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ORGANISING DEVELOPMENT PROCESSES: THE CASE OF PRODUCT–SERVICE SYSTEMS

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This study addresses the development of new integrated product–service systems (PSSs). Most empirical research on the organisation of development processes has focussed on new product development, new service development, software development and new business model development in isolation; however, the development of new, complex PSSs that require the integration of these development efforts has received limited research attention. We address this literature gap through a qualitative, in-depth study of five firms operating in the business-to-business context. The findings demonstrate that all new PSS development processes did not implement and use one specific process model. Instead, the organisation of new PSS development processes was contingent upon the type of services

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to be offered and the target business model. This study proposes a contingency framework for development processes that provides considerable guidance to managers searching for ways to facilitate the processes of developing new PSSs.

Keywords: Business model innovation; development processes; innovation processes; new product development; new service development; product–service systems; servitisation; Stage-Gate.

Introduction

To maintain a competitive advantage, an increasing number of manufacturing firms now deliver integrated product–service systems (PSSs) instead of pure products (Lightfoot *et al.*, 2013; Baines *et al.*, 2009). A PSS may be defined as 'tangible products and intangible services designed and combined so that they jointly are capable of fulfilling specific consumer needs' (Tukker, 2004, p. 246). Furthermore, firms providing PSSs often use digital technologies such as sensors, connectivity and data analytics that enable the provision of smart digital services (Parida *et al.*, 2019), as well as new forms of business models (BMs) (Aas *et al.*, 2020). Such PSSs, where firms integrate products, services and digital components, are sometimes referred to as product–service–software systems (PSSSs) (Kohtamäki *et al.*, 2019).

The phenomenon of creating new revenue streams 'by adding services to products', referred to as the servitisation of manufacturing (Baines *et al.*, 2013), is not new and has received research attention for more than 30 years (Paschou *et al.*, 2020). Empirical research suggests that the transition from product- to service-oriented BMs is very challenging for firms and that organisational dimensions such as culture and structure need to change during the transition process (Baines *et al.*, 2017). However, further empirical research on the characteristics of new PSS development processes as well as on how the development of different components of PSSs is managed and coordinated by servitised firms has remained scarce (Zhang and Banerji, 2017). To address this research gap, recent studies suggest a flexible Agile co-creation development model for the digital software components of PSSs (Sjödin *et al.*, 2020) and corresponding BMs (Linde *et al.*, 2021).

Although these contributions are valuable, PSSs do not comprise digital software components alone. They fulfil customer needs by integrating different types of value propositions (Tukker, 2004), often including complex bundles of products, traditional services and smart software-enabled digital services; these are delivered either through complex and innovative BMs or through more traditional BMs (Aas *et al.*, 2020) by organisations or ecosystems with varied structures (Kohtamäki *et al.*, 2019; Baines *et al.*, 2017). Therefore, the development of new

PSSs is seldom about the development of products, services, software or new BMs in isolation; rather, it is about integrating many development initiatives in different and intertwined areas in a manner that leads to a new effective PSS.

Thus, choosing an approach for new PSS development is not always straightforward. Literature discussing PSS development processes acknowledges that both plan-oriented and Agile approaches may have advantages and disadvantages depending on the situation (Dziallas, 2020; Ghezzi and Cavallo, 2020). For example, Agile approaches may be particularly relevant in dynamic environments when the firm is aiming for radical innovation, whereas plan-oriented approaches may be more relevant in less dynamic environments when the firm aims for incremental innovation (Bianchi *et al.*, 2020).

Therefore, whereas Agile development approaches may be preferred for some PSS components in certain situations, as recently suggested by Sjödin *et al.* (2020) and Linde *et al.* (2021), plan-oriented approaches such as Stage-Gate (Cooper, 1983), may be preferred for other components. However, how these approaches are combined and affected by contingency factors remains unclear. This study aims to continue the debate on contingency factors by qualitatively exploring the development approaches and principles that manufacturing firms utilise when developing new PSSs. In contrast to previous research (Sjödin *et al.*, 2020; Linde *et al.*, 2021), we discuss not only the development of PSSs' digital software components but also how introducing and developing new digital components is integrated into the development of other vital PSS components such as tangible products and traditional services, sometimes including new BMs (Aas *et al.*, 2020). Hence, we pose the following research questions (RQs): (1) What development process approaches are used when new PSSs are developed? (2) What are the contingency factors affecting the choice of development process approach when new PSSs are developed? (3) In what situations are different development process approaches appropriate for the development of new PSSs?

Exploring development processes in the complex context of PSSs is also relevant for firms offering less complex value propositions such as standalone products or services, because they may clarify how and why certain contingencies need to be in focus. Thus, by studying the development processes of PSSs and addressing the RQs, we advance knowledge on the wider area of how development processes may be organised.

To answer the RQs, we build on the contingency theory of organisations (Donaldson, 2001); we conducted a case study of five firms from a business cluster of firms providing PSSs in particular to the energy and maritime sectors. Our findings demonstrate that the characteristics and management of the development processes are contingent upon the BM and type of value proposition being developed.

In this study, we first provide an overview of the literature on PSSs and on development processes, resulting in a contingency framework for new PSS development processes in four different contextual situations. Next, we describe the firms in our case study and present our data collection and analysis. Thereafter, we present our findings following the four anticipated contextual situations; the findings are discussed in relation to existing theory and the anticipated contingency framework, thus nuancing and extending existing theory, exposing our contribution as the contingency framework for new PSS development processes and offering four theoretical propositions. We conclude by presenting the theoretical and practical implications of our findings and by suggesting possible avenues for further research.

