows researchers to identify and select information-rich cases related to the research phenomenon. Thus, through such an approach, we hand-picked manufacturing firms that would provide detailed insights regarding how a platform approach facilitates the implementation of service offerings.

More specifically, four key reasons motivated us to choose these firms. First, because servitization has been studied primarily within the manufacturing industry (Baines et al., 2013; Gebauer et al., 2005), we also focused on manufacturing firms with a strategic orientation

Table 1
Descriptive information about the studied firms.

Firm	No. of staff & revenue (2015)	Main products	Main services	No. of interviews
Alfa	14 900 M$ 2830	Construction equipment	Customer support and availability agreement of construction equipment including use optimization	16
Beta	115 000 M$ 27 000	Network equipment and software	Network design and optimization services	14
Delta	500 M$ 141	Press tools for automotive industry	Use-based availability agreements and optimization services for press tools	10
Gamma	19 000 M$ 3740	Manufacturing tools and productivity improvements	Productivity improvement offering based on risk and reward sharing	7

toward service implementation. For example, Alfa's vision is to generate 50% of its revenues in next three years from services. In addition, Alfa has a reputation of being technologically advanced and innovative in providing advanced services. Second, because the present study focuses on advanced services, we used Baines and Lightfoot's (2014) conceptualization to identify companies that offer these kinds of services. These authors describe advanced service offerings as including certain features, such as performance incentives, usage-based revenue structures, and multiyear contracts. The case companies are currently offering advanced services to their customers globally, which makes them appropriate for the present study. For example, Gamma offers advanced services related to optimizing their customer operations. Third, to increase variation within the sample, we selected firms that operated in different industries, albeit all firms are operating in the B2B sphere. Finally, the present study focuses on investigating the role of a platform approach and information modularity (e.g., smart, connected, and analytical tools and processes) in servitization. We wanted to include case firms that have made significant investments and have adopted real-world examples of IT systems or platforms in their servitization efforts. In this regard, all case firms illustrated a clear fit toward the research focus. Our case firms thus provided a relevant setting into studying the adoption of platform architecture consisting of different modules in ways that facilitate service implementation.

3.2. Data collection

Our data collection primarily focused on conducting interviews with participants from the four case firms. Interviews provide insightful information on how a phenomenon occurs (Yin, 2013). Aligned with similar prior studies (Eloranta and Turunen, 2016; Coreynen et al., 2016), the unit of analysis in the present study is at the organizational level due to the focus on understanding how the studied firms apply a platform approach for service implementation (see Appendix A). Interviewed respondents included marketing managers, customer solutions managers, regional managers, and front-end managers, which allowed us to capture alternative views about the research domain. Therefore, we collected data from diverse respondents that hold both strategic and operational positions. In total, the present study's results are based on 47 interviews. The number of interviews per case firms varied due to reaching data and theoretical saturation. Saturation was reached when additional data collection had diminishing returns (Bowen, 2008), that is, when nothing new was being added. For example, fitting new data into existing categories. Similarly, theoretical saturation, in effect, is the point at which no new insights are obtained, no new themes are identified, and no issues arise regarding a category of data (Strauss and Corbin, 1990).

During the interviews, we used open questions related to servitization, advanced service offerings, and the platform approach. Appendix B presents a list of key questions that triggered the discussions and ensured that we captured insights related to the present study's focus. During the interviews, respondents were given significant freedom to build and extend the discussion. Thus, departing from these specific questions was permitted to explore particularly interesting themes that emerged during the interviews. Accordingly, the interview format was adapted and changed slightly throughout the data collection process to capture emerging themes.

3.3. Data analysis

The data analysis followed the thematic analysis method (Braun and Clarke, 2006). Braun and Clark (2006, p. 78) noted, "Through theoretical freedom, thematic analysis provides a flexible and useful research tool, which can potentially provide a rich and detailed, yet complex, account of data." Thematic analysis follows an iterative series of steps to identify and relate themes to develop an empirically grounded framework from qualitative data.

The first step in our data analysis focused on in-depth analysis of raw data (e.g., interview transcripts). We familiarized ourselves with the data by reading each interview several times, each time marking phrases and passages that were interesting and noting initial ideas. In the second step, we coded common and interesting words, phrases, terms, or labels that respondents mentioned. It was then possible to identify first-order categories of codes. These codes expressed the respondents' views in their own words. The third step of the analysis built on the initial codes being analyzed further to discover links and patterns within the codes to identify themes. In a fourth step, we refined the themes further (i.e., developed second-order themes) and generated a thematic map to provide an overview of our data based on the interplay between data from interviews and secondary sources such as internal documents, presentations, newspapers, and so on. In the fifth step, we refined the specific focus of each theme and related it to the overall story of the analysis as well as the literature. Accordingly, our analysis resulted in a thematic map consisting of several themes relating to information modules as a core to advanced services offerings and how these impacted the value creation activities of the back-end and front-end roles (i.e., aggregate dimensions). For more details on the themes in the data structure see Fig. 1.

During the analysis process, the authors discussed the preliminary results extensively with knowledgeable colleagues and industry professionals to arrive at valid results. To increase reliability and transparency and to reduce the potential for replication, a case study protocol was constructed along with a case study database. The database included case study notes, documents, and analysis. In total, these steps enabled us to develop an empirically driven theoretical framework that links various phenomena emerging in the data analysis.

4. Findings

The findings provide insights regarding how our case firms adopted a platform approach to address the service paradox and ensure

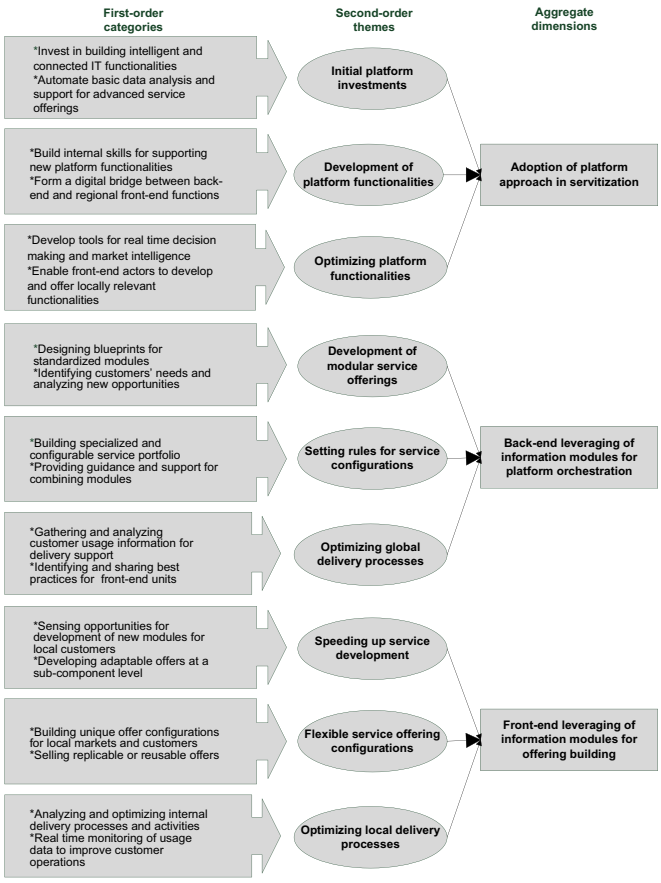

Fig. 1. Identified themes in our analysis.

advanced service offerings were implemented successfully. Specifically, we extend the current understanding of platform architectures and the revised roles of the front-end and back-end in leveraging a platform approach for servitization.

