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RESEARCH PAPER

# Non-ownership business models in the manufacturing industry: Uncertainty-exploiting versus uncertainty-mitigating designs and the role of context factors

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## Abstract
With the emergence of the Industrial Internet of Things, a growing number of manufacturing firms has started to adopt non-ownership business models (NOBMs). NOBM providers maintain ownership of offered machinery and sell only the machine use and/or performance as a service to their clients. While the adoption of NOBMs is found to be associated with novel business opportunities related to client-side uncertainties, it is also found to result in a considerable increase in provider-side uncertainties. Drawing on a multiple-case study with three leading manufacturers, we find notable differences in terms of NOBM designs, ranging from a primary focus on exploiting client-side uncertainties to a primary focus on mitigating provider-side uncertainties. Moreover, our study uncovers four context factors that help explain key differences in NOBM designs. In particular, we identify two machine attributes (human dependency and energy efficiency) and two market attributes (average client size and antitrust regulations) that "push" providers toward either uncertainty-exploiting or uncertainty-mitigating NOBM designs. Theoretical and practical implications are discussed.

**Keywords** Non-ownership business models (NOBMs) · NOBM designs · Uncertainty exploitation vs. mitigation · Context factors · Manufacturing industry · Multiple-case study

**JEL Classification** L22 · L64 · L86

## Introduction

Across industries, the emergence of new digital technologies is driving the transformation of established business models (BMs) (e.g., Alt & Zimmermann, 2014; Grieger & Ludwig, 2019; Timmers, 1998; Veit et al., 2014). One influential development associated with the digital transformation of businesses is the trend toward servitization along with the offering of so-called "non-ownership" services (e.g.Ehret & Wirtz, 2019; Lovelock & Gummesson, 2004; Wittkowski et al., 2013). With the emergence of the Industrial Internet of Things (IIoT), the servitization trend has also reached the manufacturing industry, where the majority of companies is still relying on a traditional BM centered on producing and selling physical products to clients (Schüritz et al., 2017). As such, a growing number of manufacturing firms has started to look into the adoption of non-ownership business models (NOBMs) (Ehret & Wirtz, 2017), which can be seen as a specific and novel manifestation of a servitization strategy (Weking et al., 2020). By adopting a NOBM, manufacturing firms continue to design and produce (custom-tailored)

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products or machines, such as copying machines (Chesbrough & Rosenbloom, 2002) and industrial air compressors (Bock et al., 2019); however, instead of selling their machines, firms maintain ownership and sell only the machine use and/or performance as a service to their clients (Ehret & Wirtz, 2017).

Manufacturing companies operating with a NOBM offer value-in-use to their clients (Turetken et al., 2019), thereby liberating them from the burdens and costs of machine ownership (Ehret & Wirtz, 2010). In particular, for clients, machine ownership is often not essential to their core activities and value creation, but is associated with numerous uncertainties (e.g., regarding machine maintenance, repair, and operations [MRO]). For NOBM providers, these *client-side* uncertainties present novel business opportunities; that is, by addressing these uncertainties through the effective design of their NOBM, providers can tap novel value sources (Ehret & Wirtz, 2017). For example, a key uncertainty for client firms pertains to machine performance. To address this uncertainty, a NOBM provider can leverage its superior operational expertise to offer client-specific, contractually guaranteed performance levels. While such guarantees result in less machine-related uncertainty for NOBM clients, they can in turn be used to justify additional service fees by the provider (e.g., Visnjic et al., 2016). Still, operating a NOBM is also found to be associated with a considerable increase in *provider-side* uncertainties (Ehret & Wirtz, 2017). For example, NOBM providers face uncertainties about how much a client firm will actually use the machine-based services (e.g., Gebauer et al., 2017), changing environmental and market conditions (e.g., Visnjic et al., 2018), and the occurrence of black swan events (Ndubisi et al., 2016). As such, it seems less surprising that, so far, manufacturing firms have had mixed experiences with industrial servitization strategies in general (e.g., Adrodegari et al., 2017; Jovanovic et al., 2016; Wirtz et al., 2015; Worm et al., 2017), and with the adoption of NOBMs in particular. A prominent example is the German equipment manufacturer, *Eisenmann*, which was lauded as a prime example of a NOBM provider in earlier research (e.g., Hypko et al., 2010a, 2010b), but has filed for bankruptcy in the meantime (Buchenau et al., 2019). Against this backdrop, there is an important theoretical and practical impetus for research on the successful adoption of NOBMs in the specific context of the manufacturing industry (Adrodegari & Saccani, 2017; Oliveira et al., 2018).

In this regard, prior research suggests the importance of effective *NOBM designs*, broadly defined as the purposeful selection and instantiation of relevant BM elements (e.g., Alt & Zimmermann, 2014; Loock & Hacklin, 2015; Storbacka et al., 2013), along with the importance of effective uncertainty sharing between NOBM provider and client (e.g., Ehret & Wirtz, 2019). While there is arguably little doubt about the importance of those aspects, much remains to be learned about what NOBM design elements enable providers to effectively exploit client uncertainties and mitigate the uncertainties they are facing themselves, as well as how the resulting NOBM designs differ across providers. This is partly because existing research has mainly treated NOBM providers as a homogenous group, not taking into account provider-specific NOBM designs; and partly because past research has typically looked into individual NOBM design and governance elements, such as market offerings (e.g., Berkovich et al., 2011) and relational governance mechanisms (e.g.,Ndubisi et al., 2016; Sjödin et al., 2019), whereas research at the aggregated BM level remains scarce (e.g., Böhm & Thomas, 2013). To address this shortcoming in previous research, our study sets forth to answer the following research question (RQ):

**RQ1:** ***What NOBM design elements do provider firms use to exploit (existing) client uncertainties and mitigate (emerging) provider uncertainties?***

Additionally, prior research on NOBMs and related phenomena seems to be based on the implicit assumption that effective uncertainty sharing between client and provider is under full control of the participating firms and can be proactively managed by the NOBM provider, for example, through contract negotiations with the client (e.g.,Adrodegari et al., 2017; Hou & Neely, 2017) and/or the use of appropriate digital technologies, such as the IIoT (e.g., Ehret & Wirtz, 2017). For instance, Visnjic et al. (2018) note that “the success of firms that shift to services and outcomes hinges on their ability to balance the trade-off between increased value (i.e., growth, efficiency and effectiveness) and increased uncertainty” (p. 46). In other words, extant research views the NOBM provider in the driver’s seat, thereby largely neglecting the critical role of context factors in determining and shaping the specific client-side or provider-side uncertainties that can or need to be addressed. This line of argument is consistent with the results of prior studies, which suggest that a key challenge regarding the effective design of a NOBM lies in creating an adequate fit between the unique context in which a NOBM provider operates and the chosen NOBM design (e.g.,Storbacka et al., 2013; Wirtz et al., 2016). Thus, our study also aims to answer the following question:

**RQ2:** ***How do context factors influence the design of NOBMs?***

To answer our research questions, we draw on a multiple-case study with three manufacturing firms that successfully introduced a NOBM. Our study is structured as follows: First, we introduce key concepts and provide an overview of related research. Next, we describe our methodology and present the findings of our within- and cross-case analyses.

Finally, we discuss the study's contributions, as well as its limitations and associated research opportunities.

## Research background and conceptual foundations

### Servitization in the manufacturing industry

To position our study within the existing service literature, it is important to relate the notion of a NOBM to the concepts of servitization and service-dominant logic. The term *servitization* was coined by Vandermerwe and Rada (1988). In the context of the manufacturing industry, this term is often defined as the innovation of an organization's business model to shift from selling products to selling product-service systems (PSS) (Neely, 2008). Studying the reasons for why manufacturing companies engage in servitization, past research points toward strategic, economic, and environmental drivers (Neely, 2008). Strategic drivers refer to locking out competitors, locking in customers, and increasing differentiation (Vandermerwe & Rada, 1988). Economic drivers mainly relate to the "installed base argument" and concern the potential to increase revenues by offering additional services (Neely, 2008). Finally, servitization is seen as a possibility to reduce the adverse environmental impact of products (Neely, 2008). In this context, it is argued that maintaining product ownership incentivizes manufacturers to maximize the product lifecycle, while customers are incentivized to reduce product usage. Despite these potential benefits, past research also points to the so-called servitization paradox, which refers to the situation where manufacturing firms make substantial investments in their service business but cannot achieve the anticipated higher returns (Gebauer et al., 2005; Worm et al., 2017). For example, Neely (2008) shows that manufacturing companies using servitization strategies face a higher risk of bankruptcy than manufacturers offering only physical products. Hence, manufacturing firms that want to engage in servitization face both potential upsides and downsides, and need to configure their servitization strategies (e.g., regarding their specific service offerings) accordingly (Jovanovic et al., 2016).

In terms of different servitization strategies, the literature distinguishes among five PSS (Neely, 2008): integration-oriented, product-oriented, service-oriented, result-oriented, and use-oriented PSS. In the first three types, product ownership is still transferred to the client and additional services are offered (e.g., financial and consulting services, installation, and maintenance), which still largely reflects a goods-dominant logic and where the manufacturer is not responsible for value co-creation once the product/good has been transferred to the client (Ng et al., 2012). On the other hand, result-oriented PSS describe situations in which a service completely replaces a physical product (e.g., a voicemail service replacing the need for an answering machine). Finally, in use-oriented PSS, product ownership stays with the manufacturing firm, which sells only the function of the product as a service. This PSS type therefore reflects a *service-dominant logic* (Vargo & Lusch, 2004), which emphasizes value realized by clients when actually using the product (value-in-use), value co-creation, and the importance of relational mechanisms between clients and manufacturers in managing risks related to value co-creation (Chesbrough & Rosenbloom, 2002; Macdonald et al., 2016; Ng et al., 2012; Selviaridis & Wynstra, 2015). Use-oriented PSS incorporate non-ownership services, which are defined as "service[s] in which [clients] acquire some property rights to an asset and are offered a certain degree of freedom in using this asset for a specified period of time while the burdens of ownership remain with the owner" (Wittkowski et al., 2013, p. 172). Given the above, a NOBM can be classified as a use-oriented PSS.

