
Service-oriented business models in manufacturing in the digital era: Toward a new typology

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Abstract: A stream of servitization research has focused on identifying typologies of product-service system business models. However, their relevance may be questioned in a context with increased utilization of digital technologies. Thus, the purpose of this paper is to empirically revisit existing product-service system business model typologies by raising the following research question: How can business models of servitized manufacturing firms be categorized in the digital era? This question is addressed through a qualitative multiple case study of five servitized firms. Data was collected through semi structured in-depth interviews with a total of 66 key-employees, and through participation in 26 workshops and discussion meetings with the firms. Based on our empirical findings we derived a new product-service system business model typology with 8 different categories presented in a 2x2x2 matrix.

Keywords: Business model innovation; Servitization; Product-service system; Digitalization; Typology

1 Introduction

While a business model “*defines how the enterprise creates and delivers value to customers, and then converts payments received to profits*” (Teece, 2010, p. 173), the innovation of business models is often seen as a category of innovation that “*complements the traditional subjects of process, product and organizational innovation*” (Zott et al., 2011, p. 1032). With an aim to grow revenues and profit (Aas and Pedersen, 2011) and sustain competitive advantage (Eggert et al., 2014), an increasing number of manufacturing firms are now innovating their business models “*by adding services to [their] products*” (Baines et al., 2009, p. 547) and by expanding their offering from products only to so-called Product-Service Systems (Adrodegari et al., 2015). This phenomenon is often referred to as the servitization of manufacturing and has already received attention from researchers for more than 30 years (Zhang and Banerji, 2017).

A stream of research in this area has focused on identifying and describing typologies of servitized business models (Brezet et al., 2001), often referred to as Product-Service Systems (PSS) business model (BM) typologies (Adrodegari et al., 2015). Many PSS BM typologies that were suggested in the 1990’s and 2000’s, have proven to be very useful both for management practitioners and researchers (e.g., Williams, 2007) because they describe the overarching BM innovation opportunities within a particular industry and constitute a framework for discussing benefits and challenges with different options (Adrodegari et al., 2015).

However, it may be questioned whether these typologies are still equally relevant today. Manufacturing businesses have undergone many changes in recent years, and are now “*entering the fourth industrial revolution (Industry 4.0) through capitalizing digitalization, 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 what type of new BMs that are possible to develop in manufacturing (Parida et al., 2019). As a consequence, we argue that the existing PSS BM typologies should be revisited with the aim to explore their relevance in the digital era of our time. In this paper we, therefore, aim to empirically explore the characteristics of BMs that are implemented in servitized firms. The following research question (RQ) is raised: *How can business models of servitized manufacturing firms be categorized in the digital era?*

The paper is organized in the following manner: In the next section we review the literature on PSS BM typologies. Thereafter we describe the embedded case study method we have applied. The empirical findings are presented in Section 4 and in Section 5 we discuss the results and conclude.

2 Literature review

According to Chesbrough (2010) the value of a product or a service remains latent until it is commercialized in some way via a BM. It has been suggested that a BM represents the business logic (Casadeus-Masanell and Ricart, 2010) by defining “*the rationale of how an organization creates, delivers, and captures value*” (Osterwalder and Pigneur 2010, p. 14). Thus, a BM has three dimensions: (1) It describes *what* a firm offer to its customer segments (the value proposition). This dimension is often called value creation. (2) It describes *how* the value proposition is delivered to the customers (key activities, key resources, key partnerships, channels). This dimension is often called value delivery. (3)

It describes *why* the value proposition is delivered to the customers (revenue streams, cost structure). This dimension is often called value capture.

Many PSS BM typologies have been suggested in the literature. An early contribution by Wise and Baumgartner (1999) suggested to make a distinction between four different types of PSS BMs based on service content: (1) embedded services, (2) comprehensive services, (3) integrated solutions and (4) distribution control. Another example is provided by Michellini and Razzoli (2004), who made a distinction between four different BMs in manufacturing based on ownership to 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's (2004) widely cited categorisation. He suggested a PSS BM typology based on both ownership and service content with three main categories. In Tukker (2004)'s first main category (product-oriented BMs), the firm is geared towards sales of products, and sells services as add-ons to the products. In Tukker (2004)'s second main category (use-oriented BMs), the product stays in ownership with the manufacturer and is made available through different forms of leasing, renting or sharing arrangements. In the third main category (result-oriented BMs), the provider and seller agrees on a functional result, and build a contract around the provision of this result, rather than around the provision of a specific product.

Tukker (2004) places the three types of BMs on a product-service-content continuum where the service-content increases and the product-content decreases as you go from product-oriented via use-oriented to result-oriented BMs. Although other typologies have been suggested by more recent research (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, since this typology was suggested before entering the fourth industrial revolution it may be questioned whether the categories and the continuum suggested by Tukker (2004) is equally relevant now in a contemporary context with increased reliance on digital technologies to maintain competitiveness (Adner et al., 2019). With the rise of smart products and services it is very likely that both companies and their strategies will change (Porter and Heppelman, 2014). Manufacturing businesses are increasingly capitalizing on digitalization and digital technologies affect BMs in manufacturing (Parida et al., 2019). This shift, sometimes described as 'digital servitization' (Kohtamäki et al., 2019), involves revisiting existing PSS BM typologies.

