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SERVICE-ORIENTED BUSINESS MODELS IN MANUFACTURING IN THE DIGITAL ERA: TOWARD A NEW TAXONOMY

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A stream of servitisation research has focused on the construction of taxonomies and typologies of product–service system business models (BMs). However, their relevance in the context of increased utilisation of digital technologies may be questioned. Thus, the purpose of this paper is to empirically revisit the existing product–service system BM taxonomies to explore the following research question: How can the BMs of servitised manufacturing firms be categorised in the digital era? The question is addressed through an embedded case study of five servitised firms. We found that the firms' BMs varied with regard to the degree of the suppliers' ownership of delivered products, degree of smartness of the services provided and degree of performance orientation of contracts. Based on these findings, we derived a new product–service system BM taxonomy with eight categories, presented in a $2 \times 2 \times 2$ matrix, that significantly extends earlier taxonomies.

Keywords: Business model innovation; servitisation; product–service system; digitalisation; typology; taxonomy.

Introduction

A business model (BM) defines how the enterprise creates and delivers value to customers, and then converts payments received to profits (Teece, 2010, p. 173), and BM innovation is often seen as a process that "complements the traditional subjects of process, product and organisational innovation" (Zott *et al*., 2011, p. 1032). With the aims of increasing revenues and profit (Aas and Pedersen, 2011) and sustaining competitive advantage (Eggert *et al*., 2014), increasing numbers of manufacturing firms are now innovating their BMs "by adding services to [their] products" (Baines *et al*., 2009, p. 547), expanding their offerings from products alone to product–service systems (PSSs) (Adrodegari *et al*., 2015). This phenomenon is referred to as the servitisation of manufacturing and has received research attention for more than 30 years (Zhang and Banerji, 2017).

One stream of servitisation research has focused on the construction of PSS BM taxonomies and typologies (Brezet *et al*., 2001; Adrodegari *et al*., 2015). Many PSS BM taxonomies proposed in the 1990s and 2000s (e.g., Williams, 2007) have proven to be useful for management practitioners and researchers, as these describe overarching BM innovation opportunities in a particular industry and provide a framework for discussion of the benefits and challenges associated with different options (Adrodegari *et al*., 2015). However, whether these taxonomies remain equally relevant may be questioned. Recently, manufacturing businesses have undergone many changes; they are now "entering the fourth industrial revolution (Industry 4.0) through capitalizing digitalisation, which is revolutionizing the way business is conducted in industrial value chains" (Parida *et al*., 2019, p. 2). Digital technologies related to data collection, exchange and analytics have the potential to affect the types of new BM that can be developed in manufacturing (Parida *et al*., 2019). As a consequence, we argue that existing PSS BM taxonomies should be revisited with the aim of exploring their relevance in the digital era. In this paper, we empirically explore the characteristics of BMs that are implemented in servitised firms to answer the following research question (RQ): *How can the BMs of servitised manufacturing firms be categorised in the digital era?*

The paper is organised in the following manner: In the second section, we review the literature on PSS BM taxonomies. Thereafter, we describe the embedded case study method that we employed. The empirical findings are then presented, with quotations elucidating the categorical elements of new service-oriented BMs. Finally, we discuss the results, present a new PSS BM taxonomy, and provide concluding statements.

Literature Review

According to Chesbrough (2010), the value of a product or service remains latent until it is commercialised in some way via a BM. A BM represents the business logic (Casadeus-Masanell and Ricart, 2010) by defining "the rationale of how an organisation creates, delivers, and captures value" (Osterwalder and Pigneur, 2010, p. 14). Thus, a BM has three dimensions describing (1) *what* a firm offers to its customer segments (the value proposition), often referred to as value creation; (2) *how* the value proposition is delivered to customers (e.g., via key activities, key resources, key partnerships, channels), referred to as value delivery; and (3) *why* the value proposition is delivered to customers (e.g., with regard to revenue streams, cost structure), referred to as value capture.