In this regard, it has been argued that the servitization literature underplays the contractual relations between service providers and their clients (Selviaridis & Wynstra, 2015). Arguably, this also applies to use-oriented PSS, which can rely on various contracting types. Here, earlier research on the servitization of manufacturing highlights the importance of *performance-based contracting* (PBC), which includes service pricing and has been described as a key facilitator of servitized business models (e.g., Ng et al., 2013; Selviaridis & Wynstra, 2015). Generally, PBC is defined as "the contractual approach of tying at least a portion of supplier payment to performance" (Selviaridis & Wynstra, 2015, p. 3505), and is characterized by an emphasis on the specification and evaluation of client outputs (i.e., "the direct results of the service activity or production process itself") and/or outcomes (i.e., "the value derived […] from a given service or product") (ibid, p. 3507). On this basis, some studies distinguish between *output-based* and *outcome-based* contracts (Ng et al., 2009; Selviaridis & Wynstra, 2015), which exhibit some fundamental differences from other contracting types that are based on *provider costs* (e.g., cost-plus contracts) or *client use intensity* (e.g., paying per service/product or time unit). For example, especially outcome-based contracts entail increased rewards and risks for the (NOBM) provider, as the (non-)achievement of outcome targets is usually associated with financial bonuses and penalties (Selviaridis & Wynstra, 2015; cf. Ng et al., 2013; Worm et al., 2017). Moreover, in PBC in general, the specified outputs or outcomes are co-produced through client-provider interactions (Ng et al., 2013; Selviaridis & Wynstra, 2015) and reflect customer activities and processes (Worm et al., 2017).

## Non-ownership business models (NOBMs)

Broadly speaking, a *business model* (BM) is defined as a blueprint of "the rationale of how an organization creates, delivers and captures value" (Osterwalder & Pigneur, 2010, p. 14; cf. Amit & Zott, 2001; Wirtz et al., 2016), which includes "an architecture for the product, service and information flows" (Timmers, 1998, p. 4). It is "a focusing device that mediates between technology development and economic value creation" (Chesbrough & Rosenbloom, 2002, p. 532). To describe the (design) elements that constitute a BM, Al-Debei and Avison (2010) reviewed various BM conceptualizations and derived four basic dimensions: (1) *value proposition* concerns a firm's market offerings and targeted customer segment(s); (2) *value architecture* pertains to the configuration of core resources and capabilities that a company needs to offer its products and/or services; (3) *value network* depicts the relationships and interactions with focal external partners and other stakeholders; (4) *value finance* comprises a company's cost structure, revenue streams, and pricing model. Against this conceptual background, a *NOBM* represents a specific type of BM, where value creation and delivery refer to the offering of non-ownership services that meet client needs and provide them with value-in-use, and where value capture refers to the monetary or non-monetary benefits that NOBM providers can gain from offering corresponding services (Martin et al., 2019). Although prior studies use a variety of different labels for NOBMs (e.g., outcome or subscription BMs), they essentially describe the same phenomenon (e.g., Grubic & Jennions, 2018). Based on a literature review, we identified a set of three key design elements that distinguish NOBMs, along with several additional design elements (see Table 1 for an overview).

A first key design element that characterizes a NOBM is that its *value proposition* centers around the offering of non-ownership services; that is, NOBM providers put the utility of their machine and the related value-in-use (for their clients) at the center of their market offering (e.g., Adrodegari et al., 2015). Other design elements concerning a NOBM's value proposition include the level, range, and depth of services offered (Normann & Ramirez, 1989). In this regard, earlier research points to differences in contract duration and contractually guaranteed service levels (e.g., Hou & Neely, 2017); a range of add-on services, such as consulting and/or training, which can be included in the overall service offering (e.g., Gebauer et al., 2017); and varying types and levels of customer responsibilities with regard to machine operation (e.g., Barquet et al., 2013).

A second key design element of a NOBM is that machine ownership remains within the *value architecture* of the service provider, which usually includes provider responsibility for related "burdens" (e.g., machine installation and MRO) (e.g.Adrodegari & Saccani, 2017; Wittkowski et al., 2013). Additional NOBM value architecture design elements pertain to key activities, such as evaluating potential NOBM clients and measuring service outputs (e.g.,Adrodegari

**Table 1** Overview of (key*) NOBM design elements

| Dimension | Design element | References (examples) |
|---|---|---|
| *Value proposition (VP)* | Non-ownership service offering* (basic machine utility) | Adrodegari et al. (2015), Orellano et al. (2017), Storbacka et al. (2013), Visnjic et al. (2018) |
| | Service level (e.g., contract duration, contractual guarantees) | Barquet et al. (2013), Hou and Neely (2017), Selviaridis and Wynstra (2015), Smith (2013) |
| | Service range (e.g., machine installation, MRO, consulting services) | Gebauer et al. (2017), Hypko et al. (2010b), Visnjic et al. (2018), Wittkowski et al. (2013) |
| | Service depth (e.g., client responsibilities) | Barquet et al. (2013), Hypko et al. (2010b) |
| *Value architecture (VA)* | Key resources* (machine ownership) | Adrodegari and Saccani (2017), Brax and Visintin (2016), Wittkowski et al. (2013) |
| | Key activities (e.g., client evaluation, technical upfront analysis, service measurement) | Adrodegari et al. (2017), Ehret and Wirtz (2017), Orellano et al. (2017) |
| | Key capabilities (e.g., IIoT capabilities) | Ehret and Wirtz (2017), Gebauer et al. (2017), Grubic (2014) |
| *Value network (VN)* | Financial (leasing) partners (e.g., funding for upfront investments) | Barquet et al. (2013), Hypko et al., (2010a, 2010b), Orellano et al. (2017) |
| | Insurance partners (e.g., protection against machine damage) | Gebauer et al. (2017) |
| | Technology partners (e.g., provision of customized solutions) | Brax and Visintin (2016), Storbacka et al. (2013) |
| *Value finance (VF)* | Pricing* (cost-based, outcome-based, output-based, and/or usage-based fees) | Adrodegari et al. (2017), Hou and Neely (2017), Ng et al. (2013), Selviaridis and Wynstra (2015), Smith (2013), Worm et al. (2017) |

et al., 2017; Orellano et al., 2017), as well as key capabilities including a NOBM provider's IIoT capabilities, which play a critical role in supporting the efficient operation of machinery (e.g., by enabling predictive maintenance) (e.g.,Ehret & Wirtz, 2017; Grubic, 2014). A related set of NOBM design elements pertains to the *value network*. Here, studies note that, to share the burdens associated with machine ownership, NOBM providers may involve partner companies in its NOBM's value network in order to leverage their specialized expertise. Relevant value-network partners include financial (leasing) partners (e.g., Barquet et al., 2013), insurance partners (Gebauer et al., 2017), and technology partners (e.g., Storbacka et al., 2013).

Finally, a third key design element characterizing a NOBM relates to value *finance*: instead of paying a fixed price for owning a machine, clients pay a flexible service fee based on their machine usage (e.g., Adrodegari et al., 2017), provider costs for material and time required for MRO activities (e.g., Ng et al., 2013), and/or service performance in terms of outputs or outcomes (e.g., Hou & Neely, 2017; Ng. et al., 2013; Selviaridis & Wynstra, 2015; Smith, 2013; Worm et al., 2017). For manufacturing firms adopting a NOBM, this means that the inflow of their revenues shifts from (relatively high) one-time client payments to lower but continuous service-based revenue streams spread out over the entire machine lifecycle (Adrodegari & Saccani, 2017), leading to extended payback periods for initial investments (Barquet et al., 2013; Orellano et al., 2017). In this regard, NOBM providers may also charge a (cost-based) one-time fee upfront in order to cover a certain portion of their client-specific investment (cf. Chesbrough & Rosenbloom, 2002).

As further elaborated in the following section, the design elements listed in Table 1 represent focal building blocks of different NOBM designs implemented by manufacturing firms.

## NOBM designs and the role of uncertainties

Generally, an *uncertainty* refers to a part of the future that cannot be (fully) anticipated or forecast (Ndubisi et al., 2016), and earlier research highlights the central role of uncertainties in the successful adoption and implementation of NOBMs (e.g.,Ehret & Wirtz, 2017, 2019; Gebauer et al., 2017; Grubic & Jennions, 2018; Hou & Neely, 2017; Hypko et al., 2010a; Visnjic et al., 2016). Here, an interesting perspective on uncertainty has been presented by Ehret and Wirtz (2017) who suggest that uncertainties associated with NOBM adoption can be positive or negative for both the provider and the client. On the one hand, *negative* uncertainties are those that can unpleasantly surprise decision makers. In this regard, Ehret and Wirtz (2017) draw on transaction cost theory to explain the occurrence of negative uncertainties, for example, in relation to catastrophic events, shirking actions taken by business partners, mistakes made by staff members in operating the machinery, and machine breakdowns attributed to poor job design. On the other hand, *positive* uncertainties are related to novel business opportunities for value creation. Specifically, Ehret and Wirtz (2017) suggest that opportunities can materialize in situations when the market has undervalued relevant information and inconsistencies between resource and service markets are created. In that regard, entrepreneurship theory posits that firms can leverage the unmet demand and unused potential of resources embedded in these inconsistencies to create profitable opportunities for themselves, and possibly others in their networks (ibid).