4.1. Adopting a platform architecture in servitization

The trigger for adopting a platform approach built around digital technologies was largely connected to the need for more customization and efficiency in providing service offerings globally. This meant that information modules had to take a central role in the platform architecture; as such, the combinations of product and service modules that could be constructed around such a core increased significantly. For example, a senior service development manager at Beta who had been involved in efforts to capitalize on information remarked,

> *Thinking and developing in a module format is not new for us. We have been doing that for ages. But with the introduction of IT in the core, the possibilities for offering integrated product–service combinations have become limitless.*

The platform approach is built on the ability to use smart and connected digital products to facilitate opportunities to sell advanced services. Sophisticated IT systems and sensors enable devices to connect with each other and to transmit critical information that enables opportunities for offering tailored-made functions through increased operational efficiency. For the case companies, adopting the platform approach went hand in hand with implementing the servitization strategy. Indeed, many respondents underlined the importance of leveraging flexible ways of configuring advanced service offerings enabled by combining product modules, service modules and information modules. A descriptive representation of our case firms' platform architectures is presented in Table 2.

Table 2
Description of platform architectures in the studied firms.

Modules	*Alfa*	*Beta*	*Delta*	*Gamma*
Service modules	Customer support agreements, up-time services, local optional services, fleet management services	Network management services, maintenance services, network consulting services	Monitoring services, on-site repairs, remote trouble shooting, use-based service agreements	Production design services, purchase service, productivity improvement consulting
Product modules	Product equipment categories, attachments, third-party products, and extensions	Network equipment, third-party off-the-shelf products, local optional product functions, fiber optic deployment	Customized physical press hardening tools for each customer, optional components, refurbished press blocks	Drilling tools, attachments, reamers, tool systems
Information modules	Telematics supporting the collection, distribution, and advanced analysis of customer usage data	Intelligent telecom systems with real-time transfer of usage information, cloud platforms	IT infrastructure, sensors, and mechanical measurements capturing and transmitting real-time tool usage data	Web-based open IT supporting the sale of products and services, as well as collecting and analyzing customer requirements

The initial phase of the platform journey started with investments toward building intelligent and connected IT functionalities in physical products. For example, Beta spent significant resources to develop a platform for real-time use information. Respondents from Beta emphasized the importance of using digital intelligent functionalities and information technology systems as a core module to facilitate large-scale implementation of advanced service offerings. In this respect, a service researcher engaged in finding new opportunities for service offerings described, *"To be able to offer hybrid solutions, we would largely depend upon the IT systems."* This first step allowed them to provide basic services to global markets cost efficiently, such as automated analysis of operational information and warning signals that repair or maintenance may be needed. Such systems for automatic data analysis and support for service innovation building on connected products were implemented in all companies Similarly, Alfa implemented a strategy to introduce all its equipment with a common telematics system that initially provided operational data and basic data. The service transition manager at Alfa shared a view of the strategic importance of the digital technologies: *"The telematics competence will always be internal. It is integral to our offer, the core service business model."* Delta introduced a platform consisting of sensors and the mechanical measurement ability to capture and transmit real-time tool usage data, whereas Gamma implemented a connected platform based on a digital catalogue, which is directly integrated into computer-aided manufacturing programs that their customers use. These developmental investments ensured that the provision of advanced service offerings was supported. A platform development manager from Delta who had been overseeing the development of the system explained,

> *We have broken new boundaries when it comes to developing and launching this web-based platform. This is not our core competence, but a necessary step for us to evolve into a solutions provider.*

As the firms progressed in their platform adoption journey, identifying and developing new platform functionalities or capabilities was deemed necessary. A systematic approach toward thoughtful analysis of data gleaned from early servitization efforts ensured that new platform-relevant support functions were explored. A key challenge for companies, however, related to internal skill development for supporting new platform functionalities. For example, to reap the benefits of investments into smart and connected machines, new types of skills were required among the back-end functions such as data scientists. Moreover, extensive training programs among the front-end units were required to build operational competences. In additions, skills for connecting cloud-servers and developing software, applications, and analytical tools were also needed. One major issue was finding or developing tools to navigate the substantial data stream these smart products generated.

Companies also directed efforts to use the platform architecture to form a digital bridge between headquarters and regional units for the configuration of advance service offerings. In this respect, the information modules was used by back-end for enhancing higher adaptability towards customers' specific needs, while standardizing operations that kept costs down. Specifically, information modules provided needed flow of information between multiple markets and promoted establishment of new connections with end-customers. Thus, information modules were reused as an enabler across markets while other modules (product and service) are easily interchangeable and vary. Learning to use the digital functionalities to support cooperation in offering various configurations was a key part of this journey as exemplified by a service agreement manager at Alfa,

> *Investment and development of telematics has been an important stepping stone for us. This provided the grounds for cooperating more efficiently between local and global units.*

As the manufacturers took further steps in their journeys, information modules enhanced customer awareness via embedded sensors, operating systems, and onboard software applications. In addition, seamlessly transmitting data and information continuously from an individual product or a group of products combined with analytics allows manufacturers to transform data into insights that provides grounds for critical decision making and market intelligence. For example, Delta was implementing a new product lifecycle system, which provides critical information in a visual format to simplify decisions and propose new advanced service offers. A senior technology development manager involved in developing the new information functionalities from Alfa explained,

> *Providing visual information to customers about equipment usage is becoming a key part of value creation. But this is half the story; we can also proactively provide signals to customers and dealers that they need to interact by sharing such information directly.*

A development manager from Gamma added,

> *Many customers are seeking higher operational uptime. This means a better understanding of their tools. Through sensor data and simple display possibilities, we can bridge this gap and make them more informed to make uptime decisions themselves.*

In addition, the companies were increasingly discussing opening their digital platforms to selected distributers, third-party service providers, and regional units to allow front-end actors to develop and offer locally relevant functionalities. Indeed, many respondents viewed these independent developments of additional features and functions as a vital step towards building even more advanced service offerings. This approach can be especially fruitful since individual markets may have unique service requirements that the regional units and third-party providers working in the area best understand. Giving these parties freedom to develop new services based on standard digital platforms can lead to innovative services that meet needs specific to a given market. Furthermore, it can be expensive to control developments of functionalities based on diverse customer needs across global markets. Authorizing them, therefore, can allow the company to participate in the value they create. Thus, a platform approach allows manufacturing firms to successfully implement services via leveraging information modules that provide a foundation for a modular architecture that enables both customization and operational efficiency.

