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Trapped in the supply chain? Digital servitization strategies and power relations in the case of an industrial technology supplier

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ABSTRACT

Digital servitization transforms value creation processes and subsequently affects relationships and power structures in supply chains. Yet, previous studies present insightful but incomplete views on how digital servitization changes power balances between supply chain actors. Specifically, little attention has been paid to upstream firms, although they are particularly vulnerable to becoming disadvantaged participants in a digitally servitized supply chain, as they are positioned far away from end-users. Addressing this research need, we performed an explorative single case study of an industrial supplier – using the resource dependence theory as theoretical framework – to investigate (1) the effects of digital servitization on the power balance between the supplier and its OEM customers and (2) the strategic responses of the supplier to these effects. We find that for an industrial supplier, the successful deployment of digitalized product-service systems (DPSS) depends not only on the development of digital capabilities, but also on the ability to establish close end-user connections, continuous access to product usage data, and a trustful relationship with OEM customers. In addition, we show that digital servitization shifts power towards the actor who is more dominant prior to its advent, refining the common notion that digital servitization favors per se downstream firms. We enrich existing literature by outlining five specific strategies that industrial suppliers can pursue to maintain critical resource access and regain power in a digitally servitized supply chain. Finally, we offer managers guidance in establishing DPSS offerings by providing a comprehensive picture of the industrial supplier's digital servitization journey.

1. Introduction

Digital technologies are significantly changing the way how firms conduct their business, ranging from the adoption of novel operation processes to the emergence of new business models (Loebbecke and Picot, 2015). This change becomes particularly visible in the manufacturing sector, where value is traditionally created through physical materiality (Yoo et al., 2010). In the wake of an Industry 4.0 (Obermaier, 2019), manufacturers increasingly attempt to bundle sensor-equipped components of their industrial-age products with services based on digital technologies to gain a competitive edge with digitalized product-service systems (DPSS) (Lerch and Gotsch, 2015; Porter and Heppelmann, 2014; Rymaszewska et al., 2017). This transformation from the provision of physical products towards the offering of DPSS is commonly referred to as digital servitization (Vendrell-Herrero and Wilson, 2017).

Gradually emerging over the last two decades due to the increasing attention to information capital (Rabetino et al., 2017), digital servitization expands the scope of servitization by an even stronger focus on end-user interaction (Vendrell-Herrero et al., 2017), the need to develop novel digital capabilities (Ardolino et al., 2018), closer collaboration with other actors involved in the value creation process (Pagani and Pardo, 2017), and a more data-centric business culture (Cenamor et al., 2017). Given the far-reaching effects of this transformation, digital servitization may not only lead to major organizational changes for manufacturing firms (Coreynen et al., 2017), but disrupt the entire supply chain (Holmström et al., 2019).

While a supply chain generally includes a variety of different actors, those involved in the production of a given complex physical product can generally be divided into two broad categories: suppliers and original-equipment manufacturers (OEM). Suppliers provide materials, components, and systems to OEMs, which assemble and integrate the supplied parts into products of higher complexity and offer them to distributors or directly to end-users. Therefore, OEMs typically control

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the downstream part of a supply chain (Lee and Berente, 2012). While downstream firms have already dominated the supply chain through close communication with end-users (Wise and Baumgartner, 1999), this circumstance may become even more severe in the context of digital servitization due to the increasing reliance on end-user data required to develop DPSS offerings (Neely, 2008; Porter and Heppelmann, 2014). As a result, the control over end-user ties and data may shift the power balance within a supply chain in favor of downstream firms (Vendrell-Herrero et al., 2017), potentially isolating upstream firms from end-users and leaving them trapped in their respective supply chain position. Nevertheless, suppliers might try to overcome the barrier set by OEMs and seize the novel opportunities provided by digital servitization. Specifically, they may equip their components with sensors or connectivity devices for collecting data and thus deliver services directly and self-sufficiently to end-users (Porter and Heppelmann, 2014; Huikkola et al., 2020). This strategy, however, challenges the OEM's power position, potentially resulting in conflicts between suppliers and OEMs (Paiola and Gebauer, 2020).

Surprisingly, the literature has so far remained largely silent on such disruptive potentials of digital servitization on the power structure in different sections of a supply chain (Kohtamäki et al., 2019). Only recently, Vendrell-Herrero et al. (2017) have indicated that upstream firms are becoming more dependent on downstream firms due to their control of link channels. Huikkola et al. (2020) have added to this finding by outlining that upstream firms are forced to vertically reposition themselves and by-pass intermediary actors to improve their power position. However, the extant literature in digital servitization has so far neglected that alterations in the power structure between upstream and downstream actors generally depend on different context-contingent factors such as control over critical resources (Ireland and Webb, 2007), leading to a potentially incomplete understanding of the disruptions digital servitization has on power relations in supply chains. Therefore, a more in-depth empirical investigation is needed to analyze the formation of power structures in digitally servitized supply chains (Huikkola et al., 2020) and explore the power disruptions that arise between suppliers that want to get closer to end-users and OEMs that strive to isolate other actors from end-users. In this regard, suppliers are of particular interest (Kohtamäki et al., 2019), as they need to identify adequate strategies to overcome the barriers placed by OEMs to profit from digital servitization efforts without adversely affecting the business relationships to OEMs and subsequently physical component sales.

Thus, we approach these research needs and aim to extend prior literature on power structures in digital servitization (Vendrell-Herrero et al., 2017; Huikkola et al., 2020) by conducting an in-depth single case study at a large European industrial supplier of powertrain technology. In particular, we address the following research questions: (1) How does digital servitization affect the power structure between an industrial supplier and its OEM customers? (2) Which response strategies does an industrial supplier undertake to counteract the power structure effects of digital servitization?

To answer our research questions, we build on insights from 18 in-depth expert interviews at the case firm, extensive access to internal documentations, meetings, and workshops over a three-year period, and external archival records to triangulate our results. Based on this unique dataset and by drawing on resource dependence theory, we make the following contributions to the literature on power structures in digital servitization: First, we find that for an industrial supplier the successful development and provision of DPSS is not only dependent on the development of digital capabilities, but also relies on the control of close end-user interactions, continuous access to product usage data, and inter-organizational trust with OEM customers. Second, while prior literature argues that upstream firms become more dependent on downstream organizations due to digital servitization (Vendrell-Herrero et al., 2017), we find that in fact even the contrary might be true depending on the ex-ante power constellation between supply chain members, as powerful actors can exercise their influence to gain control over emerging resource needs at the network level. Third, we provide five specific strategic responses for industrial suppliers to re-gain power within a digitally servitized supply chain: leverage tacit component knowledge, initiate data-exchange specific investments, signal relationship commitment, use end-users to pull own DPSS into OEM products, and move downstream in OEM-unserved markets.

The remainder of this article is organized as follows: in the next section, we shortly review the digital servitization literature. In section 3, we present the theoretical foundation of our work. Subsequently, we outline our research methodology in section 4 and describe our results in section 5. In the sixth section, we discuss our findings before we indicate our contributions to the literature on digital servitization in the last section.

2. Literature review

2.1. Servitization

The objective of achieving higher profitability, stable revenue streams, and in particular to counteract the increasing competition of low-cost manufacturers in recent decades (Baines et al., 2009), have brought servitization (Vandermerwe and Rada, 1988) and the related concept of product-service systems (PSS) (Baines et al., 2007; Tukker and Tischner, 2006) to the forefront in the manufacturing sector. In relation to both concepts, we define servitization as the transformation of companies from focusing on products or services to providing PSS that combine both in an integrative way (Baines et al., 2007, 2009). In this regard, we understand "product" as a material artefact (e.g. transmission or axle) and "service" as an economic activity (e.g. maintenance, repair advice) that is not necessarily resulting in the ownership of a tangible asset (Baines et al., 2009). In some instances, servitization can also result in the replacement of original product sales by availability-based contracts (Baines et al., 2011). A prominent example of this is the aero-engine manufacturer Rolls-Royce with its Power-by-the-hour offering. For upstream firms such as Rolls-Royce, the adoption of service offerings often results in vertical repositioning towards end-user (airlines) to bypass intermediaries (airplane manufacturer) and improve the standing within the supply chain (Wise and Baumgartner, 1999; Stabell and Fjeldstad, 1998). The competitive advantage of servitization is thereby considered to be more sustainable, less visible, more dependent on employee skills, and consequently more difficult to replicate (Oliva and Kallenberg, 2003). Therefore, servitization is seen as a critical aspect to provide product-centric firms with a competitive edge, particularly in mature markets with cost-based competition to avoid being caught in the commodity trap (Chesbrough, 2011).

2.2. Digital servitization

For many manufacturing firms the move towards servitization has steadily intensified with the increasing digitization, i.e. the convergence of analog into digital data (Ritter and Pedersen, 2020; Rabetino et al., 2017), and is driven by the need for higher operational efficiency and offering customization (Cenamor et al., 2017; Opresnik and Taisch, 2015). Digital technologies such as Internet of Things (IoT) solutions or data analytics are therefore seen as enablers and driving factors of servitization (Baines et al., 2020; Kohtamäki et al., 2020), leading to the emergence of DPSS. Consequently, servitization in conjunction with digital technologies has emerged as a new field of interest (Suppatvech et al., 2019) and is commonly described as digital servitization (Vendrell-Herrero and Wilson, 2017). In our work, we understand digital servitization as the evolutionary transformation from pure products offerings, add-on services, and PSS towards DPSS that enable value creation, delivery, and capture through monitoring, control, optimization, and autonomous function via digital technologies (Kohtamäki et al., 2019; Porter and Heppelmann, 2014; Lerch and Gotsch, 2015).

However, DPSS are not simply traditional PSS in digitized form, but rather involve the digitalization of the manufacturer's entire service business model (Ritter and Pedersen, 2020) and provide novel business opportunities (Rymaszewska et al., 2017). Thus, digital servitization considerably differs from the servitization understanding in some aspects. First, digital services underlying DPSS exhibit higher scalability as they can be replicated with marginal costs close to zero (Rifkin, 2014). Second, whereas traditional services are usually added to physical product sales in a complementary way (e.g. repair), digital services reinforce the trend to replace physical product sales via outcome-based contracts (Vendrell-Herrero et al., 2017), further undermining the value contribution of physical materiality (Yoo et al., 2010). Third, the provision of DPSS requires a more centralized organization encompassing data-driven platforms to efficiently manage decision-making and related strategic actions (Sklyar et al., 2019). Fourth, the relevance of co-operations between different stakeholders operating in a network is significantly higher, since companies are often unable to offer DPSS on their own due to a lack of competencies (Benitez et al., 2020). Fifth, the novel capabilities required in digital servitization offer new market entry opportunities to established actors (e.g. suppliers) or new actors (e.g. software developers), which may lead to changing power structures in supply chains and entire industry segments (Coreynen et al., 2020; Porter and Heppelmann, 2014).