Theoretical Background

Product–service systems

In recent years, the share of manufacturing firms' turnover and value added resulting from the provision of services has increased (Kowalkowski *et al.*, 2017), and many manufacturing firms have undergone a servitisation process to deliver integrated bundles of products and services (Baines *et al.*, 2017) or so-called PSSs (Pawar *et al.*, 2009). The term 'PSS' has been employed for more than 20 years (Goedkoop *et al.*, 1999); it was originally used in a number of policy reports arguing that combining products and services led to the use of fewer physical resources, resulting in environmental sustainability via the reduction in the harmful environmental impact of consumption (White *et al.*, 1999). Now, however, the term is often used more generally to describe the integrated solutions offered by servitised manufacturing firms (Tukker, 2015; Tukker and Tischner, 2006).

The BMs utilised may vary among PSSs (Lay *et al.*, 2009). A BM 'defines how the enterprise creates and delivers value to customers and then converts payments received to profits' (Teece, 2010, p. 179); a seminal article by Tukker (2004) placed different BMs used in PSSs on a continuum from pure product-oriented BMs, via use-oriented BMs, to pure result-oriented BMs. Here, product-oriented BMs refer to BMs that are 'mainly geared towards sales of products, but some extra services are added' (Tukker, 2004, p. 248); use-oriented and result-oriented BMs, in contrast, do not focus solely on product sales. Rather, 'the product stays in ownership with the provider, and is made available in a different form' (p. 248) in use-oriented BMs; in results-oriented BMs, 'the client and provider in principle agree on a result, and there is no pre-determined product involved' (p. 248). According to Tukker's (2004) categorisation, the product orientation decreases

and the service orientation increases as a manufacturer moves from product-oriented, via use-oriented, to results-oriented BMs.

Tukker's (2004) categorisation has been used and extensively cited in the literature (Adrodegari *et al.*, 2015). However, whether the three categories suggested by Tukker (2004) belong on the same continuum has been questioned. Aas *et al*. (2020, 2021), for example, argue that results-orientedness and ownership belong on different continuums. They suggest that as manufacturers transition from product-oriented to results-oriented BMs, service orientation increases without necessarily passing through use-oriented BMs. Consequently, they suggest a categorisation of PSS BMs that is more fine-grained than Tukker's categorisation (Aas *et al.*, 2020, 2021). Other PSS BM categorisations have also been suggested (see Adrodegari and Saccani (2017) for an overview), and many do not distinguish between whether product ownership is transferred to the customer (Kohtamäki, 2019; Visnjic *et al.*, 2016). Nevertheless, the distinction between product-oriented and results-oriented BMs seems to be a common feature of the various PSS BM typologies and taxonomies.

Similar to BMs varying among different PSSs, the types of services offered also vary (Pawar *et al.*, 2009). Mathieu (2001) proposed a framework distinguishing services supporting the product from services supporting the customer. Baines and Lightfoot (2013, 2014) used different customer profiles as a basis for categorising services offered by the manufacturer into base services (for 'do-it-yourself' customers), intermediate services (for customers who want the manufacturer to do it with them) and advanced services (for customers who want the manufacturer to do it for them).

Further, manufacturers increasingly deploy digital technologies when they provide PSSs (Parida *et al.*, 2019). The transformation towards the utilisation of digital technologies in PSSs, or more specifically PSSSs, is referred to as 'digital servitisation' (Holmström and Partanen, 2014; Sklyar *et al.*, 2019); literature describes digital technology both as a driver and an enabler of servitisation (Vendrell-Herrero *et al.*, 2017).

Integrating digital technologies such as sensors, connectivity and data analysis capability into physical products (Björkdahl, 2009) enables, for example, the provision of remote monitoring services related to product location, condition, use and performance (Bharadwaj *et al.*, 2013); it also enables PSS providers to act on the data analysis results (Baines and Lightfoot, 2013). Literature often distinguishes such services from traditional services, referring to them as 'smart' services — services that 'go beyond the kinds of up-keep and upgrades [firms] may be bundling with [the firm's] products, both in their value to customers and in their cost efficiency to [the firm]' (Allmendinger and Lombreglia, 2005, p. 1). According to Lim and Maglio (2019), many definitions of smart services exist, but

a common requirement in most of them is intensive data use, as indicated in the following definition proposed by Lim *et al.* (2016, p. 938): 'Smart service systems are those service systems in which connected things and automation enable intensive data and information interactions among people and organizations that improve their decision making and operations'.

Development processes

Extant literature has proposed numerous different development process models (De Jong and Vermeulen, 2003). These models may be classified on a continuum ranging from flexible iterative models on one end to linear plan-oriented models on the other (Petersen and Wohlin, 2010). Agile is a prominent example of a flexible iterative approach, whereas the Stage-Gate and Waterfall models are prominent examples of linear plan-oriented approaches (Cooper and Sommer, 2016).

The Stage-Gate model was originally suggested by Cooper in the 1980s as a step-by-step approach to managing new product development (NPD) processes (Cooper, 1983, 2008); further, an article by Royce (1970) is often recognised as the first publication suggesting a sequential Waterfall model to manage software development processes. The core idea behind both approaches is simple; it revolves around improving efficiency and reducing uncertainty by (1) dividing the development process into a set of predefined stages such as scoping, development and testing, through which the new products or software are developed and (2) establishing decision gates between each stage, where gatekeepers use predefined criteria to decide whether the development project should be allowed to continue to the next stage (Petersen and Wohlin, 2010; Cooper, 1990). Thus, like other linear plan-oriented models, both models expose a deterministic view of development as processes that can and should be planned in advance and thereafter implemented and controlled (Paluch *et al.*, 2020; Hirsch, 2005).