4.2. Leveraging information modules for advanced service offering roles and activities

Two overarching themes in the empirical data suggest that a platform approach entails redefining the roles and the value-creating activities in servitized manufacturing firms to leverage the value of information modules. Specifically, the present study's findings illustrate that back-end units assume the role of platform orchestrators and front-end units become solution builders. In addition, the central position of information modules in service offerings facilitates information-related, value-creating activities that can be leveraged by a platform approach in several ways for different roles. In other words, the findings illustrate that the platform approach allows different roles to improve advanced service implementation activities related to developing, configuring, and delivering service offerings. Fig. 2 illustrates the overall logic of the findings on leveraging the value of a platform approach for advanced service implementation.

4.2.1. Leveraging value in back-end units' role as platform orchestrators

This study found that across case firms, the back-end units were revising their role toward *platform orchestrators* that establish and coordinate activities related to platform architectures with product, service, and information modules. A customer solutions manager at the

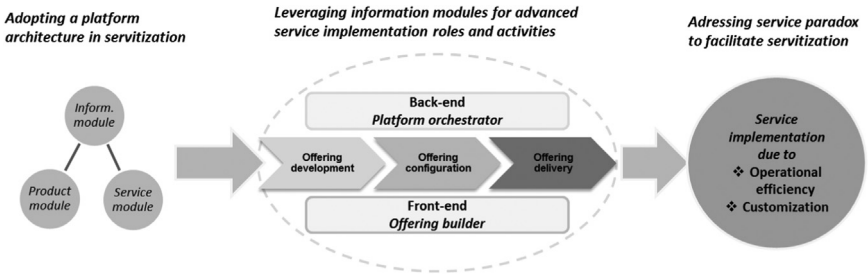

Fig. 2. Leveraging the value of a platform approach for advanced service implementation.

back-end unit of Alfa asserted,

> *We are currently in the process of putting the final touches on the next generation of the [platform]…After much negotiations, our organization has made the decision to focus on core technologies such as telematics. Everyone agrees that this has been a positive decision.*

All the studied firms' back-end units shared similar statements. Thus, the findings illustrate that back-end units are assuming the role of defining the underlying architecture and its modules. Due to their holistic view on implementing service strategy, back-end units assume the privileged position of coordinating the modules, specifically the information module, and ensuring added customer value.

First, the results show that the back-end units leveraged a platform approach to ensure *development of modular service offerings* by designing and developing blueprints for standardized product and service modules. This reduced development efforts and costs. A service development manager at Beta explained, *"Of course, we at the back-end unit want to envision solutions and the different components that we need to develop."* Along the same lines, a customer solution manager at Alfa stated, *"The platform perspective will enable us to systematically develop and launch new services and functionalities in the coming years."* Particularly important was the use of the information module for collecting critical data and identifying customers' trends. Traditionally, back-end units have been responsible for ensuring a solid business trajectory and identifying new market opportunities. A customer solutions manager at Alfa explained, *"Of course, we still have portfolio planning, but specific offer development is now more driven by customer needs than traditional product planning."* A platform approach provides greater potential to provide up-to-date and customizable offerings to different customers from diverse markets. Thus, back-end units can focus on defining and developing core modules that serve as the foundation for developing new offerings.

Moreover, the orchestrator role of back-end units entails using a platform approach and specifically leveraging the information module to identify unmet customer needs and new business opportunities. Along this line, a tool manager at Delta remarked, *"By adding a monitoring device to all our tools and developing an information system, different services can be offered, which can generate higher value for customers and an additional stream of revenue for us."* In this sense, developing the information module is a key to identifying higher-order customer needs but also making the system flexible for the front-end development of new opportunities. For example, a service development manager at Beta remarked,

> *"We need to create the opportunities for our front-end organization to innovate based on the internet of things. We need them to be flexible and to develop new services based on our platform."*

A platform approach eases the complex task of investing resources in development activities that provide the best outputs toward servitization and future competitive advantage. Thus, the findings illustrate that a platform approach offers the potential to coordinate offering development in a resource-efficient way. Moreover, a platform approach allows back-end units to efficiently identify new combinations of products, services, and information that fulfill increasingly more heterogeneous needs.

Second, the back-end units facilitate development and sales by *setting rules for service configurations* by building a specialized service portfolio that eases the configuration process. This implies that the back-end strives to create new value through the platform by providing a variety of advanced services; it does so by combining a limited number of specialized product and service modules instead of a rigid portfolio. Developing a service portfolio builds on understanding the configuration challenges of front-end units. A regional manager from Alfa explained,

> *"Telematics and a platform view provide us [with] the possibility to offer a diverse set of services and options. We are even able to support market units to develop a few simple modules onsite for higher customer satisfaction."*

Thus, the findings illustrate that a platform approach allows the back-end units to provide the front-end units and active customers with a diverse list of module combinations that can be adapted to different needs when configuring and selling new offerings.

A regional manager from Gamma added, *"Recently the focus has shifted toward creating a common set of offerings across global markets."* Customers across regions require different service offerings, which adds to the costs and sometimes leads to unprofitable business interactions. Therefore, reducing costs associated with the greater need for customization and maintaining operational efficiency places new requirements on the back-end. For example, they need to provide guidance on how to combine modules. As such, back-end units must clearly define and communicate a wide set of possibilities for value creation while maintaining efficiency requirements. The back-end can also easily define and communicate to the front-end common modules that satisfy different solutions through a platform approach.

Third, back-end units leverage platforms by facilitating *optimization of global delivery processes*. More specifically, by using information modules, back-end units can gather and analyze customer usage information that enables them to improve the offering provision stage. A telematics manager from Alfa explained, *"Our platform captures usage data, which is valuable for us. It provides possibilities to make sound decisions toward how we can best use our resources."* Thus, platforms help firms analyze information regarding customer needs as the solution is being executed. This capability enhances resource deployment and cost efficiency. A tool manager from Delta added, *"With the platform in place, the ability of the back office to capture information from different markets becomes possible."* In addition, the findings reveal that the back-end units increasingly used the platform approach and information modules to identify and share best practices for common processes, activities, and resources among the front-end units. For example, customers across regions differ, as does the ability of the front-end to implement a service strategy successfully. This could result in front-end units creating pioneering practices for service delivery. For example, they could integrate real-time usage information to coordinate service routing or optimize maintenance scheduling

through predictive maintenance systems. Indeed, learning from such cases can provide an incentive to improve but also result in practical guidelines for other front-end units. Therefore, back-end units are responsible for establishing common practices and activities for a streamlined delivery process, which could be viewed as a service delivery platform. To conclude, a platform approach enables back-end units to orchestrate activities across markets and ensure efficiency within offering delivery.

