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Boosting servitization through digitization: pathways and dynamic resource configurations for manufacturers

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Research highlights

- Our aim is to describe and explain how digitization can enable servitization for manufacturers.
- We perform a multiple-case study at four manufacturing companies that have developed and exploited digital means for service infusion.
- Three pathways for digitally-enabled servitization are identified: industrial servitization, commercial servitization and value servitization.
- Dynamic resource configurations are assigned to overcome barriers specific to each pathway.
- Competitive benefits include expansion of market reach and further integration into customers' processes.

Abstract

The importance of digital technologies for services in manufacturing has often been posited, but current literature has neglected to explain how companies can leverage digital methods to increase their service offering. In this article we contribute to current theory by examining how digitization can enable servitization for manufacturers. By performing a multiple-case study at four manufacturing SMEs, we provide evidence for a priming and a capability effect. In terms of priming, we find that specific digitization options lead to three servitization pathways: industrial, commercial and value servitization. Through a dynamic resource-based lens, the barriers, dynamic resource configurations and competitive benefits specific to each pathway are discussed. Finally, this paper offers managers insight on successfully reaching higher service levels through development of digital assets, and on the skills necessary to further integrate into customers' processes.

Keywords

Servitization

Digitization

Value innovation

Manufacturing companies

SME

1. Introduction

Servitization refers to the transformation in which manufacturers are increasingly offering services that are directly coupled to their products (Baines & Lightfoot, 2014). The topic of servitization has been thoroughly studied in previous literature, with its relevance often being cited in the literature on industrial marketing (see Kohtamäki, Partanen, Parida, & Wincent, 2013; Spring & Araujo, 2013; Ulaga & Loveland, 2014), service management (see Kindström, Kowalkowski, & Alejandro, 2015; Raddats, Burton, & Ashman, 2015; Witell & Löfgren, 2013) and operations management (see Schmenner, 2009; Smith, Maull, & Ng, 2014). Current servitization literature points to a number of opportunities for manufacturers: it is considered a strategic alternative to product innovation (Carlborg, Kindström, & Kowalkowski, 2013) and standardization (Baines et al., 2007), a means to deal with commoditization (Matthyssens & Vandenbempt, 2008) and a method to build unique, loyal customer relationships (Tukker, 2004). For customers, servitization may lead to increased value through more customized and integrated product offerings that better suit their needs (Baines et al., 2007; Bettencourt & Brown, 2013).

The array of possibilities involved in servitization, however, are growing steadily more complex (Beuren, Gomes Ferreira, & Cauchick Miguel, 2013). Additionally, such efforts by companies often result in negative financial returns (Gebauer, Fleisch, & Friedli, 2005; Visnjic, Wiengarten, & Neely, 2014), while some are actually abandoning their service strategies after only a few years' time (Baveja, Gilbert, & Ledingham, 2004). Two important reasons for these poor results lie in the cost-effectiveness and the controllability of servitization. The labor-intensiveness and lack of scalability that a switch to a service-based business implies affects the return on investing in new service capabilities (Gebauer et al., 2005). Manufacturers, particularly small and medium-sized enterprises (SMEs), often do not possess the resources or the experience for a service-oriented infusion to be implemented (Kowalkowski, Witell, & Gustafsson, 2013).

In the literature, the potential of digitization has often been discussed in a manufacturing context. For instance, advanced manufacturing technologies (AMT) offer the ability to simultaneously standardize and customize (Meredith, 1987; Zammuto & O'Connor, 1992), and they may even serve to disrupt existing cost-effectiveness boundaries by reducing transaction costs and the need for scale (Nooteboom, 1992; O'Mahony & Barley, 1999; Sultan, 2014). Also, information and communication technologies (ICT) offer possibilities for increased client-provider interaction and the 'capture' of customer needs (Gago & Rubalcaba, 2007). Previous literature has hinted at the importance of digitization for servitization, with the exploitation of ICT being called one of the foundations of services science (Chesbrough & Spohrer, 2006). Still we see that previous research on servitization has tended to take technology somewhat for granted (Tongur & Engwall, 2014), as companies' core technology often remains stable when moving into services (Gebauer et al., 2005). In summary, not enough is known at this point about how manufacturers can effectively leverage digital means to increase their service offering.

The aim of our research is to understand how digitization can enable manufacturing companies to offer a higher level of value-added services to their customers. A multiple-case study is used in order to illustrate different pathways followed by four servitizing SMEs from the manufacturing industry in Belgium. This method is chosen in an effort to increase our understanding on how digitization can overcome barriers in different service infusion strategies through a priming and a capability effect. The priming effect is demonstrated in the identification of different servitization pathways. The capability effect results in a dynamic resource-based view (DRBV) inspired description and explanation of the necessary dynamic resource configurations for digitally-enabled servitization.

The remainder of the paper is structured as follows: we begin with a brief literature review on the topics of servitization, digitization and the DRBV, followed by an explanation of our chosen research approach. We then present the findings of our four illustrative cases. In the discussion, we synthesize the results in three pathways towards digitally-enabled servitization, and identify different dynamic resource configurations with an eye towards overcoming barriers specific to each pathway. Finally, we offer several reasoned managerial guidelines as well as potential avenues for future research.

2. Literature review

2.1 Servitization

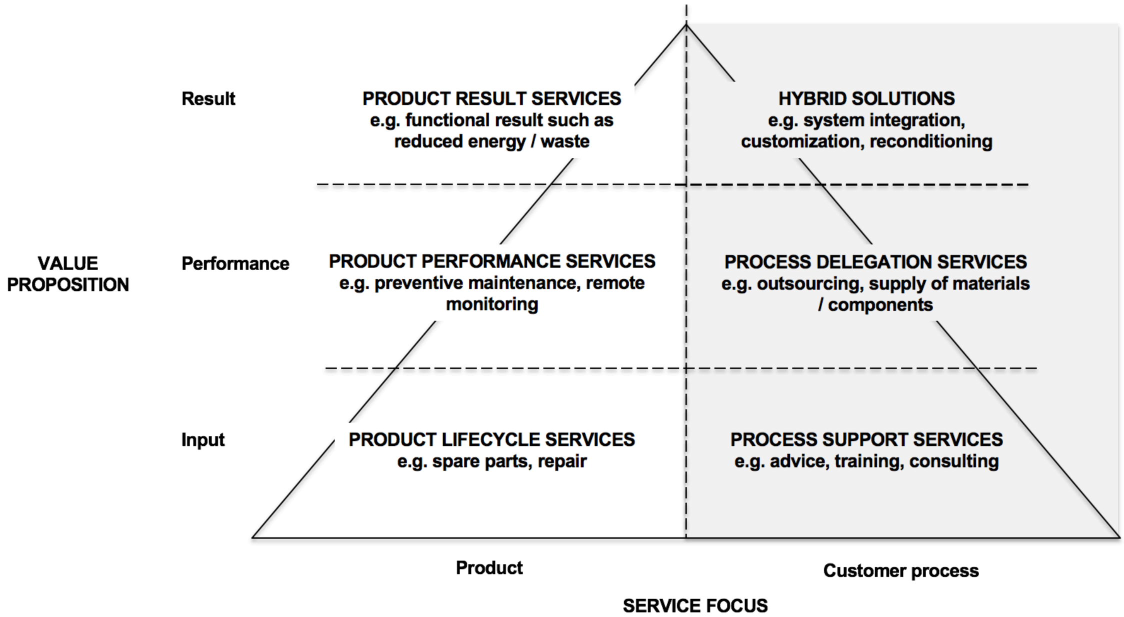
In earlier literature, servitization is described as the process of "moving from a the old and outdated focus on goods or services to integrated 'bundles' or systems with services in the lead role" (Vandermerwe & Rada, 1988, p. 314). It is used to more effectively create mutual value for both the provider and customer by shifting from simply selling industrial goods to hybrid offerings (Ulaga & Reinartz, 2011).

