

AN EXPLORATION OF DIGITAL SERVITIZATION BUSINESS MODELS IN MANUFACTURING SMEs

Abstract

Digital servitization, the integration of digital technologies into service-based business models, has gained significant traction in the industrial manufacturing sector. However, there is a limited understanding of the conditions under which Small and Medium-sized Enterprises (SMEs) develop specific digital servitization business models, owing, partly, to the lack of an appropriate business model typology. In this study, we develop a generalizable and operationalizable classification of digital servitization business models and identify the environmental and organizational factors that drive such business model innovation. We apply a multinomial logistic regression framework to analyze a dataset of 326 responses from UK manufacturing SMEs, providing insight into how the seven studied factors differentiate among SMEs following different digital servitization business models and more ‘traditional’ ones (pure product or ‘just’ servitized). The study contributes to the scarce empirical research on digital servitization in SMEs and provides implications for policy and practice.

KEYWORDS: Digital servitization, Digitalization, SMEs, Business model typology, Business Model Innovation (BMI)

INTRODUCTION

Since the emergence of the servitization concept in the late 1980s (Vandermerwe & Rada, 1988), the corresponding research stream has significantly gained traction (Baines et al., 2009; Kowalkowski et al., 2017; Rabetino et al., 2018). Recently, the integration of digital technologies such as the Internet of Things (IoT), Artificial Intelligence (AI), predictive analytics, and “smart” manufacturing, has enabled firms to develop sophisticated, “connected” products (Aliasghar et al., 2023; Kohtamäki et al., 2019; Porter & Heppelmann, 2014). In effect, these digital technologies foster servitization through digitalization (Coreynen et al., 2017). This emergent trend is increasingly being referred to as *digital servitization*. The growing research into this phenomenon has

primarily focused on the *process* of digital servitization, identifying internal and external enablers and barriers, and the capabilities required for successful transformation (see: Coreynen et al., 2017; Favoretto et al., 2022; Gebauer et al., 2021). There is a prevalent assumption that digital servitization amalgamates two interdependent yet inherently disruptive processes—servitization and digitalization (Chen et al., 2021). *As such, it may entail a fundamental shift in the firm’s entire business model* (Albats et al., 2023). *This is often assumed in relevant definitions of digital servitization, such as that of Sjödin et al. (2020), who define it as the “transformation in processes, capabilities, and offerings within industrial firms to progressively create, deliver, and capture increased service value, arising from a broad range of enabling digital technologies” (p. 479).*

Despite the increasing research interest, *from a theoretical standpoint*, it remains unclear which organizational and environmental contingencies are conducive to higher levels of digital servitization *and to what extent they drive the development of different digital servitization business models* (Coreynen et al., 2020; Favoretto et al., 2022; Kohtamäki et al., 2022). Additionally, the literature is far from conclusive about which service-based business models, and by extension, digital servitization business models, are more suitable under different conditions (Raddats et al., 2019). This lack of clarity may stem from the absence of an accepted, clear, and operationalizable typology of digital servitization business models. Furthermore, *from a methodological standpoint*, owing to the nascent stage of this line of research, there is a dearth of large-scale quantitative studies (Calabrese et al., 2019; Rabetino et al., 2021), *a shortcoming that impedes a holistic understanding of the phenomenon*. Finally, there is *scholarly* consensus that most insights generated to date are primarily relevant to large organizations (Rabetino et al., 2021), with their applicability to Small and Medium-sized Enterprises (SMEs) remaining ambiguous. Despite a few notable exceptions (Coreynen et al., 2017; Kolagar et al., 2022; Lamperti et al., 2024), this oversight is concerning, particularly given that SMEs vastly outnumber large enterprises in almost all economies, accounting for 99 percent of manufacturing firms and 58 percent of employment in the United Kingdom (Make UK, 2021), *for instance*.

The literature suggests that the resource-constrained environments in which SMEs tend to operate have a bearing on **business model development** (Eggers, 2020). Resource scarcity reflects a key limitation of small firms and is commonly referred to as a ‘liability of smallness’ (Aldrich & Auster, 1986). Scarcity is restrictive for business development, since it impedes investments toward innovative activities and venture growth (Choi et al., 2022). Liabilities of smallness may also constrain the development of new capabilities necessary for the realization of value-adding service activities, including the creation of distinct service organizations (Oliva et al., 2012) and the corresponding development of service-based business models (Albats et al., 2023).

The processes and impact of digitalization and servitization are subject to considerable variation in SMEs (see Kowalkowski et al., 2013). For example, the pace of digitalization adoption is rather inconsistent (Li et al., 2018), suggesting that it **requires a combination of complementary resources and capabilities** (Eller et al., 2020; Nguyen et al., 2015). Regarding servitization, Böhm et al. (2017) found that size is an organizational precursor of service orientation, and that smaller firms should not take service success for granted. Nonetheless, servitization offers SMEs the potential to counteract the influence of environmental pressures that are, in theory, amplified due to their small(er) size (Ambroise et al., 2018).

Given the lack of a comprehensive, widely accepted, and operationalizable typology of digital servitization business models, and against the backdrop of a limited focus on manufacturing SMEs, the aim of this work is to understand how certain environmental and organizational contingencies differentiate among SMEs following different digital servitization business models. **To this end, we advance a business model typology that is based on the role of digital technologies in creating, delivering, and capturing value from, product-service offerings, and** address the following research question: *What environmental and organizational factors drive the development of different digital servitization business models by SMEs?*

We approach digital servitization from a *business model innovation* (BMI) perspective (Frank et al., 2019; Lamperti et al., 2024; Shen et al., 2023) and advance a generalizable and operationalizable

digital servitization business model typology. We then theoretically motivate the relevance of seven salient contextual factors (two environmental and five organizational) that might have a role to play in the development of different business model types by manufacturing SMEs. To answer the research question, we apply a discrete choice modeling technique (multinomial logistic regression) using a dataset of 326 SME responses.

This work makes the following contributions. First, it advances a typology of digital servitization business models and tests it in a quantitative study of UK manufacturing SMEs. It thus deepens our understanding of how specific organizational and environmental factors might influence the development of different business models, contributing to the emerging literature on digital servitization in SMEs. Second, it highlights nuanced distinctions in digital servitization adoption between micro businesses on the one hand, and small- and medium-sized enterprises on the other. This study's implications also inform managers in manufacturing SMEs when evaluating the feasibility of digital servitization, while policymakers may be able to leverage these findings to develop inclusive policies aimed at empowering micro businesses and bridging the 'digital divide' experienced within UK manufacturing.

The remainder of the paper is structured as follows. The theoretical background introduces a Business Model Innovation perspective and motivates the relevance of seven environmental and organizational antecedents. This is followed by the methodology section, which details the construction and operationalization of the digital servitization business model typology, detailing the data collection and analysis process. Afterward, the results of the multinomial logistic regression models are presented. Finally, the findings are discussed, and theoretical and practical implications are derived.

THEORETICAL BACKGROUND

Background to Servitization

Since the introduction of the term ‘servitization’ (Vandermerwe & Rada, 1988), the academic discourse surrounding the concept has expanded significantly, incorporating diverse perspectives over the last three decades (for comprehensive overviews, see Khanra et al., 2021; Kowalkowski et al., 2017; Rabetino et al., 2018; Raddats et al., 2019; Zhang & Banerji, 2017). Closely related to servitization, and occasionally used interchangeably, is the concept of product-service systems (PSS) (Tukker, 2004), typically used within engineering management. Both concepts emphasize the strategic bundling of goods and services to enhance customer value (Baines et al., 2007, 2009; Vandermerwe & Rada, 1988). The underlying motivations for servitization are typically framed within competitive, economic, and demand-based imperatives (Cusumano et al., 2015; Oliva & Kallenberg, 2003; Raddats et al., 2016). However, despite its potential, servitization entails substantial investment, with financial returns often remaining ambiguous or unrealized (Benedettini et al., 2017; Neely, 2008). This phenomenon, described as the ‘service paradox,’ highlights the challenge of manufacturers to make services profitable (Gebauer et al., 2005).