4.2.2. Leveraging value in front-end units' role as offering builders

The analyzed firms stated that their front-end units had gradually adopted the role of *offering builders* by being responsible for crafting the final offering. Specifically, front-end units combine different product and service modules with information modules. A service development manager at Beta emphasized that the front-end played a critical role, because they interact with the customers in combining the offer: *"In the front-end the real offering is combined."* In this sense, direct customer connections may place the front-end units in an advantageous position as offering builders in the service context. For example, a service delivery specialist at Delta described how the combination of usage data and customer contact could be helpful, *"Of course, I see a lot of potential improvements when I am visiting customers, and this can be important to capture in our offerings."* In fact, most respondents realized that succeeding with advanced service offerings requires the back-end to concede responsibility to the front-end to drive development and configurations based on their insights. A service development manager at Beta underscored,

> *We give…our front-line units [the potential] to take on financial risks and develop these innovative offerings. It is extremely important to give the front-end the possibility to make these decisions.*

Thus, the findings of this study illustrate the front-end units shifting toward combining different modules to enhance the fit of offerings with customers' specific needs. In this respect, the results showed that the back-end units were leaving some space in which front-end units could participate in co-creating value as *offering builders* that complete and adapt the value creation. For example, a regional manager at Beta described,

> *We are most informed about customer needs. They typically contact us with their unique problems, and we jointly solve it by constructing a product and service combination that will generate the best outcome for them.*

A key theme in the findings is that a platform approach is based on letting front-end units *speed up service development* by sensing opportunities for new module developments for local customers. A research and development (R & D) manager from Gamma explained,

> *Local conditions can vary, and we in the back office can't directly address such needs. So, our front-end offices have the freedom to initiate the development of certain specialized product and service options.*

Thus, front-end units use data to demonstrate the analytical capabilities of the platform to create new product and service modules by collaborating with the customer. In this regard, Beta's front-end organization collaborated with a customer in the shipping industry to develop a radical ship-positioning system based upon an already existing platform. This development was driven totally by the local front-end organization and resulted in a new high-growth service module. Respondents at all the firms recognized that front-end units have a privileged position close to customers that is helpful in identifying and understanding possibilities for new service innovations. For example, a front-end manager at Alfa described that the firm began developing innovative service offerings more quickly than the back-end unit when they started leveraging the analytics of the telematics system. According to a service researcher at Beta, *"We have to be open to new possibilities, and maybe even have a certain level of imagination when it comes to enhanced customer value."* In sum, the present study's findings illustrate that a platform approach leverages value by facilitating front-end units' capability to identify new opportunities when implementing services.

Second, a platform approach facilitates *flexible service offering configurations* by leveraging front-end units' skills in identifying combinations of modules that best fulfill customers' needs. A front-end manager at Alfa explained that they initially had problems understanding and providing the rigid portfolio of services required from back-end units. After adopting a platform approach, however, new roles were possible: *"We try to craft a bundle [of services] ourselves and sell it as a larger package to the customer. It's about flexibility."* Similarly, many respondents at Beta remarked that this flexibility was a critical aspect for success in selling advanced service offerings. Thus, in adopting a platform approach, front-end units can easily customize offerings when a clearly defined modular architecture is in place to support it. As a customer solutions manager at Alfa stated, *"Having this modular approach allows us to always think of the customer."* Moreover, front-end units enhance their efficiency and flexibility by combining a predefined set of modules, instead of dealing with many disconnected options. This is important because customer needs may change over time, and this approach allows new modules to be added to or subtracted from the offering, depending on changing needs. Moreover, the frequent and clear communication that the platform enables allows front-end units to complement their current knowledge about customers with new, raw data and reports from the back-end. A regional manager from Beta expressed,

> *The smart and connected platform is the backbone of our operational success. We now know more about how our products and services are being used so when a customer approaches us we can provide the service offering, which is cost friendly for them and for us.*

Third, the information shared within the platform provides front-end units with a more complete and detailed view of the value provision that leads them to reduce costs and ensure efficient delivery. This allows them to analyze and *optimize local delivery processes* and activities for resource efficiency. A front-end manager from Alfa remarked,

> *A really interesting aspect of this transformation is how we use information, how more proactive we can be, and how more efficient we can be with scheduling work and diagnostics.*

In addition, a platform approach enables front-end units and customers to provide valuable information to the firm in an unprecedented, costless way. Specifically, smart and connected functionalities allow the front-end units to monitor more detailed usage data to improve customers' operations and decrease reporting costs. A platform development manager at Gamma explained, *"Such a platform provides possibilities to interact with any number of customers regardless of their location, and the costs for doing so are negligible."* Accordingly a platform approach enables reporting feedback from multiple stakeholders to be standardized and automated. In other words, a platform approach makes it possible for front-end units and customers to increase value creation by focusing on their core operations.

In sum, the findings illustrate that a platform approach facilitates servitization by leveraging the value of information to increase operational efficiency, while simultaneously allowing for customized and flexible offerings. Specifically, back-end units can optimize processes and resource deployment and identify new offering combinations. Meanwhile, front-end units can report valuable information to back-end units without significant effort, just by delivering the offerings and configuring new and innovative offerings to diverse customers. Table 3

Table 3
Activities for leveraging the value of the information module in servitization via a platform approach.

	Platform role	
Activity	**Back-end unit** ***Platform orchestrator***	**Front-end unit** ***Offering builder***
Offering development	1. Designing and developing blueprints for standardized modules to reduce development efforts 2. Identifying global customers' needs and analyzing new opportunities for advanced service offerings	1. Sensing opportunities for developing new modules for local customers 2. Developing offers at a subcomponent level to ensure reduced efforts with adaptability
Offering configuration	1. Building a specialized service portfolio to enable ease in configuration 2. Providing guidance and support in combining different modules	1. Building offer configurations that are innovative and unique to local markets and customer conditions 2. Achieving economy of scale through the sale of replicable or reusable offers
Offering delivery	1. Gathering and analyzing customer usage information for delivery support 2. Identifying and sharing best practices for common processes, activities, and resources among front-end units	1. Analyzing and optimizing internal delivery processes and activities for resource efficiency 2. Monitoring usage data to improve customers' operations and decrease lifecycle costs

summarizes activities for leveraging the value of the information module in servitization via a platform approach for both back-end and front-end units.