Many PSS BM taxonomies have been proposed in the literature. In an early contribution, Wise and Baumgartner (1999) suggested the distinction of four PSS BM types based on service content: (1) embedded services, (2) comprehensive services, (3) integrated solutions and (4) distribution control. Michelini and Razzoli (2004) distinguished four manufacturing BMs based on ownership of the manufactured products: (1) provision of products including lifecycle services, (2) provision of products through leasing arrangements, (3) provision of shared products and (4) function delivery. A third example is Tukker (2004)'s widely cited PSS BM taxonomy, based on ownership and service content and having three main categories: (1) product-oriented BMs, for firms oriented toward the sale of products that sell services as add-ons; (2) use-oriented BMs, for manufacturers that retain ownership of products made available through leasing, renting or sharing arrangements; and (3) result-oriented BMs, wherein the provider and seller agree on a functional result and build a contract around the provision of this result, rather than a specific product. Tukker (2004) places these three types of BMs on a product–service–content continuum in which the service content increases and the product content decreases as one moves from product-oriented to use-oriented to result-oriented BMs.

Although other taxonomies have been suggested more recently (e.g., Lay *et al*., 2009), "Tukker's classification remains the most widely accepted classification of PSS, which is used extensively in the literature" (Adrodegari *et al*., 2015, p. 248). Nevertheless, as this taxonomy predates the fourth industrial revolution, the extent of its relevance in the contemporary context, characterised by increased reliance on digital technologies to maintain competitiveness, may be questioned (Adner *et al*., 2019). With the rise of smart products and services, companies and their strategies will very likely change (Porter and Heppelmann, 2014). Manufacturing businesses are increasingly capitalising on digitalisation, which affects their BMs (Parida

et al., 2019). This shift, sometimes described as "digital servitisation" (Kohtamäki *et al*., 2019), prompts the revisiting of existing PSS BM taxonomies.

In a recent paper, Kohtamäki *et al*. (2019) conceptually derived a BM categorisation for digital servitisation. They argue that digital servitisation BMs are built on three core dimensions of "*smart solutions*" (Kohtamäki *et al*., 2019, p. 383): solution customisation, solution pricing and solution digitalisation. Solution customisation refers to how and to what degree solutions have been tailored to customers' needs. According to Kohtamäki *et al*. (2019), solutions can be customised, modular or standardised. Solution pricing relates to how value is captured and "may be product oriented, agreement oriented, availability oriented, or outcome oriented" (Kohtamäki *et al*., 2019, p. 383). Solution digitalisation refers to the role of digital technology. Kohtamäki *et al*. (2019) refer to Porter and Heppelmann (2014) and suggest that the core digital features in today's smart solutions include monitoring, control, optimisation and autonomy. According to Porter and Heppelmann (2014), smart solutions have physical, smart and connectivity components, and 'smart components amplify the capabilities and value of the physical components, while connectivity amplifies the capabilities and value of the smart components and enables some of them to exist outside the physical product itself' (p. 5).

Although the typology suggested by Kohtamäki *et al*. (2019) is an important contribution, Kohtamäki *et al*. (2019)'s categorisation encompasses only digital services, with no accounting for the potential co-existence of traditional services. We aim to extend this line of research by empirically grounding our taxonomy.

Method

Case selection and description

Due to the exploratory nature of the RQ, we used a qualitative embedded case study approach (e.g., Yin, 2003). To enable the selection of case organisations that offered opportunities to gain relevant insight, we first had a dialogue with the management of a business cluster in Norway. Members of this business cluster were leading manufacturing firms offering advanced PSSs to different industries.

Based on insights gained from this initial dialogue, we selected as case organisations five servitised manufacturing firms that strategically focused on providing combinations of products and services (i.e., PSSs) and utilising digital technologies related to data collection, exchange and analytics. The firms offer different products and services to customers in different industries: Firm A is a leading supplier of steel construction materials and services to customers in maritime industries; Firm B is a leading manufacturer of advanced drilling equipment and services to

customers in the oil industry; Firm C is a leading supplier of advanced, heavy-lifting and mooring equipment and services to customers in maritime industries; Firm D is a supplier of advanced operator chairs and related services to customers in the maritime and aviation industries; and Firm E is a supplier of lay-flat hoses and related services to customers in numerous industries (e.g., oil, maritime, agriculture), and of machines that make flat hoses.