2.3. Empirical research in digital servitization

As digital servitization literature is still in its emerging phase (Gebauer et al., 2020; Paschou et al., 2020), particularly with regard to the industrial sphere, research efforts are mostly qualitative and inductive to gain a deeper understanding of the phenomenon (Rabetino et al., 2018). Thereby, studies show that digital servitization has considerable implications on business models and value creation through novel key partner networks and the extension of value chains (Arnold et al., 2016; Rymaszewska et al., 2017). Others focus on digital capabilities that facilitate digital servitization strategies (Ardolino et al., 2018; Coreynen et al., 2017) or indicate that a digital platform approach supports customization, operational efficiency, and resource sharing (Cenamor et al., 2017; Eloranta and Turunen, 2016).

More recently, studies have also started to investigate the effect of digital servitization on dyadic relationships, particularly between downstream actors. Kamalaldin et al. (2020) analyze relationships between service providers and customers by showcasing that, along with other factors, complementary digital capabilities and knowledge-sharing routines are key components to succeed in digital servitization settings. Likewise, Sjödin et al. (2020) show that the implementation of relational governance strategies such as high service innovation, perceived switching costs, and the use of explicit contracts enables service providers to profit from servitization. In a further study, Boehmer et al. (2020) find that the adoption of IoT-based solutions draws OEMs and end-users (operators) closer together via increasing trust, self-enforcing safeguards like mutual specific investments, and risk sharing.

While it appears that digital servitization forges closer ties between downstream actors such as OEMs and end-users, not every actor in the supply chain seems to be able to benefit from these novel revenue-generating opportunities. In particular, upstream firms may have difficulties creating and capturing value by DPSS due to an inherent lack of close end-user ties (Porter and Heppelmann, 2014). Affirming this notion, Vendrell-Herrero et al. (2017) indicate that digital servitization empowers downstream firms (e-commerce retailers), as they are in control of link channels to consumers. However, upstream companies (publishers) are able to re-gain power if they can leverage organizational resources such as copyrights to counteract the dominant position of downstream firms. Huikkola et al. (2020) extend these insights and offer a diverging strategic response by outlining that upstream firms must move downstream and bypass intermediary actors via acquisitions, joint ventures, or strategic alliances in order to establish closer connections to end-users and improve their power position.

In spite of these research efforts, there is still an inadequate understanding on how context-contingent factors affect the formation of power structures in digitally servitized supply chains, indicating an eminent need for a more in-depth empirical investigation (Huikkola et al., 2020). In addition, the literature remains silent on how digital servitization impacts bargaining power of firms positioned far upstream the supply chain, such as component suppliers (Kohtamäki et al., 2019), although these actors may have a disadvantaged position in the supply chain and may fear adverse consequences from OEMs if they adopt strategies to move downstream. Therefore, it seems crucial to identify specific strategies they can undertake to address potential power disruptions caused by digital servitization. In our study, we address these research needs (1) by examining how digital servitization initiatives impact the power structure between an industrial supplier and its OEM customers, and (2) by outlining potential strategic responses an industrial suppler can undertake to extend or re-gain power in a digitally servitized supply chain.

3. Theoretical background

To investigate these research needs, we take a resource dependence theory (RDT) perspective (Pfeffer and Salancik, 1978) as it provides an explanatory framework for the formation of power structures in exchange relationships and has a well-established tradition in the evaluation of power relations (Hillman et al., 2009). Since we focus in our research on buyer-supplier relationships, we also apply the power regimes perspective (Cox et al., 2002), as it constitutes a specific application of RDT in a supply chain context and enables us to clearly assess the disruptions digital servitization has on power structures in supply chains.

3.1. Resource dependence theory

According to RDT, a firm's need for scarce and critical resources results in a dependence on its trading partners and can be a potential source of conflicts for an organization (Pfeffer and Salancik, 1978). Therefore, the success of a firm is indispensably linked with the resources and behavior of other organizations and beyond the control of a focal firm (Pfeffer and Salancik, 1978). This leads to uncertainties, as a firm's ability to maintain access to vital resources is unclear, forcing a firm to manage inter-organizational relationships and reduce environmental uncertainty in order to ensure the long-term survival of the organization (Hillman et al., 2009; Pfeffer and Salancik, 1978). Accordingly, firms engage in different arrangements such as mergers and acquisitions, joint ventures, strategic alliances, or supplier-buyer relationships to gain access to the required resources (Hillman et al., 2009). Thus, the key Proposition of RDT lies in the primary aim of a firm to gain and preserve access to critical resources in order to ensure survival, which leads to a complex network of varying inter-firm dependencies (Pfeffer and Salancik, 1978).

In this network, firms in control over critical and unique resources hold power over others (Pfeffer, 1981; Crook and Combs, 2007), which is the ability to influence the behavior of another actor contrary to its interests (Weber, 1922; Emerson, 1962). Consequently, a concentration of critical resources generally entails a concentration of power (Nienhüser, 2008). In order to maintain continued viability, firms strive to minimize their dependence and maximize their power (Ulrich and Barney, 1984). To increase power, firms can reduce their dependence on providers of critical resources by acquiring different sources of the resource or lower their need for a critical resource. Alternatively, a firm's power can increase if other actors become more dependent on its resources (Drees and Heugens, 2013; Nienhüser, 2008). This may also lead to interdependencies and fairly balanced power relations, if different actors have control over critical resources that the other party desires (Casciaro and Piskorski, 2005).

3.2. Power structures in supply chains

The necessity to manage inter-organizational relationships and ensure effective coordination with other actors is particularly prevalent in supply chains (Paulraj and Chen, 2007). Although firms act jointly in supply chains, they strive to increase their individual power to obtain greater value for themselves (Cox, 1999). Addressing this issue, Cox et al. (2002) extend the RDT by offering the power regime framework to map the different power constellations as well as outline key attributes and consequences of supplier and buyer power in supply chains.

The power regime perspective proposes that power in buyer-supplier relationships is contingent on the resource utility, i.e. the resource's operational and commercial importance to the firm's activities to generate revenues and resource scarcity, i.e. the availability of alternative resource sources (Cox et al., 2002). Thereby, power can emerge from three different resource levels: organization-specific power sources, relationship-specific power sources, and network-specific power sources (Kähkönen and Virolainen, 2011). Organization-specific power sources are internal to the organization such as capabilities and expertise (Cox et al., 2002), size (Porter, 1985), or brand (Cox, 2001). Relationship-specific power sources are tied to the dyadic relationship with another organization such as switching costs (Hart and Saunders, 1997) or the volume of sales and purchases (Cox et al., 2002). Network-specific power sources are related to actors outside the dyadic relationship such as the control over strategic relationships within a network[1] (Bustinza et al., 2013; Bigdeli et al., 2018). The power structure between supplier and buyer relies on the interplay of all these power sources (Kähkönen and Virolainen, 2011) and the resulting difference in dependencies between both actors (Caniëls and Gelderman, 2007).

That said, it is important to note that either actor can have options outside the focal network (Malhotra and Gino, 2011), as they may belong to other supply chains or are part of diverging ecosystems. This is a relevant consideration, as an actor with access to multiple outside options is less reliant on a specific supply chain and, accordingly, less dependent on other actors in that network (Falkowski, 2015).

In sum, if the buyer is more dependent on the supplier than the other way around, a power imbalance emerges (et vice versa) (Cox et al., 2002). Within an imbalanced supplier-buyer relationship, the dominant firm can utilize its ability to influence the trading partner and behave in a way to preserve its power, whereas the inferior firm often has to comply in order to maintain its access to vital resources (Kumar et al., 1995; Touboulic et al., 2014). Consequently, firms with more power can capture a disproportionate share of the value created in an exchange relationship due to their dominant position (Cox, 1999; Porter, 1985).

However, the possession of power does not necessarily imply that power is also exerted (Kumar, 2005). One reason is that the use of coercive power has been found to foster mistrust and inefficiencies in supply chains (Benton and Maloni, 2005; Hingley et al., 2015; Maloni and Benton, 2000). Thus, while a power imbalance can impede close cooperation as the dominant actor wants to maintain his position of power (Kähkönen, 2014), there are also instances where dominant actors refrain from using their power to increase trust and establish highly functioning exchanges (He et al., 2013). This provides opportunities for less powerful firms, as they can demonstrate trustworthiness and pursue trust-based strategies to compensate power differences and maintain critical resource access (Jones et al., 2014; Ireland and Webb, 2007).

3.3. Digital servitization disruption on power structures in supply chains

Digital servitization has opened up new opportunities for value creation and appropriation, particularly for manufacturing firms (Rymaszewska et al., 2017). Thereby, manufacturers pursuing a digital servitization strategy are likely confronted with changing critical resources, as they must not only shift from largely product-centric to user-centric business models, as in the case of traditional servitization, but further transform towards more data-centric business models (Cenamor et al., 2017; Kohtamäki et al., 2019; Tian et al., 2021). Yet, attempts to gain control over emerging critical resources can have unintentional consequences, such as the formation of novel dependencies (Pfeffer and Salancik, 1978). Accordingly, the disruptions caused by digital servitization may affect the power base of manufacturing firms and result in a consequent recalibration of supply chain interdependencies (Bustinza et al., 2013).

Along with digital capabilities (Ardolino et al., 2018), one of the vital resources for successful DPPS deployment is access to end-users (Porter and Heppelmann, 2014). While close end-user relationships have already played an important role in traditional PSS offerings (Wise and Baumgartner, 1999; Stabell and Fjeldstad, 1998), its relevance for the provision of DPSS appears to further increase (Vendrell-Herrero et al., 2017). First, in order to develop DPSS in the first place, manufacturers need to understand how and in which conditions their product is utilized by its users (Naik et al., 2020). Second, having closer connections to end-users is important in establishing a trustful relationship that facilitates data sharing (Kamp et al., 2017) and gain the opportunity to harness and analyze large quantities of user data (Neely, 2008). A prominent example that demonstrates the benefits of owning end-customer interactions when transforming from a producer of physical products to a provider of DPSS is John Deere. In 2012, the farm equipment manufacturer introduced its open platform MyJohnDeere, where machine, attachment, and position data are centralized via telematics solutions and combined with historical data on soil conditions, weather, etc. To provide farmers with a comprehensive virtual management system (Perlman, 2017). By offering the digital service free of charge and leveraging its direct access to a large end-user network, MyJohnDeere has quickly become one of the dominant platforms in the agricultural sector, whereby the equipment manufacturer obtained control over end-user data and reinforced its dominant market position (Pham and Stack, 2018). Consequently, downstream firms are in a prominent position to capture additional value from the new possibilities provided by digital servitization, as they control the strategically important relationship with end users and, subsequently, also have easier access to product usage and related customer data (Vendrell-Herrero et al., 2017).

In contrast, the development of DPSS seems to be far more challenging for manufacturing firms further up in the supply chain, as they are positioned far away from end-users. While upstream firms such a component suppliers can respond to these disruptions by trying to leverage organization-based power sources like superior knowledge in the development and production of physical components (Finne et al., 2015), the relevance of physical materiality and with it the basis of the associated power sources is deteriorating in a digitally servitized supply chains and being replaced by an increasing importance of software solutions (Porter and Heppelmann, 2014, 2015). This also results in the entrance of new and powerful suppliers from the information technology sector like Google that possess the critical software know-how (e.g. for autonomous driving applications), further diminishing the power position of traditional suppliers (Porter and Heppelmann, 2014).