In contrast, flexible iterative development approaches such as Agile do not perceive development as deterministic processes that can be fully planned in advance (Dybå and Dingsøyr, 2008). Instead, these are understood as stochastic evolutionary processes comprising many small increments and iterations (Cram and Newell, 2016). By involving different actors, including customers, in evaluating the results of each iteration, uncertainties, weaknesses and new opportunities are discovered early and can be addressed in the following iteration (Paluch *et al.*, 2020). This is in contrast to plan-oriented approaches, where uncertainties and opportunities need to be identified upfront. Thus, the ability to learn, accommodate and adapt to changes in a dynamic environment is at the core of flexible iterative

development processes such as Agile (Qumer and Henderson-Sellers, 2006; Campanelli and Parreiras, 2015).

Different flexible and iterative development approaches for software development had already emerged during the 1990s in response to the criticism that plan-oriented development models such as the Waterfall model, were too regulated and inefficient, especially in a dynamic environment (Martin, 1991; Kerr and Hunter, 1993). Research on flexible iterative software development methods accelerated after the Agile Manifesto was published in 2001 (Jackson, 2012); today, Agile is often used as a collective umbrella term for a range of flexible and iterative development tools, practices and approaches such as Scrum, Kanban and Extreme Programming (Dingsøyr *et al.*, 2012; Abrahamsson *et al.*, 2010). Although Agile development approaches were initially suggested for software development, their practices have recently been suggested for other development contexts, including NPD (Cooper and Sommer, 2016), new service development (NSD) (Lankhorst, 2012) and new BM development (Linde *et al.*, 2021). However, owing to the differences between software development and other development contexts, the adaptation of Agile to the specific context is often suggested; one example is the Agile–Stage-Gate hybrid model proposed for NPD (Cooper and Sommer, 2016).

Theoretical assumptions

This study aims to advance the debate on how contingency factors affect the development of new PSSs. The contingency theory of organisations (Donaldson, 2001) served as the basis for developing broad theoretical assumptions related to (1) what development process approaches are used when new PSSs are developed (RQ1), (2) what contingency factors affect the choice of development approach when new PSSs are developed (RQ2) and (3) in what situations are different development approaches appropriate for the development of new PSSs (RQ3). According to the contingency theory, the optimal way to manage activities in organisations is dependent upon the contextual situation or, in particular, a set of contingency factors (Tosi and Slocum, 1984). These contingency factors can, for example, be related to the environment surrounding the organisation, the organisational structure and the organisational strategy (Burns and Stalker, 1961; Chandler, 1962; Child, 1975).

A contingency approach is generally employed in research on development processes, and empirical research confirms that the advantages and disadvantages of a specific development approach typically vary between different contexts (Mills *et al.*, 2020). Research in the software development context, for example, indicates that plan-oriented development models may be advantageous when requirements are well known and when quality is important, whereas Agile

development processes may be advantageous when the users are unsure of their needs (Kramer, 2018; Alshamrani and Bahattab, 2015). Furthermore, research on NSD (Aas *et al.*, 2015; Zomerdijk and Voss, 2011), NPD (Salvato and Laplume, 2020) and BM innovation (Frankenberger *et al.*, 2013; Laudien and Daxböck 2017) confirms that both plan-oriented and Agile development processes are successfully used in different situations.

Thus, a suitable development model that fits all situations hardly exists. Instead, the model chosen depends on various contingency factors (Paluch *et al.*, 2020). The debate on the relevant contingency factors is still ongoing (Cooper and Sommer, 2016), but based on numerous recent empirical studies, Paluch *et al.* (2020) suggest that the development model is chosen partly based on (1) the degree of newness and (2) the development task requirements. In particular, Paluch *et al.* (2020) suggest that Agile models may be relevant for radical projects when development tasks are not well understood, and plan-oriented models (such as Stage-Gate) are apt for incremental projects with well-understood task requirements; a combination (such as Agile–Stage-Gate hybrid models) is proposed for incremental projects when development tasks are not well understood. Furthermore, Paluch *et al.* (2020) refer to Fecher *et al.* (2020) and suggest that the establishment of temporary organisational entities composed of teams working in an Agile mode detached from their organisation is relevant for radical projects when development tasks are well understood.

However, contingency factors may vary between different types of development contexts, and further research focussing on specific contexts is needed for better understanding this phenomenon (Paluch *et al.*, 2020). To bridge this gap, we study the new PSS development context. We expect that manufacturing firms perceive the development of new PSSs targeting smart digital services as innovation activities with a relatively high degree of newness (Kowalkowski *et al.*, 2021) and the development of PSSs aiming to offer more traditional services as less radical. We also expect that the development of PSSs aiming to utilise results-oriented BMs is a development task typically not well understood by manufacturing firms and their customers (Luotola, 2017), whereas the development of PSSs aiming to utilise product-oriented BMs is better understood.

Thus, according to Paluch *et al.*'s (2020) contingency framework, it is reasonable to assume that when smart digital services in combination with results-oriented BMs are targeted, Agile development models are often used, as confirmed by research (Sjödin *et al.*, 2020; Linde *et al.*, 2021). However, when smart digital services combined with product-oriented BMs are targeted, a combination of Agile and plan-oriented development models such as an Agile–Stage-Gate hybrid model, may be used. Further, when traditional services in combination with product-oriented BMs are targeted, pure plan-oriented development models such

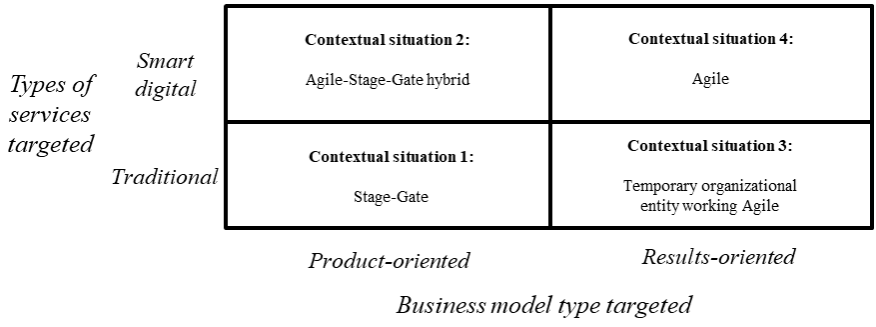

Fig. 1. Assumed contingency framework for new PSS development processes.

as the Stage-Gate model, are expected to be used. Based on the same framework (Paluch *et al.*, 2020), we also assume that the development process is organised in a temporary organisational entity working in an Agile mode when traditional services in combination with results-oriented BMs are targeted. Figure 1 summarises our assumptions.