Building on the foundations of servitization and its emphasis on integrating goods and services, the advent of digital technologies has led to the emergence of digital servitization, which enables the delivery of remote, cost-effective digital services and further expands the potential for manufacturers to redefine value creation and delivery (Gebauer et al., 2021; Kohtamäki et al., 2019; Kowalkowski et al., 2022; Paschou et al., 2020). The nascent research on the phenomenon of digital servitization is growing rapidly, with several academic papers and journal special issues attempting to map and order the evolving domain (e.g., Gebauer et al., 2021; Shen et al., 2023). Among the theoretical perspectives applied to digital servitization research, Business Model Innovation stands out, since it highlights the transformative role of digital technologies in redefining manufacturers’ business models (e.g., Paiola & Gebauer, 2020).

Business Model Innovation

Business Model Innovation (henceforth BMI) is a holistic concept that reflects changes in the firm's activity systems of value *creation, capture* and *delivery* (Foss & Saebi, 2017). BMI posits that change may be driven by modifications in any activity, resulting in systemic adaptation across all systems (Clauss, 2017). This is particularly important in SMEs, since the convergent processes of digitalization and servitization may entail a redefinition of the firm's entire business model (Chen et al., 2021; Gebauer et al., 2020). The outcome of this transition allows firms to revise the offering of an existing product or service, attract new customers, or expand the value provision to existing ones (Markides, 2006). As such, BMI expresses the firm's interpretation of customer needs, and how these could be better satisfied (Randhawa et al., 2021). The importance of BMI for SMEs is depicted in research that examines its relevance in enabling strategic agility (Clauss et al., 2021) and strategic goal implementation (Heikkilä et al., 2018), with recent findings connecting BMI to firm-level outcomes such as scaling (e.g., Cavallo et al., 2019; Mihailova, 2023; Palmié et al., 2023). Moreover, BMI represents a redirection from product offerings to offerings with an increased service focus (Cheng & Wang, 2022; Kindström & Kowalkowski, 2015). In turn, the transition of SMEs to digital servitization can also be approached from a BMI perspective (Kolagar et al., 2022; Lamperti et al., 2024; Shen et al., 2023), while the provision of "smart" products and services might help these firms to overcome the disruptive forces of the environment (Cavallo et al., 2023).

A 'suitable' business model is central to attaining desired firm-level outcomes (N. J. Foss & Saebi, 2017), particularly in SMEs (Candi & Kitagawa, 2022). It is commonly assumed that a business model creates value through an *efficiency* or a *novelty* focus, giving rise to two anchoring business model archetypes (Amit & Zott, 2001). Efficiency-focused business models reflect mechanisms employed by firms that promote transaction efficiencies (Zott & Amit, 2013) and decrease costs for all interested stakeholders (Pati et al., 2018). Conversely, business models that emphasize novelty, introduce new means of economic exchange by exercising new connections with stakeholders and novel combinations of products, information, and services (Chen et al.,

2022; Zott & Amit, 2007). Both design choices can coexist in any business model (Zott et al., 2011), as highlighted in the literature studying the firm's transition to digital servitization (Chen et al., 2021). BMI in digital servitization has emerged as a rich thematic research area (Shen et al., 2023), with previous research investigating how digital technologies are driving BMI (e.g., Sjödin et al., 2021), business model change (e.g., Friedrich et al., 2022) and the resulting benefits from this shift (e.g., Moeuf et al., 2018; Tian et al., 2022). However, the conditions under which, SMEs develop certain types of business models as opposed to others, remain under-studied.

Based on the above points, we adopt a BMI lens to study digital servitization in SMEs. A review of relevant business model descriptions and classifications follows.

Digital Servitization Business Models

Drawing from the product-service continuum, a long research tradition at the intersection of marketing and operations management has offered several typologies of *services* (for example, Mathieu, 2001) and *product-service system* offerings (see, for example, Tukker, 2004) of manufacturing firms. When it comes to service-oriented *business models* of manufacturers, an accepted, empirically derived typology is the one by Gebauer et al. (2010), who classified manufacturers into *after-sales service providers*, *customer support service providers*, *customer service providers*, *development partners*, and *outsourcing partners*. In another attempt, and after synthesizing prior theoretical and empirical knowledge, Huikkola & Kohtamäki (2018) defined four types of business models: *product*, *service agreement*, *process-oriented* and *performance-oriented*.

Although useful, these existing typologies (along with a plethora of others not outlined here) do not explicitly account for the increased technological sophistication of products that has culminated in digital servitization. Tangentially, as Favoretto et al. (2022) point out, "*information and technology are not critical, differentiating elements in these typologies*" (p. 116), a feature that poses limitations when considering value propositions that assume 'dematerialized' physical goods and a central role for information. However, despite the lack of a widely accepted *digital servitization* business model

typology, there exist two notable attempts in the right direction, describing “*the architecture of the value creation, delivery, and capture mechanisms*” (Teece, 2010, p. 172) of digitally servitized manufacturers.

The first typology was offered by Kohtamäki et al. (2022), who defined five business models: *product, industrializer, integrated solution provider, outcome provider, and platform orchestrator*. They derived their classification after reviewing four (grand) theories of the firm and other attempts to categorize (digital) servitization business models. The second typology was presented by Gebauer et al. (2020), who, as part of their empirically derived framework of digital servitization business model dynamics, defined four ‘logics’: *hardware-plus, outcome-based, software and platform*.

Nonetheless, the criticism of Favoretto et al. (2022) also applies to these typologies, as they are not centered *explicitly* on the role of digital technologies in creating, delivering, and capturing value. Another feature that hinders the holistic understanding of the phenomenon is that no typology has been tested and validated empirically in a large-N study, and it is hard to ascertain how one could operationalize them to make this endeavor feasible, *by clearly and concisely distinguishing among the different types*. Finally, both seem to assume a gradual advancement along the product-service continuum, even though the transition into different digital servitization business models can be nonlinear (Coreynen et al., 2017). A typology should allow for companies to become digitally servitized starting from different ‘vantage points’, an argument advanced by Chen et al. (2021) based on an in-depth case study of a digitally servitized firm. Intuitively, it is possible for firms providing customized *solutions to transition into ‘smart’ services*, effectively becoming digitalized solution providers, but it is also possible for non-servitized firms to digitalize their products and use the technology (like sensors, actuators, antennae) to offer digital services, without ever having offered ‘traditional’ *services (e.g., repair and maintenance)*. Relevantly, the study of ‘platforms’, a business model that has garnered increased interest *from* digital servitization scholars (Cenamor et al., 2017), has shown that in certain industries, it might be possible for a firm

to become a platform provider without necessarily ever offering other services (like maintenance and repair) prior to this (Beverungen et al., 2021).

Notwithstanding their constraints, both typologies influence the one we advance in this paper. However, the main influence is an attempt with a somewhat different and more limited focus (namely, on the Internet-of-Things), which, we show, can be readily extended and reliably operationalized. It was originally developed by Suppatvech et al. (2019) and stands out in the sense that the authors explicitly delineate the role of technology in enabling value creation and delivery. After an extensive systematic literature review, the authors inductively derived four ‘archetypes’ of *IoT-enabled* business models (and several sub-types); they labeled them *add-on*, *sharing*, *usage-based* and *solution-oriented*. Relevantly, and as the authors’ real-world examples testify, this typology is not based on the assumption of a linear progression along the product-service continuum. Although the typology proposed by Suppatvech et al. (2019) focuses solely on one technology (specifically, IoT) and has not been empirically tested to date, the clarity with which the role of digital technology is elucidated forms the foundation of our extended, fully operationalized typology. The main extension, inspired by the studies of Kohtamäki et al. (2019; 2022) and Gebauer et al. (2020), and due to the ubiquity of platforms in the digital servitization academic discourse and in the business world (also validated through our discussions with practitioners – see the Methodology section), was to introduce *platform* as an additional digital servitization business model type. The three typologies are compared to the one developed in this paper in Table 1.