Data collection

Data related to the BMs implemented by the case organisations were collected through semi-structured in-depth interviews with a total of 66 key employees, and through participation in 26 workshops and meetings with employees and managers in the firms (Table 1). We recorded and transcribed all interviews and took detailed notes in all workshops.

To obtain a thorough understanding of the development and maturation of servitisation, digitalisation and BM innovation in the case firms, data were collected in 2018–2020. We started the first round of data collection in 2018 by conducting interviews with the aim of achieving a detailed understanding of how the firms created, delivered and captured value. Interviewees were top and middle managers and key employees involved in servitisation and BM innovation

Table 1. Overview of the case organisations and data collection.

Firm	Offering	Discussion meetings	Workshops	Semistructured interviewees
A	Steel construction materials and related services such as engineering, procurement, fabrication, transportation, construction, installation and project management.	3	3	15
B	Drilling equipment and systems, and related life-cycle services such as training, remote diagnostics and online support.	3	3	17
C	Heavy-lifting and mooring equipment and related life-cycle services such as training, remote diagnostics and online support.	3	2	11
D	Advanced operator chairs and related services.	2	1	7
E	Lay-flat hoses and machines that make flat hoses and related services.	3	1	16
All	Experience exchange workshop		2	
Total		14	12	66

(e.g., service engineers, IT engineers, product engineers and business development staff members). They were asked open questions about the firms' value propositions, including the products and services already offered and those under development. We also collected information about the activities conducted to deliver these value propositions, and the resources and partners involved in these activities. In addition, we collected data related to the revenue models and cost structures that had been implemented to capture value from the delivery of the value propositions, as well as the intended revenue models for new products and services.

In late 2018 and early 2019, we facilitated and participated in several workshops at which findings from our initial interviews were presented and further elaborated. Eight to 14 employees from the firms were involved in each workshop. Ten workshops were internal, conducted in the facilities of each firm, and focused on specific servitisation and BM innovation activities. Two workshops were held with employees from all of the firms to share experiences and challenges. We participated in these workshops mainly as observers, and to some degree as facilitators. Our aim as facilitators was not to argue for or against alternatives and affect the conclusions derived in this setting, but rather to facilitate debate about BM alternatives.

In the second round of data collection, performed in late 2019 and early 2020, we conducted follow-up interviews and participated in 14 meetings with employees in the firms. In these contexts, we presented and discussed our findings from the first round of data collection.

Data analysis

The data collected in the first round were analysed qualitatively following Miles and Huberman (1994) in separate steps. Based on the three BM dimensions [i.e., value creation, value delivery and value capture (Osterwalder and Pigneur, 2010)], we first identified and noted how the case firms created, delivered and captured value and how they intended to do so in the future. We then noted patterns, made comparisons and searched for variation in each BM dimension. This step enabled us to derive and propose a new PSS BM taxonomy inductively from the empirical data. To ensure reliability, all researchers who collected data were involved in this analysis.

To assess plausibility (Yin, 2003), the new PSS BM taxonomy was presented to the informants during the second round of data collection, with discussion of its relevance and validity. Overall, these discussions assured us of the veracity of the empirical material and confirmed the relevance and validity of the taxonomy, with minor adjustments made as a result of the second round of data collection.

Findings

All case organisations provided numerous examples of PSS BMs that had been implemented in the market and that they were planning to implement in the future. Here, the findings are described according to the three key BM dimensions.

Value creation (what value proposition is offered)

Value creation refers to the value proposition a firm offers to its customers. All sampled firms offered combinations of products and services. For example, a vice president from Firm B explained:

> We have a portfolio of perhaps 10 products. There are some of these products that we can offer both as a product and service. The customers are different, so what we offer differs. One customer [anonymised] was very brave and they had a strategy. They confirmed when we were in a board meeting last week that they have a specific strategy towards their customers (…). So, they want to differentiate themselves in being able to deliver stable performance in collaboration with their suppliers. In addition, they will of course do this as inexpensively as possible (…). That means they will avoid having these five-year upgrades of our equipment which are very expensive, (…) since everything has to be refurbished. They would prefer us to base maintenance on condition.