Empirical research is needed to confirm or refute these assumptions and to deepen our understanding. Against this backdrop, we conducted our empirical investigation.

Research Method

Research approach

We used a qualitative case(s) study approach (Johnson and Harris, 2003; Edmondson and McManus, 2007; Yin, 2014) to explore how new PSSs are developed in the digital era and to answer our RQs. In particular, we adopted the flexible pattern matching approach, which allows for iteration between theory and data (Bouncken *et al.*, 2021a); this abductive approach gives equal weight to theoretical and empirical patterns to spot both consistencies and mismatches between them. It continuously does so from the early theoretical ideas and first empirical observations to the final matching of theoretically motivated patterns with organised and observed ones (Bouncken *et al.*, 2021a).

Case selection

Following the RQs, the unit of analysis is the development process of PSSs. To explore new PSS development processes, we first had a dialogue with the management of a business cluster of leading Norwegian manufacturing firms offering PSSs to the energy, maritime and aviation sectors. In this dialogue, we explained

Table 1. An overview of the firms and the empirical material.

Firm	Offering	Discussion meetings	Workshops	Semi-structured interviews
Alpha	Engineering, procurement, fabrication, transportation, construction, installation supervision and project management (on an engineer-to-order basis)	3	3	15
Beta	Tailor-made drilling equipment and systems and related life-cycle services such as training and remote diagnostics and online support	3	3	17
Gamma	Lifting equipment and related life-cycle services such as training, remote diagnostics and online support	3	2	11
Delta	Custom-made operator chairs in small series and corresponding services	2	1	7
Epsilon	Lay-flat hoses and corresponding life-cycle services; sensor hoses as future prospects	3	1	16
All	*Experience Exchange Workshop*		*1*	
Total		14	10	66

our theoretical ideas and made our first empirical observations. Based on the dialogue and theoretical sampling, we selected five servitised firms as case organisations (presented in Table 1).

All five firms strategically focussed on innovation and had several ongoing and completed new PSS development initiatives in their innovation portfolios, which made them comparable and relevant for the study. However, the firms' sizes and their degree of service orientation varied; further, they came from different parts of the industry value chain. More importantly, several development processes seemed to play a role in the firms that differed in the degree of service orientation and digitalisation of the PSS under development. Thus, in line with the idea of theoretical sampling, our case organisations provided an opportunity to compare and contrast firms and development processes with different characteristics and to gain a deeper understanding of the phenomenon (Yin, 2014).

Data collection

To reflect the overall new PSS development processes, between 7 and 11 employees in different roles and at different firm levels were interviewed in each

firm. In total, 66 semi-structured, in-depth, face-to-face interviews were conducted; our informants included managers serving at both top and middle management levels as well as key employees and technical experts involved in new PSS development.

Drawing on theory on PSS and development processes, we developed an interview guide for semi-structured interviews — that is, directing without restricting. The informants were asked for examples to ensure reliable interpretations (Korstjens and Moser, 2018). Accordingly, we started with broad, open-ended questions about concrete ongoing and completed new PSS development processes. For example, the informants were asked: Can you mention examples of new PSSs that you have recently developed or are currently developing? Can you describe the process of developing new PSSs? How do you organise the development process of new PSSs? What activities are conducted when you develop new PSSs? Who is involved in the different activities? We continued asking follow-up questions regarding the use of concrete development process approaches such as Stage-Gate or Agile, and the development of different PSS components. The duration of each interview was 1–1.5 h, and the interviews were recorded and transcribed.

In addition to data collection via interviews, we engaged in several discussions with the firms by participating in 10 internal workshops and 14 discussion meetings regarding specific new PSS development activities. Employees and managers key to the servitisation efforts attended the workshops and meetings within the firms and were all among the interviewees. Our participation in these workshops and meetings gave us rich information about the ongoing challenges and dilemmas experienced by the case organisations. During the workshops and meetings, we took detailed notes that were used with the interview transcripts for data analysis. The workshops and meetings also enabled us to complement and triangulate our initial findings from the interviews. Table 1 summarises our data collection efforts.

We also obtained data from documentation on the firms' strategy and innovation processes in different contexts. This documentation enriched our understanding of the phenomenon and helped in triangulating our understanding of the interviews.

Data analysis

The empirical data analysis is inspired by the flexible pattern-matching approach (Bouncken *et al.*, 2021a), which is employed for theory-building in qualitative studies, particularly in areas where the current understanding allows researchers to

derive theoretical assumptions before collecting and analysing empirical data (Sinkovics, 2018). The analysis is based on a comparison of the empirical data and theoretical assumptions and uses revealed mismatches for refining and extending existing theory (Bouncken *et al.*, 2021b).

Based on existing theory (Paluch *et al.*, 2020), we anticipated that new PSS development processes would be contingent upon the BM and the types of services targeted. We therefore first categorised all the new PSS development projects in our empirical data into four categories targeting the following: (1) product-oriented BMs and traditional services, (2) product-oriented BMs and smart digital services, (3) results-oriented BMs and traditional services and (4) results-oriented BMs and smart digital services.