[Insert Table 1 here]

Environmental and Organizational Determinants of Digital Servitization

The strategy literature advocates that firms need to adapt their strategy to the environment they face (Teece et al., 1997); customer demands and needs, technological shifts, and market dynamics, can influence the choice of a business model, while the ability of the firm to adapt and modify its business model in response to environmental changes is crucial for success (Teece, 2015; 2018). Tangentially, servitization scholars have also shown that the choice of a firm’s service strategy is

dependent upon the environment in which it operates (see Ambroise et al., 2018; Visnjic et al., 2019). For example, Visnjic et al. (2019) found that environmental uncertainty, reflected by several industry-level factors, determines whether a manufacturer will develop and offer product-oriented or customer-oriented services, while Morgan et al. (2019) found that market conditions and customer demand need to be considered when building a digital servitization strategy. Given that manufacturing SMEs are likely to be weak vis-à-vis their customers and competitors, in this work, we consider two salient factors that capture these sources of environmental uncertainty: *competitive intensity* and *demand unpredictability*.

Moreover, according to contingency theory (Burns & Stalker, 1961; Lawrence & Lorsch, 1967), a firm's choices are contingent upon the fit between its external environment on the one hand, and its organizational structure and capabilities on the other (Coreynen et al., 2020; see also Miller, 1981). The argument is that there is no universally optimal strategy or business model; the *right* business model is the one that best *aligns* with both environmental and organizational contingencies. As such, in what follows, we also theoretically motivate the relevance of five organizational factors that might play a role in whether an SME develops a digital servitization business model: *size*, *age*, *product complexity*, *digital maturity*, and *entrepreneurial orientation*.

Competitive intensity

Competitive intensity refers to the level of competition a manufacturing SME faces from its immediate competitors (Bodlaj & Čater, 2019), and, according to contingency theory, it is a key driver of strategic decisions (see Hall, 1980). Businesses need to continuously assess their competitive landscape and adjust their business models accordingly in response to changes in competition, to capture value and avoid growth traps (Berends et al., 2016; Saebi et al., 2017). The literature on the antecedents of servitization specifically, has emphasized that the increasing competitive intensity faced by manufacturers erodes product profit margins, and drives them to transition into services to maintain profitability (Gebauer, 2008; Kohtamäki et al., 2020; Morgan et al., 2019). This is because after-sales services such as repair, spare parts, and maintenance, offer

higher margins compared to product sales (Cohen et al., 2006), and constitute standard options for manufacturers seeking cost-leadership and operational efficiency (Gebauer, 2008). This is even though many manufacturers encounter the ‘service paradox’ (Gebauer et al., 2005) and need to amass a certain level of service activity beyond which services become profitable (Visnjic-Kastalli & Van Looy, 2013). On the other hand, where the market growth potential is high (so, cost-based competitive intensity is likely low), manufacturers might seek differentiation through customer-oriented services (Gebauer, 2008; Raddats et al., 2016; Visnjic et al., 2016). SMEs, specifically, are more likely to benefit from a move towards advanced service-based business models in contexts with low competitive intensity (Ambroise et al., 2018). Services provide an avenue for further business growth, and in today’s digitalized marketplace, so do digital services (Gebauer et al., 2020; Kohtamäki et al., 2020). As such, SMEs might consider a digital servitization business model to be suitable in a relatively less competitive environment, to differentiate themselves through innovative offerings (Coreynen et al., 2020).

Demand unpredictability

The second source of environmental uncertainty is demand unpredictability, which refers to the degree to which customer demand can be accurately predicted (Dröge et al., 2003). As customer needs evolve, firms must adapt to remain competitive in their environment. A significant challenge faced by many manufacturers is the unpredictability of demand for ‘traditional’ services (for example, repair and maintenance), as customers tend to seek them only when equipment fails. This increases the unpredictability of product sales, makes it difficult to plan service visits or predict equipment failures, and impairs forecasting of spare parts and capacity planning. The emergence of digital servitization comes with significant advancements in digital technology that promise to circumvent the need for some labor-intensive services while allowing customer proximity at a distance. Advanced digital technologies such as the Internet of Things (IoT), sensors, digital twins, big data, and artificial intelligence (AI), offer unprecedented opportunities to improve the predictability of demand for products and services (Raff et al., 2020) and deliver support remotely.

Digital servitization can enable **insights into customer needs, real-time usage patterns and service performance**, thereby improving demand forecasting and resource allocation. As such, servitized SMEs facing an unpredictable demand might consider introducing digital technologies and developing a digital servitization business model to achieve a more efficient delivery of value to customers, by, for example, remotely diagnosing equipment failures and delivering predictive maintenance (Chen et al., 2021; Tronvoll et al., 2020).

Firm Size

Firm size has been depicted as a critical determinant of managerial and organizational processes in SMEs (O'Regan & Ghobadian, 2004) and is of particular importance for business model development (Pucci et al., 2017). The “liabilities of smallness” may be more pronounced in smaller, “micro businesses” than in small or medium-sized enterprises (Drnevich & West, 2023). Smaller size reflects resource deficiencies and capability disadvantages that might fail to provide the fundamental basis for developing sophisticated business models (Gherhes et al., 2016). This suggests that micro businesses may be more selective in orchestrating scarce resources towards evolving opportunities (Sirén et al., 2017), **and carefully proceed to incremental business model modifications that fit their resource profile** (Brinckmann et al., 2010; Rosenbusch et al., 2011). Conversely, larger (small and medium-sized) manufacturers, might have the capacity to allocate more productive resources to experiment with advanced business models.

Firm Age

Firm age represents a precursor of innovation in SMEs, reflecting the *nature* of a firm's resource stock (Rosenbusch et al., 2011). While younger, less established SMEs may be susceptible to the well-documented “liabilities of newness” (Gimenez-Fernandez et al., 2020), they may also be able to mobilize less specific, yet highly deployable resources to develop novel business models (Chen & Hambrick, 1995), and use the learning advantage to fully utilize such mobility (Autio et al., 2000). On the other hand, mature SMEs may already have an established set of resources and operating

307 routines (Amit & Schoemaker, 1993) that can be leveraged to transition towards more
308 sophisticated business models. Yet, such resource and capability stocks may be harder to mobilize
309 (Schreyögg & Kliesch-Eberl, 2007). Thus, although interesting theoretically, it is unclear whether
310 younger or older firms are more likely to develop digital servitization business models.

311 *Product complexity*

312 A product or process is complex if it is comprised of many parts (or elements) that interact with
313 each other in many ways (Vickery et al., 2016). Complex products can create lucrative service
314 opportunities, often leading to more profitable, long-term service contracts due to their demand-
315 based and economic motivations such as cost savings and service quality improvement (Raddats
316 et al., 2016). This is due to the higher value and extended lifecycle of complex products,
317 necessitating ongoing service and maintenance. Moreover, product modularity in complex
318 products can facilitate scalable, customized, service-oriented solutions, enhancing flexibility and
319 reducing differentiation costs (Jovanovic et al., 2023). Complex products are also better candidates
320 to be ‘networked’ (Haug et al., 2023), since they require more information to adequately describe
321 and understand, and their failure could severely impact the organization (Allmendinger &
322 Lombreglia, 2005). Digital technologies can be used to capture and employ this information,
323 transforming complex products into “smart, connected” ones (Porter & Heppelmann, 2014). By
324 leveraging data capture and analytics, these smart technologies can enhance service offerings and
325 improve overall decision-making capabilities (Raff et al., 2020). For SMEs, adopting digital
326 technologies to manage complex product-service systems could lead to innovation in their
327 business models. Such a change could enable SMEs to differentiate themselves in competitive
328 markets, offering digitally enabled, flexible solutions that are tailored to specific customer needs.