The literature today shows a wide variety of service categorizations. A particularly popular categorization is based on a company's revenue model, i.e. whether the provider promises to perform a deed (input-based), offer availability of a product or ultimately even agree on a result (output-based). For instance, Tukker (2004) refers to eight product-service systems (PSS's) in which the customer ultimately values asset performance (e.g. outsourcing, pay-per-use), or use (e.g. leasing, sharing), higher than mere ownership. This type of PSS is increasingly referred to in servitization literature (see for instance Baines et al., 2009; Beuren et al., 2013; Bezerra Barquet et al., 2013; Smith et al., 2014). However, Parida et al. (2014, p. 46) argue "these categories are highly generalized", and they suggest a more differentiated categorization. A second popular categorization is based on a service-oriented focus, i.e. whether the manufacturer delivers services supporting products or services that support customer processes (Oliva & Kallenberg, 2003). A provider may either offer services geared towards the functioning of the product, or services designed to assist customers in improving their own business processes (Ulaga & Reinartz, 2011).

Beyond the increased complexity in services, little insight is offered on *how* manufacturers can increase their service offerings. The costs associated with servitization do not tend to lead to immediate financial return for manufacturers, and this interplay between service business model innovation and product innovation may even sometimes result in a short-term performance decline (Visnjic et al., 2014). This issue is referred to as the "servitization-paradox" (Gebauer et al., 2005; Visnjic & Van Looy, 2013). A further finding, though, posits that although offering lower value-added services may have a negative financial impact at first, this step may be a necessary stepping stone for a later move into higher value-added services with a greater financial benefit (Parida et al., 2014; Visnjic et al., 2014).

A framework that guides manufacturers to successfully build-up their service offerings for the customer may be considered useful at this point, which brings us to the concept of the 'servitization pyramid' (see figure 1). The servitization pyramid consists of two dimensions: on the horizontal dimension we make a distinction in service focus between services that support 'products' versus 'customer processes' (Oliva & Kallenberg, 2003; Ulaga & Reinartz, 2011), while on the vertical dimension, we present three different value propositions that manufacturers can offer, i.e. providing customers with a certain input, a performance agreement or a guaranteed result (Kindström & Kowalkowski, 2014; Tukker, 2004). These value propositions are oriented towards customers "who want to do it themselves", "who want us to do it with them" and "who want us to do it for them" respectively (Baines & Lightfoot, 2014, p. 4). Examples of this are shown in figure 1.

Figure 1: the servitization pyramid



Source: based on Kindström & Kowalkowski (2014, p. 102); Ulaga and Reinartz (2011, p. 17)

Manufacturers may encounter a number of internal and external barriers when moving into higher-value added services (Beuren et al., 2013; Matthyssens & Vandenbempt, 2010). For instance, there may be resistance within companies to extend their involvement beyond the point-of-sale (Mont, 2002) due to an overemphasis on tangible features and a certain skepticism of the economic potential of services (Gebauer et al., 2005). A fundamental shift in corporate culture in favor of delivering services, rather than simply products, is often necessary (Mont, 2002). On the demand side, customers are often found to have a service-for-free attitude, reluctant to pay extra for services (Witell & Löfgren, 2013). This type of 'first-order barrier' needs to be overcome in order for manufacturers to reach the first stage of the servitization pyramid.

When moving towards the second stage, manufacturers may be confronted with what we refer to as ‘second-order barriers’. Today’s customers are still accustomed to the concept of acquiring products rather than paying for a performance or function (Rexfelt & Ornäs, 2009), and the cultural shift of placing value on having a need met, as opposed to owning products, is considered a major barrier within PSS literature (Baines et al., 2007). It is also noted that customers may not always want to engage in a deeper collaboration with the provider, due to fears of valuable company information being shared entities outside the firm (Matthyssens & Vandenbempt, 2010).

Finally, when attempting to reach the third stage of the pyramid, manufacturers may encounter ‘third-order barriers’. Many providers lack experience in the structuring of an organization to design and successfully deliver PSS (Baines et al., 2007), or they may shy away from absorbing the risks previously assumed by the customer (Aurich, Wolf, Siener, & Schweitzer, 2009). In sum, providers are confronted with problems related to ‘fit’ correlated with the current business model when going through the different stages of the servitization pyramid.

For the remainder of this paper, we generally maintain a customer process perspective (oriented towards the right-hand side of the pyramid), whereby the provider aims to add customer value by further integrating itself into the business process of the customer (Matthyssens & Vandenbempt, 2008). From this perspective, providing services is considered “a longitudinal, relational process that comprises the joint identification and definition of value creation opportunities, the integration and customization of solution elements, the deployment of these elements into the customer’s process, and various forms of customer support during the delivery” (Storbacka, Windahl, Nenonen, &

Salonen, 2013, p. 707). As will become apparent throughout the cases in this paper, these elements may also include services oriented towards the functioning of the product (oriented on the left-hand side of the pyramid).

In the following sections, we will discuss how digitization can prime different pathways for companies to increase their service offering, and introduce the DRBV as a lens to describe different dynamic resource configurations obtained to overcome barriers in digitally-enabled servitization.

2.2 Digitization options as primers to servitization pathways

Digitization refers to the increasing use of digital technologies for connecting people, systems, companies, products and services (Hsu, 2007), a trend which offers a number of opportunities for manufacturers. In general, it has the potential to radically improve performance and expand the reach of companies (MIT Center for Digital Business & Capgemini Consulting, 2011). For servitization in particular, the use of digital methods may facilitate different types of service innovation (Gago & Rubalcaba, 2007). However, manufacturers deal with issues revolving around cross-functionality within the company when managing a solution business. These issues may be viewed from two operational perspectives: industrial and commercial (Storbacka, 2011). For each perspective we consider a number of digital applications that support these areas, and offer examples of services that these applications can spur.