For each category, we noted the characteristics of all identified new PSS development projects, including the PSS components under development and the alignment of the components' development. For instance, in the case of a new PSS development project involving the creation of a new service, a new BM and a new physical product, we analysed how the development process was organised. We examined whether it was treated as a single project or divided into multiple smaller projects. Further, we observed how the development teams responsible for different components collaborate and noted any overlaps in the personnel involved in the components' development. Thereafter, we coded and categorised information about the characteristics of the development processes and whether specific development models or approaches such as Agile, Stage-Gate or Agile–Stage-Gate hybrid, had been used or combined; we also searched for patterns within each of the four categories. Finally, we compared the categories to verify whether our empirical findings confirmed the anticipated impact of BMs and the type of service on development processes.

To enhance the trustworthiness of the analysis and confirm our findings (Lincoln and Guba, 1985), the results were presented to and discussed with our informants in a second round of interviews and in workshops and discussion meetings conducted at different time points. Moreover, comparing the insights from different informants provided additional rich data on how new PSSs were developed in the case organisations, further strengthening the credibility of the data (Shenton, 2004). To ensure robustness in our data analysis, we employed investigator triangulation (Denzin, 1978) by involving multiple researchers. Our team comprised four senior researchers; all participated in the data collection. Each interview was conducted by at least two researchers. Following the interviews, all four researchers read and reviewed the transcriptions. The data analysis was initially conducted by one researcher (the first author) and subsequently reviewed by the other three researchers; iterative and comprehensive

discussions were conducted until a unified interpretation and consensus was achieved.

Findings

The case organisations had many new PSSs that had recently been successfully developed and launched in the market or were under development. As expected, these varied in terms of both the types of services offered (smart digital services vs. traditional services) and the BM targeted (product-oriented BM vs. results-oriented BM). Our analysis revealed systematic variations related to how new PSS development processes were organised. In the following, we expose how the new PSS development processes were organised in the four anticipated contextual situations (see Fig. 1).

Contextual situation 1: New PSS development processes targeting product-oriented BMs and traditional services

Although most firms in our sample had a long-term ambition to deliver smart digital services and transform their BMs from product orientation towards results orientation (documents), the combination of product-oriented BMs and traditional services still dominated. One top manager at Beta explained:

> *Traditionally, service offerings in our firm have consisted of the sale of spare parts and service engineers that travel to the customer's rig and repair the equipment. It used to be quite a small part of our business, but the sale of spare parts and the sale of service engineering services grew quite a lot until 2012 and is still important.*

Another informant, a manager responsible for after-sales services at Gamma, said:

> *So, in principle, we [after sales] take over the products after our product development department has built them and delivered them to the customer.…We provide services such as spare parts, technical support services. We also help the customer if he needs to make technical changes to the equipment, extend the equipment's lifetime and many other such things. We also offer training in a simulator. And we also have a 24/7 agreement with the customer. They can call us and ask for help.*

Our findings suggest that when developing new PSSs targeting product-oriented BMs and traditional services, the development projects comprised two components: NPD and NSD. These were conducted by two separate teams — a product team and a service team — with very little interaction. Examples of this practice were evident in all case organisations in our sample. A manager at Gamma explained:

> *We [the department of after-sales services] and the department of product development are in different 'silos'. . . .Normally the product development department just delivers the new equipment — for example, a new winch — to the customers. Then it is up to the customer later to look at what type of services they need to operate and maintain the equipment. It varies what the customers want from us. Some just don't want to touch the equipment; others want to do everything themselves.*

The companies used different development models for NSD and NPD when developing new PSSs targeting product-oriented BMs and traditional services. Formal plan-oriented development models were typically used to manage the idea-to-launch processes of NPD in this contextual situation, as a top manager at Epsilon described:

> *When we develop new products, we do a real business case and see whether this is financially justifiable, that is, payback time and such things, and during the development process, we use a Stage-Gate system. . .*

The NSD processes, in contrast, were typically managed ad hoc, often with strong customer interaction and without using a specific plan-oriented or Agile development model. For example, a manager at Gamma identified the access to end-user information in this way:

> *Even if we deliver the equipment to the yard and have a contract with the yard, we also have a connection to the end-users of our equipment. We especially have a good relation with them when we provide training services. Then the end-users come to us. . . . This is very valuable for us. The instructor of the course gets a lot of information from the end-users about how we can 'support' them and such. It is incredibly important for us to get this*

information, and we use it to offer new services. But there is certainly a greater opportunity than what we use today.

Contextual situation 2: New PSS development processes targeting product-oriented BMs and smart digital services

We also found several examples of new PSS development projects aiming to combine product-oriented BMs and smart digital services. One illustrative example is the 'be attentive' (anonymised) PSS developed by Gamma and described by a manager as follows:

On the advanced cranes that we deliver, we have developed an online system. We offer what we call a ['be attentive'] contract. It is a bit like this: If the customer calls in and has problems and needs help with a crane, then we can connect to the crane, download information, and be online with the crane when the customer runs their operations. We can run diagnostics to find out what is causing problems and come up with solutions. . .

These PSS development processes comprised two components, NSD and NPD, which were typically conducted by two separate teams that undertook different steps from idea to launch. The two development processes were synchronised only to a limited degree. The digital smart services were typically developed after having launched the product. Nevertheless, some collaboration and interaction between the NSD and NPD teams were necessary because the integration of digital components such as sensors to develop and provide the services, had to be incorporated in or aligned with the product designs. For example, an innovation manager at Delta explained how, after having launched the product, they digitalised the client interface with an opportunity to tailor product specifications through a web-based ordering system:

After the launch of this new product, we started developing a web shop based on our electronic product catalogue, where clients can order and specify special product requirements. Our ambition is to integrate the web shop with our suppliers to enable the automation of orders of product parts from suppliers. The development of this functionality is performed by our IT staff in collaboration with our product unit.