5. Discussion and conclusion

Servitization is increasing in complexity with progressively higher requirements for customization and operational efficiency. These new requirements hinder manufacturing firms' ability to offer advanced services successfully. Emerging research points to a platform approach as a potential way to address these challenges (Eloranta and Turunen, 2016; Thomas et al., 2014). However, current understanding within the management literature is still limited regarding how to leverage value through a platform approach in servitization. Based on qualitative data from four manufacturing firms, the findings reveal a longitudinal path in how firm apply a platform approach to implement servitization successfully. Furthermore, drawing on modularity and platform roles, this study explains how a platform approach may facilitate both customization and operational efficiency by leveraging the value of digital technologies to overcome the service paradox. Thus, the present paper provides theoretical implications for the servitization literature and offers managerial implications for senior managers from the manufacturing industry that are responsible for servitization initiatives that drive the implementation of advanced service offerings.

5.1. Theoretical implications

Increasingly, manufacturing firms are developing and selling advanced product–services to achieve a competitive advantage. Such complex value offerings are required to fulfill customers' increasingly heterogeneous needs (Baines and Lightfoot, 2013) but have a tendency to increase costs and risk undercutting profits. Therefore, there is a need to understand how manufacturing firms can structure offerings and roles to implement advanced product–services successfully. In this direction, our findings hold the following theoretical implications.

First, we illustrate how a platform approach with information as a core module can address the service paradox in driving servitization efforts forward. In a platform-centered architecture, manufacturing firms may find an approach that guides the successful implementation of advanced services by leveraging the value of information and digital technologies. The firms in the present research illustrate a trend toward redefining an updated modular architecture based on product, service, and information modules. In our case firms, we found a shift in focus from the discrete importance of specific elements (i.e., products vs. services) to the entire architecture. In other words, products, services, and information are all recognized as key pieces in advanced service offerings, and a platform approach guides how to combine and leverage value from them. In fact, the manufacturers' awareness of these elements, as they are embedded in different advanced service offerings, has led them to provide a wider portfolio of offerings with competitive costs. Notably, core information modules are replacing the traditional central role of product components. This finding contributes to emerging research on platforms within the servitization literature by further disentangling the core modules of advanced service architectures. We also extend the insights on digital servitization (Opresnik and Taisch, 2015; Vendrell-Herrero et al., 2016) by explaining how information modules simultaneously enable new opportunities to generate revenue and decrease the costs associated with service offerings. The position of information modules at the core of the platform architecture provides the potential to generate new or reconfigure existing product and service modules based on analyzing customers' needs and how they consume products. In this sense, the information-centered architecture allows manufacturers to exploit operational efficiency and customization simultaneously and hence overcome the service paradox.

Second, a platform approach may lead firms to address servitization by identifying and defining new roles. Indeed, by adopting the platform approach, back-end and front-end units are assuming new roles in leveraging the value of information in servitization and enhancing innovation in different ways. Specifically, our findings illustrate that back-end units assume the role of *platform orchestrators*, which establish and coordinate activities related to platform architectures with product, service, and information modules. Meanwhile, front-end units assume the role of *offering builders* by being responsible for crafting the final offering by combining different modules. This finding contributes to the servitization literature (Baines and Lightfoot, 2014; Kowalkowski et al., 2011) by providing insights into the organizational approach to implement services successfully. Notably, the central position of information modules in advanced service offerings facilitates information-related value co-creation activities between manufacturing firms and their customers, which can be leveraged by a platform approach through revised organizational roles. This finding adds to the dialog about the importance of information in providing advanced service offerings (Baines and Lightfoot, 2014; Opresnik and Taisch, 2015) by addressing how a platform approach helps distribute activities across different roles, which leads to the successful commercialization of advanced product–service offerings. Indeed, we contribute to the recent research on the digital servitization (Coreynen et al., 2016; Vendrell-Herrero et al., 2016) by explaining how digital platforms allow manufacturers to leverage the value added by the different units. Specifically, our findings specify how the platform approach enables manufacturers to achieve an efficient and flexible coordination of the activities of the front-end and the back-end units.

In addition, this study illustrates how back-end and front-end roles

can leverage the value of information modules in a platform approach to develop, configure, and deliver service offerings. As such, the traditional distinction between the back-end and front-end units is being challenged (Gebauer and Fleisch, 2007; Oliva and Kallenberg, 2003) by a platform approach that generates new value for the organization. Specifically, back-end units assume the responsibility of designing and developing blueprints for standardized modules to reduce development efforts, whereas front-end units contribute by sensing opportunities to develop new modules for local customers. Similarly, to configure services, the front-end can leverage information modules to build offerings that are innovative and unique to local markets and customer conditions based on a broad portfolio of modules that the back-end maintains. Finally, delivery activities are leveraged in the front-end through usage and service data to analyze and optimize internal delivery processes and activities for resource efficiency. As such, developments in delivery processes can be captured and further scaled, refined, and disseminated by back-end units. Thus, we contribute to the servitization literature by explaining how platform roles facilitate servitization by enabling coordinated efforts to accomplish customization and operational efficiency. These interrelated goals usually create underlying tensions that are difficult to achieve together (Eisenhardt, 2000; Luscher et al., 2006; Smith and Lewis, 2011). In this respect, our findings extend the current research on paradoxes (Cunha et al., 2016; Smith et al., 2010) by explaining how platform roles may enable manufacturers to overcome the service paradox.

Finally, explaining the nature of a platform approach within servitization represents a step forward in developing the platform approach concept itself. The present study adds to the platform literature (Gawer, 2014; Thomas et al., 2014; Zhang, 2015) by proposing a type of platform architecture that may be a middle step from product platforms to platform ecosystems. Specifically, it combines the benefits of product and service modularity and establishes the fundamentals of a potential business model based on network interactions. In this respect, we bridge insights from different types of platform literature streams, which may strengthen our understanding of the evolution of platforms. In other words, the architecture and platform roles in servitized manufacturers strengthen our understanding of how to create platform ecosystems. In sum, the present study could be helpful in understanding the success of platform ecosystems that are the result of a deep transformation from product-centered business models.