329 *Digital maturity*

330 Digital maturity is synonymous to the degree of digital transformation of an organization. Digital
331 technology adoption has an overarching impact across the organization’s processes, sales, and

supply channels (Schwer et al., 2018; Urbach & Ahlemann, 2016), and entails a critical emphasis on new forms of customer interaction and proactive development of digital skills (Ostmeier & Strobel, 2022; Schwer et al., 2018). Although business models and technological innovation are intertwined, the concept of a business model is conceptually distinct from technology (Baden-Fuller & Haefliger, 2013). In SMEs, the established operational model is characterized by low levels of digital sophistication (Denicolai et al., 2021), with recent research suggesting that the success of digitalization initiatives may be contingent on the firm's **prior** digital maturity level (Tronvoll et al., 2020). Framed in the above premises, in the case of digital servitization, the organization's degree of digitalization represents a precursory condition that demonstrates the organization's state to strategically develop and leverage new business models (Mikalef et al., 2019). As digital servitization represents a long-term strategy, digitally mature firms should have the processes in place to lead this transformation (Forliano et al., 2023; Kane et al., 2015).

Entrepreneurial Orientation

Decisions related to business model innovation may be contingent on a firm's strategic posture (Saebi et al., 2017). Entrepreneurial orientation demonstrates how ventures initiate actions in response to changes in the external environment and reflects the propensity to innovate, take calculated risks and proactively anticipate market and competitive behaviors (Wiklund & Shepherd, 2003). Varying degrees of entrepreneurial orientation may be pronounced in the manufacturing SME sector, with the most entrepreneurial of **them being more likely to transition toward advanced business models**. This is a reasonable assumption, as the concepts of innovativeness and risk-taking dimensions are interlinked to experimentation (Ferrerias-Méndez et al., 2021) and a firm's proactive tendency suggests the capacity to create opportunities by market redefinition (Kreiser et al., 2013).

METHODOLOGY

Development of the Business Model Descriptors

As discussed earlier, we started with the typology of Suppatvech et al. (2019), who identified four archetypes of ‘IoT-enabled business models’: *add-on*, *sharing*, *usage-based*, and *solution-oriented* (Table 2). However, because digital servitization does not reflect *solely* the use of IoT, but the possible adoption of a host of other digital technologies (see Paschou et al., 2020), we extended and generalized the four types of Suppatvech et al. (2019) into **digital servitization** business model types. This was the first step toward our final typology. The second was to address the omission of the Suppatvech et al. (2019) typology to not consider a separate type that would capture an exceedingly pertinent and popular digital servitization approach of entrepreneurial SMEs (Cenamor et al., 2019): the digital platform. As such, we integrated the *platform provider* archetype into our typology (Gebauer et al., 2020; Kohtamäki et al., 2019).

[Insert Table 2 here]

The third step was to develop descriptors for each business model type, in lay language, which knowledgeable respondents from SMEs could use to self-classify their firm. Drafts of the model descriptors were reviewed for clarity, relevance, and comprehensiveness by six academic experts, with areas of expertise including servitization, digitalization, and business models. Four SME practitioners with extensive experience in manufacturing and technology firms also provided their views over short interviews. Their feedback helped us simplify the descriptors and make the respective business models clearly distinct, as well as make them directly relevant to SMEs. Crucially, the *sharing* category was absorbed in the description of the *usage-based* model, because it was suggested that the value creation and capture mechanisms of the underlying model was also based on the ‘usage’ of an asset. As such, and after several iterations, we ended up with four digital servitization business model types (and the respective descriptors). In the survey, we also included descriptors for a *product-only* (no services) category denoting SMEs that exclusively manufacture

and sell a physical product, as well as a ‘*just*’ *servitized* category to capture manufacturers that offer complementary services, but digital technologies play no role in their provision. All descriptors can be found in Appendix A1.

Upon suggestions from our panel of experts, we directed respondents to self-classify their SME’s “primary or established” business model, so our analysis could focus on the firms’ main line of business. Additionally, recognizing that an SME’s primary business model might share features of more than one of the types, we asked respondents to choose the descriptor that “best represents” their model. Finally, to avoid the possibility that participants classify their firm after reading solely the names of the business model types and not fully engaging with the textual descriptors, the names of the business models were hidden.

Measures of Environmental and Organizational Antecedents

This being a survey-based research project, all constructs of interest (apart from size and age) needed to be operationalized through perceptual, Likert-scale type measures developed and validated in past academic research. However, there exist numerous different multi-item scales for each construct, so we needed to make a justified choice. Because all constructs have been previously used by servitization scholars, we preferred, where possible, scales that have ‘worked’ well in past servitization survey-based studies. In addition, we preferred measures that have been used in research investigating SMEs (rather than large firms solely). More importantly, because: a) the mode of data collection was online panels of respondents organized by Qualtrics (see next section); and, b) the population of interest (SME owners and high-level managers) is generally considered to have limited time to reply to research surveys, we sought scales that sufficiently captured the underlying concept, which were also relatively short. As an example, to measure *entrepreneurial orientation* (EO), and following previous publications in the *Journal of Small Business Management* (e.g., Moreno-Moya & Munuera-Aleman, 2016), we adopted five items from the Naman and Slevin (1993) *entrepreneurship scale* (as operationalized in Hult and Ketchen, 2001)

as opposed to a longer, multi-dimensional operationalization of the construct (e.g., Lumpkin & Dess, 1996).

For *competitive intensity* (CI), we adopted the original scale of Jaworski and Kohli (1993). The scale reflecting *product complexity* (PPC) comes from Vickery et al. (2016). To capture *demand unpredictability* (DU), we adopted the 3-item scale of Dröge et al. (2003), but to make it more relevant to our context, we added an item capturing the extent of predictability of product and/or service failures. For *digital maturity* (DIG), we used the four-item digital maturity scale developed by PwC (Greif et al., 2016) that considers the degree of digitalization of processes and infrastructure, people and culture, sales, and customer involvement. It is treated as formative; all other multi-item scales are treated as reflective. *Age* was measured as the number of years since the establishment of the SME, while *size* was captured as a categorical variable that distinguished between micro businesses, small businesses, and medium-sized enterprises. All measures are self-reported by managers.

Control Variables

Because some business models might be more feasible or appropriate in certain industries, it is necessary to rule out potential confounding effects that are driven by the industry in which SMEs operate. For example, for SMEs in the IT or Telecoms industries, the platform business model might be relatively more feasible and promising (due to the higher levels of digitalization of the entire industry) than for SME manufacturers of construction equipment or components. At the same time, contextual factors such as the variability of the demand and competitive intensity, might differ systematically across industries, and consequently for the SMEs operating in them. We thus control for *industry type* in our models. The responses to the ‘primary industry’ options provided in the survey (see Appendix A2) were grouped into five categories: transport, industrials, IT & telecoms, healthcare, and consumer goods. Industry type was captured as a categorical variable, entering the model as a set of ‘dummy’ variables.

Similarly, it is not uncommon for the business model of a firm to be dictated, or at least partly influenced, by the requirements of one or more of its business customers. Moreover, if an SME does not serve business customers (dealing only with individual consumers), it might be very inefficient for it to develop a sophisticated business model that guarantees a certain level of product performance (*solution-oriented*). At the same time, SMEs that do not cater for business clients clearly operate at the downstream end of supply chains, which suggests that they face a less variable (and possibly more predictable) demand due to the widely studied ‘bullwhip effect’ (Wang & Disney, 2016). SMEs that serve business customers might also be different from those operating solely in consumer markets in terms of organizational factors such as product complexity and digital maturity; business customers might dictate relationship-specific investments that involve additional product features and upgrades in IT and digital infrastructure. To ameliorate the confounding influence of *customer nature*, we include in our models a dummy variable that takes the value of ‘1’ for firms that served business customers and ‘0’ otherwise.