The focus of our study is on the perspective of the NOBM provider that keeps ownership and assumes responsibility for the machinery and in so doing faces *negative uncertainties* (e.g., regarding machine maintenance/repair and the future behaviors and solvency of NOBM clients), while relieving its clients of what can be described as negative uncertainties from their perspective (e.g., regarding machine operation and performance). In line with the arguments outlined above, these client-side uncertainties can in turn be considered as *positive uncertainties* from the provider perspective, as they present the NOBM provider with novel business opportunities that can ultimately enable the provider to tap new value sources. The latter is in keeping with Ehret and Wirtz (2017) who emphasize "the role of asset [machine] ownership for exploring and exploiting business opportunities as owners have residual power of assets and can use assets without the need to [re-]negotiate contracts" (p. 115). Machine ownership thus represents a core value-creation mechanism by allowing providers to experiment with resources and leverage their expertise in order to lower transaction costs (efficiency); envision, develop, and market new products or services and reach new customer segments (novelty); and set the terms for machine access and engage clients in repeated transactions and long-term contracts (lock-in) (Amit & Zott, 2001; cf. Gebauer et al., 2017; Hypko et al., 2010a). For example, a common key uncertainty for client firms concerns the often hard-to-predict MRO costs associated with machine ownership. To address this uncertainty, a NOBM provider can guarantee its clients an output-based service fee that covers all operational costs, while leveraging its extensive experience and superior expertise to steadily decrease the (provider-internal) costs of service delivery, thereby steadily increasing its profit margin (e.g., Visnjic et al., 2016). On the downside, however, operating a NOBM also entails the emergence of novel (negative) uncertainties on the provider side (e.g., Ehret & Wirtz, 2017; Gebauer et al., 2017; Ndubisi et al., 2016; Visnjic et al., 2018), as already indicated above (see the "Introduction" section).

In this context, there continues to be a paucity of research on how the design of a NOBM—defined as a provider's purposeful selection and instantiation of corresponding BM elements (Alt & Zimmermann, 2014; Loock & Hacklin, 2015; Storbacka et al., 2013)—enables the exploitation of (positive) client-side uncertainties and the mitigation of (negative) provider-side uncertainties, as well as how such designs differ across NOBM providers. This research shortcoming can be explained by existing studies' tendency to treat manufacturers operating with a NOBM as a largely homogenous group (e.g.,Adrodegari & Saccani, 2017; Storbacka et al., 2013), along with these studies' often-exclusive focus on individual NOBM design elements (e.g.,Berkovich et al., 2011; Böhm & Thomas, 2013). To address this shortcoming, our study focuses on the provider perspective and examines NOBM designs in a more holistic manner, thereby drawing on the work by Ehret and Wirtz (2017), and in particular the distinction between *uncertainty-exploiting* and *uncertainty-mitigating* NOBM designs.

### NOBM designs and the role of context factors

Existing research indicates that NOBMs require unique design elements, especially when compared to traditional BMs that are based on the sales of machinery (e.g., Visnjic et al., 2016). Relatedly, extant research on the effective design of BMs (in general) points out that one key objective, and challenge, lies in creating a 'good' fit between a company's unique context and the specific BM design elements it selects and implements (e.g.,Storbacka et al., 2013; Wirtz et al., 2016). However, earlier studies on NOBMs and related phenomena tend not to adequately explore the impact of contextual constraints on the effective design of such BMs; rather, they seem to imply that both the effective exploitation of positive uncertainties and the effective mitigation of negative uncertainties can always be proactively influenced and managed by the NOBM provider, for example, through contract design choices (e.g.,Adrodegari et al., 2017; Hou & Neely, 2017) and/or the appropriate use of digital technologies such as the IIoT (e.g., Ehret & Wirtz, 2017). That is, prior literature tends to view the NOBM provider in the driver's seat, thereby running the risk of underestimating the importance of context factors, which may either "push" a provider toward a focus on the use of uncertainty-mitigating elements or an increased focus on uncertainty-exploiting elements.

While extant literature has remained largely silent on how context factors influence the effective design of NOBMs, particularly the selection and instantiation of uncertainty-exploiting versus uncertainty-mitigating design elements, prior research has touched upon a series of potentially relevant factors. These context factors can be classified into four categories: attributes of the offered machinery, attributes of the NOBM provider and client organization, as well as attributes of the market and broader environment. For example, *machine* attributes mentioned in past studies include the size of the initial investment and total cost of ownership (Jovanovic et al., 2016), the machine's technical complexity (Bikfalvi et al., 2013), level of automation (Jovanovic et al., 2016), customization (Hypko et al., 2010a; Storbacka et al., 2013), and its position in the life cycle (Waldner et al., 2015). *Provider* attributes comprise the firm size (Neely, 2008) and capabilities (e.g., Amit & Zott, 2015; Wei et al., 2017), as well as its entrepreneurial skills and technological knowledge/tools (Turunen & Finne, 2014). Attributes of the *client* organization include its size (Wittkowski et al., 2013), personnel capabilities and technological competencies (Grieger & Ludwig, 2019), price sensitivity (Gebauer, 2008), and production facilities (Jovanovic et al., 2016). *Market* attributes include the cost of capital (Oliveira et al., 2018), market competitiveness and growth rates (Gebauer, 2008), as well as market-specific regulatory aspects such as tax regulations (Oliveira et al., 2018) and regulatory requirements for offering product-related services (Turunen & Finne, 2014).

In summary, prior studies point to a plethora of context factors that may influence the effective design of NOBMs. However, most of these studies neither detail the identified context factors nor do they examine the role of these factors in 'pushing' NOBM providers toward a focus on uncertainty-mitigating or uncertainty-exploiting designs. Against this backdrop, our study sets forth to explore (1) *what NOBM design elements provider firms use to exploit client-side and mitigate provider-side uncertainties*, and (2) *how context factors influence the design of NOBMs*.

## Research methodology

To answer our research questions, we adopted a multiple case-study approach (Yin, 2018). This approach allowed us to examine different NOBM designs in their real-world setting. Also, it allowed us to do pattern matching within each case and across cases, thereby enabling a broader exploration of our research questions (Eisenhardt, 1989).

### Selection of case companies

To identify relevant case companies (i.e., manufacturing firms operating with a NOBM), we browsed through company websites, industry reports and blogs. We then used our personal networks, along with professional networking sites (e.g., Xing, LinkedIn), to contact senior managers working at the identified companies and sent them a brief outline of the study scope and goals. Short informational meetings with these managers provided us with a basic understanding of their company's NOBM. Next, we defined a set of basic criteria for selecting our case companies: on the one hand, we were looking for manufacturing firms that had successfully introduced a NOBM (alongside their traditional, product-centric BM) and shared some common ground (e.g., in terms of firm size and brand strength); on the other hand, we were particularly interested in NOBM providers showing some variance in terms of attributes of the offered machinery. Most notably, we aimed to select manufacturing firms that market clearly distinguishable machine types used for different production technologies (i.e., small batch, large batch/mass production, and process) (Woodward, 1980). The use of this sampling strategy helped us shed light on the role of context factors in shaping NOBM designs (see RQ2), as well as in determining whether a specific case finding was idiosyncratic to a single case or was replicated among several cases (Eisenhardt & Graebner, 2007). On this basis, we chose three leading manufacturing firms as our case companies: PRINT, ROB, and COMP (firm names have been anonymized at the firms' request). An overview of the case companies is given in Table 2. All three companies had successfully introduced a NOBM and had been able to reap tangible benefits from the introduction of their NOBM. For example, at COMP, the NOBM has led to the establishment of long-term partnerships with several client firms; at PRINT, introducing a NOBM provided the company with access to new client segments (e.g., clients that could not afford the price premium for PRINT's market-leading printing machines).

## Data collection and analysis

To collect the case data, we relied on semi-structured interviews with key informants as our primary data source (see also Table 2 above). Before entering the field, we prepared an initial interview guideline, which included questions on the overall NOBM design (and the use of IIoT-based solutions), the factors leading to the NOBM introduction, as well as the resulting benefits (e.g., novel business opportunities) and challenges (e.g., negative uncertainties). Prior to each interview, we sent the interviewee a description of our study along with the interview guideline. As suggested by Eisenhardt (1989), we started to analyze the collected case data in parallel to our data collection efforts. This enabled us to adjust and fine-tune the interview guideline throughout the data-collection process. In each case firm, we first conducted an interview with our primary contact (again, see Table 2)—namely, the person responsible for the firm's NOBM—and then identified additional interviewees in close collaboration with this person. Doing so provided us with access to top-level managers and helped us ensure that informants had a sound understanding of the respective NOBM (design). Overall, we engaged in close interactions with all three case companies over an extended time period of almost three years (from July 2017 to March 2020).

Across the three companies, we conducted a total of thirteen interviews. Our interview partners had job titles such as Chief Digital Officer (CDO), Head of Sales Consulting, and Head of Project Sales. The interviews were carried out onsite (10) or by phone (3) until saturation was reached at each company (i.e., until no new concepts or insights emerged). The first author conducted all interviews and was joined by the second author for three onsite interviews. The total duration of the interviews was 18 h and 33 min (average duration of 1 h and 26 min). Interviews were tape-recorded and resulted in 238 pages of transcriptions.

Moreover, to clarify follow-up questions and discuss preliminary findings, we had regular informal phone calls and/

**Table 2** Overview of case companies

| Company | PRINT | ROB | COMP |
|---|---|---|---|
| Industry | Manufacturing | | |
| Traditional BM | Selling of machinery and technical equipment (and complementary services) | | |
| Machine type (production technology) | Printing machines (small batch) | Robot stations (large batch/mass production) | Industrial air compressors (process) |
| Machine utility | Printing capacity | Automation capacity | Compressed air |
| Employees (in 2016) | 11,500 | 13,000 | 5,000 |
| Revenue (in 2016) | 2.5 billion € | 3 billion € | 0.8 billion € |
| Number of interviews | 6 interviews (all onsite) | 3 interviews (2 onsite, 1 phone) | 4 interviews \(2 onsite, 2 phone) |
| Number of workshops | 1 (half-day) | 1 (half-day) | 1 (half-day) |
| Additional data sources (examples) | Follow-up emails and phone calls, direct observations, internal documentation, publicly available documents | | |
| Primary contact | Head of Customer Segment Management | Head of Sales Consulting | Head of Project Sales |
| Job titles of additional interviewees (examples) | CDO, Head of IT Processes and Solutions | Consultant Global Customer Services | Engineer Project Sales |
| Total interview duration | 9 h 24 min | 3 h 33 min | 5 h 36 min |

or exchanged emails with our primary contacts. Also, to validate our (preliminary) findings, we conducted a half-day workshop at each case company. During the workshops, we triangulated the data we gathered through interviews, informal phone calls and emails with specific questions about discrepancies and feedback about the findings from the workshop participants. Further, we triangulated the data with supplementary data (company-internal documents and direct observations in the form of field notes), as well as publicly available information (e.g., annual reports, client brochures, industry blogs/reports) (Yin, 2018). For example, a two-hour tour and demonstration of a printing facility (used for client-demonstration purposes) provided us with first-hand insights into main machine attributes and provider-side uncertainties related to PRINT's NOBM. Similar tours of the production and assembly facilities were conducted at both COMP and ROB. In addition, at ROB, our main contact gave us a detailed demonstration of implemented IIoT functionalities. Examples of internal documents that we used to triangulate our findings included presentations and status reports on the case companies' NOBMs. All case data were integrated into a central case database (Yin, 2018).