5.2. Managerial implications

The present study has several managerial implications for senior managers who are active in servitization efforts within manufacturing firms. First, we identified how adopting a platform approach allows manufacturers to discover how different modules contribute to the value proposition. In this regard, firms in the present study highlight the central role of information modules in successfully accomplishing servitization. Thus, our findings recommend that managers in manufacturing firms could redesign modular architectures with specific emphasis on information modules at the core and acting as the foundation for connecting product and service modules. This implication is especially relevant considering that manufacturing firms started servitization with products as the main source of value, even as they aspired to become service providers. Thus, the present study illustrates that servitization is not a linear process with services at the end. By implementing advanced services, manufacturing firms are identifying new modules and are restructuring their modular architecture, which reveals new paths for improvements.

Second, adopting a platform approach enabled the case firms to revise their traditional roles and responsibilities. Our findings reveal a platform approach that enables successful servitization by defining platform roles for both back-end and front-end units. A platform approach requires a complete transformation of the organization with long-term consequences. More important, all actors involved in the new architecture should know their role and have a resolute commitment to working collaboratively to leverage the value of the information module. Thus, the present study explains a platform approach that provides the potential to turn the challenges of providing service into opportunities to outperform competitors. Our findings may encourage the top managers of manufacturing firms to accomplish the transformation, assuming a clear and determined position.

5.3. Limitations and outlook

The present study has several limitations that may inspire future research. First, our findings are based on cases from business-to-business manufacturing firms. The IT-enabled interactions in business-to-consumer contexts, however, are considerably different (Tukker, 2015). Future research could broaden the research analysis to additional industries to enrich our insights by further analyzing the role of customers in the platform approach. Second, we have adopted an internal perspective of the platform. Thus, the interviewed managers were from both back-end and front-end units. Future research could expand the perspective of a platform approach by combining an external and an internal view of the actors involved in providing value, such that the analysis includes network partners and customers. For example, generating insights on the external view, especially customers, would provide deeper insights into value co-creation and a more complete picture of how the platform approach influences the processes of servitization. Finally, informants at four successful manufacturing firms provided knowledge for the present study. Future research could extend our insights by conducting quantitative methods to test proposed relationships between variables, such as the moderating role of the platform approach for advanced product–service offerings.

Appendix A. List of respondents

Firm	Respondents
Alfa	Soft products manager, R & D manager, customer solutions manager (2), front-end manager (2), portfolio manager, regional manager (3), product manager log data, senior technology manager, service transition manager (2), telematics manager, after sales manager
Beta	R & D manager, service development manager, service researcher (3), senior network manager, regional manager (3), service development manager (4), senior service development manager
Delta	R & D manager (2), quotation manager, sales manager, service engineer, senior service delivery specialist, R & D engineer, project manager, tool manager (2)
Gamma	Platform development manager (2), regional manager (2), development manager (2), R & D manager

Appendix B

Interview guide themes

Describe your formal position, role, and how involved you are with servitization efforts in the firm.

Describe the key services of your firm at the moment. What are the future aspirations toward service implementation? Provide examples of how the servitization journey has been.

Describe the key challenges for your firm in developing, configuring, and delivering advanced services to diverse customers?

Describe how you are dealing with these challenges and what activities are needed for your side to be able to offer more advances services (e.g., offering availability)?

Describe how roles, responsibilities, and activities related with developing, configuring, and delivering advanced services has been conducted by front-end and back-end?

Describe how current information technology systems have been developed. How are they used to support service implementation?

Describe the benefits of adopting information technology systems for advanced service development and implementation.

References

Baines, T., Lightfoot, H., 2013. Made to Serve: How Manufacturers can Compete Through Servitization and Product Service Systems. John Wiley & Sons, NJ.

Baines, T., Lightfoot, H.W., 2014. Servitization of the manufacturing firm: exploring the operations practices and technologies that deliver advanced services. Int. J. Oper. Prod. Manag. 34, 2–35. http://dx.doi.org/10.1108/IJOPM-02-2012-0086.

Baines, T.S., Lightfoot, H.W., Benedettini, O., Kay, J.M., 2009. The servitization of manufacturing: a review of literature and reflection on future challenges. J. Manuf. Technol. Manag. 20, 547–567. http://dx.doi.org/10.1108/17410380910960984.

Baldwin, C., Woodard, C.J., 2009. The architecture of platforms: a unified view. In: Gawer, A. (Ed.), Platforms, Markets and Innovation. Edward Elgar Publishing, Cheltenham, UK and Northampton, MA, 19–44.

Bask, A., Lipponen, M., Rajahonka, M., Tinnilä, M., 2011. Framework for modularity and customization: service perspective. J. Bus. Ind. Mark. 26, 306–319. http://dx.doi.org/10.1108/08858621111144370.

Bask, A., Lipponen, M., Rajahonka, M., Tinnilä, M., 2010. The concept of modularity: diffusion from manufacturing to service production. J. Manuf. Technol. Manag. 21, 355–375. http://dx.doi.org/10.1108/17410381011024331.

Benedettini, O., Swink, M., Neely, A., 2016. Examining the influence of service additions on manufacturing firms' bankruptcy likelihood. Ind. Mark. Manag.. http://dx.doi.org/10.1016/j.indmarman.2016.04.011.

Beuren, F.H., Gomes Ferreira, M.G., Cauchick Miguel, P.A., 2013. Product-service systems: a literature review on integrated products and services. J. Clean. Prod. 47, 222–231. http://dx.doi.org/10.1016/j.jclepro.2012.12.028.

Bowen, G.A., 2008. Naturalistic inquiry and the saturation concept: a research note. Qual. Res. 8 (1), 137–152.

Böttcher, M., Klingner, S., 2011. Providing a method for composing modular B2B services. J. Bus. Ind. Mark. 26, 320–331. http://dx.doi.org/10.1108/08858621111144389.

Braun, V., Clarke, V., 2006. Using thematic analysis in psychology. Qual. Res. Psychol. 3, 77–101. http://dx.doi.org/10.1191/1478088706qp063oa.

Bryman, A., 2012. Social Research Methods. Oxford University Press, New York.

Chaturvedi, A.R., Dolk, D.R., Drnevich, P.L., 2011. Design principles for virtual worlds. MIS Q. 35, 673–684.

Coreynen, W., Matthyssens, P., Van Bockhaven, W., 2016. Boosting servitization through digitization: pathways and dynamic resource configurations for manufacturers. Ind. Mark. Manag.. http://dx.doi.org/10.1016/j.indmarman.2016.04.012.

Cunha, M.P., Fortes, A., Gomes, E., Rego, A., Rodrigues, F., 2016. Ambidextrous leadership, paradox and contingency: evidence from Angola. Int. J. Hum. Resour. Manag.. http://dx.doi.org/10.1080/09585192.2016.1201125.

Cusumano, M.A., Kahl, S.J., Suárez, F.F., 2015. Services, industry evolution, and the competitive strategies of product firms. Strateg. Manag. J. 36, 559–575. http://dx.doi.org/10.1002/smj.2235.

de Blok, C., Luijkx, K., Meijboom, B., Schols, J., 2010. Modular care and service packages for independently living elderly. Int. J. Oper. Prod. Manag. 30, 75–97. http://dx.doi.org/10.1108/01443571011012389.