Sample and Data Collection Process

The entire survey instrument was first reviewed by two academic and two industry contacts with survey experience, and its final version can be found in Appendix A2. To collect responses from appropriate informants, we commissioned Qualtrics, a market research company with access to several online panels of individuals willing to reply to research surveys for a fee. The use of online panels of participants (Porter et al., 2019), has increased in popularity in recent years, constituting a convenient way to reach relatively hard-to-get populations, such as managers in SMEs.

We specified to Qualtrics that responses must be sourced from panels of business owners and managers (rather than consumer panels) who satisfy the following criteria: they must be owners or ‘high-level’ employees of UK manufacturing SMEs, operating in industries with products of medium or high technology intensity (for example, electrical and electronic equipment, automotive etc., excluding industries such as jewelry, food and beverages, paper and packaging).

Because Qualtrics cannot guarantee that a research instrument will be exclusively distributed to members of the target population, certain questions in the survey instrument acted as automatic filters. For example, if an individual responded that they were currently working in a company with more than 250 employees, or if they replied that their company operates in any industry other than the specified ones, they were automatically disqualified centrally by Qualtrics. To identify inattentive individuals, we also included a set of simple attention checks (for example, “3+2=?”). To further ensure that respondents were sufficiently knowledgeable about their firm, we included three 7-point Likert scale questions inquiring about their level of knowledge concerning their firm’s strategy, processes, and offerings.

A pilot study was conducted involving 38 participants to get an understanding of the duration of the survey, and to gather views about the relevance of factors, the clarity of the questions and the respondents’ overall experience with the survey. The feedback was overall excellent. A careful skimming through the data led to the identification of eight responses that were completed in an abnormally short period of time, suggesting insufficient engagement and/or random answers. Based on this, discussions with Qualtrics led to slight modifications to their screening and recruitment strategy, and to the implementation of a minimum ‘elapsed time threshold’ to increase the chances that respondents had adequately engaged with the questions.

Main phase data collection took place in March 2023. Overall, we were provided with 422 unique responses. 39 of them were discarded because the participant failed one or more attention checks or because they admitted low levels of knowledge of their business (a mean score of 4 – out of 7 – or lower). An analysis for multivariate outliers (based on Mahalanobis distance – Baumgartner & Weijters, 2022) revealed 35 observations that lay beyond the desired threshold, which were duly omitted. The remaining 348 responses served as the inputs for our statistical analysis. On average, participants had been working for their company for 7.8 years (SD = 6.2).

Data Analysis

For the reflective constructs, we conducted an Exploratory Factor Analysis (EFA) with a maximum likelihood factoring method and an oblimin rotation (Sass & Schmitt, 2010), which allows emergent factors to correlate (Costello & Osborne, 2005). The four-factor solution produced a Root Mean Square of Error Approximation (RMSEA) index of 0.036, and a Tucker Lewis Index (TLI) of factoring reliability of 0.946. Two items of the Entrepreneurial Orientation construct were removed, due to very low loading on the latent factor (<0.5). Cronbach's alphas were acceptable, ranging from 0.71 (Competitive Intensity) to 0.87 (Product Complexity). We then calculated the means of the latent factors for further analysis. For digital maturity (the only formative construct), we built a multiplicative index, under the assumption that digitizing more aspects of the business has a synergistic effect (Hortovanyi et al., 2023). Since 22 respondents provided an inappropriate value for firm age (probably confusing 'year of establishment' with 'years since establishment'), we ended up with a sample of 326 observations for the main statistical analysis.

Since our primary interest lies in the four digital servitization business model types, and because initial analysis revealed that SMEs following a *pure product* or a *just servitized* business model were very similar across all dimensions, we merged the two types into one category that we named *Non-DS*. The four digital servitization business models acted as separate categories, so our nominal categorical outcome has a total of five categories. Table 3 reports descriptive statistics across the categories, offering a 'rough' picture of the relationship between business model prevalence and each explanatory variable. One- and two-way ANOVA and Chi-squared tests were conducted to test for statistically significant differences among SMEs following the five different models. All tests (not reported here) produced sufficiently large test statistics (all corresponding to p-values < 0.01), suggesting that SMEs following different business models exhibit systematic differences across the studied dimensions. On average, and without accounting for the influence of other factors, *non-DS* SMEs are older, smaller (that is, relatively more micro-businesses), less digitally

mature (lower ‘DIG’), and less entrepreneurially oriented (lower ‘EO’) than digitally servitized SMEs. They also provide products of lower complexity (lower ‘PPC’) and are less likely to cater to business customers (lower ‘B2B’). The picture is blurrier when it comes to the environmental contingencies; *platform* providers and *non-DS* firms report the highest levels of demand unpredictability (DU), while SMEs following a *solution-oriented* business model deal with a much more predictable demand. When it comes to the intensity of competition (CI), differences are relatively small, with *add-on* business model followers reporting the lowest CI, and SMEs following a *usage-based* model reporting the highest. It is also noteworthy that SMEs following an *add-on* business model, although larger than *non-DS* firms, seem to be more similar to the latter across all dimensions, than to manufacturers that follow any of the more ‘advanced’ digitally servitized business models.

[Insert Table 3 here]

The correlations between pairs of continuous variables can be found in Table 4. CI, DIG, PPC and EO are all positively (and statistically significantly) correlated. All these variables are also negatively correlated with firm age. This is because older SMEs are less likely to be digitally servitized, and, as shown in Table 3, these SMEs report lower levels of CI, DIG, PPC and EO. The correlation between DU and CI is close to zero, suggesting that the two constructs tap different aspects environmental uncertainty. DU is also negatively (and statistically significantly) correlated with DIG, PPC and EO; entrepreneurial, digitally mature manufacturing SMEs of complex products seem to deal with a relatively more predictable demand.

[Insert Table 4 here]

The Multinomial Logit regression model

As the outcome variable of interest is categorical, and specifically, nominal, we employ a multinomial logistic regression model (Long, 1997), aiming at assessing how SMEs’ organizational and environmental factors are associated to the likelihood of the different business model types.

To this end, suppose each SME, i , is a utility maximizer, that follows a primary business model that can be categorized as one of J alternatives (in our application $J = 5$: *non-DS*, *add-on*, *usage-based*, *solution-oriented*, and *platform*). Each business model, j , would allow the SME to derive a net utility U_j assumed to be a linear function of the explanatory variables:

$$U_{ij} = \boldsymbol{\beta}_j \mathbf{X}_i + u_{ij}, \quad (1)$$

where $\mathbf{X}_i$ is the column vector of explanatory variables, $\boldsymbol{\beta}_j$ is a row vector of parameters to be estimated denoting the linear relationship between each explanatory variable and net utility, and u_{ij} is an error term. Nevertheless, these utilities are unobserved. We only observe the business model type each SME follows in their primary line of business, in the expectation that this type will help the SME derive the highest net utility. That is:

$$Y_i = j \text{ if } U_{ij} > U_{ik} \forall j \neq k. \quad (2)$$

For example, an SME would follow, let's say, an *add-on* business model, if the net utility expected to be gained from it is higher than the net utility that would be gained from any other business model. Then, the conditional probability of observing $Y_i = j$ is given by:

$$\begin{aligned} \Pr(Y_i = j | \mathbf{X}) &= \Pr(U_{ij} > U_{ik}, \forall j \neq k | \mathbf{X}) \\ &= \Pr(\boldsymbol{\beta}_j \mathbf{X}_i + u_{ij} > \boldsymbol{\beta}_k \mathbf{X}_i + u_{ik}, \forall j \neq k | \mathbf{X}) \\ &= \Pr(u_j - u_k > \boldsymbol{\beta}_j \mathbf{X}_i - \boldsymbol{\beta}_k \mathbf{X}_i, \forall j \neq k | \mathbf{X}). \end{aligned} \quad (3)$$