To analyze our case data, we used the software tool *MAXQDA* and focused on understanding each case as a stand-alone entity and identifying case-specific patterns. We conducted multiple coding cycles. Specifically, in a first cycle, we conducted open or initial coding by breaking the data into discrete parts and relating some to concepts in the literature and allowing others to emerge from the data to form new codes (Saldaña, 2015). In the repeated coding cycles, we iteratively grouped the first-cycle codes into subcategories and then tried to link the subcategories into categories; that is, we tried to make sense of the collected data by mapping data slices onto focal study concepts (i.e., NOBM design elements, client- and provider-side uncertainties, context factors). The line-by-line coding was done by the first author. The (intermediate) coding results were triangulated through extensive discussion among, and scrutinization by, the other members of the author team. Here, team members alternated between critical and constructive positions, and were able to resolve any disagreements by jointly revisiting the case data and discussing the coding for the relevant text passages. On this basis, we compiled detailed write-ups for each case. Finally, based on the write-ups, we conducted a cross-case analysis to identify commonalities and differences across the cases (Yin, 2018). The focus of this analysis was on extracting key (context) factors that could explain the identified differences in companies' emphasis on the use of uncertainty-exploiting or uncertainty-mitigating NOBM design elements.

## Case analyses

In the following, we present our analysis results for the three case firms (PRINT, ROB, COMP). Each subsection starts with a short description of the specific case context, followed by a presentation of the NOBM design, with a particular focus on the design elements used for exploiting client-side and mitigating provider-side uncertainties.

### PRINT: Case context and NOBM design

Operating in a highly regulated market, PRINT is specialized in producing industrial printing machines. Its clients come from multiple industries (e.g., packaging and labeling) and are rather small in size with around 100 employees on average. To satisfy client-specific printing requirements, PRINT customizes its printing machines by adding certain features (e.g., camera system, additional printing units) to a base version. Operating the printing machines is associated with a high number of manual tasks (e.g., feeding paper, refilling colors, starting print jobs), and is thus highly labor-intensive and dependent on human involvement. Further, the machines require numerous consumables (e.g., paper, colors, printing blankets) to operate. The conditions inside a printing facility (e.g., in terms of humidity and temperature) considerably impact a machine's maintenance intervals, as well as its total printed output. PRINT's NOBM centers around a non-ownership service offering in the form of printing capacity. Non-ownership contracts typically cover a maximum period of five years and guarantee clients a certain number of pages that can be printed. While PRINT retains ownership of the equipment and is responsible for all related upfront investments, the printing equipment is installed at the client facility and client staff is responsible for operating the machines.

**Exploitation of client uncertainties:** PRINT's clients typically struggle to fully utilize the machinery's potential output and operate with an average overall equipment effectiveness (OEE) of only 30%. For PRINT, taking over related client-side uncertainties resulted in two main business opportunities. First, it enabled the company to sell services only rarely sold as standalone offerings, such as consulting and consumables, as part of an 'all-round carefree package.' Consequently, PRINT included consulting services (e.g., client staff trainings and process improvements) and the provision of all consumables (except for paper supply), as well as machine installation, maintenance, and repair as mandatory services in its NOBM (VP).

> We want to increase our market share for consumables. That is, one mandatory aspect is that the [NOBM] client must use our consumables. Often times, clients ask if we can leave consumables out of the contract […]. No, that is not possible. (Head of Customer Segment Management, PRINT)

Second, keeping ownership of the machinery and being responsible for the delivery of all services included in the NOBM's service range enabled PRINT to reduce MRO costs. To realize this business opportunity, PRINT leveraged its IIoT capabilities (VA) by equipping each printing machine with about 1,000 sensors collecting data on machine settings, engine temperatures, electricity consumption, etc. These sensor data are used, for example, for statistical analyses and comparisons (e.g., of engine temperatures), with the goal of identifying technical issues before they materialize (predictive maintenance). Doing so enabled PRINT to fix imminent technical failures during planned maintenance intervals and thus to reduce repair costs. Additionally, PRINT's traditional clients (i.e., those opting for purchasing/owning the machinery) face major uncertainties concerning the return on their investment. Specifically, traditional clients do not know whether it will pay off to invest the 40% price premium associated with purchasing PRINT's 'high-end' machinery. Offering output-based pricing thus enabled PRINT to reach (new) clients that were unwilling, or unable, to pay the price premium. In the NOBM, these more price-sensitive clients pay a contractually agreed-upon fee for every single page they print with the installed machinery (VF).

> We are the clear market leader, but also the price leader; and it happens often enough that we lose a bid because of the price. [...] and with this model [NOBM], we are trying to specifically reach these [price-sensitive] clients. (Head of Customer Segment Management, PRINT)

**Mitigation of provider uncertainties:** PRINT faces considerable uncertainties regarding its clients' level of professionalization (e.g., in terms of process standardization and staff qualification), which can negatively affect the output that a client can realize with the installed printing machine(s). At least in part, these uncertainties stem from the relatively small average size of PRINT's clients. To mitigate them, PRINT integrated consulting and training as mandatory services into the service range of its NOBM (VP).

> What is crucial is the human factor. This is where we have the biggest issue—if the client has the wrongly trained, or untrained, personnel operating the machine. That is the most critical factor for us. (Head of Customer Segment Management, PRINT)

Relatedly, PRINT also faces uncertainties regarding the behavior of client staff operating the printing machines (e.g., incorrect operation damaging the installed machinery). To mitigate these uncertainties, all NOBM clients need to have insurance covering machine damage (e.g., caused by staff). In this context, PRINT also leverages data gathered from IIoT technologies to monitor the behavior of client staff operating the printing machine(s). Doing so, for example, enables PRINT to identify situations in which client staff behavior causes a reduction in machine output, which consequently triggers appropriate remedial actions (e.g., in the form of consulting).

Additional provider-side uncertainties concern the potential loss of PRINT's client-specific investments (e.g., related to machine customization and installation) in case of a client filing for bankruptcy. To mitigate these uncertainties, PRINT performs a carefully (upfront) evaluation of potential NOBM clients' solvency (VA). Because of the small average size of its clients, PRINT also decided to assess the market attractiveness and BM of potential NOBM clients, as well as to conduct BM development workshops with them (VA):

> We are forced to identify printing firms that are successful, that have the right management and an innovative product portfolio. These are all aspects we need to look at during the due diligence. That means we analyze the client's value creation and perform [BM] canvas workshops. We want to understand the market and see what clients they address. (Chief Digital Officer, PRINT)

Moreover, PRINT charges its NOBM clients a one-time upfront fee that represents around 5–10% of the machine investment (VF) to further mitigate provider-side uncertainties related to client bankruptcy:

> We have a one-time payment. For us, this represents a signing fee that shows us a certain commitment from the client. How high should this fee be? It represents our greatest possible uncertainty. Meaning, we build a printing machine, deliver it to the client, and [this client] might go bankrupt the very next day. This fee covers our fixed costs, resulting from logistics, installation and deinstallation. (Head of Customer Segment Management, PRINT)

In addition, PRINT faces uncertainties regarding the conditions inside clients' printing facilities (e.g., level of dust, humidity, and temperatures), which can affect machine output and durability (e.g., high wear due to high levels of dust). To address these uncertainties, PRINT performs an upfront assessment of facility conditions and uses data collected from IIoT technologies (VA) to continuously monitor these conditions. Finally, the output-based pricing model that underlies PRINT's NOBM has resulted in provider-side uncertainties concerning the extent to which clients will use the installed machinery. To mitigate these uncertainties, PRINT combines the output-based fee with a monthly base fee, which corresponds to an expected minimum usage of the printing machine (VF).

### ROB: Case context and NOBM design

ROB offers equipment in the form of robot stations for the automation of production process steps (e.g., handling parts, welding, lacquering); that is, while some sub-tasks are performed by the robot stations, other tasks (e.g., feeding or removing of parts) are still performed by humans. Typical clients of ROB are large corporations that operate large-scale production facilities. The conditions inside a facility (e.g., a foundry) have a high impact on the durability and maintenance intensity of the robot stations. In this context, ROB's NOBM offering is focused on providing clients with automation capacity by guaranteeing clients a contractually defined output (i.e., a certain number of parts that can be processed). Contract durations range from three to eight years. While ROB retains the ownership of the installed machinery, clients are responsible for performing all manual tasks necessary to operate the robot stations.

**Exploitation of client uncertainties:** Especially for ROB's traditional clients (i.e., those owning the robot stations), machine operation represents a key uncertainty. In particular, clients are often unable to operate robot stations with optimal cycle times, resulting in situations where stations are significantly underutilized. By keeping ownership of the machinery and guaranteeing a certain number of processed parts, ROB's NOBM helps reduce clients' machine operation-related uncertainties, which in turn presented ROB with three major business opportunities. First, through its NOBM, ROB can sell after-sales services that face high competition in its traditional BM. In particular, ROB has capitalized on this opportunity by integrating the installation of customized automation equipment, as well as all related maintenance and repair services, as mandatory aspects into the service range of its NOBM (VP).