In a recent paper Kohtamäki et al. (2019) conceptually derived a BM typology for 'digital servitization' with three dimensions; solution customization, solution pricing and solution digitalization. While this is an important contribution, we aim at extending this line of research in two ways. Firstly, Kohtamäki et al. (2019)'s typology only considers digital services, without taking into account that traditional services may co-exist with digital services. Secondly, Kohtamäki et al.'s (2019) framework does not consider ownership, which is an essential feature of PSSs and which was one of the key dimensions in Tukker's (2004) typology. We aim at an empirical contribution by grounding our typology in real-life data.

3 Method

Due to the explorative nature of the RQ we used a qualitative embedded case study approach (e.g., Yin, 2003). To enable selection of case organizations that offered opportunities to gain relevant insights, 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 product-service systems to different industries.

Based on insights from this initial dialogue we selected five servitized manufacturing firms as case organizations. The firms offered different products and services to customers in different industries: Firm A was a leading supplier of steel constructions and services for customers in maritime industries. Firm B was a leading manufacturer of advanced drilling equipment and services especially for customers in the oil industry. Firm C was a leading supplier of advanced, heavy lifting and mooring equipment and services for customers in maritime industries. Firm D was a supplier of advanced operator chairs, and related services, to customers in maritime, as well as aviation industries. Firm E was a supplier of lay flat hoses and related services for customers in many different industries, such as the oil industry, the maritime industry and the agriculture industry. Firm E was also a supplier of machines making flat hoses. All firms had a strategic focus on providing a combination of both products and services (i.e. PSS), and on utilizing digital technologies related to data collection, exchange and analytics.

Data related to the business models implemented by the case organizations was collected through semi structured in-depth interviews with in total 66 key-employees, and through participation in 26 workshops and discussion meetings with the firms (see Table 1).

Table 1 An overview of the firms and empirical material

<i>Firm</i>	<i>Offering</i>	<i>Discussion meetings</i>	<i>Workshops</i>	<i>Semi-structured interviewees</i>
A	Engineering, Procurement, Fabrication, Transportation, Construction, Installation supervision, Project management.	3	3	15
B	Drilling equipment and systems, and related life-cycle services such as training and remote diagnostics and online support.	3	3	17
C	Lifting equipment and related life-cycle services such as training, remote diagnostics and online support.	3	2	11
D	Custom-made operator chairs in small series.	2	1	7
E	Lay flat hoses. Sensored hoses as future prospects.	3	1	16
<i>All</i>	<i>Experience exchange Workshop</i>		2	
Total		14	12	66

The data was collected in two rounds in 2018 and in 2020 to grasp the servitization development. In the first round of data collection, we conducted interviews with the aim to achieve a detailed understanding of how the firms created, delivered and captured value. We asked open questions about the value propositions of the firms, including the products and services already offered, as well as products and services 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 delivering the value propositions, as well as the intended revenue models for new products and services under development.

We recorded and transcribed the interviews, and we coded and analysed the data resulting from this process in an inductive manner. The resulting analysis was conducted using the following procedure: We first identified how the sampled firms created, delivered and captured value. Thereafter we searched for variations within these three BM dimensions (value creation, value delivery and value capture). Based on this exercise we were able to describe a new PSS BM typology.

In the second round of data collection, we conducted follow up interviews and participated in workshops to discuss the relevance and validity of the new PSS BM typology that had emerged from the initial interviews.

4 Findings

All case organizations provided a high number of examples of PSS BMs that had already been implemented in the market and that they were planning to implement in the future. We now report findings within the three key BM dimensions (value creation, value delivery and value capture):

Value creation (what value proposition is offered)

Our findings suggested that all sampled firms offered a combination of products and services. A vice president in Firm B for example explained:

“We have a portfolio of perhaps ten 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 [anonymized] 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. And they will of course do this as cheap 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 rather like 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 either those who also provide software or services and take responsibility of the entire life cycle 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 link the customer close to you. Then you also become much more predictable in earnings to a

much greater extent than if you only sell equipment (...). If you have a very large life cycle portfolio that is constantly running, then there is incredible security 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. So, in a way, you want to connect more closely to the customer with a view to selling spare parts, services, etc.

The value creation dimension varied with respect to whether the supplier transferred ownership of the manufactured equipment to their customers or whether the ownership of the product remained at the supplier also in the period of operation. In most examples in our sampled firms, ownership to the equipment was transferred. When asked whether Firm B lease out their equipment, a vice president for example stated:

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

However, we also identified that this question was on the agenda in many of the sampled firms, and that several firms were planning or considering to implement leasing models in the future. The CFO of Firm C for example 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 70% loan 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 (...)”