If the error terms are independent across business models and all follow a type-I extreme value (Gumbel) distribution, it can be shown that from (3):

$$\Pr(Y_i = j | \mathbf{X}) = \frac{\exp(\boldsymbol{\beta}_j \mathbf{X}_i)}{\exp(\boldsymbol{\beta}_1 \mathbf{X}_i) + \exp(\boldsymbol{\beta}_2 \mathbf{X}_i) + \dots + \exp(\boldsymbol{\beta}_J \mathbf{X}_i)}. \quad (4)$$

For a given sample, the vector of parameters for each alternative business model, $\boldsymbol{\beta}_j$, is then estimated by Maximum Likelihood Estimation (MLE) using numerical optimizers such as the Newton-Raphson. Note, however, that we need a restriction to the parameter vector of one of the business models; otherwise, this maximization problem has an infinite number of solutions.

Commonly, the first vector β_1 is set to $\mathbf{0}$, known as the baseline, allowing estimation of the remaining vectors, $\beta_2, \dots, \beta_J$. In our application, the baseline business model is *non-DS*, while β_2 corresponds to *add-on*, β_3 to *usage-based*, β_4 to *solution-oriented*, and β_5 to *platform*. Then, the conditional probability of an SME following a *non-DS* model is given by:

$$\Pr(Y_i = 1|\mathbf{X}) = \frac{1}{1 + \exp(\beta_2\mathbf{X}_i) + \exp(\beta_3\mathbf{X}_i) + \exp(\beta_4\mathbf{X}_i) + \exp(\beta_5\mathbf{X}_i)},$$

while the conditional probability of choosing any of the other business models, j , is:

$$\Pr(Y_i = j|\mathbf{X}) = \frac{\exp(\beta_j\mathbf{X}_i)}{1 + \exp(\beta_2\mathbf{X}_i) + \exp(\beta_3\mathbf{X}_i) + \exp(\beta_4\mathbf{X}_i) + \exp(\beta_5\mathbf{X}_i)}$$

Because of the restriction $\beta_1 = \mathbf{0}$, the estimated coefficients for each of the other categories provide contrasts between category j and the baseline (*non-DS*). For example, if the coefficient of DU is positive in the *add-on* category, the interpretation is that an increase in demand unpredictability is predicted to increase the probability of following an *add-on* over a *non-DS* business model. To fit the model, we used Stata 18's *mlogit* routine.

RESULTS

Tables 5-7 present the estimated coefficients (and standard errors) of the multinomial logistic regression models detailed in the rest of this section. Table 8 presents Chi-squared statistics of Wald tests for the joint significance of the variables across business model types, in the three regression models. As shown, apart from firm age, all other variables meaningfully (and statistically significantly) differentiate among SMEs following the five business models.

Model (1) in Table 5 includes only the environmental determinants, alongside the control variables. The negative coefficients of DU suggest that the more unpredictable the demand, the less likely it is for SMEs to follow a digital servitization business model than a *non-DS* one; the coefficients are statistically significant (at the 10 percent level at least) for all but the *platform* business model. On the other hand, even though CI differentiates among business models overall

(Table 8), its coefficient is (positive and) statistically significant (at the 10 percent level) only for the *usage-based*. This suggests mild evidence that SMEs facing strong competitors are more likely to develop a *usage-based* model than a *Non-DS* one.

[Insert Table 5 here]

Model (2) in Table 6 includes only the organizational determinants, alongside the control variables. Holding the control variables constant, age does not differentiate among SMEs following different business models; this can also be seen from the tests of joint significance of the age coefficients (Table 8). When it comes to size, larger SMEs are more likely to prefer digital servitization business models over a *non-DS* model: small firms are statistically significantly more likely (p-value < .05) to follow a *platform* model, while medium-sized firms are more likely to follow an *add-on* one (p-value < .05). As digital maturity (DIG) increases, SMEs are statistically significantly more likely to transition to a digital servitization business model (apart from *add-on*), while more entrepreneurially oriented (EO) SMEs are more likely to follow a *usage-based* or *platform* business model than a *non-DS* one. Finally, while the coefficients of product complexity (PPC) are positive (and jointly significant – Table 8), the coefficient is statistically significant only for the *solution-oriented* business model (p-value < .01).

[Insert Table 6 here]

Model (3) in Table 7 includes both the environmental and the organizational determinants. The reported coefficient of each factor is now ‘adjusted’ for the influence of all other factors (environmental *and* organizational). Regarding the coefficients of the organizational factors, no meaningful difference can be observed between Table 6 and Table 7: Generally speaking, SMEs are more likely to develop digital servitization business models if they are larger, more digitally mature, more entrepreneurially oriented, and have built their business model around a relatively more complex product. On the other hand, the coefficients of the two environmental factors change to some extent. Model (3) suggests that when holding the organizational contingencies of SMEs ‘fixed’, the higher the CI, the lower the likelihood of following one of the digital servitization

business models; all CI coefficients are negative and statistically significant (at the 5 percent significance level) apart from the coefficient for *usage-based*. In other words, all other factors held equal, SMEs tend to follow these three digital servitization business models in relatively less competitive environments. Regarding DU, accounting for the influence of the organizational contingencies, results in only the coefficient for *solution-oriented* being (negative and) statistically significant; SMEs facing a more unpredictable demand tend to prefer a non-DS business model over a *solution-oriented* one. This might be because for it to be feasible, a *solution-oriented* business model, which normally entails long-term collaborative relationships with (selected) customers (Kamalaldin et al., 2020; Storbacka, 2011) hinges on a predictable demand pattern from these customers. Because of the inter-relationships among all explanatory variables and the counter-intuitiveness of these results, we examine the role of environmental and organizational contingencies in separate sections.

[Insert Table 7 here]

[Insert Table 8 here]

The Role of Organizational Factors

To assist with the interpretation of the coefficients of nonlinear models, such as the multinomial logistic regression model employed herein, it is customary to graphically present the model's predicted probabilities of the alternative outcomes, for different levels of the explanatory variables. We plot these probabilities only for the continuous organizational factors (PPC, DIG, EO), excluding the statistically insignificant SME age. To produce the graphs (Figures 1-3), we rely on the model that includes all explanatory variables (Model 3). As such, the predicted probabilities of SMEs following one business model over the others at different levels of a given organizational factor are calculated while holding all remaining explanatory and control variables fixed at their mean values, basically representing an 'average' SME.

Figure 1 shows that SMEs with relatively less complex products are more likely to follow a less sophisticated business model (*non-DS* or *add-on*), while, as product complexity increases, a

solution-oriented business model becomes the most prevalent choice. This is not surprising given the premise that solution offerings are generally deemed to be more viable for products of medium to high complexity (Davies, 2004; Paiola et al., 2013). Interestingly, the *platform* and the *usage-based* business models are almost uniformly likely along the entire product complexity range, suggesting that these business models can be built around both simpler and more complex products (cf. Raddats et al., 2016).

[Insert Figure 1 here]

Regarding digital maturity (Figure 2), again, the *non-DS* and *add-on* business models are more likely to be followed by relatively digitally immature SMEs, and as digital maturity increases, these less sophisticated business models become less likely. The most likely business model of digitally mature SMEs is the *usage-based* (followed by the *solution-oriented* one). The feasibility of such models hinges considerably on digital capabilities (for the capture, analysis and communication of data and information), for which digitized internal processes and infrastructure are almost a prerequisite (Hortovanyi et al., 2023; Tronvoll et al., 2020).