Another informant, the CEO of Firm C, stated:

> You don't make any money if you only provide equipment today. You earn very little. Those who make money today are those who also provide either software or services and take responsibility for the entire lifecycle of the product. You can deliver the hardware at a relatively low price, but then you serve the customer throughout the lifetime. In this way, you tie the customer closer to you. Then, earnings to a much greater extent also become much more predictable than if you only sell equipment (…). If you have a very large lifecycle portfolio that is constantly running, it provides more financial stability for the company. This is where you manage to make money today. So, for us this means that if we are to have good earnings in the future, then we must move even more in the service direction. Thus, in a way, you want to connect more closely to the customer with an ambition to selling spare parts, services, etc.

Little variation was observed among the case firms with respect to the offering of combinations of services and products. However, the value creation dimension varied with respect to whether the supplier transferred ownership of the manufactured equipment to their customers or retained it during the period of operation.

In most examples, the case firms transferred the ownership of the equipment to their customers. When asked whether Firm B leased out their equipment, a vice president stated:

> No. It has been discussed a bit, but nothing has been done about it yet.

This question was on the agenda in many of the case firms, and several firms were planning or considering the implementation of leasing models in the future. The CFO of Firm C stated:

> You can see this from a customer perspective: one of our customers is for example building a huge ship for a hundred million dollars. It is a lot of money. This needs to be funded. If the customer is lucky, he gets a loan for 70% and he must have 30% in cash. It's money he doesn't want to spend. He prefers to use it for other things. Therefore, he wants to reduce the price. One way to do this is by deciding not to buy a crane [from us] (…). This means that it will be easier for the customer to reach the goal of having the ship built. (…) We have these discussions with some customers, and quite a few financing models come up. (…) There are many solutions here (…). One way is to enter into a form of lease agreement. (…)

The head of a department in Firm E stated:

> Leasing out the machines [that Firm E manufactures] is something I consider. It's something I've been talking about for a long time (…). I want to go to a customer and say I can take the old machines and then he gets new ones from me. Then I can refurbish the old ones and I sell them again. (…) We can take responsibility for the entire machinery park (…) and we can be here to manage and help a customer who has problems with a machine. So then automatically you know when you lease it out there will also be training and much more close connection with the users (…).

Value delivery (how the value proposition is offered)

The case firms utilised a large variety of resources and partnerships when conducting the activities needed to deliver their value propositions. The value delivery dimension varied with respect to whether the supplier utilised digital technology to provide smart services when conducting these activities. In some cases, digital technology was not used at all to provide the services. For example, the CTO of Firm B explained:

> You've probably heard about our [product name anonymised]? (…) Our new [product name anonymised] is a machine that handles both pipes and casing (…). This means that the crew [those who are permanently on board] can now do casing

> themselves. This saves the oil company [anonymised] approximately a million a year. So, what we really sell is a machine that has a slightly different fletcher, (…) but our customer perceives this as a new "casing crew". (…) From a business model perspective this is a product sale, but the sale is result oriented. (…) And it is not digital. It is not smart. It is traditional. But we are selling the result.

We also identified some cases in which digital technology was used intensively to increase the quality of traditional non-smart services. For example, the CTO of Firm B stated:

> I really believe in the digital worker concept. Our customer can just have generic personnel on board, such as electricians and mechanics. Then we can, through digital tools, first give [the generic worker] access to everything that we have access to, animations explaining how to fix equipment, and if that doesn't work, we can connect [the generic worker] directly and guide [the generic worker] through camera etc. (…) Theoretically, you then have access to the best expertise available in no time.

In other cases, digital technology was utilised to a large extent to provide smart services. For example, the R&D manager of Firm C stated:

> A new digital service we are developing now is for example [anonymised] (…). It is a service to help the customer in the operation and maintenance of our equipment. (…) We also have many other ongoing digital initiatives.