First, from an industrial or ‘back-end’ perspective, providers aim to improve their ability to effectively and efficiently create solutions (Pawar, Beltagui, & Riedel, 2009; Storbacka, 2011). Emerging technologies in a company’s back-end operations enhance operational performance, for instance through automation (Meredith, 1987), and increase transparency for better-informed decision-making such as the allocation of resources (Ness, Swift, Ranasinghe, Xing, & Soebarto, 2015). Such digital methods disrupt certain general assumptions on manufacturing costs (Nooteboom, 1992) and may eventually break the effectiveness-efficiency trade-off to such an extent that they can even reverse off-shoring trends (McKinsey & Company, 2014). Manufacturers can leverage this knowledge to improve not only their own processes, but also their customers' processes, by providing advice or training services, for example. Ultimately, manufacturers may further integrate into the customer's process by taking over certain design and production activities (Tukker, 2004; Ulaga & Reinartz, 2011).

Second, from a commercial or 'front-end' perspective, providers aim to better understand the customer's value creating process (Pawar et al., 2009; Storbacka, 2011) and enable customers to reach their own goals (Bettencourt & Brown, 2013). Front-end digitization allows for new types of customer interaction, such as through the creation of self-service touch points like personal digital assistants (Yao, Strombeck, & Chi, 2005). It also offers providers the possibility of sharing in-depth information between the customer and provider (Gago & Rubalcaba, 2007), possibly leading to deeper understanding of customer preferences.

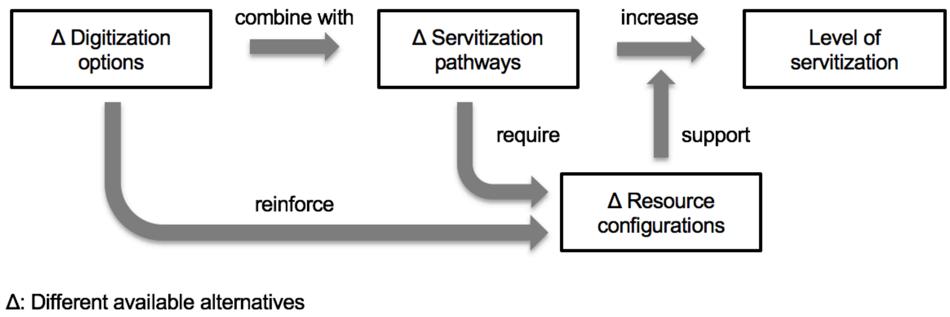
Manufacturers today are implementing digital methods not only to improve their back- or front-end operations. A third pathway is to create digitally-enabled offerings that radically change customer processes and have a more disruptive impact on provider-customer relations. This form of digitization includes digitally-modified businesses combining physical and digital offerings, for example by adding online monitoring or tracking devices to products (Lee, 1998; Porter & Heppelman, 2014). Such modified products create new opportunities for manufacturers to provide better services in the areas of maintenance, repair and field operations. It also refers to new digital businesses by adding digital products that complement or substitute traditional customer techniques (MIT Center for Digital Business & Capgemini Consulting, 2011).

2.3 Dynamic resource configurations to support digitally-enabled servitization

In this paper, we investigate how distinct digitization options enable manufacturers to pursue distinct customer process-oriented servitization pathways. While we have argued that different digitization regimes might lead towards specific servitization pathways, they are not guaranteed to overcome the aforementioned servitization barriers. To this end, we consider how digitization also has a capability effect to accommodate realization of the servitization pathway. A capability effect of digitization on competitive advantage has been suggested before, to the extent that it can translate computing power into knowledge (Barney, Wright, & Ketchen Jr., 2001). Day (1994) furthermore asserts that the creative use of ICT enhances capabilities that support distinct inside-out, outside-in and boundary-spanning processes. Here, we assess how it is also linked with the outcomes of idiosyncratic digital servitization pathways.

We thereby look beyond the potential effect of the possession of digital tools on servitization realization because competitors may easily obtain or imitate similar resources (Barney, 1991). Rather, building on the dynamic resource-based view (DRBV), we argue in the remainder of this section that success in accomplishing servitization hinges on (1) the configurational and (2) the dynamic character of the resource base. In this view, servitization hinges on the way that digitization-based resources are accumulated, assimilated and used in a configuration that addresses the servitization pathway's specific resource needs.

Figure 2: this study's interpretive framework



For one, the DRBV considers strategic resources to have their own lifecycle (Helfat & Peteraf, 2003). It does not assume that valuable resources are simply 'picked' or purchased on factor markets, but rather developed over time. When resources are accumulated in a firm-specific way they are harder to imitate or substitute and more closely tied to competitive advantage (Barney, 1991; Dierickx & Cool, 1989). Hence, it is the path-dependently grown configuration of resources and its fit with environmental demands that lead to competitive advantage, rather than the resource alone (Black & Boal, 1994). The strategic relevance of distinct resource configurations comes from supporting distinct strategic options (Borch, Huse, & Senneseth, 1999) or paths (Black & Boal, 1994), as is already established for product-oriented servitization strategies (Raddats & Easingwood, 2010). Similarly, this paper's resource-based frame envisages the identification of resource configurations underlying customer process-oriented servitization pathways.

Second, from a DRBV perspective, we argue that even the resource configuration is insufficient on its own to explain digitalization's capability effect on servitization realization. In fact, a more evolutionary notion of resource value and appropriability is needed (Foss & Ishikawa, 2007). Realizing the potential of accumulated resources and capabilities requires continuous assimilation, transformation and exploitation into organizational routines (Zahra & George, 2002), also in the context of digitally-enabled servitization. This calls for higher order dynamic capabilities (Ambrosini, Bowman, & Collier, 2009; Danneels, 2008), which indicate an organization's capability to "extend, modify and create ordinary capabilities" (Winter, 2003, p. 991). As such, DRBV configurations contain a hierarchical categorization of resources (the static possessions deployed to operationalize a strategy), capabilities (the know-how of wielding such resources effectively) and dynamic capabilities (Amit & Schoemaker, 1993; Makadok, 2001).

Previous research has already hinted at the link between digitization and dynamic capabilities. For instance, managing endogenous ('from inside') and exogenous ('from outside') knowledge with digital applications improves a firm's dynamic capabilities (Sher & Lee, 2004). In this paper we are interested in whether this link also manifests itself in servitization pathways. At least in terms of contextual boundary conditions, there seems to be a similarity between both servitization and the DRBV. Both apply to routinized (product) business models responding to dynamic pressures (Raddats et al., 2015; Baines et al., 2007; Teece, Pisano, & Shuen, 1997). Just like a dynamic capability, servitization, in the sense of augmenting existing production capabilities into the development of a service offering (Matthyssens & Vandenbempt, 2008), counters inertia amid dynamic environments. Known examples of such capabilities in the context of servitization are ‘hybrid offering sales’, ‘hybrid offering deployment’ and ‘service-related data processing and interpretation capabilities’ (Ulaga & Reinartz, 2011).

In sum, the purpose of this study is to identify digitization-reinforced resource configurations in differing degrees of dynamicity supporting distinct customer process-oriented servitization pathways.

3. Methodology

We have chosen a case study methodology for studying digitally-enabled servitization pathways and their related dynamic resource configurations. Qualitative case studies are increasingly used for building new business marketing theory (Beverland & Lindgreen, 2010). This approach is preferred when relevant behaviors cannot be manipulated and the boundaries between the phenomenon of interest and context are not clear (Yin, 2009, 2011). Through a multiple-case study approach we are able to draw evidence from more than one unit of analysis to add both breadth and depth to data collection (Kindström, 2010).