> [The NOBM] is excellently suited to sell aftersales services. Usually, the client buys a robot station, operates it, and takes care of maintenance and repair. [In the NOBM] we can say, handling one part costs 15 cents, which makes it much easier to sell these additional service components. (Head of Sales Consulting, ROB)

Second, keeping machine ownership enables ROB to reduce the total (provider) costs of its NOBM offering by leveraging IIoT capabilities and the associated installation of numerous sensors collecting data on the number of parts processed, engine temperatures, and the torque that occurs in robot joints. Here, ROB also implemented an IIoT component for transferring sensor data to a central cloud database, as well as a centralized data-processing unit (VA). Among other things, the gathered data are used for remote monitoring and predictive maintenance, which play a crucial role in increasing ROB's operational efficiency and reducing its service delivery costs. Third, as ROB did not face any (antitrust) regulations limiting contract durations, the NOBM offering enabled ROB to 'lock' its NOBM clients in non-ownership contracts lasting for up to eight years (VP).

Moreover, ROB's traditional clients face uncertainties concerning the return of their high upfront investment for purchasing the robot stations. The introduction of the NOBM thus provided access to new client firms (unwilling to make this investment) by enabling ROB to offer these clients the payment of an output-based fee that is based on the number of parts processed by the robot stations (VF).

**Mitigation of provider uncertainties:** For ROB, key uncertainties associated with its NOBM relate to client staff behaviors, which may result in severe damage (e.g., a human-operated forklift 'crashing' into and breaking the arm of a robot station). To mitigate these uncertainties, ROB requires its NOBM clients to have insurance covering station breakdowns caused by their staff (VP), and relies on IIoT-based data to clarify ambiguities regarding the sources of machine breakdowns and halts (VA); i.e., to differentiate between breakdowns/halts caused by technical problems (provider responsibility) and those caused by client staff (client responsibility):

> For example, I might receive an error message that reads 'operator safety is activated.' The robot scans its environment and if someone approaches it, it first reduces its speed and then completely halts. And if that happens too often, I don't earn any money. But based on the data, I can reproduce that this was actually the client's fault. (Head of Sales Consulting, ROB)

Additionally, ROB faces uncertainties in relation to NOBM clients' solvency and potential bankruptcy, which may lead to major financial losses due to the need for client-specific upfront investments (e.g., customization of robotic arm, installation cost). As such, ROB considers the evaluation of the solvency of potential NOBM clients as a key activity (VA). Another set of uncertainties faced by ROB pertains to the conditions inside a client's production facility, which may lead to a decrease in machine lifetime (e.g., caused by high temperatures inside a foundry) or an increase in maintenance intervals (e.g., caused by high levels of dust and/or humidity). For this reason, ROB also checks the facility conditions as part of its upfront client evaluation and leverages the data gathered via IIoT technologies to continuously monitor these conditions (VA):

> …the client transfers the responsibility to choose the right equipment to us, because we only earn money if the machinery is running. That means, as a provider it is in my interest to evaluate all relevant environmental factors, such as dust or humidity. (Head of Sales Consulting, ROB)

Finally, the NOBM's flexible pricing model is particularly attractive to clients that are unwilling, or unable, to make a large one-time investment. For ROB, this pricing model, however, creates considerable uncertainties regarding the extent to which clients will use the robot stations. To reduce these uncertainties, ROB requires its NOBM clients to pay a monthly base fee that corresponds to a minimum machine utilization rate (VF).

## COMP: Case context and NOBM design

COMP produces customized air compressor stations—usually consisting of multiple compressors and additional equipment such as dryers—for clients from a broad range of industries. Average clients are large firms operating their own production facilities. Compressor stations are operated 'unmanned' (at the client site), and their operating costs are location-dependent, with facility conditions such as high temperatures and/or humidity having a negative effect on compressor durability and maintenance intervals. Also, since compressors suck in external air, outside conditions matter as well (e.g., high levels of pollen or dust increasing the required number of filter changes). At the heart of COMP's NOBM is the provision of compressed air in the form of a non-ownership service offering. Service contracts range from eight to ten years in duration and provide clients with several guarantees in terms of compressor availability, air pressure, energy efficiency, etc. Further, retaining ownership of the compressor station, COMP exempts its NOBM clients from any service provision-related responsibilities.

**Exploitation of client uncertainties:** The operation of compressor stations represents a major source of uncertainty for COMP's traditional clients. This is because, for the production processes of many client firms, compressed air is as important as electrical power; consequently, any compressor downtime will affect their production output. By maintaining ownership of the compressor stations and guaranteeing certain service levels (e.g., for compressor availability), COMP's NOBM effectively addresses this major client-side uncertainty, resulting in various business opportunities. First, the introduction of the NOBM enabled COMP to "package" add-on services and therefore to increase its overall service revenues in a highly competitive service market. Relevant mandatory services of COMP's NOBM offering include compressor installation and MRO services, as well as services related to legal operator obligations (e.g., pressure tests and risk assessment of pressure tanks).

> As soon as the [non-ownership] contract is signed, the competition is gone. We have very strong competition. [And with the NOBM] we do not have to 'reacquire' the client in terms of [service] sales, because the client is tied to us for 10 years. (Head of Project Sales, COMP)

Second, keeping machine ownership allowed COMP to better leverage IIoT capabilities, which in turn helped improve the efficiency of service delivery. Specifically, at COMP, each compressor is equipped with sensors collecting data on compressed air usage, energy efficiency, engine temperature and vibrations, etc. A tablet-like device (installed at each client site) aggregates the sensor data in a central cloud database, where data are then processed. On this basis, COMP was able to reduce its (internal) service costs, for example, by using remote monitoring and predictive maintenance to smoothen the handling of technical problems, or to prevent them altogether. Third, the NOBM introduction presented COMP with the opportunity to lock clients into its service offering and to establish a long-term partnership with them. Here, not being constrained by any market-specific antitrust regulations, COMP enforces relatively long contract durations of 8 to 10 years.

> What I noticed is how much clients get accustomed to the NOBM offering; that is, to the all-round carefree package. And, when the contract has expired, how difficult it is for them to return to owning the machinery [i.e., to operate it on their own]. (Engineer Project Sales, COMP)

Adding to this, traditional clients face uncertainties regarding the return on their high investments, especially since COMP charges a price premium for its high-end compressor stations. In this regard, COMP's NOBM, where clients pay a contractually defined (output-based) fee per cubic meter of compressed air consumed (VF), helped attract new client groups that are unable, or unwilling, to pay this premium. A related client-side uncertainty concerns the energy-efficient operation of compressor stations. This is because energy costs make up a substantial portion of total operating costs (about 80%) and because client firms are typically not able to operate compressors in the most energy-efficient way. For COMP, this opened the business opportunity of tapping additional profit pools by including outcome-based bonus and malus payments related to the energy-efficient operation of compressors in its NOBM's pricing model (VF):

> Compressed air is an energy that is very expensive, but used everywhere. Around 80% of the total compressed air costs are energy costs. Therefore, the energy-efficient operation [of the compressors] is very important. [With our NOBM], we are able to contractually guarantee this to our clients. There are even contractual bonus and malus regulations for this, so if we consumed less electricity, we would receive a part of the client's energy savings. Clients are not able to realize these efficiency guarantees on their own. (Head of Project Sales, COMP)

**Mitigation of provider uncertainties:** A focal provider-side uncertainty that emerged with the market introduction of COMP's NOBM concerns the future development of a client's business, which, in the worst case (bankruptcy), may lead to the loss of all client-specific upfront investments (e.g., for machine customization and installation). To mitigate this uncertainty, COMP conducts a due diligence of potential NOBM clients, with a particular focus on their solvency (VA). Additional uncertainties for COMP's NOBM relate to the conditions inside and outside the client production facility, which play an important role for machine durability (inside conditions, such as humidity and temperature) and the number of required maintenance intervals (outside conditions, such as levels of dust or pollen). To tackle these uncertainties, COMP also performs a diligent upfront evaluation of the prevailing conditions within and around a potential client's production facility (VA):

> For example, if the client […] has a lot of cottonwood trees outside of its production facility […] then in the worst case, the filters of the machinery must be cleaned every day. [In the NOBM], all of this is included in the offering, so if we miss this aspect during or upfront evaluation, we need to send someone to the client every day. And that, of course, is not factored into the service price. Therefore, the upfront evaluation of surrounding conditions is the be-all and end-all [for our NOBM]. (Head of Project Sales, COMP)

In addition to the upfront evaluation, COMP also uses IIoT technology to continuously monitor the conditions at the client facility, as well as the status of its compressor stations installed at the facility (VA). Furthermore, COMP faces uncertainties regarding NOBM clients' actual usage levels of the provided machinery. To reduce these uncertainties, COMP combines the output-based service fee with a monthly base fee that corresponds to a contractually agreed minimum output of compressed air (VF).

Table 3 gives an overview of the (client) uncertainty-exploiting and (provider) uncertainty-mitigating NOBM design elements used by the three case companies.

## Cross-case analysis

Based on the case-specific analysis results outlined above, we now turn to the results of our cross-case analysis. We start with a brief discussion of the commonalities identified across the NOBM designs implemented by the three case companies. The focus of this section then lies on discussing key differences in NOBM designs along with context factors that help explain those differences.

The cross-case analysis results reveal several notable commonalities among the NOBM designs used by PRINT, ROB, and COMP. This suggests that NOBM providers face a basic set of client-side uncertainties (and related business opportunities) and provider-side uncertainties regardless of the specific company context. To seize the former and mitigate the latter, manufacturing firms implement a common set of NOBM design elements. For example, in all three cases, the efforts and responsibilities associated with machine operation represented a main source of uncertainties for (traditional) client firms, which in turn presented the case companies with the opportunity to market their non-ownership services, and to do so in combination with add-on services that would face high competition if marketed as standalone offerings. To realize this business opportunity, all three firms implemented IIoT solutions, which played a key role in ensuring the reliable and cost-efficient delivery of repair and maintenance services included in their NOBM offerings. Moreover, given the output-centric pricing model of their NOBMs, all three case companies faced uncertainties in relation to the extent to which client firms will utilize the provided machinery and thus introduced a monthly base fee to mitigate these provider-side uncertainties.