Other examples were provided by a manager and a vice president from Firm B:

> We get [digital] signals from the rig and process them. We analyse it in relation to how well the equipment works. The automated service we provide is called [anonymised]. (…) We monitor the smart modules and how well they work compared to manual driving. (…) So, we really measure the effect of our automated service. (…)
>
> A spare part is a physical object. You can't digitise it, but you can digitise how to handle it. This is a typical example of us working with electronic data exchange where we have to automate the ordering of parts. No web shop, but a little more on a lower level. That you put a parts catalogue for a rig right into our system that automatically places the orders and automatically sends out packages.

Value capture (why the value proposition is offered)

The case firms captured value in different ways. The value capture dimension varied with respect to whether the contract between the supplier and the customer

was built around the provision of a specific product or of a result or performance in connection with the product. The sampled firms built most contracts around the provision of products. For example, a vice president from Firm B stated:

> If you look 30 years back, then the company was a pure product supplier, then we teamed up with system suppliers and started to (…) deliver complete rig packs as a system. We did this for a number of years, then we started with services and fixing the machines (…).

However, we also identified contracts that the case firms built around the provision of performance. A contract manager from Firm B explained:

> It is a pretty well-founded strategic direction for our firm that we want to be more connected to the customers we have. We talk to many customers about performance contracts. The contract we have with [anonymised] is a good example of a performance-oriented contract. This contract takes the traditional service models a step further in terms of risk sharing and what we traditionally deliver (…). The main equipment included in the agreement is critical equipment (…), where we also saw potential to optimise the operation of that equipment.

The ability to capture value often depended on the BMs of other actors in the ecosystem. The CTO of Firm B stated:

> This service [anonymised] is about digitising the drilling process itself. Then we are in "real time". Someone else has to take care of it during the planning phase and everything that happens before and get a digital operation on board. Take away all the paper and get everything into the same system, so that the information is consistent and everyone uses the same system and participates in the process. It may sound simple, but it is not. After all, there are many players with their systems that are part of such an operation. So, it's a big enterprise. We have started small. In terms of business, the challenge ahead is figuring out how to get paid. We can't answer that yet. We work on it, but we can't answer. Our service is beneficial for oil companies and rig owners (…) and their business models have changed very little. They are still mainly day-rate oriented. I think the reason is the "oversupply" of rigs. The oil companies appear to be profiting from pushing day rates to a much greater extent than we had hoped. So, the line-up of business models is weaker than we had hoped. (…)

Discussion and Conclusions

The RQ raised in this paper is: How can the BMs of servitised manufacturing firms be categorised in the digital era? We found variation in the three key BM

dimensions — value creation (what value proposition is offered), value delivery (how the value proposition is delivered) and value capture (why the value proposition is offered). In the value creation dimension, the firms' BMs varied with regard to the degree of the suppliers' ownership of products. In the value delivery dimension, these varied with regard to the degree of smartness of the services provided to customers. In the value capture dimension, the firms' BMs varied with regard to the degree of performance orientation of contracts between the suppliers and their customers.

Our findings indicate that the three dimensions are separate continua. Outliers in the value creation dimension were (1) that the supplier did not transfer ownership of the product to the customer and (2) that product ownership was transferred to the customer. Although the transfer of product ownership to the customer through a sales transaction is often referred to as the traditional way in which manufacturers create value, the literature increasingly acknowledges, in line with our findings, that manufacturers have the option to retain product ownership and make products available to customers through various leasing arrangements (e.g., Tukker, 2004). These leasing arrangements have always been available for manufacturers, but some authors argue that this option is particularly relevant in the digital era. Porter and Heppelmann (2014, p. 21), for example, argue that while "manufacturers have traditionally focused on (…) transferring ownership of the good to the customer through a sales transaction (…) [s]mart, connected products allow the radical alteration of this long-standing business model." Our findings confirm this argument, and also suggest that manufacturers may choose a leasing arrangement for other reasons, such as those related to funding. This pattern implies that leasing arrangements are relevant options when manufacturers provide traditional services, as well as when they provide smart digital services.