We also found that the development processes in this contextual situation were more complex than those in contextual situation 1. Whereas plan-oriented development models were typically used to manage the idea-to-launch processes for the NPD, the NSD processes were inspired by Agile. The processes were typically run by a team of experts in digital NSD. A top manager at Gamma explained:

> *We have established a separate R&D group centrally in [Gamma] responsible for digitalisation. We have moved most of our digital experts into that group. This group was responsible for the ['be attentive'] development project. . . .They also run many other development projects. [Rubin (anonymised)] is one example. . . .This system transfers critical data from the vessels to a central hub. . .*

Whereas the NSD processes were coordinated and managed by NSD experts, people with in-depth knowledge about customer needs — either the customers themselves or internal staff with customer insights — were also continuously involved in each iteration. A manager from the after-sales service department at Gamma explained:

> *The ['be attentive'] project was run by the R&D group in [Gamma], but we [the after-sales service department] also had a role in the project. . . .My role in this context was mostly guidance. I tried to suggest smart solutions. We were involved in all three design reviews that were run in the project. . . .One of the reviews was a reference review and quite elementary stuff. . . .We also gave advice related to maintenance. Are these bolts available? Are you able to dismantle the equipment?. . .Then, of course, there is operation. I was on a rig earlier, and it was incredibly impractical to have those buttons 'there'; it seemed intuitively wrong. So we provide input to the R&D group on such things. . . .We also provide our inputs related to the use of sensors. It is almost like if you increase the number of sensors, you increase the number of errors as well. . . .It is often the connection between sensors that is important and not the number of sensors. . .*

Contextual situation 3: New PSS development processes targeting results-oriented BMs and traditional services

The case organisations were involved in a few PSS development activities targeting results-oriented BMs and traditional services. One example was the

engineers at Gamma doing maintenance jobs as part of a results-oriented contract (documents). Another example was found in an interview with a senior manager at Gamma, who explained how they had developed a combination of two PSSs that replaced the need for a costly service operation in relation to a pipe that had to be shielded. According to the manager, the service was 'not smart at all'; nevertheless, the BM was results-oriented.

Alpha had also developed a results-oriented service through its transportation operations that could be added to an engineering, procurement, construction (EPC) or and EPC management (EPCM) project. The transportation service was not digitalised; it contained elements of results orientation through early completion bonuses and heavy delay sanctions.

The development of such PSSs involved NSD and NPD, as in contextual situation 2; however, an additional dimension of the new PSS development project was related to BM innovation. The BMs were typically iteratively developed in close collaboration with the customers to enable their development to benefit both parties. The manager responsible for this process at Beta described its development as follows:

> *This was a process that started three years ago, where we really came up with an approach for them [the customer]. . . .[The customer] said that they had made a strategic decision and wanted to find the best business model for the future. They had done a process internally where they had written up on the board what their aim was and their suppliers' aims were, and it didn't fit at all. So they wanted a business model that put us in the same chair, really.*

Furthermore, owing to the performance orientation of the contracts in this contextual situation, the firms had a strong incentive to design and develop products that were easy to operate and maintain (documents). They achieved this by increasing the coordination between the NPD and NSD teams and by using plan-oriented approaches for the integrated NPD and NSD processes.

Contextual situation 4: New PSS development processes targeting results-oriented BMs and smart digital services

Most case organisations aimed to provide PSSs offering smart services through results-oriented BMs. This aim was driven by the belief that securing a competitive advantage is easier for firms that can build long-term relationships with customers than for firms that cannot. A top manager at Gamma explained:

> *If you are a pure equipment manufacturer, it is difficult to make money. You earn very little. Those who make money today are those who deliver software or pure services where you have the entire 'life-cycle' of the product. They often deliver 'hardware' too, but at a relatively low price, and they serve the customer throughout the lifetime. They build a strong customer relationship, and their revenue is much more predictable than our revenue. Certainly, if you get the products digitised in a good way and you can offer services and, to a great extent, sit and monitor the equipment for the customer, then it is clear that you get the aftermarket, too. It's really important.*

Although most case organisations aimed to provide smart digital services through results-oriented BMs, we identified relatively few examples of such PSSs already being implemented. Beta had recently established a long-term, results-oriented, full-service contract with a rig operator through which they utilised digital technology (documents). A manager at Beta explained:

> *It is a contract with a lot of small print, but in a simplified way, it can be explained like this: The customer gets a fixed price and an up-time commitment from us for ten years. With that, they get a discount of 20%. And then we get a penalty if the downtime is too high and a bonus if the customer gets higher earnings. The penalty and bonus elements are not so difficult, but it does show that the intention is that they [the customer] have the rig available as much as before or more. And they have got a 20% discount, and if we do more than that, we have an upside. So if we utilise modern digital systems and manage to spend less on maintenance than the 20% we have given in a discount, then we have an upside.*

The development process of new PSSs targeting results-oriented BMs and smart services in the case organisations comprised three components: NPD, NSD and new BM development. In this contextual situation, the development of these components was intertwined and conducted by a united cross-functional development team in close collaboration with other ecosystem actors. A top manager at Beta explained:

> *I [the digitalisation department] am responsible for developing digital technology,...but it is another part of the organisation [the aftermarket division] that...provides the services. Before [when we used product-based contracts], it was just about*

> *sending out a man with a coverall, and our role was to make technology that was useful for him. . . .Now, with results-oriented business models, we work much more in collaboration than before. So that's a big change. . . .They [the product development department] will learn a lot from what we do to understand what the problem with the equipment is. They will learn that we have some machines that are practically impossible to destroy, so the customer doesn't really care. And they are going to learn that other things are broken unexpectedly quickly. . .*