Besides these commonalities, our analysis results point to several notable differences across the NOBM designs of the three case companies (see also Table 3 above). More specifically, the design of PRINT's NOBM shows a relatively strong focus on uncertainty-*mitigating* elements (e.g., the inclusion of consulting and training services, as well as the addition of a one-time fee), whereas COMP's NOBM design exhibits a more pronounced focus on uncertainty-*exploiting* elements (e.g., the combination of an output-based fee with an outcome-based one) and whereas ROB's NOBM relies on a fairly balanced use

**Table 3** Uncertainty-exploiting and uncertainty-mitigating NOBM design elements across case companies

| Client uncertainty (and related *business opportunity for providers)* | NOBM design elements (dimension) | | |
|---|---|---|---|
| | PRINT | ROB | COMP |
| **Machine operation** (*offering of non-ownership services*) | Service range (VP): machinery, installation, MRO | | |
| | ...and consumables (excluding paper supply) | N/A | ...and operator obligations |
| **Machine operating costs** (*reduction in clients' MRO costs*) | Key capabilities (VA): process optimization via IIoT technologies | | |
| **Machine operating skills** (*client lock-in)* | N/A | Service level (VP): Maximum contract duration of 8 and 10 years, respectively | |
| **Return on investment** (*new client segments and/or profit pools*) | Pricing (VF): output-based fee | | |
| | N/A | N/A | ...and outcome-based fee |
| Provider uncertainty | | | |
| **Client maturity (in terms of processes and structures)** | Service range (VP): consulting and training | N/A | N/A |
| **Client staff behavior** | Service depth (VP): clients responsible for machine operation and insurance | | N/A |
| | Key capabilities (VA): monitoring of staff behavior via IIoT technologies | | |
| **(Changes in) conditions at client production facility** | Key activities (VA): evaluation of facility conditions inside | | |
| | N/A | N/A | …and outside |
| | Key capabilities (VA): monitoring of conditions via IIoT technologies | | |
| **Future development of client business** | Key activities (VA): evaluation of solvency | | |
| | ...and client BM | N/A | N/A |
| | Additional fees (VF): one-time upfront fee (cost-based) | | |
| **Level of machine utilization** | Additional fees (VF): monthly base fee (usage- and/or output-based) | | |

*Notes:* Value proposition (VP); Value architecture (VA); Value network (VN); Value finance (VF).

of *both* uncertainty-exploiting and uncertainty-mitigating design elements. Here, the results of our cross-case analysis suggest that many of the observed differences in NOBM designs can be traced back to four context factors related to *machine* attributes (human dependency and relative importance of energy efficiency) and *market* attributes (average client size and antitrust regulations), 'pushing' providers toward a focus on either uncertainty-exploiting or uncertainty-mitigating NOBM design elements. We discuss these context factors and their specific effects on NOBM designs in the following.

## Machine attributes

*Human dependency* refers to the extent to which operating a specific type of machinery requires manual work (by humans). For example, in the case of PRINT's NOBM, operating the printing machines is associated with a high number of manual tasks to be performed by human operators (e.g., feeding paper, refilling colors, starting print jobs). Similarly, in ROB's NOBM, human operators are needed as well (e.g., feeding and removing of processed parts). In contrast, in COMP's NOBM, compressor stations are operated "unmanned" (i.e., there is no need for a human operator) and often located in a separate room, resulting in a low level of human dependency. Given that client staff is responsible for operating the machinery in both PRINT's and ROB's NOBM, the two providers face uncertainties regarding staff-caused machine breakdowns, and thus regarding reduced machine utilization rates (resulting from incorrect machine operation). To mitigate these uncertainties, PRINT and ROB required their NOBM clients to take out insurance against machine damage (VP) and implemented IIoT-based solutions not only to monitor machine conditions but also to monitor client staff behavior (VA). For example, at ROB, the latter played a key role in settling disputes with clients about whether a machine stop, and thus a production stop, had been caused by a technical error (ROB's responsibility) or by a human error (client's responsibility). This suggests that the use of uncertainty-mitigating NOBM design elements increases with the level of human dependency of the offered machinery.

Another machine-related context factor pertains to the *relative importance of energy efficiency*, which refers to the share of energy costs in total operating costs. At COMP, energy costs make up a significant share (about 80%) of the total costs for operating the compressor stations, whereas at PRINT and ROB, energy costs account for only a relatively small share of total operating costs, especially when compared with the cost shares for consumables (PRINT) and operating staff (ROB/PRINT). Against this backdrop, the level of energy costs represents a focal ‘pain point’ and uncertainty for COMP’s clients, which often lack the highly specialized knowledge needed to ensure the energy-efficient operation of compressor stations. For COMP, this client-side uncertainty opened the business opportunity to tap additional profit pools by adding an energy efficiency-related (outcome-based) fee to the pricing model of its NOBM offering (VF). This implies that the relative importance of energy-efficient machine operation amplifies (cost-related) client-side uncertainties, thereby presenting providers with additional opportunities for exploiting these uncertainties through the design of their NOBM.

### Market attributes

A market attribute that seemed to have a profound impact on the design of the case companies’ NOBM is the *average size* of their client firms. For example, the clients of COMP’s and ROB’s NOBM are typically large corporations (with usually far more than 250 employees). In contrast, due to the overall market structure of the printing industry, the average client firm of PRINT’s NOBM has around 100 employees, which corresponds to a small to medium average firm size. Consequently, PRINT was confronted with additional uncertainties in its NOBM. This is because small- and medium-sized client firms are less likely to have processes and structures in place to ensure efficient operations and appropriate staff training; and because the business of smaller client firms is arguably more vulnerable to negative market developments, which, in the worst case, may lead into bankruptcy. To mitigate these uncertainties, PRINT added consulting and staff training services as mandatory components to its NOBM offering (VP); broadened the scope and increased the intensity of its client evaluation activities (VA); and introduced a one-time upfront fee (VF). Taken together, this suggests that dealing with predominantly small-sized client firms introduces additional provider-side uncertainties, forcing providers to make increased use of uncertainty-mitigating NOBM design elements.

Potentially constraining the (introduction and) design of NOBMs in an industry, *antitrust regulations* represent another relevant market-related attribute. Here, our cross-case analysis revealed that PRINT’s NOBM was subject to extensive market-specific antitrust regulations, which limited the duration of NOBM contracts to a maximum of five years; whereas neither COMP nor ROB faced such regulatory constraints, enabling the two providers to lock their NOBM clients into (more) long-term contracts with a duration of 8 to 10 years. As such, our analysis results indicate that the relative absence of antitrust regulations can play a critical role in the design of a NOBM by fostering the exploitation of client-side uncertainties and resulting business opportunities.

## Discussion

The overarching goal of this study was to shed light on distinct NOBM designs in the manufacturing industry, with a particular focus on (1) the NOBM design elements used to exploit client-side uncertainties and mitigate provider-side uncertainties, and (2) the influence of context factors on the use of corresponding design elements.

Overall, the study at hand contributes to a more nuanced understanding of NOBM designs in the specific context of the manufacturing industry. Specifically, the results of our study make three important contributions to the existing body of knowledge. First, our results offer detailed and partly novel insights into how NOBM providers aim to do both exploiting business opportunities (resulting from client-side uncertainties) and mitigating adverse provider-side uncertainties through the design of their NOBM. In particular, while earlier studies tend to look at manufacturers operating with a NOBM as one homogenous group (Adrodegari & Saccani, 2017; Storbacka et al., 2013), our study offers novel insights into the different NOBM design elements that providers implement in order to leverage client-side uncertainties to their advantage, as well as to protect themselves against emerging provider-side uncertainties. As such, our study answers existing calls for research, highlighting the need for a more detailed investigation and understanding of differences in NOBM designs (Adrodegari & Saccani, 2017). In this regard, our study also extends extant research by identifying design elements that have not yet been discussed in the literature, at least not in depth, such as the IIoT-based monitoring of client staff as a key activity in a NOBM’s value architecture, as well as the combination of output-based and outcome-based fees in its value finance (Selviaridis & Wynstra, 2015).

Second and relatedly, conceptualizing a NOBM as a use-oriented PSS, our study offers a more nuanced view of such systems by clarifying different contracting types, and especially different pricing models, used in the value finance of NOBMs. In particular, besides cost-based and usage-based pricing, we explicitly distinguish between two specific forms of PBC, namely, output-based and outcome-based pricing (Ng et al., 2009; Selviaridis & Wynstra, 2015). In doing so, we find that the (complementary) use of an outcome-based pricing model represents a particularly desirable option for NOBM providers and that the general availability of this option also depends on context factors, such as the highly energy-intensive operation of air compressors in general (machine attribute) and the resultant increased importance of energy efficiency in the case of COMP. As such, the findings of our study contribute new insights to our current understanding regarding the specific requirements of PBC. For example, while existing studies suggest that the successful application of PBC requires NOBM providers to adopt a broader perspective of their clients' service ecosystem and to integrate clients even more closely into their operations (Hou & Neely, 2017; Macdonald et al., 2016; Ng et al., 2013; Selviaridis & Wynstra, 2015; Worm et al., 2017), these studies remain largely silent on contextual requirements. In this regard, it also seems noteworthy that PBC has already been applied in numerous manufacturing contexts (beyond the NOBM context) and firms, of which the most frequently cited example is Rolls-Royce's "power-by-the-hour" model (e.g., Smith, 2013; Smith-Gillespie et al., 2018). Although this model is not a NOBM (ibid), it exhibits some commonalities with the three NOBMs analyzed in the study at hand, and in particular with COMP's use of PBC. For example, both COMP and Rolls-Royce assumed responsibility for client outcomes, which enabled them to reap efficiency benefits, as well as to enhance their competitiveness and grow their overall business. Also, to ensure efficient and reliable equipment operations, both companies relied on the use of sensors in combination with advanced data analytics (Smith, 2013). Still, there are also some important differences between COMP's NOBM and Rolls-Royce's "power-by-the-hour" model, especially with regard to key properties of the technical equipment underlying these two models. For example, while COMP's air compressors represent a general-purpose technology that is only loosely coupled with other machines or technologies (via standardized interfaces), the application scope of Rolls-Royce's aero engines is clearly defined and the engines are closely integrated into larger technical systems (i.e., aircrafts). These differences in machine/equipment attributes might also help explain why Rolls-Royce decided to keep selling its engines, and thus against the adoption of a 'full-fledged NOBM.'