Another example was the head of a department in Firm E. He 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)

Our findings suggested that the sampled firms utilized a large variety of resources and partnerships when conducting the activities needed to deliver the value proposition. However, the value delivery dimension varied with respect to whether the supplier utilized digital technology or not when conducting these activities. In some cases, digital technology was not used. For example, the CTO of firm B gave the following example:

“You've probably heard about our [product name anonymized]? (...) Our new [product name anonymized] 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 approx. [anonymized] 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”.

In other cases, digital technology was utilized to a large extent. The R&D manager of Firm C for example stated:

“A new digital service we are developing now is for example [anonymized] (...). 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, a vice president and the CTO in 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 [anonymized]. (...) 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 digitize it, but you can digitize 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 PH for a rig right into our system that automatically places the orders and automatically sends out packages.”

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

Value capture (why the value proposition is offered)

Our findings indicated that the sampled firms captured value in different ways. In particular, 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 around the provision of a result or performance in connection with the product. Most contracts in the sampled firms were built around the provision of a product. A vice president in Firm B for example 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 some contracts in the sampled firms that were built around provision of a performance. A contract manager in 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 [anonymized] 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 optimize the operation of that equipment.”

It should also be noted that the ability to capture value was often dependent of the BMs of other actors in the ecosystem. The CTO of Firm B stated:

This service [anonymized] is about digitizing 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 big undertaking. So, 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 has changed very little. They are still mainly day rate oriented. I think the reason is "over supply" 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. (...)"

5 Discussion and conclusions

The RQ raised in this paper reads: How can business models of servitized manufacturing firms be categorized in the digital era? We found variations within the three key BM dimensions – value creation, value delivery and value capture. In the value creation dimension, the examples varied with regards to the degree of the supplier's ownership to the product. In the value delivery dimension, the examples varied with regards to the degree of (smart) digital services that were provided to the customer, and in the value capture dimension, the examples varied with regards to the degree of performance-orientation of the contracts between the supplier and the customer.

Our findings indicated that all three dimensions were separate continuums where the outliers in the value creation dimension were (a) that the supplier did not transfer ownership of the product to the customer and (b) that the ownership of the product was transferred to the customer. In the value delivery dimension, the outliers were (a) digital services and (b) non-digital services, and in the value capture dimension, the outliers were (a) performance-oriented contracts and (b) product-oriented contracts. By combining these outliers in a three-dimensional 2x2x2 matrix a new PSS BM typology with 8 different categories emerged. The PSS BM typology is illustrated in Figure 1.

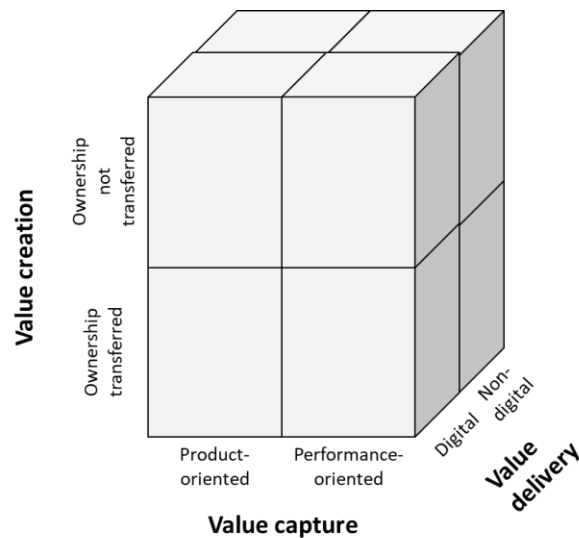


Figure 1 Suggested PSS BM typology

The new PSS BM typology derived from our empirical findings share some similarities with existing typologies such as the typologies suggested by Tukker (2004) and Kohtamäki et al. (2019). However, our findings also have some differences from the findings of prior research. Ownership to the products as well as type of contract (performance- vs. product-oriented) are important factors in both our typology and Tukker’s (2004) typology, our findings indicated that the factors represent two distinct dimensions that cannot be described on a one-dimensional product-service-content continuum. Our exploration also revealed a third dimension (digital vs. non-digital services) that is not present in Tukker (2004)’s typology. This dimension, however, is reflected in the typology suggested by Kohtamäki et al. (2019). Nevertheless, our typology differs from Kohtamäki et al. (2019)’s typology with regards to the ownership dimension that is not present in Kohtamäki et al. (2019), but found to be an important factor in our study.

Thus, our findings indicated that firms’ PSS BM options are more complex and involve additional dimensions than what have been identified by prior research. This is an important contribution to the BM innovation literature also answering the call for more empirical studies supplementing the rapidly emerging body of literature on PSS BMs (Reim et al., 2014).

The new PSS BM typology suggested in this paper is a useful tool for managers in manufacturing firms that are aiming to develop new digital and service-oriented BMs. The typology describes the set of opportunities for the firm and constitute a framework for discussing the firm’s benefits and challenges with different options.

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