4. Methodology

4.1. Research design

Given the nature of our research questions, we employed an exploratory single case study approach. Case study research is an increasingly popular qualitative research approach in management literature (Piekkari et al., 2009) and ideally suited for the investigation

[1] Following Carter et al. (2015), we view a supply chain as a network.

of important emerging phenomena, which have not yet been comprehensively studied (Gebauer et al., 2020; Gibbert et al., 2008; Yin, 2018). Following Yin (2018, p. 15), a case study "investigates a contemporary phenomenon (the 'case') in depth and within its real-world context." Gerring (2004, p. 342) further specifies the single case study as "an intensive study of a single unit for the purpose of understanding a larger class of (similar) units." The choice of a single case study enables a profound investigation of the underlying case and offers the possibility to describe the procedure in great detail, resulting in a high degree of transparency and comprehensibility (Dyer and Wilkins, 1991). Applied to our case, it offers a deeper understanding and more persuasive way (Siggelkow, 2007) to discuss the mechanisms of power formation in supply chains against the background of RDT than broad empirical research methods do.

We followed the process of inductive theory building from case studies (Eisenhardt, 1989; Welch et al., 2011), which is rooted in grounded theory (Glaser and Strauss, 1967). The theory is grounded, as it derives from data and emerges out of the interplay between researchers and data (Strauss and Corbin, 1998). Placing the grounded theory concept of constantly comparing data and theory throughout data collection and analysis at the center of attention, inductive theory building is ideally suited to develop novel theory that is testable and empirically valid (Eisenhardt, 1989).

4.2. Research setting and case description

The impact of digital servitization is particularly visible in manufacturing, where value was traditionally created by physical materiality (Yoo et al., 2010). New digital technologies, which enable autonomous driving or platforms gain increasing attention and diffuse into industrial mobility applications (Pham and Stack, 2018). Thereby, not only OEMs, but also material and component suppliers strive to participate in this new business field.

Consequently, we investigated a division of a large European industrial supplier of powertrain technology (hereafter labelled as PowerTrain SE) covering a multitude of industrial mobility and stationary applications within different business units in order to holistically grasp the digital servitization phenomenon and its impact on the power structure in an industrial supply chain. Due to its extensive product portfolio and diverse customer base, the findings from PowerTrain SE may be applicable to a larger group of suppliers within the industrial sector. In addition, PowerTrain SE enabled us to investigate the digital servitization phenomenon in an industrial supplier's organization previously inaccessible to researchers, which made it an ideal and revelatory case study subject (Seuring, 2008; Yin, 2018). While the business units are quite heterogeneous, they possess common characteristics like mature customer markets, long established customer relations, and mostly large OEM customers. The traditional business model of PowerTrain SE presents itself as a buy-and-sell relationship to OEMs. For the majority of the business units, aftermarket occupies a noteworthy share of the overall revenues. Thus, end-user interaction with fleet operators and consumers partially exists, but is mainly limited to reactive service activities. Starting in 2016, efforts to digitally servitize were intensified with the launch of various projects to develop software add-ons for their physical products, enabling DPSS offerings.

4.3. Dataset

Following Yin (2018), our results are based on three different data sources. First, we gathered our main results from 18 semi-structured expert interviews in German and English language conducted between June 2019 and March 2020. Second, we included internal documentations such as e-mails, presentations, and other records related to DPSS projects as well as protocols from direct observations over a three-year period from seven workshops, 19 project meetings, and two fair visits to enrich our interview data. Third, we integrated archival records (i.e. annual reports and media reports) in our analysis to view the phenomenon comprehensively from different angles (Gibbert et al., 2008).

The selection process of our interview partners followed the approach of purposeful sampling (Lincoln and Guba, 1985; Corley and Gioia, 2004). We chose our informants based on the assumption about who would be most appropriate to answer our research questions. We started our interviews with key informants – two employees from the corporate strategy department – who had a profound overview and insight into all DPSS projects within PowerTrain SE. Additionally, by using snowballing technique, we asked them to recommend further suitable interlocutors from ongoing DPSS development projects. All representatives were required to have a detailed understanding of the case firm's digital servitization projects, act in a responsible position, and be aware of the underlying interaction with OEMs and other relevant stakeholders. In order to draw an encompassing picture, we chose interviewees with diverse backgrounds and from different business units, ranging from project and sales managers over head of communication to head of engineering (see Table 1). Central to our study were managers who headed data analytics or digitalization departments in the various business units, as they were able to provide detailed insights into data-specific topics in DPSS projects that are particularly relevant to our research questions. In addition, we paid special attention to the executive board since top managers are critical actors in the perception of organizational change (Corley and Gioia, 2004).

Each interview was executed and subsequently coded by the first two authors and lasted on average 50 min. The majority of the interviews were conducted face-to-face. As the workplaces of informants were spread all over Europe, some interviews were carried out by telephone. We stopped expanding our dataset when we reached theoretical saturation (Strauss and Corbin, 1998). We used a self-developed template with five thematic blocks to guide through the interview. Each interviewee was asked to describe (1) the current business model, (2) the drivers of digital servitization, (3) how digital servitization affects power structures in the supply chain, (4) which associated problems and disruptions occur during the process of digital servitization, and (5) which strategic responses are being applied. We often adapted the questions within these five thematic blocks in order to let the phenomenon itself surface. All interviews were recorded and transcribed verbatim. We used the software MAXQDA 2018 for the documentation of the coding process consisting of 318 full text interview pages, 92 full text pages of internal documentations, and 81 full text pages of external archival records relevant to digital servitization efforts, containing overall 1167 single codings.

4.4. Data analysis

We applied the widely used three step procedure proposed by Gioia et al. (2013) to progress systematically from raw data to theoretical constructs while executing qualitative rigor. First, both researchers read through the transcribed interviews and protocols without any pre-coding scheme and generated codes of statements that were considered relevant with regard to our stated research questions. The open and inductive coding has led to the creation of in-vivo codes, meaning that words and terms of the interviewees are so remarkable that they are used as codes (Corbin and Strauss, 2008). During this first step of analysis, deviations in our coding were discussed until agreement was reached in order to create a common first-order concept scheme, which emerges from the data itself. We coded each interview immediately after conducting and constantly adjusted our coding scheme throughout the whole data collection (Smith et al., 1996). Second, we searched for commonalities and variations among the first-order concepts using axial coding to generate second-order themes, which are the results of the researcher's interpretations and emerge, therefore, from the researchers themselves. Third, we aggregated the elaborated second-order themes to create distilled dimensions.

In order to lay the foundation for analysing the power structures in

Table 1
Overview of interview partners.

Expert	Department	Position	Expert	Department	Position
1	Executive board	Head of division	10	Business unit A	Head of data analytics
2	Executive board	Head of division	11	Business unit A	Project manager
3	Central department	Head of strategy	12	Business unit A	Sales manager
4	Central department	Corporate strategist	13	Business unit A	Head of communication
5	Central department	Corporate strategist	14	Business unit B	Business developer
6	Central department	Business developer	15	Business unit B	Head of digital engineering
7	Central department	Head of project house	16	Business unit C	Head of pre-development
8	Central department	Head of project house	17	Business unit D	Head of digitalization
9	Aftermarket	Head of Connectivity	18	Business unit D	Head of data analytics

supply chains through digital servitization and its associated changing critical resources, we first had to understand why the case firm decided to strategically invest into digital servitization efforts. Therefore, we structured our data into three parts: (1) drivers of digital servitization, (2) change in critical resources, and (3) response strategies to address those changing critical resources (see Fig. 1).

In order to ensure validity and reliability of our data, we followed a threefold approach: First, similar to Ulaga and Reinartz (2011), we asked two independent researchers from our faculty to review our coding structure and verbatim transcripts. For this purpose, they first assigned randomly sorted first-order constructs to second-order themes. Then they coded fifteen randomly selected passages relevant for our data structure from varying interviews by using the second-order themes. In assessing the reliability between judgements, we applied the index developed by Perreault and Leigh (1989), which reached 0.89 for the data structure assessment and 0.85 for the coding evaluation, both well above the threshold of 0.70 required for exploratory studies. Any disagreements were discussed until consensus was reached. Second, throughout the whole data analysis process, we debated the data structure with two corporate developers from our case firm in order to avoid an over-interpretation of our results. Third, we discussed our framework in a workshop setting with the board of directors and other senior executives after the completion of data collection in order to further strengthening the validity of our data construct.

5. Results

5.1. Initial situation and drivers of digital servitization

PowerTrain SE is regarded as a premium provider of industrial technology equipment. However, low-cost providers have started to catch up and have reached a level of quality that partially rivals that of premium suppliers. While the industrial supplier is still an innovation leader for most of its physical industrial components, parts of the product portfolio seem to have a decreasing value contribution. In most customer markets of PowerTrain SE, there has already been some form of consolidation, resulting in concentrated markets with a few large and dominating OEM customers. Thereby, OEMs exert their power advantage by trying to keep their suppliers interchangeable via the definition of clear component requirements. Consequently, the potential to differentiate becomes increasingly limited, leading to a commoditization of physical products.

“Our field of innovation is rather limited because of the relation with the [OEM] customer. […] It is our [OEM] customers that say what

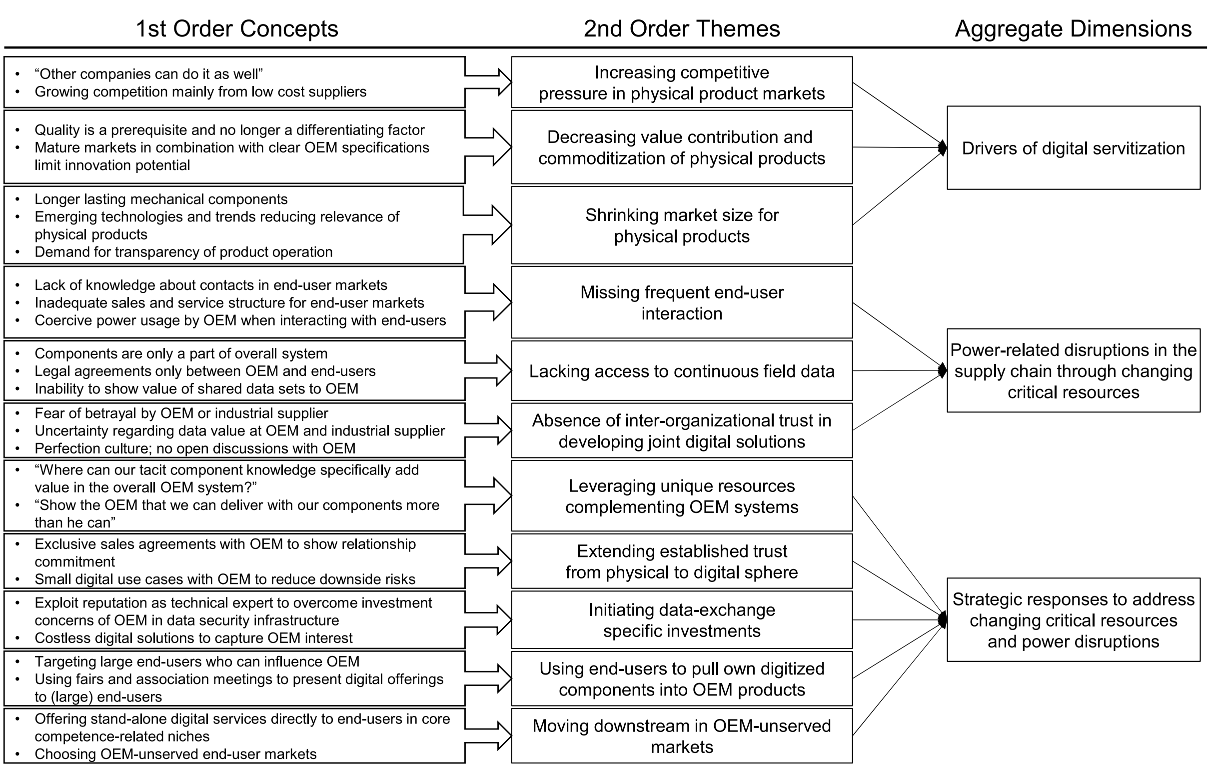

Fig. 1. Process of abstracting from raw data to insights.