The empirical data stems from four manufacturing SMEs based in Belgium that utilize digital tools for service infusion, and which have shown evidence of strong growth and innovation (see table 1). Over the course of three years, we visited more than twenty local manufacturing companies that have initiated, or shown interest in initiating, a strategic transition to cope with changing circumstances in their sector. Based on these preliminary meetings, we purposefully sampled four players that are especially relevant due to their development and utilization of digital approaches geared towards service growth, and who have also been recognized with awards or accreditations as ‘best practice’ examples in strategic efforts. Furthermore, these companies have been chosen for illustrative purposes, meaning that we want to offer real-life cases that support the internal logic of the presented concepts (Siggelkow, 2007).

Table 1: company cases

Company	**Main products**	**Size**	**Geographical scope**
Alpha	Metalwork	75 employees Revenue: €10 million	Belgium, the Netherlands and Germany
Beta	Electric switchboards	180 employees Revenue: €33 million	Belgium, the Netherlands and Germany
Gamma	Precision-engineered components and parts, e.g. dental frames	50 employees Revenue: €6 million (est.)	The Netherlands, Germany, the US and Asia
Delta	Functional insoles and foot scanner	15 employees Revenue: €1.2 million	Mostly Belgium, also the Netherlands

We draw our results primarily from in-depth interviews, along with support from online media, expert discussions and workshops (see table 2). The use of different sources permits triangulation and allows for internal validity (Jack & Raturi, 2006; Yin, 2009). Two rounds of interviews, ten in total, were conducted with the selected companies, with each interview lasting one to two hours. Before the interviews, we familiarized ourselves with each case by studying the company's website and consulting online presentations, news articles and videos featuring the company in question. Participating interviewees were those seen as the decision makers in their respective companies, such as owners and/or CEOs. The interviews were conducted in a semi-structured fashion using pre-determined topics and open-ended questions grounded in the servitization and digitization literature (see appendix). The first round of interviews took place in the summer of 2014, and the second round in the summer of 2015. Issues discussed during an interview that needed additional clarity were followed up by the interviewers at a later date, via face-to-face meetings or telephone discussions with the specific respondent. The interviewers also created extensive transcripts or shorter summaries of each recording, after the end of the interview.

After the first round of interviews, preliminary findings were weighed against existing theories on servitization and digitization. This practice reflects the iterative grounded theory method by Orton (1997), who describes a continuous and systematic combining of theory and empirical data (Dubois & Gadde, 2002). The interview results were also discussed with experts from Agoria, the Belgian sector federation for the technology industry including ICT, production technology and mechatronics, and UNIZO, the representative organization for Belgian-based SMEs, based on summaries of the interview recordings.

Finally, two workshops on servitization strategies, drivers, barriers and enablers were organized, covering two of the four cases in question, featuring experts from Agoria and UNIZO. The workshops allowed us to present and adapt current thinking through group discussion, with summaries of each workshop being available for review.

Table 2: data collection

Company	**Interviews**	**Other**
Alpha	2	a, c, d
Beta	3	a, c, d, e
Gamma	2	a, b, c
Delta	3	a, b, c, d, e
Other: a) official websites including brochures and presentations, b) online news articles, c) online videos, d) expert discussions, e) workshop participation		

After the collection of data covered above, a within-case analysis was performed to allow the authors familiarize themselves with each case before beginning to identify common themes among the cases. These analyses were then given to the respondents as reports to ensure the accuracy and validity of our findings. Next, a cross-case analysis was made using a pattern matching logic (Beverland & Lindgreen, 2010; Eisenhardt, 1989). On the basis of these findings, a pattern emerged of digitally-enabled pathways for servitization, and the dynamic resource configurations necessary to overcome barriers for each path.

4. Results

In this section, we give a description of each case individually, and offer insights into the digital methods the company has developed to offer higher value-added services that support customer processes. We also describe the observed capabilities that have helped these companies overcome certain barriers to growth in their service offerings.

4.1 Alpha

Alpha is a supplier of metalwork specializing in laser and plate treatment, profile working, welding and assembly. The company aims to build long-term relationships with clients by offering customized solutions at high speed and low cost. In 2015, it received a regional best practice award for manufacturing due to their digital transition.

Around 2010, Alpha found itself unable to accept additional customers unless it expanded the company’s capacity by building a new warehouse. This facility need, however, was not in line with the company’s philosophy of cost minimization. At the same time, customers were expecting products to be delivered faster than they had in past years. This led to Alpha adopting QRM (Quick Response Manufacturing), a production method for splitting up large orders into smaller production series to reduce the time from customer order to ready-for-delivery, known as lead-time. The company also implemented a digital

POLCA system (Paired-cell Overlapping Loops of Cards with Authorization) in its back-end operations to help visualize and further improve workflow. The implementation of QRM-POLCA transformed a somewhat rigid and centralized company into a decentralized organization with flexible and self-steering production cells.

A further step saw Alpha beginning to leverage its experience in QRM-POLCA by designing new services for clients. First, the manufacturer introduced customer support services such as training and consulting on QRM-POLCA to help (potential) clients who prefer maintaining control over their own operations. Second, the company shifted from supplying metalwork to providing fully assembled products for a limited amount of goods to further assist the customer. Since the introduction of QRM-POLCA, the company has been able to increase its workforce by 60 percent in just a few years, and in 2015, the CEO announced a revenue increase target of 15 percent.

Despite this success, Alpha has run into a number of barriers when deploying such services for the customer, such as the company's sales force requiring more advanced skills to better engage with the customer. For that purpose, the company has organized a two-day internal workshop on value selling for all sales staff. Also, negotiation with potential customers still mostly takes place with the Purchasing Manager, slowing the decision-making process at potential customers. The owner-founder explains: "Problems today are still often passed on to the supplier, yet these decisions should be made on a more strategic level". To alleviate this, the company is currently developing a tool to make it easier to visualize how a particular customer may benefit from using QRM-POLCA. Finally, some customers, such as large original equipment manufacturers (OEMs), do not put high value on QRM-POLCA because they place orders so far in advance. To combat this, Alpha ultimately seeks to gradually strengthen its relationship with clients, by providing everything from smaller components to fully-assembled metal products to convince clients of the value of QRM-POLCA.

4.2 Beta

Beta is a company that engineers, assembles and sells custom-made electric switchboards. The company focuses mainly on large B2B clients such as OEMs, while delivering to the rest of the industrial market via local installers. Beta has been recognized as a best practice case for digitization in its region.