Other informants provided similar descriptions. A top manager at Gamma, for example, reflected:

> *I think it is completely wrong to distinguish between new service and new product development. It might have been correct before when it was a much larger volume and the oil companies queued up and called for spare parts, but now that you are moving more and more towards a 'life-cycle race', it is clear that you have to gather the value chain in one organisation.*

The development of the PSS components in this contextual situation was intertwined and conducted by united cross-functional development teams, and a combination of plan-oriented and Agile development models was typically used to manage the idea-to-launch processes. In practice, Stage-Gate systems were often used as a guiding framework accompanied by Agile approaches in one or several stages. The typical practice may be exemplified with the process implemented at Gamma. During one of the workshops at Gamma, the following model for new PSS development was presented by the management.

Even if plan-oriented models such as Stage-Gate were often used as an overarching framework in our case organisations when targeting results-oriented BMs and smart services, the importance of using Agile principles in some stages (as illustrated in Fig. 2) was highlighted by several informants. One manager at Beta stated:

> *We have learned a lot from being agile and working closely with customers.*

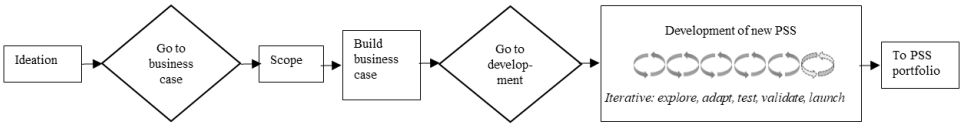

Fig. 2. New PSS development process at Gamma.

Discussion and Conclusions

Previous research on new PSS development processes focussed on the development of different PSS components such as digital services (Sjödin *et al.*, 2020) or new BMs (Linde *et al.*, 2021), in isolation. Our study shows how the NPD, NSD and new BM development processes are intertwined during new PSS development. Our data confirm our assumption that new PSS development processes are contingent upon both the type of services and the BM targeted. Our detailed findings for the four contextual situations are now discussed in light of our theoretical assumptions (Fig. 1).

Contextual situation 1

In contextual situation 1, product-oriented BMs and traditional services are targeted. Based on Paluch *et al.*'s (2020) framework, we assumed that plan-oriented development models such as the Stage-Gate model, would be used here. This was partly confirmed by our empirical data. Plan-oriented development models were used to manage the development of the physical products to be included in the new PSSs. These findings correspond with the results from NPD research (Barczak and Kahn, 2012). Although novel development models are discussed for NPD (Cooper, 2016), empirical research still recognises plan-oriented Stage-Gate models as a well-functioning practice (Markham and Lee, 2013); further, because NPD in this contextual situation may be a task that is well understood by manufacturers, the use of plan-oriented development models is not surprising (Paluch *et al.*, 2020).

However, in contrast to our initial assumptions, the development of the services to be included in the new PSS was only aligned with NPD to a very limited degree. This finding can probably be explained by the nature of the product-oriented target BM; products are at the core, and services are offered as an additional value proposition after selling the product (Aas *et al.*, 2020). Thus, developing products first and corresponding services thereafter in separate processes is possible, as practised by the firms in our sample.

Our findings suggest that the NSD processes in this contextual situation could be described as ad hoc; they were performed without using a specific development model, in line with the results of NSD research (De Jong and Vermeulen, 2003; Randhawa and Scerri, 2015). NSD literature often describes NSD processes as more ad hoc than NPD, especially when traditional services without a technological component are developed (De Jong and Vermeulen, 2003; Zomerdijk and Voss, 2011), as is the case of contextual situation 1. Therefore, we offer the following proposition:

P1: In the contextual situation of new PSS development targeting product-oriented BMs and traditional services, NPD and NSD are separated and follow plan-oriented and ad hoc approaches, respectively.

Contextual situation 2

In contextual situation 2, product-oriented BMs and smart services are targeted. Based on Paluch *et al.*'s (2020) framework, we assumed the use of Agile–Stage-Gate hybrid models. However, although both Agile and Stage-Gate models were used by the case organisation, we did not find any evidence of the use of hybrid models. Instead, as in contextual situation 1, NSD and NPD processes were found to be loosely aligned. Furthermore, Agile was used for NSD, whereas Stage-Gate was used for NPD. The nature of product-oriented BMs (Aas *et al.*, 2020) can probably explain why NSD and NPD are only loosely aligned, whereas the use of Stage-Gate for NPD may be explained by the low degree of task uncertainty (Paluch *et al.*, 2020).

The finding on the use of Agile for NSD aligns well with recent empirical research on digital service innovation (Sjödin *et al.*, 2020). Similar to Sjödin *et al.* (2020), we found that Agile approaches were used when smart digital services were developed; this is in line with Paluch *et al.*'s (2020) framework, as the customer needs are probably not well-understood upfront and as the development of these services has a high degree of newness for manufacturing firms. We offer the following proposition:

P2: In the contextual situation of new PSS development targeting product-oriented BMs and smart digital services, NPD and NSD are aligned and follow plan-oriented and Agile approaches, respectively.

Contextual situation 3

In contextual situation 3, results-oriented BMs and traditional services are targeted. Based on Paluch *et al.*'s (2020) framework, we assumed the establishment of a temporary organisational entity working in an Agile mode to develop new PSSs. However, the implementation of such entities working in an Agile mode detached from the organisations, as described by Paluch *et al.* (2020) and Fecher *et al.* (2020), was not found. Nevertheless, we found that NPD and NSD were aligned and intertwined and that cross-functional teams responsible for both NPD

and NSD were established. These new PSS development teams were also responsible for new BM design and development, an additional component of new PSS development not found in contextual situations 1 and 2.