> they want and it's hard to compete then. In the end they want to pay certain euros per kilogram powertrain component and then differentiating is difficult so it becomes a price game and you become a commodity." (Expert 17)

Among other trends, the emergence of monitoring systems and predictive maintenance solutions, ensures that components are operated and maintained at an optimal capacity, which results in a longer product lifetime. This in turn would cause a significant reduction in the sales of spare parts, which represents one of the most profitable business segments. In conjunction with longer lasting components due to technological advances, it is evident that the market size of physical products is shrinking, further reinforcing competitive pressure. Accordingly, knowledge in the development of physical components is becoming less valuable.

> "Well, it's like this, if you talk about value now, the knowledge in the traditional field is becoming less valuable. So you have to compensate in some way. […] If I have nothing there, I can't sell anything and my company is worth nothing. Novel know-how has to be generated for new trends […] such as connectivity, Internet of Things […], and also the technologies around autonomous driving and everything that is connected to it. That fills our asset base again at the end of the day." (Expert 7)

In order to avoid being trapped in a vicious cycle of increasing competition in physical markets in conjunction with a diminishing value contribution and shrinking market size, the management of PowerTrain SE has decided to launch systematically different projects in which DPSS are developed. Thereby, PowerTrain SE strives to compensate the decreasing revenue from physical component sales by introducing new digital service add-ons.

> "The change is that we try to secure the traditional business and to market additional add-ons based on it, […] e.g. in the direction of predictions, data analytics, there is already a lot to read out or provide […]. All this is very service-intensive in order to have this compensatory effect." (Expert 4)

5.2. Power-related disruptions in the supply chain through changing critical resources

However, during the development of DPSS, obstacles have emerged that were not necessarily linked to technological issues but rather to other actors within the supply chain. Contrary to the past, where PowerTrain SE would just sell components to OEMs, close and frequent end-user interaction now constitutes a critical resource to develop and launch DPSS. End-users must be involved early in the development process to identify their pain points and understand where a DPSS can add value. Besides, PowerTrain SE needs to be aware of the application areas in which the product is used in order to provide accurate and reliable digital service add-ons. According to one Executive Board member, however, there is a lack of knowledge about end-customer markets despite sporadic end-user contact in the aftermarket.

> "Do we need more end-customer contact when developing our digital products in order to better understand the end-customer? Then I say yes. Because we also offer analysis services with digital products, which of course are much closer to the end-customer. […] We need to understand the application area of the product and the needs of the end customer." (Expert 2)

However, the management of PowerTrain SE is reluctant to address this issue and engage with end-users on a large scale, as it fears the consequences this might have on the business relationship with its OEM customers.

> "An OEM would react to that and say, ok, if you now serve end-users, which is actually my business, then I will deduct the project from your account. He wouldn't say that directly, but he would do it." (Expert 4)

As PowerTrain SE still generates the vast majority of its revenue by selling physical products to OEMs, such adverse consequences are detrimental to its core business. This relates in particular to large OEM customers, who have the digital capabilities and resources to develop DPSS without being reliant on suppliers. On the contrary, for PowerTrain SE it is difficult to offer DPPS on its own, as it can provide digital services only for specific components and not for the entire end-product.

> "It doesn't benefit the end user, if [our component] holds up well and the rest of the vehicle breaks all the time. So, it has to be an overall solution for the entire vehicle and we have the competence for just one piece of the puzzle. […] We are simply one too low in the food chain." (Expert 10)

By assembling the end-product, OEMs control another critical resource to be competitive in a digital market: continuous access to product usage data. Up to now, the industrial supplier has only been able to access product usage data in case of repair orders in the aftermarket. Although PowerTrain SE has the technical capabilities to transfer data from its components, it is not permitted to do so once they are in use, because OEMs generally hold exclusive legal rights for data usage and are generally unwilling to share data.

> "Someone told them that data is the new gold. Well, and nobody likes to share gold. I think there's just a lot of emotion behind it […] and of course, why should I [OEM] give away my data? I'd rather do it myself." (Expert 8)

There are mainly three reasons why OEMs refrain from sharing data. First, OEMs can offer many digital services without necessarily depending on the involvement of a component supplier, as they have at least basic knowledge on the operability of most diagnosis-relevant components. Second, data exchange is a complex issue due to the specification of legal terms, alignment of data formats, and establishment of a reliable data connection. Thus, OEMs need to undertake costly efforts to set up a data-sharing infrastructure. Third, due to lack of experience and knowledge the value of data is still often difficult to determine for OEMs. This results in a dilemma, where access to data is not granted by OEMs, but necessary for the supplier to show OEMs the benefits of sharing data.

> "To a certain extent we have a chicken-or-egg problem, because you can only develop a digital business model if you know what to do with the data. If you don't have any data, it's difficult to estimate in advance. In some places you go around in circles. […] The common thing for us is that we are dependent on the vehicle manufacturer, which means that if he does not provide us with any data, we are completely powerless." (Expert 10)

In addition, the uncertainty regarding data value leads to a latent fear that one party could benefit more from sharing data than the other, cumulating in reciprocal mistrust.

> "[OEMs] do not really know what the value of the data is. […] What if they give data to the supplier and he will use it to compete with them? How do they assure that they get enough back?" (Expert 17)

If OEMs mistrust PowerTrain SE or vice versa, the establishment of data exchange becomes impractical or very restrictive, which results in the inability of PowerTrain SE to offer digital services add-ons. Hence, trust plays an essential role in the development process of DPSS.

> "If you want to develop analytics, the value is often in bringing different data sets together and doing an analysis on the combined

data set. In that respect you both have to give something in and that involves trust." (Expert 18)

However, this circumstance is not true for the entire OEM business. In the case of small OEM customers, PowerTrain SE is able to utilize digital servitization as a lever to become a system supplier of telematics solutions and hence sets the agenda regarding the implementation of DPSS. Those generally lack digital competencies and financial means to develop DPPS without a strong business partner. Thus, small OEM customers are generally open to provide PowerTrain SE with end-user contacts and grant them data access in turn for assistance in digitizing their products and services. As a result, PowerTrain SE is able to improve its power position in these relationships. One member of the Executive Board describes the two different power constellations that are relevant for PowerTrain SE as follows.

"There are very large [OEMs] that are trying to expand their power and create an ecosystem where they fully captivate their customers […]. They only let us participate as a suppressed player. And then there are also those who are not so dominant, who often operate in smaller markets, who cannot afford to do something like that and are very open to the idea of doing something together. This is where we can actually position ourselves even stronger than before. Thus, there are two cases […]." (Expert 1)

5.3. *Strategic responses to power-related disruptions of digital servitization*

Two fundamentally different constellations between PowerTrain SE and its OEM customers have emerged. On the one hand, in relations with smaller OEMs, PowerTrain SE can increase its power through digital servitization. On the other hand, the dominance of already powerful OEM customers is reinforced, which is a major concern for the management of the case company.

To counteract this power shift in the latter of the two cases, PowerTrain SE has tried to systematically identify unique and critical resources that can be leveraged to re-gain power in a digital servitization context. While the ability to produce high-quality physical components has become less valuable, in-depth knowledge regarding the operability and permissible thresholds of its components may have become more important. To provide a predictive maintenance solution, the ability to accurately predict when a component is about to break is crucial. Thus, for components that are complex and critical to the overall system PowerTrain SE can utilize its knowledge and demonstrate its ability to enhance DPSS offerings of OEMs.

"[Our components] are often critical components that have a high thermal load during operation […] and we have the deep know-how for thermal management on our side. Of course, the vehicle manufacturer has a certain basic idea about this, but only we know the components in detail, [e.g.] which temperature peaks are permissible, that is our know-how, our competence. […] Our approach is to show him that we can do much more with the data than what he [OEM] can do himself." (Expert 10)

In order to demonstrate the value that PowerTrain SE can add to the service offerings of its OEM customers, it needs to establish trust in its abilities and intentions. Alongside long-standing partnerships, small scale use cases are particularly helpful to build bridges between the two parties. However, often the weaker actor has to take the first step to create a first delicate plant of trust. One measure to build such a first layer of trust is by entering into exclusive service contracts with specific OEMs in traditional markets.

"That's their ambition in the partnership to get more exclusivity with us. We would not do that without them, nor would we do it with competitors or even alone. […] That's one potential way to hopefully overcome that [mistrust]." (Expert 17)

To further underline the commitment to a combined solution, the industrial supplier has decided to initially offer certain digital services free of charge to its OEM customers. Even though, the industrial supplier would offer digital services without receiving any initial compensation, OEMs still have to undertake relationship-specific investments in order to enable data exchange. While this might prevent some OEMs from committing to a cooperative solution, it strengthens the ties between the two parties, if successful. Only once the value is apparent to both parties, a discussion about a financial compensation may start.

"We are not yet discussing with the [OEM]-customer that we want to see money sometime when we offer services there. That is still completely out of question." (Expert 10)

There are also some markets, where only a few, large end-users exist and have a dominant bargaining position vis-à-vis OEMs. Therefore, they possess power to influence the design of the end-product and which components it contains. In these markets, PowerTrain SE has decided to strategically approach end-users or actors with significant influence on end-users (e.g. federations) to promote its DPSS. If end-users are convinced and demand the DPSS, uncooperative OEMs are forced to integrate these solutions into their offerings.

"If we manage to offer condition monitoring or other services to the end-user, then in future we will be able to influence them so that they will prefer our products [in the OEM's overall system]." (Expert 14)

At the same time, PowerTrain SE tries to reduce the dependence on OEMs by moving downstream in business fields that are un-served by its OEM customers. These markets are mostly niche markets that are unattractive for large OEMs to enter, avoiding competition with current OEM customers. However, for PowerTrain SE these business relations constitute an important building block for gaining knowledge about end-user markets and positioning oneself as reliable partner to end-users. In doing so, PowerTrain SE seeks not only to offer digital service add-ons to its primary products, but rather to develop digital services that are unrelated to the existing product portfolio.