Around 2010, Beta found itself wanting to expand its reach into the lower segment of the market, a segment consisting of approximately 5,000 small-sized installation companies. These installers generally configure the switchboard themselves, and according to Beta's founder, are "highly sensitive to price and delivery time". To this end, Beta developed a user-friendly web application as part of its front-end operations, adapted to the needs of both the installer and Beta's own back office. This new customer interface allows installers to quickly configure switchboards online, while the system it is based upon automatically generates documents such as a bill of materials, technical specifications and panel layout, giving the installer the full picture before the item is even purchased. Beta's founder points out: "Previously, these steps were all manually performed by our own people, which ran up to 15 to 20 percent of our operational costs". Beta is currently investigating the potential of using advanced robotics to increase automation gains. Besides helping Beta to expand its reach into the local installer market, the web app also raised interest among foreign competitors. "We are entering a new market", discloses the founder. "We want to be international, but sending switchboards to Finland or Spain makes no economic sense”. Thus, Beta is actually generating additional revenue through licensing the web app to switchboard manufacturers abroad.

The implementation of the web app led to two main benefits for Beta. First, the company reduced its lead-time for small-sized electric switchboards from five weeks to two weeks maximum, providing switchboards at a lower cost than if the installer were to buy all the components separately. Additionally, the web app increased Beta’s insight into customer demand and helped reduce complexity within the firm. The founder points out: “We are now able to find 80 percent of the solutions by using only 20 percent of our components.”

However, Beta did encounter a number of hurdles when implementing the new web app. Unforeseen technical issues kept installers from using the web app’s interface when it was first rolled out, and the company now believes is should have involved its lead customers much more in the process. “We had originally intended to implement the web app much quicker”, the founder admits. At this time, Beta has also not been able to attract its target number of customers, who remain unfamiliar with the new web app. The company is therefore investigating how to use social media to attract and educate potential customers.

4.3 Gamma

Gamma develops, produces and supplies precision-engineered components and parts for over twenty different industries, including oil-and-gas, medical, chemical and machine building. The company is considered a pioneer in 3-D printing in Belgium, serving clients worldwide, including well-known multinational companies based in the United States, Asia and Europe. Over the past five years, under the leadership of the previous CEO, Gamma won several awards for industry innovation and environmental best practice.

In the mid-2000s, Gamma introduced a new production technology to its back-end operations called '3-D printing' (also known as 'digital layered manufacturing' or 'additive manufacturing'). In addition to traditional molding techniques, Gamma started creating components by initially designing them using the client's digital data, then producing them through metal-based 3-D printing. The dental prosthetics sector, including partial dental frames, crowns, bridges and implants, was one of Gamma's first markets for this new technology. Next, Gamma implemented an online marketplace in its front-end operations, allowing dental laboratories to manage their own data and follow-up on production in real-time. Finally, Gamma is now actually able to implement a fully digital production concept at the customer's own location, per the customer's request. The company currently has several machines printing worldwide for which it offers services such as remote monitoring and necessary materials. Over the past decade, Gamma has transitioned from supplying components to helping customers transform their 'traditional' supply chains into new digital value chains. According to the previous CEO: "3-D printing has become a means to create a full technological transition of the customer's processes".

The implementation of 3-D printing is an example of back-end digitization that has enabled Gamma to manufacture customized, high precision components for a wider range of industrial applications. The lead-time for prosthetics has been reduced to only one day, and the company uses about eight times less materials and energy than before. Currently, about half of Gamma's revenue is generated through the production of components via 3-D printing.

Despite these clear benefits, Gamma encountered much initial resistance among potential customers due to a fear of change, a fear of employment layoffs and a lack of digital skills among employees. In essence, Gamma found itself replacing design and production techniques that have dominated the sector for decades. By involving one lead customer and thoroughly testing their concept at this one dental lab, Gamma was able to convince other laboratories to follow. The investment in 3-D printing is also considered a barrier among potential clients because of the high investment cost; therefore, Gamma first needed to make the benefits tangible to prove the added value for the customer.

4.4 Delta

Delta develops and produces functional shoe insoles, addressing both comfort and pain stemming from arthritis, injuries and athletics. Although the company was founded quite recently, in 2007, it received a regional best SME award only five years later.

In 2012, Delta launched its own fully integrated foot scanner, a product sold to podiatrists for scanning and measuring patients' feet. By using the scanner, the client podiatrist can outsource both the design and production of insoles to Delta. Most podiatrists today use traditional techniques such as plaster molding to make insoles, which is "a messy assignment which often takes place after office hours", explains the co-founder and CEO. "Podiatrists need to focus on biomechanical analyses, that is their know-how".

Delta recently transitioned from free 24-hour scanner repair service to a model based on contracts which include these services, or simply an hourly-rate service. Delta's long-term goal is to further expand by developing a fully integrated solution for podiatrists: "We want to offer a total package so customers can design and produce insoles themselves", explains the CEO. To this end, he company is looking into the use of 3-D printing while also developing a user-friendly web application for podiatrists to digitally design the insoles themselves. Delta has also begun to mine date from podiatrists' design requests in an effort to develop new insole standards.

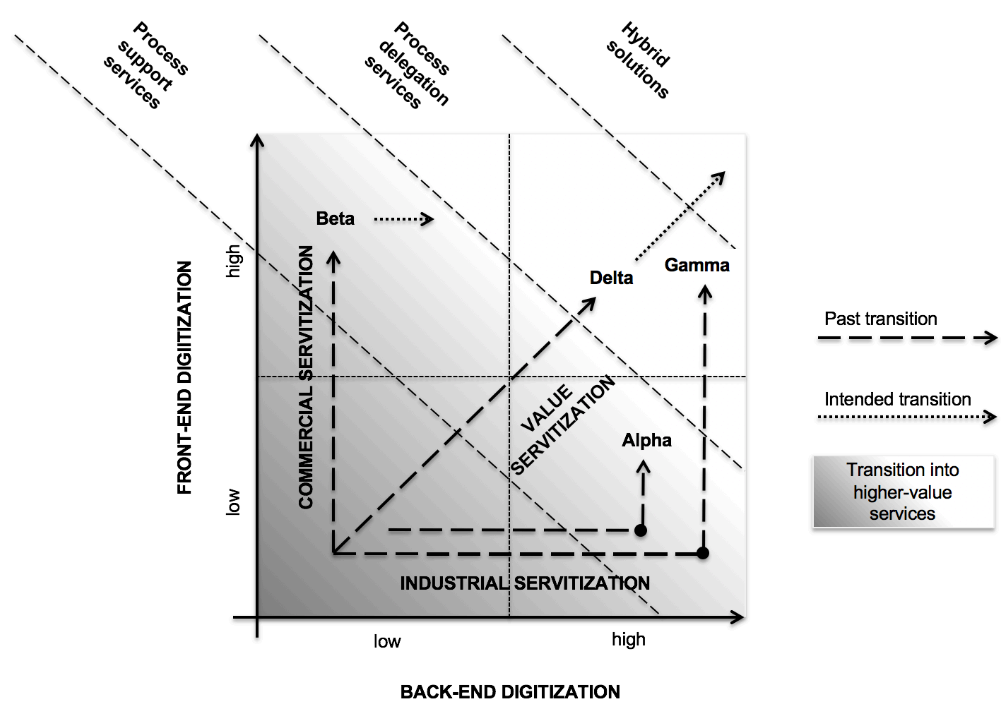
After only one year since its implementation, 70 percent of Delta's clientele has switched to the scanner. However, the company has run into several barriers as well. The first barrier relates to the reluctance of some podiatrist practices to outsource the design and manufacturing of insoles. "They still prefer making the insoles by hand through plaster molding", explains the CEO. Since the process of measuring patients' feet and making on-the-spot corrections requires a more abstract way of thinking, Delta provides a three-day training course to potential customers on the use of the scanner, along with advice to podiatrists on their office setup.