Eggert, A., Hogreve, J., Ulaga, W., Muenkhoff, E., 2014. Revenue and profit implications of industrial service strategies. J. Serv. Res. 17, 23–39. http://dx.doi.org/10.1177/1094670513485823.

Eisenhardt, K.M., 2000. Paradox, spirals, ambivalence: the new language of change and pluralism. Acad. Manag. Rev. 25, 703–705. http://dx.doi.org/10.5465/AMR.2000.3707694.

Eisenhardt, K.M., Graebner, M.E., 2007. Theory building from cases: opportunities and challenges. Acad. Manag. J. 50, 25–32.

Eloranta, V., Turunen, T., 2016. Platforms in service-driven manufacturing: leveraging complexity by connecting, sharing, and integrating. Ind. Mark. Manag. 55, 178–186. http://dx.doi.org/10.1016/j.indmarman.2015.10.003.

Franco, R.D., Ortiz Bas, Á., Lario Esteban, F., 2009. Modeling extended manufacturing processes with service-oriented entities. Serv. Bus. 3, 31–50. http://dx.doi.org/10.1007/s11628-008-0056-0.

Gawer, A., 2014. Bridging differing perspectives on technological platforms: toward an integrative framework. Res. Policy 43, 1239–1249. http://dx.doi.org/10.1016/j.respol.2014.03.006.

Gawer, A., Cusumano, M.A., 2014. Industry platforms and ecosystem innovation. J. Prod. Innov. Manag. 31, 417–433. http://dx.doi.org/10.1111/jpim.12105.

Gebauer, H., Fleisch, E., 2007. An investigation of the relationship between behavioral processes, motivation, investments in the service business and service revenue. Ind. Mark. Manag. 36, 337–348. http://dx.doi.org/10.1016/j.indmarman.2005.09.005.

Gebauer, H., Fleisch, E., Friedli, T., 2005. Overcoming the service paradox in manufacturing companies. Eur. Manag. J. 23, 14–26. http://dx.doi.org/10.1016/j.emj.2004.12.006.

Gebauer, H., Paiola, M., Saccani, N., 2013. Characterizing service networks for moving from products to solutions. Ind. Mark. Manag. 42, 31–46. http://dx.doi.org/10.1016/j.indmarman.2012.11.002.

Grönroos, C., 2011. Value co-creation in service logic: a critical analysis. Mark. Theory 11, 279–301. http://dx.doi.org/10.1177/1470593111408177.

Hart, C.W.L., 1995. Mass customization: conceptual underpinnings, opportunities and limits. Int. J. Serv. Ind. Manag. 6, 36–45. http://dx.doi.org/10.1108/09564239510084932.

Henderson, R.M., Clark, K.B., 1990. Architectural innovation: the reconfiguration of existing product technologies and the failure of established firms. Adm. Sci. Q. 35, 9. http://dx.doi.org/10.2307/2393549.

Hyötyläinen, M., Möller, K., 2007. Service packaging: key to successful provisioning of ICT business solutions. J. Serv. Mark. 21, 304–312. http://dx.doi.org/10.1108/08876040710773615.

Jha, A.K., Bose, I., Ngai, E.W.T., 2016. Platform based innovation: the case of Bosch India. Int. J. Prod. Econ. 171 (Part 2), 250–265. http://dx.doi.org/10.1016/j.ijpe.2015.09.037.

Kindström, D., Kowalkowski, C., 2014. Service innovation in product-centric firms: a multidimensional business model perspective. J. Bus. Ind. Mark. 29, 96–111. http://dx.doi.org/10.1108/JBIM-08-2013-0165.

Kohtamäki, M., Partanen, J., Parida, V., Wincent, J., 2013. Non-linear relationship between industrial service offering and sales growth: the moderating role of network capabilities. Ind. Mark. Manag. 42, 1374–1385.

Kowalkowski, C., Kindström, D., Brehmer, P., 2011. Managing industrial service offerings in global business markets. J. Bus. Ind. Mark. 26, 181–192. http://dx.doi.org/10.1108/08858621111115903.

Lerch, C., Gotsch, M., 2015. Digitalized product-service systems in manufacturing firms: a case study analysis. Res.-Technol. Manag. 58, 45–52. http://dx.doi.org/10.5437/08956308×5805357.

Lin, Y., Pekkarinen, S., 2011. QFD-based modular logistics service design. J. Bus. Ind. Mark. 26, 344–356. http://dx.doi.org/10.1108/08858621111144406.

Luscher, L.S., Lewis, M., Ingram, A., 2006. The social construction of organizational change paradoxes. J. Organ. Change Manag. 19, 491–502. http://dx.doi.org/10.1108/09534810610676680.

Marion, T.J., Meyer, M.H., Barczak, G., 2015. The influence of digital design and IT on modular product architecture. J. Prod. Innov. Manag. 32, 98–110. http://dx.doi.org/10.1111/jpim.12240.

Matthyssens, P., Vandenbempt, K., 2010. Service addition as business market strategy: identification of transition trajectories. J. Serv. Manag. 21, 693–714. http://dx.doi.org/10.1108/09564231011079101.

Meyer, M.H., Jekowsky, E., Crane, F.G., 2007. Applying platform design to improve the integration of patient services across the continuum of care. Manag. Serv. Qual.: Int. J. 17, 23–40. http://dx.doi.org/10.1108/09604520710720656.

Meyer, M.H., Lehnerd, A.P., 1997. The Power of Product Platforms: Building Value and Cost Leadership. Free Press, New York.

Mikkola, J.H., 2006. Capturing the degree of modularity embedded in product architectures. J. Prod. Innov. Manag. 23, 128–146. http://dx.doi.org/10.1111/j.1540-5885.2006.00188.x.

Oliva, R., Kallenberg, R., 2003. Managing the transition from products to services. Int. J. Serv. Ind. Manag. 14, 160–172. http://dx.doi.org/10.1108/09564230310474138.

Opresnik, D., Taisch, M., 2015. The value of Big data in servitization. Int. J. Prod. Econ. 165, 174–184. http://dx.doi.org/10.1016/j.ijpe.2014.12.036.

Paiola, M., Saccani, N., Perona, M., Gebauer, H., 2013. Moving from products to solutions: strategic approaches for developing capabilities. Eur. Manag. J. 31, 390–409. http://dx.doi.org/10.1016/j.emj.2012.10.002.