"First of all, we try to secure the core business. The second is to open a separate channel, where you take care of exactly these issue [OEM dependence], which are not necessarily related to the primary product, so you don't build a solution around a powertrain component, but you create a new market for yourself." (Expert 4)

6. Discussion

Digital servitization is emerging as an increasingly prevalent phenomenon in both practice and academic research. Yet, insights about the disruptive potential of digital servitization on power structures are still elusive (Kohtamäki et al., 2019), especially regarding actors far upstream the supply chain. Addressing this research need and extending the literature on power structures in digital servitization settings (Vendrell-Herrero et al., 2017; Huikkola et al., 2020), our case study uses RDT to investigate (1) effects of digital servitization on the power constellations between an industrial supplier and its OEM customers, and (2) strategic responses of an industrial supplier to extend or re-gain power. Building on our case results, we derive eight propositions based on two scenarios of an ex ante supplier-dominated or OEM-dominated relationship, which are illustrated in Fig. 2 and will be elaborated in the following sections. We start by describing how the industrial supplier has already moved into the commodity trap in some markets. Thereafter, we discuss how the power relations between OEM customers and industrial suppliers caught in the commodity trap are affected by digital servitization. We also show how this differs in cases

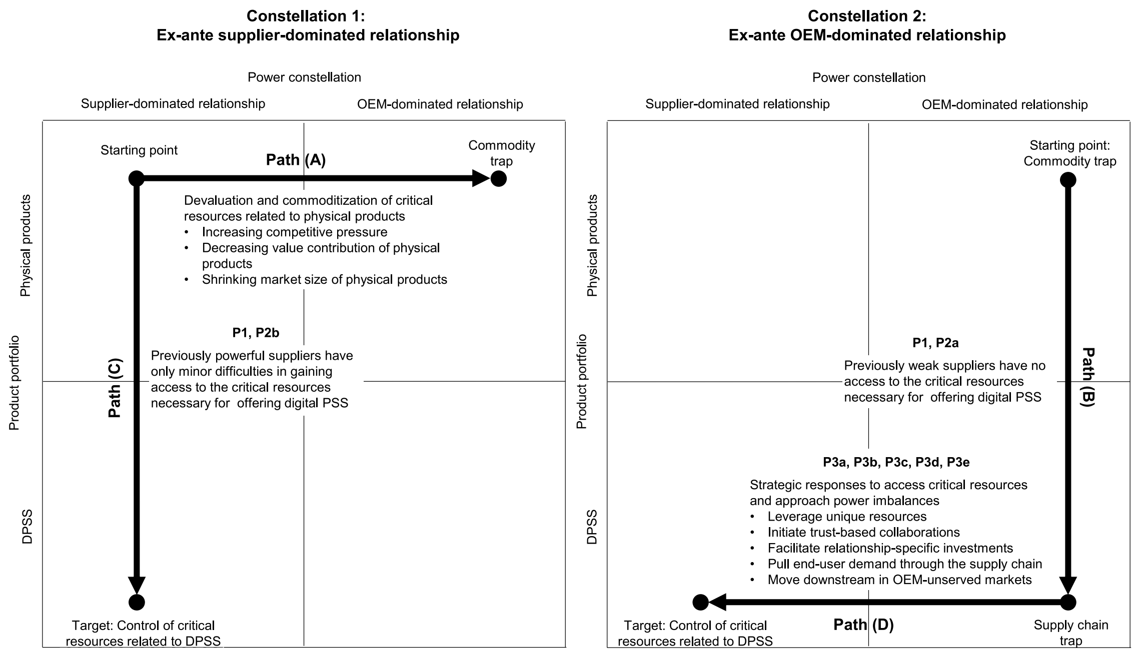

Fig. 2. Overview of power constellations and propositions.

where the industrial supplier is more dominant than OEM customers (Constellation 1). Lastly, we outline strategic responses for weak industrial suppliers in order to shift towards a more supplier-dominated power relation with OEM customers (Constellation 2).

6.1. Understanding digital servitization efforts

PowerTrain SE is considered a premium supplier of industrial technology with advanced knowledge in the production and development of complex powertrain components, which enabled it to achieve a dominant position towards OEM customers in some markets. However, PowerTrain SE is increasingly operating in mature markets, where the innovation potential for physical components is limited due to their advanced stage of development and specifications given by OEM customers. This has already led to a commoditization of product technology and its applications. Yet, obligatory product-related services in form of maintenance and repair does not appear to be a sustainable measure to differentiate from competitors (Matthyssens and Vandenbempt, 2008), as traditional service offerings have – at least in our case – also become commoditized. As a result, it becomes increasingly difficult for our case firm to differentiate from low-cost competitors and in some instances, it has already lost its once dominant market position. In addition, emerging trends such as the transition to big data analytics and artificial intelligence affect the revenue potential of physical product suppliers in the industrial sector. In particular, these trends tend to reduce the spare parts required, as, for instance, DPSS like monitoring or predictive maintenance solutions prolong the product lifetime.

Thus, the viability of PowerTrain SE is threatened, since the relevance of once critical resources in form of knowledge regarding the production of high-quality physical components diminishes, deteriorating its standing in the supply chain and shifting power towards OEM customers (Cox et al., 2002; Pfeffer and Salancik, 1978) (see Fig. 2: Constellation 1, path (A)). Since the pursuit of cost leadership to withstand competition is not viable for a European supplier of premium powertrain technology due to its cost structure, PowerTrain SE has decided to pursue a digital servitization strategy to compensate for the decreasing value contribution of once critical resources related to physical products and avoid moving further into the commodity trap.

6.2. Digital servitization and power disruptions

While studies have so far primarily focused on the development of digital capabilities as a key prerequisite for the successful transformation from a manufacturer of physical products to a provider of DPSS (Ardolino et al., 2018; Ritter and Pedersen, 2020), we identify three additional emerging resources that are critical to the provision of DPSS for the case firm: frequent end-user access, continuous access to product usage data, and inter-organizational trust with OEM customers.

The importance of close end-user ties has substantially increased as DPSS like predictive maintenance solutions require knowledge of the conditions at the point of use (Porter and Heppelmann, 2014). Specifically, frequent end-user interaction enables the industrial supplier to understand end-users' pain points and integrate them into iterative development processes to create value for end-users. Once the DPSS is in use, continuous access to product usage data is required to understand end-user behavior and to be able to continuously improve, adjust, and derive additional DPSS offerings, aiming to support the end-users' success (Rymaszewska et al., 2017; Loebbecke and Picot, 2015). Consequently, continuous access to product usage data allows more proactive DPSS offerings, creating additional revenue potential (Baines et al., 2009). However, the industrial supplier typically delivers only a limited number of components for a complete solution to OEMs, while OEMs combine the different components in the end-product (e.g. a smart tractor) and integrate telematic solutions to permit a continuous data transfer. This forces PowerTrain SE to collaborate with OEMs in order to offer a DPSS, as it relies on them to gain data access. For the industrial supplier it is therefore critical to establish inter-organizational trust with OEMs in order to initiate data exchange agreements (Lee and Whang, 2004; Tronvoll et al., 2020) and offer DPSS in the first place. Accordingly, a lack of control over any of the three identified critical resources will reduce the revenue potential of DPSS or completely prevents its development. For instance, if frequent interaction with the end-user is not possible, then there is no way to develop a DPSS that matches the actual end-user needs and creates value, as the sole access to product usage data and trustful relationship with the OEM cannot completely compensate for this. Therefore, the three identified novel critical resources form an interdependent construct, leading us to our first Proposition:

Proposition 1. *In order to successfully offer digitalized product-service systems, industrial suppliers need to gain access to emerging critical resources in the form of frequent end-user interaction, continuous access to product usage data, and inter-organizational trust with OEM customers.*

As a consequence of this shift in critical resource needs, novel interdependencies within a supply chain are potentially emerging and disrupting existing power structures (Cox et al., 2002). While Vendrell-Herrero et al. (2017) argue that digital servitization increases the relative dependence of upstream on downstream firms, we find that a more nuanced perspective is required to better understand the impact of digital servitization on the power balance within a supply chain. According to our results, the impact of digital servitization on the power balance between OEMs and suppliers depends rather on the power structure between both prior to the advent of digital servitization as it determines the influence one can exert to gain control over novel critical resources. Consequently, the ex-ante distribution of power is central to explain the impact of digital servitization on power structures.

In markets where the industrial supplier is already caught in the commodity trap and hence in a weaker position vis-à-vis OEMs prior to the introduction of DPSS (see Constellation 2 in Fig. 2), the given power structure seems to be further reinforced. Powerful OEMs are generally able to develop DPSS on their own, as they are often large corporations with sufficient financial means to develop digital capabilities and digitalize their PSS offerings. Moreover, OEMs typically act as direct point of contact for end-users. They are therefore centrally located in the supply chain network and are able to control the strategically important relationship with end-users. Hence, the central network position is an important power source in a digitally servitized supply chain (Kähkönen and Virolainen, 2011), as it enables easy access to emerging critical resources in form of frequent end-user interaction and continuous access to product usage data.

As a result, it is extremely challenging for firms far upstream the supply chain such as PowerTrain SE to gain access to emerging critical resources. If PowerTrain SE attempts to approach end-users in order to develop DPSS, OEM customers generally exploit their dominant position in the network to prevent the industrial supplier from interacting with end-users by using coercive power (i.e. threating to cancel their sales orders). Therefore, the OEM's control of organization-specific (digital capabilities) and in particular network-specific power sources (end-user interface and data access) restricts the industrial suppliers' alternatives to develop DPSS on its own and further increases its dependence on already dominant OEMs.

Thus, in the case of more powerful OEMs prior to digital servitization, power asymmetry seems to further shift towards OEMs with the onset of digital servitization efforts, as it leaves industrial suppliers trapped in the supply chain behind OEMs (see Fig. 2: Constellation 2, path (B)).

Proposition 2a. *When industrial suppliers hold less power than their OEM customers before the advent of digitalized product-service systems, the inability to gain control over critical resources related to digital servitization will reinforce given power structures.*

However, in markets where the industrial supplier is still in a more powerful position before the implementation of DPSS (Constellation 1 in Fig. 2), weaker OEMs are generally inclined to provide the supplier with access to end-users and product usage data. This is the case when OEMs either do not possess the financial means and digital capabilities to develop DPSS by themselves or have strategically decided to outsource DPSS development projects to suppliers. Hence, weak OEMs become more dependent on PowerTrain SE as they need a capable business partner to provide them with telematics solutions and data analytics capabilities to enable the provision of DPSS solutions. Thereby, PowerTrain SE is able to improve its power position and exert more influence over the supply chain, as it gains control over end-user interaction and product usage data. But unlike a powerful OEM, the industrial supplier does not utilize coercive power forcing the weaker OEM to take a smaller share of the DPSS sales, as the industrial supplier is still interested in maintaining a trustful relationship in order to share risks while gaining knowledge of end-user markets. Nonetheless, as the successful deployment of new services is generally related to the degree of control a manufacturer can exert over a service value chain (Raynor and Christensen, 2002), this enables the industrial supplier to succeed in its digital servitization efforts und increase its dominance (see Fig. 2: Constellation 1, path (C)).