A second barrier is the expectation of Delta's clients that scanner repairs will be carried out within a short period of time. Though the company expanded its workforce from 11 to 15 employees since the scanner was launched, there are still constraints to providing timely repair services. Though some repair issues can be resolved remotely by Delta staff, using an online web application, many of the incidents require an on-site visit. Delta is currently training one of its technical employees to take responsibility for more of these on-site repair visits.

5. Discussion

The four cases used in this study illustrate different approaches for companies to exploit digitization as a servitization enabler. Based on the literature review, we establish a two dimensional framework of 'back-end' and 'front-end' digitization. It offers insight into three potential pathways for companies to increase their service offerings: 'industrial servitization', 'commercial servitization' and 'value servitization' (see figure 3).

Figure 3: case companies' pathways



Plotting the cases on the combined digital-servitization framework leads to insights on how higher levels of servitization can be reached through different pathways. As argued earlier, increasing servitization is fraught with risks and barriers, often requiring new capabilities. For instance, we see that rising towards the first level on the servitization pyramid requires companies to augment their sales arguments, capabilities and pricing models to align with service- or solution-based value propositions. Delta and Gamma, who arguably rose to the second level, indicate that entirely new challenges arise at that level. Due to the disruptiveness of the new solutions, which now differ on both customer's core processes and on the supplier's value delivery, customers become hesitant and need to be convinced of the superiority of a new way of working. As such, we list resource configurations supporting the successful execution of the three pathways in table 3 and provide explanation in the following three sections.

As argued previously, digitization reinforces the required resource base to the extent that it translates digital data into knowledge (Barney et al., 2001) and fits a path-specific configuration (Peteraf, 1993). Table 3 lists the case-specific digital methods supporting the servitization pathway, as well as their contribution at different levels of the dynamic resource configuration. These levels follow DRBV's hierarchic distinction between resources, capabilities and dynamic capabilities, with increasing impact on learning and competitive advantage (Danneels, 2008; Winter, 2003). The digitization and dynamic resource configuration contents in table 3 are based on the above case insights and are in line with earlier studies (Kindström & Kowalkowski, 2014; Parida et al., 2014; Ulaga & Reinartz, 2011). Neither the resource configurations nor the barriers listed here are meant to be exhaustive, but instead represent those elements that we could derive from the cases and the existing state of the literature. They offer a basis for further research identifying managerially relevant resources and constraints at the nexus of servitization and digitization.

Table 3: comparative table of case companies according to servitization pathway

	1. Industrial servitization	**2. Commercial servitization**	**3. Value servitization**
Cases	• Alpha • Gamma	• Beta • Gamma	• Delta
Digital means	• Information and communication technologies (ICT) for workflow visualization, e.g. QRM-POLCA • Advanced manufacturing technologies (AMT), e.g. 3-D printing	• Information and communication technologies (ICT) for customer relations management, e.g. web app, digital 'marketplace'	• Digital products that radically change provider-customer relations, e.g. scanner
Services	• Process support services, e.g. advice, consulting on new digital means to optimize workflow	• Process support services, e.g. online self-service data management tools for product configuration, purchasing and adjustments	Similar to 1 & 2, and in addition: • Process delegation services, e.g. outsourcing of production activity, materials provision, service agreements incl. monitoring • Hybrid solutions, e.g. customization, integration and reconditioning of digital products in the customer's process
Barriers	• Developing new sales competences • Making benefits tangible & billable for the customer • Convincing customers to alter their processes	• Developing customer interfacing skills • Streamlining front-end customization processes with production and delivery	Similar to 1 & 2, and in addition: • Uncertain investments in totally new value chains • Customer competence destruction
Resources	• Digital product manufacturing assets	• Online customer interface • Customer involvement	Similar to 1 & 2, and in addition: • Field service organization • Product usage and process data

Capabilities	• Design-to-service capability	• Integrated development capability • User involvement and engagement capability	Similar to 1 & 2, and in addition: • Execution risk assessment and mitigation capability
Dynamic capabilities	• Hybrid offering sales capability • Value visualization capability	• Hybrid offering deployment capability • Customer needing interpretation capability	Similar to 1 & 2, and in addition: • Service-related data processing and interpretation capability
Competitive benefits	• Shorter lead-times through workflow visualization • Reduction of costs, e.g. stock, material, energy • Leveraging internal production knowledge to educate clients	• Shorter lead-times through scalable systems • Increased operational efficiency through customer insight • Increased capture of customer needs for product innovation	Similar to 1 & 2, and in addition • Expand markets through new products and their related services • Further integration of the provider in customer processes

5.1 Industrial servitization

In industrial servitization, the provider translates knowledge gained from internal process optimization into tangible value-added services for the customer. As observed in Alpha and Gamma, digital product manufacturing assets (Ulaga & Reinartz, 2011) such as information and communication technologies (ICT) for workflow visualization purposes, or advanced manufacturing tools (AMT), are considered to be critical resources. By implementing the QRM-POLCA and 3-D printing systems, respectively, Alpha and Gamma optimized workflow in their back-end operations, resulting in faster production and delivery of competitively-priced customized goods needing fewer materials. However, such systems cannot offer sustained competitive advantage by themselves, since they are likely to be imitable, or copied, by other companies (Barney, 1991).

This pathway can be considered an inside-out process and, therefore, internal functional capabilities are relevant for its realization (Day, 1994). The observed companies, for example, display features of the design-to-service capability, or the capacity to create new hybrid offerings grounded in core manufacturing assets (Kindström & Kowalkowski, 2014; Ulaga & Reinartz, 2011). Alpha and Gamma use digital manufacturing tools not only for producing customized goods more efficiently, but also to leverage this expertise to provide (potential) clients with advisory and consulting services. Such first-level support services are of particular interest to customers that prefer to maintain control over their operations. Thus, we see that firms that are able to turn (tangible) digital means into (intangible) knowledge may develop a sustainable advantage over competitors (Barney et al., 2001).

In terms of dynamic capabilities, the need for a hybrid offering sales capability is observed in both companies, emphasizing a capacity to reach key decision makers and sell value-based (Ulaga & Reinartz, 2011). The transition from products to services requires a different sales approach, because the sales process is often more complex, takes longer and requires stronger customer empathy. What makes this such a dynamic capability is the ability it gives to continuously adapt to different customer needs, such as Gamma targeting different sectors. Alpha, on the other hand, is an example of a company that has run into problems convincing customers of their new offering in this direction, leading to a necessary retraining of its current sales force and the proactive development of a tool designed to clarify the benefits of the QRM-POLCA system for different customers. The latter method has also been referred to as a value visualization capability, which entails the ability to choose from various methods to convince customers of the new value being provided (Kindström & Kowalkowski, 2014). Similar training and value visualization efforts have also been observed at Gamma.