In accordance with Linde *et al.* (2021), we found that firms use Agile approaches when developing and designing new results-oriented BMs. This may be explained by the fact that many customers and manufacturers have limited experience with results-oriented BMs (as product-oriented BMs are still common in manufacturing (Aas *et al.*, 2020)); moreover, the design of optimal BMs is difficult.

However, the intertwined NPD and NSD process in this contextual situation followed a planned approach rather than the anticipated Agile approach. The nature of results-oriented BMs may explain why the NPD and NSD processes were intertwined. A results-oriented BM requires that products be optimally designed as seen from a maintenance and an operational perspective (Aas *et al.*, 2020), which may be difficult to achieve without intertwining the NPD and NSD processes. However, why the firms chose a plan-oriented development model for this intertwined process rather than an Agile model was puzzling. Perhaps manufacturers have prior experience with NPD and the development of traditional services and therefore perceive both task requirements as stable and the degree of newness of the products and services as low, even if the BM has a high degree of newness. Hence, the following proposition is offered:

> *P3: In the contextual situation of new PSS development targeting results-oriented BMs and traditional services, Agile approaches are used to develop new BMs, whereas NPD and NSD are intertwined and follow plan-oriented approaches.*

Contextual situation 4

In contextual situation 4, results-oriented BMs and smart services are targeted. Based on Paluch *et al.*'s (2020) framework, we assumed the use of an Agile approach. As in contextual situation 3, we found that new PSS development comprises three components: New BM development, NPD and NSD. Whereas NPD and NSD were intertwined in contextual situation 3, the development of all three components was intertwined in contextual situation 4. Our findings suggested that the new BM opportunities enabled by digital technology implied that new BM development, NSD and NPD, should go hand in hand, as indicated by prior research (Paschou *et al.*, 2020); therefore, they need to be perceived as one fully integrated development project. Combining plan-oriented and Agile development processes (see Fig. 2) also makes sense in this contextual situation.

As suggested by Paluch *et al.* (2020), Agile–Stage-Gate hybrid approaches are particularly relevant when the customers' needs are not well understood and when the degree of newness is low. The degree of newness for the different components of new PSSs in this contextual situation may vary; they may be high for some components (such as new BMs and new digital elements) and low for other components (such as the new products). Thus, a pure Agile approach may not be the most efficient (Paluch *et al.*, 2020). The following proposition is offered:

> *P4: In the contextual situation of new PSS development targeting results-oriented BMs and smart digital services, the developments of new BMs, new services and new products are intertwined, and a combination of plan-oriented and Agile development approaches is used to develop the new PSS.*

Theoretical and practical implications

Our analysis of the empirical data revealed systematic variations related to how new PSS development processes were organised in the case organisations. Although previous research has suggested the idea that the development process model is chosen based on different factors (Paluch *et al.*, 2020), our study is the first to expose how contingency factors affect the organisation of new PSS development processes. Our findings and discussion reveal a novel framework that serves as both a culmination of our exploratory groundwork and a prologue to future stages of explanatory and validating research. The framework suggests how new PSS development processes are contingent on four contextual situations (Fig. 3).

In addition to being a theoretical contribution, the contingency framework provides considerable assistance and guidance to managers searching for better ways to facilitate the processes of developing new PSSs. One insight for managers

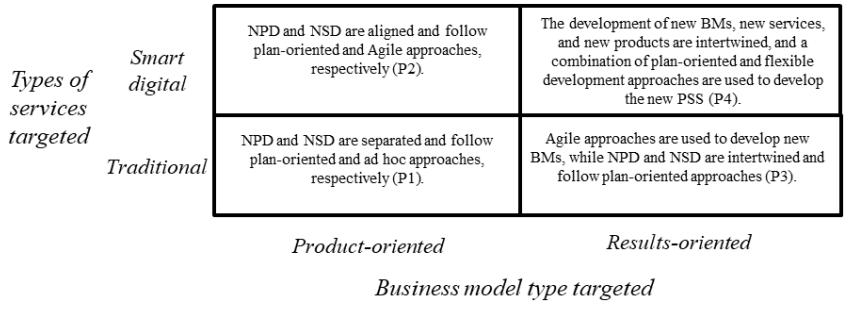

Fig. 3. Contingency framework for new PSS development processes.

is that there is no specific development process model that should be implemented and used in all new PSS development initiatives. Instead, managers need to select an approach that fits the services and BM targeted in the PSS being developed. In practice, decisions related to the organisation of new PSS development processes should be made after deciding the BM and new service types targeted in the specific development project. Because firms often have many PSSs and can target different BMs and services in different cases (Baines *et al.*, 2017), a firm is unlikely to rely on one approach for new PSS development processes. Accordingly, managers need to be prepared to vary the new PSS development approach on a case-by-case basis.

Limitations and future research

New PSS development is a complex development task; the contingency framework proposed in our study demonstrates that research on new PSS development is particularly relevant to further explore how Agile and plan-oriented development approaches are combined in practice. However, a limitation of our study is its reliance on observations from relatively few cases of new PSSs targeting results-oriented BMs and smart digital services. Another limitation is that a few of the cases were targeting use-oriented BMs based on Tukker's (2004) typology. Thus, we were unable to explore the characteristics of new PSS development to verify the relevance and depth of our framework. Future studies should explore the relevance of our contingency framework in other types of manufacturing industries such as those operating in a business-to-consumer context and those outside of manufacturing, where development projects also include many different components. In line with prior research (Paluch *et al.*, 2020), we suggest that most development approaches have strengths and weaknesses that vary between contexts; therefore, continued research to better understand the contingency factors will be particularly valuable.

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