Proposition 2b. *When industrial suppliers hold more power than their OEM customers before the advent of digitalized product-service systems, the ability to gain control over critical resources related to digital servitization will reinforce given power structures.*

6.3. Strategic responses to power imbalances

For industrial suppliers that are positioned in the quadrant of OEM-dominated DPSS, the objective should be to shift power relations toward or, ideally, into the supplier-dominated DPSS quadrant. (see Fig. 2: Constellation 2, path (D)). To achieve this, industrial suppliers can either increase the dependence of OEMs on them or reduce their own dependence on OEMs (Cox et al., 2002). In addition, suppliers may also utilize trust-based strategies to compensate for a lack of power and maintain access to vital resources (Ireland and Webb, 2007). Related to these mechanisms, we have identified five specific strategies that PowerTrain SE utilizes to exploit novel opportunities in a digitally servitized supply chain and improve its power position (see Table 2).

To re-balance power relations, the industrial supplier tries to leverage its unique knowledge about components that are critical to the accurate and reliable provision of DPSS (Ulaga and Reinartz, 2011; Finne et al., 2015). When providing a predictive maintenance solution, it is essential to have adequate knowledge to predict when a certain component is going to fail. However, OEMs often lack high-end component knowledge, as they have outsourced large parts of the component production, causing a lack of necessary engineering capabilities (Takeishi, 2001). Likewise, while Power Train SE has

Table 2
Strategic responses of an industrial supplier to address power imbalances in digitally servitized supply chains.

Focus point	Strategic response	Specific action to realize strategic response	Mechanism
OEM	a. Leverage DPSS-critical component knowledge	Utilize tacit knowledge about the load profiles and fatigue patterns of complex components to add value to the DPSS of OEMs	Increase relative dependence of OEMs
	b. Facilitate data-exchange specific investments	Develop a joint data sharing infrastructure with OEMS by offering digital services free of charge to build-up switching costs	Increase relative dependence of OEMs
	c. Signal relationship commitment in traditional service offerings	Commit to exclusive contracts with specific OEMs in traditional service markets to signal relationship commitment and jointly transform these services into DPSS	Build inter-organizational trust to compensate lack of power
End-user	d. Exploit empowered end-users to pull demand through the supply chain	Directly engaging with end-users to create a demand for an industrial supplier's DPSS, in order to force OEM customers to implement the DPSS into their offerings	Decrease relative dependence on OEMs
	e. Move downstream in OEM-unserved markets	Go downstream in OEM-unserved markets to create new revenue streams by selling DPSS to end-users and avoid competition with current OEM customers	Decrease relative dependence on OEMs

disadvantages in the development of new software solutions compared to novel market participants from the information technology sector such as Google, these new participants lack sufficient knowledge about the load profiles, fatigue patterns, and permissible thresholds of physical components. Particularly, for complex components such as gearboxes or engines, this domain knowledge enables the industrial supplier to more accurately predict component failures. Hence, while the relevance of physical materiality likely decreases in a digitally servitized supply chain (Porter and Heppelmann, 2014), the knowledge about the operability of physical components remains critical when combined with sufficient analytics capabilities to enable accurate and reliable predictive maintenance solutions. Consequently, in cases where the case firm delivers a sufficiently complex component that constitutes a critical part of the overall system, OEMs depend on the tacit component knowledge of PowerTrain SE to provide a DPSS offering covering the entire end-product.

Proposition 3a. *By leveraging the implicit knowledge of complex physical components integrated in digitalized product-service systems, industrial suppliers can increase the relative dependence of their OEM customers*.

The joint development and provision of DPSS requires the development of a common data sharing infrastructure (Porter and Heppelmann, 2014), which entails considerable investments for the involved actors. Given that there are still hardly any uniform data formats, structures, and interfaces in most manufacturing industries, these investments are often tied to the relationship with a certain OEM, thereby creating relation-specific digital assets (Kamalaldin et al., 2020). In this respect, digital services underlying DPSS differ significantly from traditional services, as close cooperation between the industrial supplier and its OEM customers is usually not essential for the provision of traditional services (e.g. repairs). Hence, the close cooperation required to develop joint DPPS offers the opportunity (or threat) to build-up switching costs and lock the involved parties into the relationship (Cox et al., 2002). Tian et al. (2021) support this by outlining a more sequential approach for upstream actors in their digital servitization transformation journey, focusing first on improving the collaboration to supply chain partners and then shifting to lock-in measures in the downstream part of the supply chain. PowerTrain SE tries to exploit this circumstance by offering its OEM customers certain digital service solutions free of charge in order to persuade them into setting up a joint data infrastructure and engage in regular interactions regarding DPSS projects. While this entails substantial investments on the industrial supplier-side with no immediate returns, the aim is to build up enough switching costs over time to establish mutual dependencies.

Proposition 3b. *By encouraging OEM customers to undertake data-exchange specific investments for the joint development of digitalized product-service systems, industrial suppliers can increase the relative dependence of their OEM customers*.

Since PowerTrain SE already has long-standing and trusting business relationships with its OEM customers in physical markets, it tries to exploit them (Obal, 2013). However, this trust does not necessarily extend to DPSS, as a change of the underlying objective of a relationship can alter trust between partners (Otto and Obermaier, 2009). Particularly, the uncertainty about the value of data and its applications seems to raise concerns that one party might betray the other, e.g. by using the data to compete with the other party. To address this issue, our case company tries to demonstrate its trustworthiness by making concessions in traditional service offerings and signal commitment to the business relationship. Hart and Saunders (1997, p. 33) state that "as one partner demonstrates confidence-inspiring behavior, we would expect that the other partner would reciprocate and practice similar behaviors." Accordingly, PowerTrain SE guarantees exclusivity regarding traditional services like repair and maintenance to a particular OEM to signal relationship commitment and reaffirm OEM customer's trust to potentially transform these traditional reactive services into joint DPSS such as remote monitoring or predictive maintenance solutions.

Proposition 3c. *By embracing a stronger commitment to a close partnership in traditional service offerings, industrial suppliers can reaffirm trust with their OEM customers regarding the joint development of digitalized product-service systems, thereby compensating power imbalances*.

In our case, however, some OEM customers were simply refusing to cooperate with the industrial supplier to maintain their position of power (Kähkönen, 2014). Nevertheless, the increasing relevance of product usage and customer-related data may not only have strengthened the position of actors in control of end-user interfaces, but also empower the standing of end-users such as operators and consumers in the supply chain (Bustinza et al., 2013). This offers end-users the opportunity to exert more control over the supply chain. To exploit this, the industrial supplier applied a so-called pull strategy (Kotler et al., 1999). This means that our case firm is engaging with end-users to convince them of the benefits of its DPPS, but is not selling them directly to end-users. Instead, if the industrial supplier is successful and end-users demand its DPSS (e.g. a monitoring solution for a component), they will pass the demand onto OEMs and force them to integrate the industrial supplier's DPSS into their offerings (e.g. a smart tractor). Thus, the demand of end-users "pulls through" the supply chain to the industrial supplier. Thereby, our case firm is able to sell its DPSS without moving downstream and bypassing the OEM as an intermediary, but rather indirectly forces OEMs to integrate its solution into the end-product. This approach offers the advantage that the industrial supplier does not necessarily circumvent OEMs and thus has to fear countermeasures from them, but remains in its upstream supply chain position and continues to leave the customer interface to OEMs. Since OEMs are typically less concerned about the sourcing of a certain component, as long as they get the sales order, PowerTrain SE can interact with end-users within the same supply chain without losing the trust of its OEM customers. However, this strategy is only meaningful in specific markets with large end-users (e.g. government entities) or end-user associations (e.g. machinery cooperatives), as the effort to approach a high number of individual end-users is impractical for the industrial supplier due to the missing sales network. In this regard, our case firm leverages conferences or fairs, association meetings, or contacts to governmental agencies in order to generate interest from large end-users for its DPSS.

Proposition 3d. *By convincing powerful end-users or large end-user associations of their digitalized product-service system, industrial suppliers can force OEMs to incorporate it into the final system, reducing the dependence on OEM customers*.

Lastly, our case firm has chosen to move downstream, but only in markets outside of its current supply chain. While vertical repositioning is a common strategic response to (digital) servitization efforts (Huikkola et al., 2020; Rymaszewska et al., 2017; Wise and Baumgartner, 1999), the role of power structures in strategic re-position moves is often neglected (Rabetino and Kohtamäki, 2018). Yet, vertical repositioning usually involves contesting the position of other actors in the supply chain, potentially causing serious conflicts between them (Paiola and Gebauer, 2020; Wise and Baumgartner, 1999). Accordingly, PowerTrain SE fears that powerful OEMs may exert coercive power and cut or cancel their orders if the industrial supplier decides to move downstream within its current supply chain. Thus, PowerTrain SE has decided to move downstream only in markets unattended by its OEM customers to avoid adverse effects on the physical product business and not undermine efforts to establish trust with OEM customers. As the sales of physical products to OEMs still constitutes its primary business model, the risk of losing this business for the - at least at first - relatively small sales from DPSS is not a valid option for the industrial supplier. Particularly, as the market for single component solutions is mostly limited to specific high-value components (e.g. engines), as end-users generally desire a solution for the complete product. Hence, the industrial supplier pursues such a re-positioning strategy only in markets currently unserved by OEM customers and even tries to develop digital services unrelated to its physical product portfolio in order to join different supply chain networks, thereby creating outside options (Malhotra and Gino, 2011). To achieve this aim, the industrial supplier is working to establish close collaborations with new types of end-users to jointly develop DPSS that are niche applications now but have the potential to evolve into significant revenue contributors in the future.

Proposition 3e. *By moving downstream into markets outside of the current supply chain, industrial suppliers can reduce the dependence on OEM customers without incurring negative repercussions.*

7. Conclusion

While the research focus in the literature on digital servitization has so far been on OEMs or commercial end-users (Paiola and Gebauer, 2020), we explicitly adopt the perspective of an industrial supplier of powertrain technology and investigate through the lens of resource dependence theory how digital servitization disrupts the power structures between an industrial supplier and its OEM customers as well as outline specific response strategies. Thereby, we especially react to the research needs expressed by Kohtamäki et al. (2019) urging to better understand how digital servitization alters power constellations in different sections of the supply chain, and Li et al. (2020) demanding more theory grounded research in digital servitization literature.

7.1. Theoretical implications

Our first contribution is that we highlight three emerging novel critical resources for industrial suppliers in the form of frequent end-user interaction, continuous access to product usage data, and inter-organizational trust with OEM customers, which are pivotal to succeed in digital servitization efforts. By linking these critical resources to different levels of power sources, we enrich existing digital servitization literature with findings from conceptual power regime works and outline that digital servitization does particularly increase the relevance of network-level power sources such as the control over strategic relationships. Second, we refine and specify the notion of Vendrell-Herrero et al. (2017) that digital servitization favors per se downstream actors, as we show that digital servitization shifts power to supply chain actors that are more dominant prior to the advent of digital servitization. Specifically, dominant actors are able to exert influence over the digital service value chain, as they gain control over emerging network-level resources and thereby can exclude other actors from accessing them to further reinforce their supply chain standing. Therefore, we conclude that digital servitization is at least initially reinforcing rather than dissolving (Holmström et al., 2019) given power structures between industrial suppliers and its OEM customers. Third, we contribute to the literature on strategic responses to power disruptions of digital servitization (Vendrell-Herrero et al., 2017; Huikkola et al., 2020; Finne et al., 2015) by identifying five specific strategies related to established mechanisms in power regimes that non-dominant industrial suppliers can pursue to combat power imbalances without fearing adverse effects on the business relationship with OEMs. In this way, we complement the literature by outlining alternative strategies to the often-cited moving downstream narrative that do not require a re-positioning in the focal supply chain and still provide access to critical resources related to digital servitization.