5.2 Commercial servitization

In commercial servitization, the provider aligns its value creation routines with the customer's internal processes through new forms of interaction. As observed in the cases of Beta and Gamma, the use of ICT for managing customer relations enables scalability as the company grows, while also building deeper customer relationships through continuous interactions. By implementing online customer interfaces (Kindström & Kowalkowski, 2014) in front-end operations, we see that both companies were able to cover more sales territory and expand their commercial reach.

Similar to the industrial pathway, commercial servitization generates the possibility for companies to provide services that specifically support customers that want to maintain control over their own operations. However, in this case, customers are supported by online self-service data management tools for product configuration, purchasing and adjustment purposes. As an outside-in customer-oriented pathway, commercial servitization is predominantly supported by capabilities that support customer linking, channel bonding and technology monitoring (Day, 1994). An integrated development capability supports companies in linking disconnected front- and back-end processes within the company, enhancing the capture of customer needs (Parida et al., 2014). In addition, involving and engaging users (Kindström & Kowalkowski, 2014) during the development of such customer interfaces is often crucial to a successful implementation. For instance, Beta was unable to implement the new web app within the foreseen timeframe due to a lack of customer involvement in the early development stages, while Gamma chose to work closely with one specific key customer, opening the door for other customers to follow suit.

In addition, companies need to possess the ability to continuously balance both front-office customization and back-office production and delivery processes, otherwise known as the hybrid offering deployment capability (Ulaga & Reinartz, 2011). Both Beta and Gamma rely on flexible platforms, i.e. the web app and online marketplace, which are further streamlined with back-end operations through standard production and administrative methods. What turns this into a dynamic capability is that the new functionality has enabled both companies to leverage the scalability of the digital platform. With a relatively small amount of effort, the companies were able to apply the core solution of the hybrid offering to different applications and industries. For instance, Beta is currently licensing the web app to switchboard manufacturers abroad, and Gamma has started venturing beyond the dental sector into other industries like fine chemical and machine building. Finally, companies can use their potential to capture customer needs to create new ideas for products, known in the literature as the customer needing interpretation capability (Kindström & Kowalkowski, 2014). Beta, for instance, is now better able to track which components installers need for configuring switchboards, and Gamma can advise customers better on product design and quality.

5.3 Value servitization

Value servitization implies a fundamental renewal of the current value chain through the creation of new digital products that impact customer processes and provide a more disruptive impact on provider-customer relations. As we see in the case of Delta, which developed its own scanner for measuring patients' feet, this pathway has the potential for manufacturers to expand the market and further integrate into the customer's process.

Similar to the previously discussed pathways, companies that introduce new digital products may initially develop resources and capabilities to move into first-level service offerings. The use of in-house manufacturing experience can be observed in Delta's rethinking of the entire shoe insole production process. Similar to the commercial path, Delta involved lead customers in the creation and testing of the new digital product. Such capabilities allowed the company to expand into services like product training for proper use of the scanner, which support podiatrists in performing their jobs. Furthermore, value servitization also taps into a more dynamic, renewal-oriented form of service innovation (Ambrosini et al., 2009), and some of the resources and capabilities tied to this pathway tend to be more radically new to the organization or industry (Abernathy & Clark, 1985).

Value servitization tends to rest on more integrated capabilities which, as Day (1994) suggests, typically underlie boundary-spanning processes. One such example is the installment of a field service organization, the stock of resources allocated to a network of specialized technicians aimed at deploying and servicing the firm's installed base (Kindström & Kowalkowski, 2014; Ulaga & Reinartz, 2011). As observed in the Delta case, companies invest resources in providing second-level services such as maintenance and repair in order to guarantee customers a certain performance expectation. Such a forward base of operations keeps lead-times short for service events and allows for synergies in service delivery. Similar services are also provided by Gamma, which managed to combine both industrial and commercial servitization pathways. In a higher phase, companies may perhaps provide result-oriented services to customers, which guarantee a product's outcome rather than just performance, e.g. as savings on material or energy. If so, an execution risk assessment and mitigation capability is likely necessary (Ulaga & Reinartz, 2011). These considerations lie beyond the scope of this study, but are worthy of future investigation.

An example of the dynamic capability level is a data processing and interpretation capability, which analyzes product usage and process data to help customers achieve certain outcomes (Kindström & Kowalkowski, 2014; Ulaga & Reinartz, 2011). This capability addresses the competence destruction barrier, as providers take over non-essential tasks from customers, by enabling them to constantly upgrade and customize their offering targeted at the client's core skills. This type of offering is considered a hybrid solution, and is observed in Delta who, in addition to taking over production activity from the client, has started to develop new shoe insole standards based on client data. Those standards can then be customized to fit a specific patient's needs faster using less material. Delta is also looking into current usage data to develop an online web application for podiatrists to design insoles themselves.

6. Conclusions

6.1 Theoretical contributions

Over the past three decades, innovation research has steadily increased its focus towards services (Carlborg et al., 2013), mirroring a shift from a product dominant logic to a service dominant logic in marketing, as observed by Vargo and Lusch (2004). Today, not the exchange of tangible (manufactured) goods, but intangibles such as specialized skills, knowledge and processes are the new focal point. This new logic is more customer-centric, which means learning from customers, being adaptive to their individual and dynamic needs and co-creation are essential. The service literature calls on companies not to merely innovate service, but rather to help customers get a specific job done (Bettencourt & Brown, 2013). Earlier work suggested that the exploitation of digital means may facilitate different types of servitization (Gago & Rubalcaba, 2007). We set out to find out how different digitization options enable manufacturing companies to follow distinct servitization pathways when supported by unique dynamic resource configurations. In turn, these pathways lead to different service levels in which the provider further integrates into the customer's processes, thus increasing its competitive advantage over other providers.

Based on a multiple-case study involving four illustrative cases from the Belgian manufacturing industry, we consider the following two main theoretical contributions. Our first contribution, concerning a priming effect, is that we develop insight into three potential pathways for manufacturers to increase their service offerings through digitization. Initially, we started out by introducing the servitization pyramid as an extension on current theories (e.g. Kindström & Kowalkowski, 2014; Ulaga & Reinartz, 2011). Next, we identified two cross-functional areas – commercialization and industrialization – for managing a solution business model (Storbacka, 2011), and considered different applications of digital methods that support these areas (MIT Center for Digital Business & Capgemini Consulting, 2011). Using four illustrative cases, we then propose a framework that presents three distinct pathways for manufacturers wanting to increase their service offerings through digitization. Industrial and commercial servitization (first and second pathway) enable services that support customers completing tasks on their own, such as advice, training, consulting and online self-service management tools. These pathways are supported by digitizing either back- or front-end operations, as we observed in the cases of Alpha and Beta respectively. In addition, by combining both pathways in one integrated offering, companies may gradually take over certain activities traditionally performed by the customer, as observed in Gamma. Value servitization (third pathway) enables companies to unburden customers from certain activities more quickly. This pathway involves a more radical change in provider-customer relationships by introducing new digital products that change customer processes and allow the provider to gather data, learning from the client. Ultimately, when companies are able to fully customize, integrate and recondition their hybrid offering, they will reach the stage of providing customers with a solution.