[Insert Figure 2 here]

Finally, as shown in Figure 3, *usage-based* and *platform* business models are particularly unlikely to be developed by SMEs that are not entrepreneurially oriented. The other three business models are almost equiprobable for such SMEs. For highly entrepreneurial SMEs though, the differences in the probabilities of different models are not particularly large, but *platform* clearly becomes more likely than a *non-DS* business model.

[Insert Figure 3 here]

The Role of Environmental Factors

Given the relatively counterintuitive results regarding the relationships between business model choices and demand unpredictability (DU) or competitive intensity (CI), to illustrate the role of the external environment, we adopt a different approach to the one followed previously. Specifically, we consider five different external environments based on combinations of DU and

CI (that is, ‘Average’, ‘High’, ‘Low’), and calculate the predicted probabilities of all business models, separately for a ‘typical’ micro, small and medium-sized business. ‘Typical’ here refers to an SME of a given size (for example, a micro-business) that exhibits mean levels of all variables included in Model (3) (apart from DU and CI, which we ‘manipulate’) *given* its size. So, for example, a typical micro business’s level of EO is the mean of EO across all 41 micro businesses. We manipulate the external environment by defining combinations of ‘average’ (sample mean), ‘high’ (mean + 1SD) and ‘low’ (mean - 1SD) levels of DU and CI based on the *entire* sample. The results of this exercise are presented in Table 9.

[Insert Table 9 here]

As illustrated in the table, a typical micro business is by far more likely to follow a *non-DS* business model in all environmental contexts, apart from when it faces a relatively stable environment of low DU and low CI where the preferred type is *add-on*. This suggests that micro businesses might not have the resources or capabilities to develop sophisticated business models unless the external environment is stable enough to allow such a ‘risky’ move. Furthermore, and for the same reason, the *platform* business model is the most unlikely business model type in all environments; simply, typical micro businesses will not, or cannot, implement this business model. This is in stark contrast with small businesses, whose most likely business model is *platform* in three of the five scenarios, specifically when DU is not low. When DU is low, or in other words, when demand is relatively predictable, a typical small business is predicted to marginally follow a *usage-based* business model (in a highly competitive environment) or an *add-on* business model (when CI is also low) over a *solution-oriented* one. In all but one environmental configuration, the least likely business model type is *non-DS*, with evidence of clear, qualitative differences between a typical micro and a typical small manufacturing firm. For a typical medium-sized enterprise, universally and unequivocally, the most likely business model is the *add-on*, with the second likeliest type in three cases being a *usage-based* business model. As expected, in three out of five environments, the

non-DS business model type is the least likely, while in the most turbulent environment (high DU and CI), a medium-sized enterprise is very unlikely to follow a *solution-oriented* model.

We use this analysis to suggest two salient points, which we discuss in the next section. First, micro businesses are starkly different to larger SMEs in terms of what business models are reasonably applicable to them. Second, to some extent, SMEs, and particularly micro businesses, might require a relatively less uncertain environment to develop a digital servitization business model; in other words, competitive intensity and demand unpredictability might hinder, rather than encourage, SMEs to transition to digital servitization.

DISCUSSION AND CONCLUSIONS

Summary of findings

In this study, we advanced and applied a digital servitization business model typology after *integrating relevant previous attempts*. The four business model types were then operationalized in a way to enable a large-scale quantitative study. Descriptive statistics and a multinomial logistic regression analysis framework, using a sample of 326 responses from UK manufacturing SMEs, revealed that, overall, firms that follow digital servitization business models are larger, more digitally mature, more entrepreneurially oriented, and have built their business model around a relatively more complex product. Detailed analysis of the role of the environment also revealed the stark contrast between the business models followed by typical micro businesses on the one hand, and typical small-to-medium sized enterprises on the other. As shown, sophisticated digital servitization business models might not be realistic options for most micro-businesses, unless they find themselves operating in a very stable environment with predictable demand and low competition. On the other hand, small and medium-sized manufacturers are more likely than not to follow a digital servitization business model.

Theoretical Implications

The findings have clear implications for the study of digital servitization in SMEs. Firstly, the digital servitization business model typology advanced herein, and the textual descriptors developed collaboratively with academic and practitioner experts, comprise theoretical contributions in their own right. Scholars interested in digital servitization can adopt or adapt our typology to empirically study the prevalence of these business models in contexts other than UK manufacturing.

Secondly, the business model typology (and respective descriptors) helped us enhance our understanding of the antecedents of digital servitization in the context of manufacturing SMEs. As such, this work extends the limited (but growing) research in this type of firms (Coreynen et al., 2020), answering related calls in the literature (Rabetino et al., 2021). More importantly, the methodological approach we followed produced insights of considerable nuance, since it revealed that different organizational and environmental contingencies pertinent to the manufacturing SME might have led them to develop different types of business models (including the four digital servitization ones). By showing how the seven selected factors ‘differentiate’ among the five business models, the findings highlight when and where manufacturing SMEs might prefer one type of business model over others. As such, this work can act as a benchmark to guide qualitative and/or quantitative studies in manufacturing SMEs, and a starting point toward identifying the underlying mechanisms of digital servitization business model innovation, and, subsequently, explaining differential SME performance.

Thirdly, the substantive differences between micro businesses, on the one hand, and small and medium-sized enterprises, on the other, should be positioned against the extant literature that suggests that manufacturers tend to embrace digital servitization in response to competitive pressures (Morgan et al., 2019; Shen et al., 2023). When it comes to the broader SME sector, this claim does not seem to be supported in the case of micro businesses. The latter are more likely to develop a digital servitization business model in a relatively less uncertain environment of low

competitive intensity and low demand unpredictability; otherwise, they prefer to remain pure product providers or ‘just’ servitized. These (naturally) constrained firms in terms of resources and capabilities, might be willing to risk a transition to digital servitization only when they face low levels of environmental uncertainty, wherein they can first build adequate intrafirm relational capital (Ritala et al., 2021) and face no urgency to reap quick returns. In such circumstances, a micro business may take advantage of the stable conditions to enable a slower, albeit more manageable, transition towards digital servitization, and facilitate the buildup of trust between itself and its customers. It is an open empirical question as to whether this preference of micro businesses translates into performance improvements.

Finally, this work theoretically bolsters the view of digital servitization as a form of Business Model Innovation (BMI), in line with previous literature (Gebauer et al., 2020; Visnjic et al., 2016). The empirical application of the developed business model typology demonstrates the complex nature of business models and confirms that BMI is a valuable theoretical perspective that can further nurture the theory and practice of digital servitization (Shen et al., 2023). This complements existing attempts to extend BMI theorization beyond the business model design stage (Cavallo et al., 2023; Lamperti et al., 2024).

Implications for Practice and Policy

Our study can assist practitioners in manufacturing SMEs when assessing the extent to which digital servitization is feasible for their company, given the environmental and organizational contingencies they face. For example, a *solution-oriented* business model might hardly make any sense if the product is not of sufficient complexity to be ‘connected’ (Porter & Heppelmann, 2014). Meanwhile, SME owners and high-level managers need to evaluate their firm’s digital maturity and invest in initiatives that will digitalize internal processes, before modifying the business model in its entirety. Although environmental uncertainty might not necessarily forbid certain digital servitization business models, our work suggests that such models are potentially more feasible for

small- and medium-sized enterprises, or micro businesses that find themselves in an environment with a relatively low competitive intensity and a predictable demand. This suggests that managers in such contexts may be able to **direct resources to relatively risky** strategic endeavors such as digital servitization, and not towards operational-level measures to address competition (like cutting purchasing costs) and demand unpredictability (like advanced forecasting technologies).