7.2. Managerial implications

Turning digital servitization into a success story poses a number of challenges for managers, particularly in product-centric firms upstream in the supply chain. Our study offers a guide by providing a comprehensive picture of the digital servitization journey of an industrial supplier. In particular, our four-field framework illustrates paths for diverse constellations, demonstrating how industrial suppliers can succeed in a digitally servitized environment. Executives might consider it notably useful to get an idea which critical resources should be under control in order to acquire relationship- and network-specific power sources. Moreover, the concrete application examples underlying the various strategic responses enable managers to act appropriately in constellations where the supplier is the less powerful actor. In essence, the acknowledgement of the importance to position oneself within the supply chain in correspondence to changing critical resources and its implications on power balances constitutes ultimately a key element for managers to actively and successfully handle digital servitization efforts.

7.3. Limitations and avenues for further research

Although we are deeply convinced that our in-depth single case study reveals some profound insights, of course, our study is not without limitations. As with any single case study, the generalizability of our findings is limited. For instance, the case company is large compared to the industry average and ranks among the leaders in certain markets for industrial drive technology. Having said this, we are convinced that due to the extensive product portfolio and diverse customer base of our case firm, it is still at least revelatory for industrial suppliers. Additionally, the risk of over-interpretation influencing the results and conclusion constitutes a limitation in case study research (Yin, 2018). We tried to address this limitation by continuously exchanging our interpretations with employees of the case firm, involving independent researchers to validate our data structure, and applying rigorous data structure development.

Our recommendations for future research are tripartite: First, we strongly recommend to study the phenomenon of power disruptions by digital servitization through a multi-actor lens along the supply chain or through a network perspective. The simultaneous investigation of suppliers, OEMs, end-users, and other actors might offer a valuable and encompassing picture of inter-actor dependencies. Second, we invite researchers to empirically test or extend our stated propositions in order to offer a better generalization among different industries and to further deepen the understanding of digital servitization. Third, we encourage research to complement our identified strategic responses, for instance with a more explicit ecosystem perspective including actors outside the traditional supply chain (e.g. alliances among suppliers or the integration of third-party developer communities), or to evaluate ex-post under which conditions our identified strategies are particularly effective.

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References

Ardolino, M., Rapaccini, M., Saccani, N., Gaiardelli, P., Crespi, G., Ruggeri, C., 2018. The role of digital technologies for the service transformation of industrial companies. Int. J. Prod. Res. 56 (6), 2116–2132.

Arnold, C., Kiel, D., Voigt, K.-I., 2016. How the industrial internet of things changes business models in different manufacturing industries. Int. J. Innovat. Manag. 20 (8), 1–25.

Baines, T., Bigdeli, A.Z., Sousa, R., Schroeder, A., 2020. Framing the servitization transformation process: a model to understand and facilitate the servitization journey. Int. J. Prod. Econ. 221 (in press).
Baines, T., Lightfoot, H., Smart, P., 2011. Servitization within manufacturing. J. Manuf. Technol. Manag. 22 (7), 947–954.
Baines, T.S., Lightfoot, H.W., Benedettini, O., Kay, J.M., 2009. The servitization of manufacturing: a review of literature and reflection on future challenges. J. Manuf. Technol. Manag. 20 (5), 547–567.
Baines, T.S., Lightfoot, H.W., Evans, S., Neely, A., Greenough, R., Peppard, J., Roy, R., Shehab, E., Braganza, A., Tiwari, A., 2007. State-of-the-art in product-service systems. Proc. IME B J. Eng. Manufact. 221 (10), 1543–1552.
Benitez, G.B., Ayala, N.F., Frank, A.G., 2020. Industry 4.0 innovation ecosystems: an evolutionary perspective on value cocreation. Int. J. Prod. Econ. 228 (in press).
Benton, W.C., Maloni, M., 2005. The influence of power driven buyer/seller relationships on supply chain satisfaction. J. Oper. Manag. 23 (1), 1–22.
Bigdeli, A.Z., Bustinza, O.F., Vendrell-Herrero, F., Baines, T., 2018. Network positioning and risk perception in servitization: evidence from the UK road transport industry. Int. J. Prod. Res. 56 (6), 2169–2183.
Boehmer, J.H., Shukla, M., Kapletia, D., Tiwari, M.K., 2020. The impact of the Internet of Things (IoT) on servitization: an exploration of changing supply relationships. Prod. Plann. Contr. 31 (2–3), 203–219.
Bustinza, O.F., Parry, G.C., Vendrell-Herrero, F., 2013. Supply and demand chain management: the effect of adding services to product offerings. Supply Chain Manag.: Int. J. 18 (6), 618–629.
Caniëls, M.C.J., Gelderman, C.J., 2007. Power and interdependence in buyer supplier relationships: a purchasing portfolio approach. Ind. Market. Manag. 36 (2), 219–229.
Carter, C.R., Rogers, D.S., Choi, T.Y., 2015. Toward the theory of the supply chain. J. Supply Chain Manag. 51 (2), 89–97.
Casciaro, T., Piskorski, M.J., 2005. Power imbalance, mutual dependence, and constraint absorption: a closer look at resource dependence theory. Adm. Sci. Q. 50 (2), 167–199.
Cenamor, J., Sjödin, D.R., Parida, V., 2017. Adopting a platform approach in servitization: leveraging the value of digitalization. Int. J. Prod. Econ. 192, 54–65.
Chesbrough, H., 2011. The case for open services innovation: the commodity trap. Calif. Manag. Rev. 53 (3), 5–20.
Corbin, J., Strauss, A., 2008. Strategies for qualitative data analysis. In: Corbin, J., Strauss, A. (Eds.), Techniques and Procedures for Developing Grounded Theory. Basics of Qualitative Research. SAGE, Thousand Oaks, CA, pp. 65–86.
Coreynen, W., Matthyssens, P., van Bockhaven, W., 2017. Boosting servitization through digitization: pathways and dynamic resource configurations for manufacturers. Ind. Market. Manag. 60, 42–53.
Coreynen, W., Matthyssens, P., Vanderstraeten, J., van Witteloostuijn, A., 2020. Unravelling the internal and external drivers of digital servitization: a dynamic capabilities and contingency perspective on firm strategy. Ind. Market. Manag. 89, 265–277.
Corley, K.G., Gioia, D.A., 2004. Identity ambiguity and change in the wake of a corporate spin-off. Adm. Sci. Q. 49 (2), 173–208.
Cox, A., 1999. Power, value and supply chain management. Supply Chain Manag.: Int. J. 4 (4), 167–175.
Cox, A, 2001. Understanding buyer and supplier power: A framework for procurement and supply competence. J. Suppl. Chain Manag. 37 (2), 8–15.
Cox, A., Ireland, P., Lonsdale, C., Sanderson, J., Watson, G., 2002. Supply Chains, Markets and Power: Mapping Buyer and Supplier Power Regimes. Routledge, London.
Crook, T.R., Combs, J.G., 2007. Sources and consequences of bargaining power in supply chains. J. Oper. Manag. 25 (2), 546–555.
Drees, J.M., Heugens, P.P., 2013. Synthesizing and extending resource dependence theory: a meta-analysis. J. Manag. 39 (6), 1666–1698.
Dyer Jr., W.G., Wilkins, A.L., 1991. Better stories, not better constructs, to generate better theory: a rejoinder to Eisenhardt. Acad. Manag. Rev. 16 (3), 613–619.
Eisenhardt, K.M., 1989. Building theories from case study research. Acad. Manag. Rev. 14 (4), 532–550.
Eloranta, V., Turunen, T., 2016. Platforms in service-driven manufacturing: leveraging complexity by connecting, sharing, and integrating. Ind. Market. Manag. 55, 178–186.
Emerson, R.M., 1962. Power-dependence relations. Am. Socio. Rev. 27 (1), 31–41.
Falkowski, J., 2015. Resilience of farmer-processor relationships to adverse shocks: the case of dairy sector in Poland. Br. Food J. 117 (10), 2465–2483.
Finne, M., Turunen, T., Eloranta, V., 2015. Striving for network power: the perspective of solution integrators and suppliers. J. Purch. Supply Manag. 21 (1), 9–24.
Gebauer, H., Paiola, M., Saccani, N., Rapaccini, M., 2020. Digital servitization: crossing the perspectives of digitization and servitization. Ind. Market. Manag. (in press).
Gerring, J., 2004. What is a case study and what is it good for? Am. Polit. Sci. Rev. 98 (2), 341–354.
Gibbert, M., Ruigrok, W., Wicki, B., 2008. What passes as a rigorous case study? Strat. Manag. J. 29 (13), 1465–1474.
Gioia, D.A., Corley, K.G., Hamilton, A.L., 2013. Seeking qualitative rigor in inductive research: notes on the Gioia methodology. Organ. Res. Methods 16 (1), 15–31.
Glaser, B.G., Strauss, A.L., 1967. The Discovery of Grounded Theory: Strategies for Qualitative Research. Wiedenfeld and Nicholson, London.
Hart, P., Saunders, C., 1997. Power and trust: critical factors in the adoption and use of electronic data interchange. Organ. Sci. 8 (1), 23–42.
He, Q., Ghobadian, A., Gallear, D., 2013. Knowledge acquisition in supply chain partnerships: the role of power. Int. J. Prod. Econ. 141 (2), 605–618.
Hillman, A.J., Withers, M.C., Collins, B.J., 2009. Resource dependence theory: a review. J. Manag. 35 (6), 1404–1427.
Hingley, M., Angell, R., Lindgreen, A., 2015. The current situation and future conceptualization of power in industrial markets. Ind. Market. Manag. 48, 226–230.
Holmström, J., Holweg, M., Lawson, B., Pil, F.K., Wagner, S.M., 2019. The digitalization of operations and supply chain management: theoretical and methodological implications. J. Oper. Manag. 65 (8), 728–734.
Huikkola, T., Rabetino, R., Kohtamäki, M., Gebauer, H., 2020. Firm boundaries in servitization: interplay and repositioning practices. Ind. Market. Manag. 90, 90–105.
Ireland, R.D., Webb, J.W., 2007. A multi-theoretic perspective on trust and power in strategic supply chains. J. Oper. Manag. 25 (2), 482–497.
Jones, S.L., Fawcett, S.E., Wallin, C., Fawcett, A.M., Brewer, B.L., 2014. Can small firms gain relational advantage? Exploring strategic choice and trustworthiness signals in supply chain relationships. Int. J. Prod. Res. 52 (18), 5451–5466.
Kähkönen, A.-K., 2014. The influence of power position on the depth of collaboration. Supply Chain Manag.: Int. J. 19 (1), 17–30.
Kähkönen, A.-K., Virolainen, V.M., 2011. Sources of structural power in the context of value nets. J. Purch. Supply Manag. 17 (2), 109–120.
Kamalaldin, A., Linde, L., Sjödin, D., Parida, V., 2020. Transforming provider-customer relationships in digital servitization: a relational view on digitalization. Ind. Market. Manag. 89, 306–325.
Kamp, B., Ochoa, A., Diaz, J., 2017. Smart servitization within the context of industrial user–supplier relationships: contingencies according to a machine tool manufacturer. Int. J. Interact. Des. Manuf. 11 (3), 651–663.
Kohtamäki, M., Parida, V., Oghazi, P., Gebauer, H., Baines, T., 2019. Digital servitization business models in ecosystems: a theory of the firm. J. Bus. Res. 104, 380–392.
Kohtamäki, M., Parida, V., Patel, P.C., Gebauer, H., 2020. The relationship between digitalization and servitization: the role of servitization in capturing the financial potential of digitalization. Technol. Forecast. Soc. Change 151 (in press).
Kotler, P., Ang, S.H., Leong, S.M., Tan, C.T., 1999. Marketing Management: an Asian Perspective. Prentice Hall, Singapore.
Kumar, N., 2005. The power of power in supplier-retailer relationships. Ind. Market. Manag. 34 (8), 863–866.
Kumar, N., Scheer, L.K., Steenkamp, J.-B.E.M., 1995. The effects of perceived interdependence on dealer attitudes. J. Market. Res. 32 (3), 348–356.
Lee, J., Berente, N., 2012. Digital innovation and the division of innovative labor: Digital controls in the automotive industry. Organiz. Sci. 23 (5), 1428–1447.
Lee, H.L., Whang, S., 2004. E-business and supply chain integration. In: Harrison, T.P., Lee, H.L., Neale, J.J. (Eds.), The Practice of Supply Chain Management: where Theory and Application Converge. Springer, Boston, pp. 123–138.
Lerch, C., Gotsch, M., 2015. Digitalized product-service systems in manufacturing firms: a case study analysis. Res. Technol. Manag. 58 (5), 45–52.
Li, A.Q., Kumar, M., Claes, B., Found, P., 2020. The state-of-the-art of the theory on Product-Service Systems. Int. J. Prod. Econ. 222 (in press).
Lincoln, Y.S., Guba, E., 1985. Naturalistic Inquiry. SAGE, Beverly Hills.
Loebbecke, C., Picot, A., 2015. Reflections on societal and business model transformation arising from digitization and big data analytics: a research agenda. J. Strat. Inf. Syst. 24 (3), 149–157.
Malhotra, D., Gino, F., 2011. The pursuit of power corrupts: how investing in outside options motivates opportunism in relationships. Adm. Sci. Q. 56 (4), 559–592.
Maloni, M., Benton, W.C., 2000. Power influences in the supply chain. J. Bus. Logist. 21 (1), 49–74.
Matthyssens, P., Vandenbempt, K., 2008. Moving from basic offerings to value-added solutions: strategies, barriers and alignment. Ind. Market. Manag. 37 (3), 316–328.
Naik, P., Schroeder, A., Kapoor, K.K., Bigdeli, A.Z., Baines, T., 2020. Behind the scenes of digital servitization: actualising IoT-enabled affordances. Ind. Market. Manag. 89, 232–244.
Neely, A., 2008. Exploring the financial consequences of the servitization of manufacturing. Operations Management Research 1 (2), 103–118.
Nienhüser, W., 2008. Resource dependence theory: how well does it explain behavior of organizations? Manag. Rev. 19 (1/2), 9–32.
Obal, M., 2013. Why do incumbents sometimes succeed? Investigating the role of interorganizational trust on the adoption of disruptive technology. Ind. Market. Manag. 42 (6), 900–908.
Obermaier, R., 2019. Industrie 4.0 und Digitale Transformation als unternehmerische Gestaltungsaufgabe. In: Obermaier, R. (Ed.), Handbuch Industrie 4.0 und Digitale Transformation. Springer Gabler, Wiesbaden, pp. 3–46.
Oliva, R., Kallenberg, R., 2003. Managing the transition from products to services. Int. J. Serv. Ind. Manag. 14 (2), 160–172.
Opresnik, D., Taisch, M., 2015. The value of big data in servitization. Int. J. Prod. Econ. 165, 174–184.
Otto, A., Obermaier, R., 2009. How can supply networks increase firm value? A causal framework to structure the answer. Logistics Research 1 (3–4), 131–148.
Pagani, M., Pardo, C., 2017. The impact of digital technology on relationships in a business network. Ind. Market. Manag. 67, 185–192.
Paiola, M., Gebauer, H., 2020. Internet of things technologies, digital servitization and business model innovation in BtoB manufacturing firms. Ind. Market. Manag. 89, 245–264.
Paschou, T., Rapaccini, M., Adrodegari, F., Saccani, N., 2020. Digital servitization in manufacturing: a systematic literature review and research agenda. Ind. Market. Manag. 89, 278–292.
Paulraj, A., Chen, I.J., 2007. Strategic buyer–supplier relationships, information technology and external logistics integration. J. Supply Chain Manag. 43 (2), 2–14.
Perlman, C., 2017. From Product to Platform: John Deere Revolutionizes Farming. https://digital.hbs.edu/data-and-analysis/product-platform-john-deere-revolutionizes-farming/.