Our second contribution, concerning a capability effect, is that we unpack the resources and capabilities for manufacturers to overcome barriers related to different levels of servitization. The critical capability requirements to increase servitization differ according to the pathway chosen to reach it. In the case of industrial servitization, digitization holds potential for gains in the customer's operational efficiency, but barriers derive from the need to adapt the client's core technical processes. This requires, for example, negotiating higher up in the buying organization's hierarchy, as the new solutions' required changes have to at least pass through the production manager function. Commercial servitization, in contrast, starts from adapting one's own channels to support existing customer activities, backed by a front-end digital application. When well-executed, the necessary value delivery and capturing routines are embedded within the digital solution. However, the formerly product-oriented suppliers are likely not organized to systematically codify customers' value delivery preferences into reliable digital interfaces. This requires new skills, e.g. on business process consulting, as well as ensuring back-office capability to keep maintaining the digital platform. In short, we can attribute different resource configurations to each pathway in ascending order of dynamism (Danneels, 2008; Winter, 2003). Although this list is not meant to be exhaustive, it opens up valuable avenues for manufacturers towards servitization maturity.

This paper takes a DRBV lens to study the phenomenon of servitization, as it supports our aim to operationalize the identified pathways into different necessary resource configurations (Black & Boal, 1994). This DRBV lens does not only fit within the boundary conditions of dynamic competition that underlie both the servitization and the digitization phenomena (Baines et al., 2007); it also contributes to our interpretation of the servitization cases by helping structure the different strategic requirements to implement the pathways in a horizontal direction (to which path do they pertain) and in a vertical direction (in terms of their dynamism and thus on increasingly deep levels of learning and strategic impact) (Danneels, 2008; Teece et al., 1997). Taking a DRBV lens to the digitization-servitization nexus thus helps one discern how digital technologies can support servitization, not only on an operational level, but strategically as well. In every path, the case-based digital applications also contributed to the dynamic capabilities supporting servitization. Hence, digitization strategically supports a servitization pathway to the extent that it has an impact on the higher-order routines regulating the development, integration and modification of ordinary capabilities (Winter, 2003), and as mentioned earlier, has the potential to encode change-oriented routines (Merrifield, Calhoun, & Stevens, n.d.; Pentland, Feldman, Becker, & Liu, 2012).

6.2. Managerial implications

The study of digitization as an enabler for servitization has substantial practical relevance for managers. Our study offers concrete guidelines for managers who seek to increase their competitive advantage over other providers by further integrating into customers' processes. First, we untangle and integrate earlier service typologies by introducing the servitization pyramid (figure 1), which offers managers a way to pinpoint and interpret their current value proposition at different service levels, explore future avenues for customer integration and consider potential barriers along the way.

Secondly, we see that managers are faced with cross-functional issues when managing a solution business model. In this paper, we investigated digital applications in both front- and back-end operations that help companies address some of the main problems associated with servitization implementation. Generally, such tools enable standardization, transaction cost reduction and scalability (Nooteboom, 1992; O'Mahony & Barley, 1999). In the context of servitization, they address the problems of cost-effectiveness and controllability that typically plague companies, particularly SMEs

(Kowalkowski et al., 2013). Building on the cases of four 'best practice' manufacturers, we offer three distinct strategic choices for companies that aim to implement digital methods for service innovation purposes (figure 2).

Thirdly, since the implementation of digital tools is not usually sufficient for companies to gain a sustained competitive advantage (Barney, 1991), we offer managers practical insight into the necessary capabilities specific to each pathway, which include skills related to the design, sales and deployment of hybrid offerings for first-level services, and processing and interpreting customer data for higher-level services. This paper's case illustrations offer concrete examples of such capabilities along with the context and manner in which they were applied.

6.3 Limitations and suggestions for future research

Beyond our contributions to existing literature, we do note a number of limitations to our work that call for further research. First, regardless of their future intentions, none of the cases have actually reached the third level of the servitization pyramid, i.e. to provide customers with a solution. Though the three pathways offer distinct possibilities for reaching the first and second level of the pyramid (to provide a certain input or agree on a performance metric), providing customers with a solution entails other changes. These include an organization gaining the capability to assess whether or not contractually agreed-upon outcomes may be realized (Ulaga & Reinartz, 2011), and the organization having the ability to adapt a new value-based pricing strategy that takes internal profit goals into account (Parida et al., 2014). Further research is needed on the specific capabilities necessary for manufacturers to reach this highest level of service offering.

Second, one needs to be careful when generalizing these results. For theory-building purposes, this paper is mostly exploratory in nature, so we therefore utilized a case study approach grounded in a purposeful sampling strategy. It should also be noted that our work is heavily influenced by Kindström and Kowalkowski (2014) and Ulaga and Reinartz, (2011) when describing different dynamic resource configurations, and the list of capabilities listed in this study is not to meant to be exhaustive. Further quantitative research is needed to develop and test hypotheses regarding, for example, the impact of different dynamic resource configurations on service growth, and the relative success of various digital investments as far as their actual "return on investment" is concerned.

Third, though we selected companies from Belgium's discrete manufacturing industry as case illustrations (Siggelkow, 2007), the use of digital methods can certainly be found in other industries as well, including process industries such as chemical, medical and foodstuffs. Investigating cases from other industries could well lead to different trajectories and dynamic capability needs being discovered, providing further valid contributions to the literature.

Acknowledgements

The acknowledgements may follow later if accepted.

Appendix

<u>General questions:</u>

What is your function in the company?

In what year was the company established?

What are the company's main activities?

What is the strategic vision of the company?

What was the company’s revenue over the past three years?

Who are the company’s most important customers (segments/geographically)?

How many employees does the company currently have?

<u>Service-related questions:</u>

What products and services are provided to the customer today?

What product customization services are offered, if any?

What basic product support services are offered (e.g. spare parts, warranty)?

What intermediate services are offered (e.g. maintenance, helpdesk, training)?

What advanced services are offered (e.g. support agreements, outsourcing)?

What strategies regarding services has the company considered?

What were/are possible external barriers for implementing service in the company (e.g. with clients, suppliers)?

What enablers/solutions did the company find to overcome these external barriers?

What were/are possible internal barriers for implementing service in the company (e.g. culture, financial resources)?

What enablers/solutions did the company find to overcome these internal barriers?

<u>Digitization-related questions:</u>

To what extent do you consider digital tools to be implemented in the company today?

What digital tools are currently used to manage external relations (for instance, for the exchange of information)?

What digital tools are currently used to improve internal processes (for instance, in development, production)?

How are the digital tools for managing external relations and improving internal processes integrated with each other?

What were/are possible external barriers for implementing digital tools to manage external relations (e.g. with clients, suppliers)?

What enablers/solutions did the company find to overcome these external barriers?

What were/are possible internal barriers for implementing digital tools for improving internal processes (e.g. culture, financial resources)?

What enablers/solutions did the company find to overcome these internal barriers?

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