Parida, V., Rönnberg-Sjödin, D., Lenka, S., Wincent, J., 2015. Developing global service innovation capabilities: how global manufacturers address the challenges of market

heterogeneity. Res.-Technol. Manag. 58, 35–44. http://dx.doi.org/10.5437/08956308×5805360.
Parida, V., Rönnberg-Sjödin, D., Wincent, J., Kohtamäki, M., 2014. Mastering the transition to product-service provision: insights into business models, learning activities, and capabilities. Res.-Technol. Manag. 57, 44–52.
Pekkarinen, S., Ulkuniemi, P., 2008. Modularity in developing business services by platform approach. Int. J. Logist. Manag. 19, 84–103. http://dx.doi.org/10.1108/09574090810872613.
Pratt, M.G., 2009. From the editors: for the lack of a boilerplate: tips on writing up (and reviewing) qualitative research. Acad. Manag. J. 52, 856–862. http://dx.doi.org/10.5465/AMJ.2009.44632557.
Raddats, C., 2011. Aligning industrial services with strategies and sources of market differentiation. J. Bus. Ind. Mark. 26, 332–343. http://dx.doi.org/10.1108/08858621111144398.
Rahikka, E., Ulkuniemi, P., Pekkarinen, S., 2011. Developing the value perception of the business customer through service modularity. J. Bus. Ind. Mark. 26, 357–367. http://dx.doi.org/10.1108/08858621111144415.
Ransbotham, S., Kane, G.C., 2011. Membership turnover and collaboration success in online communities: Explaining rises and falls from Grace in Wikipedia. MIS Q. 35, 613–627.
Reim, W., Parida, V., Örtqvist, D., 2015. Product–Service Systems (PSS) business models and tactics – a systematic literature review. J. Clean. Prod. 97, 61–75. http://dx.doi.org/10.1016/j.jclepro.2014.07.003.
Reinartz, W., Ulaga, W., 2008. How to sell services more profitably. Harv. Bus. Rev. 86, 90–96.
Rönnberg Sjödin, D., Parida, V., Kohtamäki, M., 2016. Capability configurations for advanced service offerings in manufacturing firms: using fuzzy set qualitative comparative analysis. J. Bus. Res. 69 (11), 5330–5335.
Salvador, F., 2007. Toward a product system modularity construct: literature review and reconceptualization. IEEE Trans. Eng. Manag. 54, 219–240. http://dx.doi.org/10.1109/TEM.2007.893996.
Settanni, E., Newnes, L.B., Thenent, N.E., Parry, G., Goh, Y.M., 2014. A through-life costing methodology for use in product–service-systems. Int. J. Prod. Econ. 153, 161–177. http://dx.doi.org/10.1016/j.ijpe.2014.02.016.
Silvestro, R., Lustrato, P., 2015. Exploring the “mid office” concept as an enabler of mass customization in services. Int. J. Oper. Prod. Manag. 35, (xxx-xxx. doi).
Simpson, T.W., Siddique, Z., Jiao, J., 2005. Platform-based product family development: introduction and overview. In: Simpson, T.W., Siddique, Z., Jiao, J. (Eds.), Product Platforms and Product Family Design: Methods and Applications. Springer, New York, 1–16.
Smith, W.K., Binns, A., Tushman, M.L., 2010. Complex business models: managing strategic paradoxes simultaneously. Long Range Plan. 43, 448–461. http://dx.doi.org/10.1016/j.lrp.2009.12.003.
Smith, W.K., Lewis, M.W., 2011. Toward a theory of paradox: a dynamic equilibrium model of organizing. Acad. Manag. Rev. 36, 381–403. http://dx.doi.org/10.5465/amr.2009.0223.
Strauss, A., Corbin, J.M., 1990. Basics of qualitative research: grounded theory procedures and techniques. Sage Publications, Inc..
Suárez, F.F., Cusumano, M.A., Kahl, S.J., 2013. Services and the business models of product firms: an empirical analysis of the software industry. Manag. Sci. 59, 420–435. http://dx.doi.org/10.1287/mnsc.1120.1634.
Thomas, L.D.W., Autio, E., Gann, D.M., 2014. Architectural leverage: putting platforms in context. Acad. Manag. Perspect. 28, 198–219. http://dx.doi.org/10.5465/amp.2011.0105.
Tukker, A., 2015. Product services for a resource-efficient and circular economy – a review. *J. Clean. Prod.*, Special Volume: Why have “Sustainable Product-Service Systems” not been widely implemented? 97, 76–91. http://dx.doi.org/10.1016/j.jclepro.2013.11.049.
Turunen, T., Finne, M., 2014. The organisational environment's impact on the servitization of manufacturers. Eur. Manag. J. 32, 603–615. http://dx.doi.org/10.1016/j.emj.2013.11.002.
Tuunanen, T., Cassab, H., 2011. Service process modularization: reuse versus variation in service extensions. J. Serv. Res. 14, 340–354. http://dx.doi.org/10.1177/1094670511413912.
Vähätalo, M., Juhani Kallio, T., 2015. Organising health services through modularity. Int. J. Oper. Prod. Manag. 35, 925–945.
Vandermerwe, S., Rada, J., 1988. Servitization of business: adding value by adding services. Eur. Manag. J. 6, 314–324. http://dx.doi.org/10.1016/0263-2373(88)90033-3.
Vendrell-Herrero, F., Bustinza, O.F., Parry, G., Georgantzis, N., 2016. Servitization, digitization and supply chain interdependency. Ind. Mark. Manag.. http://dx.doi.org/10.1016/j.indmarman.2016.06.013.
Voss, C.A., Hsuan, J., 2009. Service architecture and modularity. Decis. Sci. 40, 541–569. http://dx.doi.org/10.1111/j.1540-5915.2009.00241.x.
Wareham, J., Fox, P.B., Cano Giner, J.L., 2014. Technology ecosystem governance. Organ. Sci. 25, 1195–1215. http://dx.doi.org/10.1287/orsc.2014.0895.
Windahl, C., Lakemond, N., 2006. Developing integrated solutions: the importance of relationships within the network. Ind. Mark. Manag., IMP 2005: Dealing with Dualities 35, 806–818. http://dx.doi.org/10.1016/j.indmarman.2006.05.010.
Yin, R.K., 2013. Case Study Research: Design and Methods. SAGE Publications, Thousand Oaks, CA.
Yoo, Y., Boland, R.J., Lyytinen, K., Majchrzak, A., 2012. Organizing for innovation in the digitized world. Organ. Sci. 23, 1398–1408. http://dx.doi.org/10.1287/orsc.1120.0771.
Zhang, L.L., 2015. A literature review on multitype platforming and framework for future research. Int. J. Prod. Econ. 168, 1–12. http://dx.doi.org/10.1016/j.ijpe.2015.06.004.