Third, the study results contribute to an integrated understanding of the relationships between NOBM provider-specific context factors, on the one side, and providers' use of uncertainty-exploiting and uncertainty-mitigating NOBM design elements, on the other side. In doing so, and despite its focus on the provider perspective, our study also adds empirical insights and provides fresh impetus to the literature on effective uncertainty-sharing practices between NOBM providers and clients, thereby going beyond the mostly conceptual discussions of such practices in prior research (e.g., Ehret & Wirtz, 2017) and the often-exclusive research focus on selected practices such as client engagement (e.g., Ehret & Wirtz, 2019) and relational governance (e.g., Ndubisi et al., 2016). As well, our study extends existing research, which has primarily viewed effective uncertainty sharing as something that is under the full control of the NOBM provider (and its clients), thereby largely neglecting the role of context factors in 'pushing' provider firms toward a focus on uncertainty-mitigating NOBM design elements, or in presenting them with unique opportunities for exploiting client-side uncertainties through the design of their NOBM. More specifically, our study findings suggest that context factors related to machine and market attributes can amplify client-side uncertainties (e.g., high importance of energy-efficient machine operation), lead to additional provider-side uncertainties (e.g., high human dependency of machine operation and small average client size), and enable the use of uncertainty-exploiting design elements (e.g., relaxed antitrust regulations). As such, our study adds novel insights to existing literature, which points to a number of potentially relevant context factors but has remained largely silent on how these factors influence the design of a NOBM. One notable exception is the study by Jovanovic et al. (2016), which suggests that the successful introduction of a NOBM necessitates a high level of machine automation (i.e., a low level of human dependency), which is in keeping with the results of our study. Moreover, taken together, our study results also provide managers with actionable insights on how to effectively design a NOBM in light of their company's unique context.

Lastly, as with any research, our study is not without limitations, which present promising opportunities for future studies. First, in our multiple-case study, we primarily adopted the NOBM provider's perspective, as opposed to the client's perspective. Future research considering both perspectives is needed to further our understanding regarding the sharing of uncertainty exposure between the client and provider (Ndubisi et al., 2016), as well as client-specific requirements with regard to the co-production of value (e.g., Lovelock & Gummesson, 2004; Ng et al., 2012, 2013; Worm et al., 2017). Second and relatedly, our study was limited to large manufacturing firms that operate with premium brands and are market leaders in their respective industry sectors. In this regard, a promising path for future research would be to examine the extent to which our results translate to small- and medium-sized enterprises (SMEs) that have less market power and no premium brand. Third, our study examined the NOBM of the three case firms as a standalone entity, and thus neglected its interplay with the firms' coexisting 'traditional' BM. Building on our findings, future studies could explore the synergies, or complementarities, and tensions resulting from this duality (Amit & Zott, 2001; Wiener et al., 2018). Fourth, our study adopted a rather static perspective on NOBM designs, thereby largely disregarding the sequence of design choices and the design changes that the case firms implemented in response to emerging business challenges and/or opportunities. For example, at ROB, managers pointed to the reuse of robot stations in subsequent non-ownership contracts (with other clients) as one future business opportunity emerging from its NOBM (cf.

Smith-Gillespie et al., 2018). Thus, one promising avenue for future research lies in conducting longitudinal studies that explore how, and why, provider firms adjust the design of their NOBMs over time (Sjödin et al., 2020).

## Conclusion

As part of the ongoing digital transformation of the manufacturing industry, companies have increasingly started to adopt NOBMs. Focusing on this important trend, our study contributes to the literature on IIoT-enabled BMs by advancing our understanding of different NOBM designs. Most notably, the study results point to some noticeable differences in NOBM designs in terms of their reliance on uncertainty-exploiting and uncertainty-mitigating design elements and offer novel insights regarding the role of context factors in shaping NOBM designs. Specifically, while existing studies often build on the (implicit) assumption that manufacturing firms can freely decide on the design of their NOBM, our study identifies a set of machine and market attributes that either 'force' NOBM providers to focus on the use of uncertainty-mitigating design elements or allow them to focus on the use of uncertainty-exploiting elements. In conclusion, we hope that our study will inspire additional research on NOBM designs in a variety of contexts and that our results will help manufacturing firms in tapping the full potential of their NOBM.

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## References

Adrodegari, F., Alghisi, A., Ardolino, M., & Saccani, N. (2015). From ownership to service-oriented business models: A survey in capital goods companies and a PSS typology. *Procedia CIRP, 30*, 245–250. https://doi.org/10.1016/j.procir.2015.02.105

Adrodegari, F., & Saccani, N. (2017). Business models for the service transformation of industrial firms. *The Service Industries Journal, 37*(1), 57–83. https://doi.org/10.1080/02642069.2017.1289514

Adrodegari, F., Saccani, N., Kowalkowski, C., & Vilo, J. (2017). PSS business model conceptualization and application. *Production Planning & Control, 28*(15), 1251–1263. https://doi.org/10.1080/09537287.2017.1363924

Al-Debei, M. M., & Avison, D. (2010). Developing a unified framework of the business model concept. *European Journal of Information Systems, 19*(3), 359–376. https://doi.org/10.1057/ejis.2010.21

Alt, R., & Zimmermann, H.-D. (2014). Electronic markets and business models. *Electronic Markets, 24*(4), 231–234. https://doi.org/10.1007/s12525-014-0178-2

Amit, R., & Zott, C. (2001). Value creation in e-business. *Strategic Management Journal, 22*(6/7), 493–520. https://doi.org/10.1002/smj.187

Amit, R., & Zott, C. (2015). Crafting business architecture: The antecedents of business model design. *Strategic Entrepreneurship Journal, 9*(4), 331–350. https://doi.org/10.1002/sej.1200

Barquet, A. P. B., Oliveira, M. G., Amigo, C. R., Cunha, V. P., & Rozenfeld, H. (2013). Employing the business model concept to support the adoption of product-service systems (PSS). *Industrial Marketing Management, 42*(5), 693–704. https://doi.org/10.1016/j.indmarman.2013.05.003

Berkovich, M., Leimeister, J. M., & Krcmar, H. (2011). Requirements engineering for product service systems: A state of the art analysis. *Business & Information Systems Engineering, 3*, 369–380. https://doi.org/10.1007/s12599-011-0192-2

Bikfalvi, A., Lay, G., Maloca, S., & Waser, B. R. (2013). Servitization and networking: Large-scale survey findings on product-related services. *Service Business, 7*(1), 61–82. https://doi.org/10.1007/s11628-012-0145-y

Bock, M., Wiener, M., Gronau, R., Martin, A. (2019). Industry 4.0 enabling smart air: Digital transformation at KAESER COMPRESSORS. In N. Urbach, & M .Röglinger (Eds.), *Digitalization Cases. Management for Professionals*. Cham: Springer.

Böhm, M., & Thomas, O. (2013). Looking beyond the rim of one's teacup: A multidisciplinary literature review of product-service systems in information systems, business management, and engineering & design. *Journal of Cleaner Production, 51*, 245–260. https://doi.org/10.1016/j.jclepro.2013.01.019

Brax, S. A., & Visintin, F. (2016). Meta-model of servitization: The integrative profiling approach. *Industrial Marketing Management, 60*, 17–32. https://doi.org/10.1016/j.indmarman.2016.04.014

Buchenau, M.-W., Çayir, F., & Renner, M. (2019). *Eisenmann meldet Insolvenz an – 3000 Mitarbeiter betroffen.* https://www.handelsblatt.com/unternehmen/industrie/anlagenbauer-eisenmann-meldet-insolvenz-an-3000-mitarbeiter-betroffen/24850942.html

Chesbrough, H., & Rosenbloom, R. S. (2002). The role of the business model in capturing value from innovation: Evidence from Xerox Corporation's technology spin-off companies. *Industrial and Corporate Change, 11*(3), 529–555. https://doi.org/10.1093/icc/11.3.529

Ehret, M., & Wirtz, J. (2010). Division of labor between firms: Business services, non-ownership-value and the rise of the service economy. *Service Science, 2*(3), 136–145. https://doi.org/10.1287/serv.2.3.136

Ehret, M., & Wirtz, J. (2017). Unlocking value from machines: Business models and the Industrial Internet of Things. *Journal of Marketing Management, 33*(1–2), 111–130. https://doi.org/10.1080/0267257X.2016.1248041

Ehret, M., & Wirtz, J. (2019). Sharing uncertainty across organizations: Service capital and customer engagement for realizing nonownership value. In L. Hollebeek & D. Sprott (Eds.), *Handbook of research on customer engagement* (pp. 423–440). Edward Elgar Publishers.

Eisenhardt, K. M. (1989). Building theories from case study research. *Academy of Management Review, 14*(4), 532–550. https://doi.org/10.5465/amr.1989.4308385

Eisenhardt, K. M., & Graebner, M. E. (2007). Theory building from cases: Opportunities and challenges. *Academy of Management Journal, 50*(1), 25–32. https://doi.org/10.5465/amj.2007.24160888

Gebauer, H. (2008). Identifying service strategies in product manufacturing companies by exploring environment-strategy configurations. *Industrial Marketing Management, 37*(3), 278–291. https://doi.org/10.1016/j.indmarman.2007.05.018

Gebauer, H., Fleisch, E., & Friedli, T. (2005). Overcoming the service paradox in manufacturing companies. *European Management Journal, 23*(1), 14–26. https://doi.org/10.1016/j.emj.2004.12.006

Gebauer, H., Haldimann, M., & Saul, C. J. (2017). Competing in business-to-business sectors through pay-per-use services. *Journal of Service Management, 28*(5), 914–935. https://doi.org/10.1108/JOSM-07-2016-0202

Grieger, M., & Ludwig, A. (2019). On the move towards customer-centric business models in the automotive industry – A conceptual reference framework of shared automotive service systems. *Electronic Markets, 29*(3), 473–500. https://doi.org/10.1007/s12525-018-0321-6

Grubic, T. (2014). Servitization and remote monitoring technology: A literature review and research agenda. *Journal of Manufacturing Technology Management, 25*(1), 100–124. https://doi.org/10.1108/JMTM-05-2012-0056

Grubic, T., & Jennions, I. (2018). Do outcome-based contracts exist? The investigation of power-by-the-hour and similar result-oriented cases. *International Journal of Production Economics, 206*, 209–219. https://doi.org/10.1016/j.ijpe.2018.10.004

Hou, J., & Neely, A. (2017). Investigating risks of outcome-based service contracts from a provider's perspective. *International Journal of Production Research, 56*(6), 2103–2115. https://doi.org/10.1080/00207543.2017.1319089

Hypko, P., Tilebein, M., & Gleich, R. (2010a). Benefits and uncertainties of performance-based contracting in manufacturing industries. *Journal of Service Management, 21*(4), 460–489. https://doi.org/10.1108/09564231011066114

Hypko, P., Tilebein, M., & Gleich, R. (2010b). Clarifying the concept of performance-based contracting in manufacturing industries: A research synthesis. *Journal of Service Management, 21*(5), 625–655. https://doi.org/10.1108/09564231011079075

Jovanovic, M., Engwall, M., & Jerbrant, A. (2016). Matching service offerings and product operations: A key to servitization success. *Research-Technology Management, 59*(3), 29–36. https://doi.org/10.1080/08956308.2016.1161403

Loock, M., & Hacklin, F. (2015). Business modeling as configuring heuristics. In C. Baden-Fuller & V. Mangematin (Eds.), *Advances in strategic management: Business models and modelling* (pp. 187–205). Emerald.