In the value delivery dimension, the outliers identified were (1) smart digital services and (2) non-smart services. Here, the term "smart digital services" refers to products and services employing digital technologies, such as sensors, connectivity and data analysis technology, which allow proactive measures to be taken based on the results of data analysis (Allmendiger and Lombreglia, 2005). These services "go beyond the kinds of up-keep and upgrades you [firms] may be bundling with your [firms'] products, both in their value to customers and in their cost efficiency to you [firms]" (Allmendiger and Lombreglia, 2005, p. 1). Moreover, Vial (2019, p. 130) suggested that "smart products and services, through the embedding of artificial intelligence that leverages (big) data, can enable automated, algorithmic decision making". Nevertheless, our findings suggest that traditional, non-smart services remain relevant in the digital era and thus should be included in PSS BM taxonomies.

In the value capture dimension, the outliers were (1) performance-oriented contracts and (2) product-oriented contracts. Performance-oriented contracts are long-term contracts according to which the customer pays for a performance or result, such as those related to product availability, reliability or maintainability (Liinamaa *et al*., 2016). Product-oriented contracts are those according to which the customer pays for a product and buys extra services related to that product on a case-by-case basis (Tukker, 2004). Although performance-oriented contracts are often suggested to be especially relevant in the digital era (e.g., Parida *et al*., 2019), we found that product-oriented contracts remain relevant, and that the transition to more performance-oriented contracts often requires challenging changes to the BMs of several actors in the ecosystem.

A new eight-category PSS BM taxonomy can be constructed based on our empirical findings by combining the outliers in the three BM dimensions in a three-dimensional $2 \times 2 \times 2$ matrix (Fig. 1). This taxonomy shares some properties with existing taxonomies and typologies, such as those proposed by Tukker (2004) and Kohtamäki *et al*. (2019), but also has clear differences from them and extends prior research in several important ways. Product ownership and contract type are important factors in our taxonomy and that of Tukker (2004). However, our findings indicate that these factors represent distinct dimensions that cannot be described with a one-dimensional product–service–content continuum. Our research also revealed a third dimension (smart digital services vs. non-smart services) that is not present in Tukkers (2004) taxonomy, but is reflected in the typology proposed

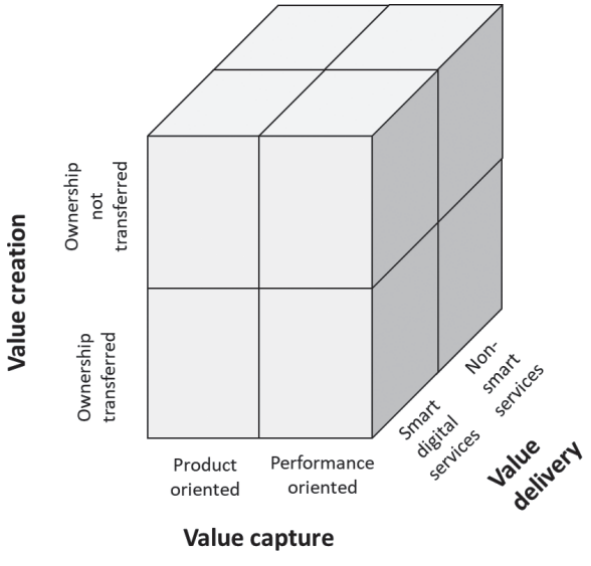

Fig. 1. A new product–service system BM taxonomy.

by Kohtamäki *et al*. (2019). Conversely, Kohtamäki *et al*. (2019)'s typology lacks an ownership dimension, which was found to be an important factor in our study.

Thus, our findings indicate that firms' PSS BM options are more complex and involve additional dimensions not identified in prior research. Our taxonomy provides an important contribution to the BM innovation literature while answering the call for more empirical studies to supplement the rapidly emerging body of literature on PSS BMs (Reim *et al*., 2015).

Future research can build on the taxonomy proposed in this paper, using it as a framework to explore when different types of PSS BM are beneficial, as well as the challenges and success factors associated with different PSS BM types. Moreover, this study revealed close connections between PSS BMs and the ecosystem. Further research should seek to identify important contingency factors related to the eight categories of the PSS BM taxonomy proposed in this study.

The proposed taxonomy can also serve as a useful tool for managers in manufacturing firms that aim to develop new digital and service-oriented BMs. The taxonomy describes the set of opportunities for a firm and provides a framework for discussion of the benefits and challenges associated with different BM options.

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