Perreault Jr., W.D., Leigh, L.E., 1989. Reliability of nominal data based on qualitative judgments. J. Market. Res. 26 (2), 135–148.
Pfeffer, J., 1981. Power in Organizations. Pitman, Marshfield.
Pfeffer, J., Salancik, G.R., 1978. The External Control of Organizations: A Resource Dependence Perspective. Stanford University Press, Stanford.
Pham, X., Stack, M., 2018. How data analytics is transforming agriculture. Bus. Horiz. 61 (1), 125–133.
Piekkari, R., Welch, C., Paavilainen, E., 2009. The case study as disciplinary convention: evidence from international business journals. Organ. Res. Methods 12 (3), 567–589.
Porter, M.E., Heppelmann, J.E., 2014. How smart, connected products are transforming competition. Harv. Bus. Rev. 92 (11), 64–88.
Porter, P., 1985. Competitive Advantage. Free Press, New York.
Rabetino, R., Harmsen, W., Kohtamäki, M., Sihvonen, J., 2018. Structuring servitization-related research. Int. J. Oper. Prod. Manag. 38 (2), 350–371.
Rabetino, R., Kohtamäki, M., 2018. To servitize is to (Re) position: utilizing a porterian view to understand servitization and value systems. In: Kohtamäki, M., Baines, T., Rabetino, R., Bigdeli, A.Z. (Eds.), Practices and Tools for Servitization. Springer International Publishing, Cham, pp. 325–341.
Rabetino, R., Kohtamäki, M., Gebauer, H., 2017. Strategy map of servitization. Int. J. Prod. Econ. 192, 144–156.
Raynor, M., Christensen, C.M., 2002. Integrate to Innovate: the Determinants of Success in Developing and Deploying New Services in the Communications Industry. Deloitte Research Publication, New York.
Rifkin, J., 2014. The Zero Marginal Cost Society: the Internet of Things, the Collaborative Commons, and the Eclipse of Capitalism. Palgrave Macmillan, New York.
Ritter, T., Pedersen, C.L., 2020. Digitization capability and the digitalization of business models in business-to-business firms: past, present, and future. Ind. Market. Manag. 86, 180–190.
Rymaszewska, A., Helo, P., Gunasekaran, A., 2017. IoT powered servitization of manufacturing–an exploratory case study. Int. J. Prod. Econ. 192, 92–105.
Seuring, S.A., 2008. Assessing the rigor of case study research in supply chain management. Supply Chain Manag. 13 (2), 128–137.
Siggelkow, N., 2007. Persuasion with case studies. Acad. Manag. J. 50 (1), 20–24.
Sjödin, D., Parida, V., Kohtamäki, M., Wincent, J., 2020. An agile co-creation process for digital servitization: a micro-service innovation approach. J. Bus. Res. 112, 478–491.
Sklyar, A., Kowalkowski, C., Tronvoll, B., Sörhammar, D., 2019. Organizing for digital servitization: a service ecosystem perspective. J. Bus. Res. 104, 450–460.
Smith, J.A., Harre, R., van Langenhove, L. (Eds.), 1996. Rethinking Methods in Psychology. SAGE, London.
Stabell, C.B., Fjeldstad, Ø.D., 1998. Configuring value for competitive advantage: on chains, shops, and networks. Strat. Manag. J. 19 (5), 413–437.
Strauss, A., Corbin, J., 1998. Basics of Qualitative Research Techniques. SAGE, Thousand Oaks.
Suppatvech, C., Godsell, J., Day, S., 2019. The roles of internet of things technology in enabling servitized business models: a systematic literature review. Ind. Market. Manag. 82, 70–86.
Takeishi, A., 2001. Bridging inter-and intra-firm boundaries: management of supplier involvement in automobile product development. Strat. Manag. J. 22 (5), 403–433.
Tian, J., Coreynen, W., Matthyssens, P., Shen, L., 2021. Platform-based Servitization and Business Model Adaptation by Established Manufacturers. Technovation (in press).
Touboulic, A., Chicksand, D., Walker, H., 2014. Managing imbalanced supply chain relationships for sustainability: a power perspective. Decis. Sci. J. 45 (4), 577–619.
Tronvoll, B., Sklyar, A., Sörhammar, D., Kowalkowski, C., 2020. Transformational shifts through digital servitization. Ind. Market. Manag. 89, 293–305.
Tukker, A., Tischner, U., 2006. New Business for Old Europe: Product-Service Development, Competitiveness and Sustainability. Greenleaf Publishing, Sheffield.
Ulaga, W., Reinartz, W.J., 2011. Hybrid offerings: how manufacturing firms combine goods and services successfully. J. Market. 75 (6), 5–23.
Ulrich, D., Barney, J.B., 1984. Perspectives in organizations: resource dependence, efficiency, and population. Acad. Manag. Rev. 9 (3), 471–481.
Vandermerwe, S., Rada, J., 1988. Servitization of business: adding value by adding services. Eur. Manag. J. 6 (4), 314–324.
Vendrell-Herrero, F., Bustinza, O.F., Parry, G., Georgantzis, N., 2017. Servitization, digitization and supply chain interdependency. Ind. Market. Manag. 60, 69–81.
Vendrell-Herrero, F., Wilson, J.R., 2017. Servitization for territorial competitiveness: taxonomy and research agenda. Compet. Rev.: An International Business Journal 27 (1), 2–11.
Weber, M., 1922. Wirtschaft und Gesellschaft. Grundriss der verstehenden Soziologie. Tübingen, Mohr.
Welch, C., Piekkari, R., Plakoyiannaki, E., Paavilainen-Mäntymäki, E., 2011. Theorising from case studies: towards a pluralist future for international business research. J. Int. Bus. Stud. 42 (5), 740–762.
Wise, R., Baumgartner, P., 1999. Go downstream. Harv. Bus. Rev. 77 (5), 133–141.
Yin, R.K., 2018. Case Study Research and Applications. Design and Methods. SAGE, Los Angeles.
Yoo, Y., Henfridsson, O., Lyytinen, K., 2010. Research commentary —the new organizing logic of digital innovation: an agenda for information systems research. Inf. Syst. Res. 21 (4), 724–735.