Lovelock, C., & Gummesson, E. (2004). Whither services marketing? In search of a new paradigm and fresh perspectives. *Journal of Service Research, 7*(1), 20–41. https://doi.org/10.1177/1094670504266131

Martin, P. C. G., Schroeder, A., & Bigdeli, A. Z. (2019). The value architecture of servitization: Expanding the research scope. *Journal of Business Research, 104*, 438–449. https://doi.org/10.1016/j.jbusres.2019.04.010

Macdonald, E. K., Kleinaltenkamp, M., & Wilson, H. N. (2016). How business customers judge solutions: Solution quality and value in use. *Journal of Marketing, 80*(3), 96–120. https://doi.org/10.1509/jm.15.0109

Ndubisi, N. O., Ehret, M., & Wirtz, J. (2016). Relational governance mechanisms and uncertainties in nonownership services. *Psychology & Marketing, 33*(4), 250–266. https://doi.org/10.1002/mar.20873

Neely, A. (2008). Exploring the financial consequences of the servitization of manufacturing. *Operations Management Research, 2*(1), 103–118. https://doi.org/10.1007/s12063-009-0015-5

Ng, I., Ding, D. X., & Yip, N. (2013). Outcome-based contracts as new business model: The role of partnership and value-driven relational assets. *Industrial Marketing Management, 42*(5), 730–743. https://doi.org/10.1016/j.indmarman.2013.05.009

Ng, I., Maull, R., & Yip, N. (2009). Outcome-based contracts as a driver for systems thinking and service-dominant logic in service science: Evidence from the defence industry. *European Management Journal, 27*(6), 377–387. https://doi.org/10.1016/j.emj.2009.05.002

Ng, I., Parry, G., Smith, L., Maull, R., & Briscoe, G. (2012). Transitioning from a goods-dominant to a service-dominant logic: Visualising the value proposition of Rolls-Royce. *Journal of Service Management, 23*(3), 416–439. https://doi.org/10.1108/09564231211248480

Normann, R., & Ramirez, R. (1989). A theory of the offering: Toward a neo-industrial business strategy. In C. C. Snow (Ed.), *Strategy, organization design and human resource management* (pp. 111–130). JAI Press.

Oliveira, M., Mendes, G., Albuquerque, A., & Rozenfeld, H. (2018). Lessons learned from a successful industrial product service system business model: Emphasis on financial aspects. *Journal of Business & Industrial Marketing, 33*(3), 365–376. https://doi.org/10.1108/JBIM-07-2016-0147

Orellano, M., Neubert, G., Gzara, L., & Le-Dain, M. A. (2017). Business model configuration for PSS: An explorative study. *Procedia CIRP, 64*, 97–102. https://doi.org/10.1016/j.procir.2017.03.008

Osterwalder, A., & Pigneur, Y. (2010). *Business model generation: A handbook for visionaries, game changers, and challengers*. John Wiley.

Saldaña, J. (2015). *The coding manual for qualitative researchers* (3rd ed.). SAGE.

Schüritz, R., Seebacher, S., & Dorner, R. (2017). Capturing value from data: Revenue models for data-driven services. *Proceedings of the 50th Hawaii International Conference on System Sciences (HICSS)*, Hawaii.

Selviaridis, K., & Wynstra, F. (2015). Performance-based contracting: A literature review and future research directions. *International Journal of Production Research, 53*(12), 3505–3540. https://doi.org/10.1080/00207543.2014.978031

Sjödin, D., Parida, V., Jovanovic, M., & Visnjic, I. (2020). Value creation and value capture alignment in business model innovation: A process view on outcome-based business models. *Journal of Product Innovation Management, 37*(2), 158–183. https://doi.org/10.1111/jpim.12516

Sjödin, D., Parida, V., & Kohtamäki, M. (2019). Relational governance strategies for advanced service provision: Multiple paths to superior financial performance in servitization. *Journal of Business Research, 101*, 906–915. https://doi.org/10.1016/j.jbusres.2019.02.042

Smith, D. J. (2013). Power-by-the-hour: The role of technology in reshaping business strategy at Rolls-Royce. *Technology Analysis & Strategic Management, 25*(8), 987–1007. https://doi.org/10.1080/09537325.2013.823147

Smith-Gillespie, A., Muñoz, A., Morwood, D., & Aries, T. (2018). *Rolls Royce: A circular economy business model case.* http://hdl.handle.net/10347/20428

Storbacka, K., Windahl, C., Nenonen, S., & Salonen, A. (2013). Solution business models: Transformation along four continua. *Industrial Marketing Management, 42*(5), 705–716. https://doi.org/10.1016/j.indmarman.2013.05.008

Timmers, P. (1998). Business models for electronic markets. *Electronic Markets, 8*(2), 3–8. http://www.electronicmarkets.org/archive/issues/volume-8/volume-8-issue-2/

Turetken, O., Grefen, P., Gilsing, R., & Adali, O. E. (2019). Service-dominant business model design for digital innovation in smart mobility. *Business & Information Systems Engineering, 61*(1), 9–29. https://doi.org/10.1007/s12599-018-0565-x

Turunen, T., & Finne, M. (2014). The organizational environment's impact on the servitization of manufacturers. *European Management Journal, 32*(4), 603–615. https://doi.org/10.1016/j.emj.2013.11.002

Vandermerwe, S., & Rada, J. (1988). Servitization of business: Adding value by adding services. *European Management Journal, 6*(4), 314–324. https://doi.org/10.1016/0263-2373(88)90033-3

Vargo, S. L., & Lusch, R. F. (2004). Evolving to a new dominant logic for marketing. *Journal of Marketing, 68*(1), 1–17. https://doi.org/10.1509/jmkg.68.1.1.24036

Veit, D., Clemons, E., Benlian, A., Buxmann, P., Hess, T., Spann, M., Kundisch, D., & Leimeister, J. M. (2014). Business models: An information systems research agenda. *Business & Information Systems Engineering, 6*(1), 45–53. https://doi.org/10.1007/s12599-013-0308-y

Visnjic, I., Jovanovic, M., Neely, A., & Engwall, M. (2016). What brings the value to outcome-based contract providers? Value drivers in outcome business models. *International Journal of Production Economics, 192*, 169–181. https://doi.org/10.1016/j.ijpe.2016.12.008

Visnjic, I., Neely, A., & Jovanovic, M. (2018). The path to outcome delivery: Interplay of service market strategy and open business models. *Technovation, 72–73*, 46–59. https://doi.org/10.1016/j.technovation.2018.02.003

Waldner, F., Poetz, M. K., Grimpe, C., & Eurich, M. (2015). Antecedents and consequences of business model innovation: The role of industry structure. In C. Baden-Fuller & V. Mangematin (Eds.), *Advances in strategic management: Business models and modelling* (pp. 347–386). Emerald Group.

Wei, Z., Song, X., & Wang, D. (2017). Manufacturing flexibility, business model design, and firm performance. *International Journal of Production Economics, 193*, 87–97. https://doi.org/10.1016/j.ijpe.2017.07.004

Weking, J., Stöcker, M., Kowalkiewicz, M., Böhm, M., & Krcmar, H. (2020). Leveraging industry 4.0 – A business model pattern framework. *International Journal of Production Economics, 225*, 107588. https://doi.org/10.1016/j.ijpe.2019.107588

Wiener, M., Hoßbach, N., & Saunders, C. (2018). Omnichannel businesses in the publishing and retailing industries: Synergies and tensions between coexisting online and offline business models. *Decision Support Systems, 109*, 15–26. https://doi.org/10.1016/j.dss.2018.01.008

Wirtz, B. W., Pistoia, A., Ullrich, S., & Göttel, V. (2016). Business models: Origin, development and future research perspectives. *Long Range Planning, 49*(1), 36–54. https://doi.org/10.1016/j.lrp.2015.04.001

Wirtz, J., Tuzovic, S., & Ehret, M. (2015). Global business services: Increasing specialization and integration of the world economy as drivers of economic growth. *Journal of Service Management, 26*(4), 565–587. https://doi.org/10.1108/JOSM-01-2015-0024

Wittkowski, K., Moeller, S., & Wirtz, J. (2013). Firms' intentions to use nonownership services. *Journal of Service Research, 16*(2), 171–185. https://doi.org/10.1177/1094670512471997

Worm, S., Bharadwaj, S. G., Ulaga, W., & Reinartz, W. J. (2017). When and why do customer solutions pay off in business markets? *Journal of the Academy of Marketing Science, 45*(4), 490–512. https://doi.org/10.1007/s11747-017-0529-6

Woodward, J. (1980). *Industrial organization: Theory and practice* (2nd ed.). Oxford University Press.

Yin, R. K. (2018). *Case study research and applications: Design and methods* (6th ed.). SAGE.

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