Our findings also point towards a stark difference in technology adoption between micro businesses on the one hand, and small and medium-sized enterprises on the other, indirectly confirming the presence of a ‘digital divide’ (van Dijk, 2020). This is consistent with extant literature suggesting that firm characteristics influence technology adoption (Arendt, 2008), and, by extension, digital servitization business models. For policymakers, this is of profound importance, since micro businesses represent a rapidly growing segment within UK Manufacturing (MAKE UK, 2021), which, however, is characterized by productivity levels of approximately 60 percent of their larger counterparts (UKRI, 2023). Although our study does not suggest that this difference in productivity **is solely due to the differences in the rate of digital technology adoption**, it suggests the need for a more inclusive policy framework that would allow micro businesses to become familiar with advanced digital technologies and **enhance the technological and digital skills of their employees**. UK policymakers should empower micro businesses through the provision of training, access to financial capital, and technology support.

Limitations and Further Research

This work is not free from limitations. Firstly, using the online panels of Qualtrics for data collection means that we can never be sure that all respondents come from the target population of high-level managers (or owners) of UK manufacturing SMEs. **Like previous studies that have used this approach** (Davis & Bendickson, 2021), **we relied on the respondents’ word, the Qualtrics panel filters, a set of control questions, and post-hoc removal of problematic responses to assert membership to the target population**. Future studies investigating digital servitization business

models of SMEs should combine multiple data sources. This will comprise a good test of the credence of our findings. Tangentially, another direction towards validating and potentially generalizing our findings would be by replicating this study in different countries, since our work was by design limited to the UK industrial context.

The third limitation relates to the theoretical framing of this work. While we tried to investigate environmental and organizational contingencies that have saliently been considered relevant in the literature, there is no doubt that our attempt to maintain parsimony has left other interesting factors unexamined. Scholars should theoretically motivate and empirically test other factors that might play a role in SMEs' choice of digital servitization business models. For example, certain customers might drive, or even 'force', important SME suppliers to follow a particular business model, which will enable the former to transfer certain risks and optimize their operations. More generally, this work did not directly address the influence that the business ecosystem might have on business model choice. For example, the availability (or lack thereof) of competent partners (technology, logistics, customer service, etc.) in the SME's environment, might, to some extent, determine the feasibility of certain *usage-based*, *solution-oriented* and *platform* business models. Scholars should explicitly focus on such factors in future studies. Tangentially, scholars can adopt alternative conceptualizations (and operationalizations) of the factors that were considered herein. For example, treating EO as an individual- (Clark et al., 2024) and/or team-level (Covin et al., 2020) construct in the context of digitally servitized SMEs, can generate nuanced multi-level insight into the role of entrepreneurship.

Methodologically, our study is effectively a 'snapshot' in time because it relies on cross-sectional data. As such, our estimates do not represent causal effects, and we have neither theorized upon nor tested any 'mechanism' underlying the statistically significant coefficients. A natural extension of our study would comprise a longitudinal approach, compiling data from the same SMEs at certain points over an extended time window.

Finally, this work did not focus on the outcomes of the different digital servitization business model types. Further research can investigate how the latter contribute toward scalability and profitability (Korkeamäki et al., 2021; Mihailova, 2023; Palmić et al., 2023), and compare amongst them. An interesting question is whether scaling one's operations through the adoption of certain digital servitization business models can help the SME avoid the service paradox and make services profitable much faster.

Declaration of interest statement

The authors report there are no competing interests to declare.

References

- Albats, E., Podmetina, D., & Vanhaverbeke, W. (2023). Open innovation in SMEs: A process view towards business model innovation. *Journal of Small Business Management*, 61(6), 2519–2560. <https://doi.org/10.1080/00472778.2021.1913595>
- Aldrich, H., & Auster, E. R. (1986). Even dwarfs started small: Liabilities of age and size and their strategic implications. *Research in Organizational Behavior*, 8, 165–198.
- Aliasghar, O., Sadeghi, A., & Rose, E. L. (2023). Process innovation in small- and medium-sized enterprises: The critical roles of external knowledge sourcing and absorptive capacity. *Journal of Small Business Management*, 61(4), 1583–1610. <https://doi.org/10.1080/00472778.2020.1844491>
- Allmendinger, G., & Lombreglia, R. (2005). Four strategies for the age of smart services. *Harvard Business Review*, 83(10), 131.
- Ambroise, L., Prim-Allaz, I., & Teyssier, C. (2018). Financial performance of servitized manufacturing firms: A configuration issue between servitization strategies and customer-oriented organizational design. *Industrial Marketing Management*, 71, 54–68. <https://doi.org/10.1016/J.INDMARMAN.2017.11.007>
- Amit, R., & Schoemaker, P. J. H. (1993). Strategic assets and organizational rent. *Strategic Management Journal*, 14(1), 33–46. <https://doi.org/10.1002/smj.4250140105>
- 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>
- Arendt, L. (2008). Barriers to ICT adoption in SMEs: How to bridge the digital divide? *Journal of Systems and Information Technology*, 10(2), 93–108. <https://doi.org/10.1108/13287260810897738/FULL/PDF>
- Autio, E., Sapienza, H. J., & Almeida, J. G. (2000). Effects of Age at Entry, Knowledge Intensity, and Imitability on International Growth. *Academy of Management Journal*, 43(5), 909–924. <https://doi.org/10.5465/1556419>
- Baden-Fuller, C., & Haefliger, S. (2013). Business Models and Technological Innovation. *Long Range Planning*, 46(6), 419–426. <https://doi.org/10.1016/J.LRP.2013.08.023>
- Baines, T. S., Lightfoot, H. W., Benedettini, O., & Kay, J. M. (2009). The servitization of manufacturing: A review of literature and reflection on future challenges. *Journal of*

- Manufacturing Technology Management*, 20(5), 547–567.
<https://doi.org/10.1108/17410380910960984/FULL/PDF>
- Baines, T. S., Lightfoot, H. W., Evans, S., Neely, A., Greenough, R., Peppard, J., Roy, R., Shehab, E., Braganza, A., Tiwari, A., Alcock, J. R., Angus, J. P., Bastl, M., Cousens, A., Irving, P., Johnson, M., Kingston, J., Lockett, H., Martinez, V., ... Wilson, H. (2007). State-of-the-art in product-service systems. *Proceedings of the Institution of Mechanical Engineers, Part B: Journal of Engineering Manufacture*, 221(10), 1543–1552.
<https://doi.org/10.1243/09544054JEM858>
- Baumgartner, H., & Weijters, B. (2022). How to Identify Careless Responders in Surveys. In H. Baumgartner & B. Weijters (Eds.), *Measurement in Marketing (Review of Marketing Research)* (Vol. 19, pp. 121–141). Emerald Publishing Limited.
- Benedettini, O., Swink, M., & Neely, A. (2017). Examining the influence of service additions on manufacturing firms' bankruptcy likelihood. *Industrial Marketing Management*, 60, 112–125.
<https://doi.org/10.1016/j.indmarman.2016.04.011>
- Berends, H., Smits, A., Reymen, I., & Podoyntsyna, K. (2016). Learning while (re)configuring: Business model innovation processes in established firms. *Strategic Organization*, 14(3), 181–219.
- Beverungen, D., Kundisch, D., & Wunderlich, N. (2021). Transforming into a platform provider: strategic options for industrial smart service providers. *Journal of Service Management*, 32(4), 507–532. <https://doi.org/10.1108/JOSM-03-2020-0066/FULL/PDF>
- Bodlaj, M., & Čater, B. (2019). The Impact of Environmental Turbulence on the Perceived Importance of Innovation and Innovativeness in SMEs. *Journal of Small Business Management*, 57(S2), 417–435. <https://doi.org/10.1111/JSBM.12482>
- Böhm, E., Eggert, A., & Thiesbrummel, C. (2017). Service transition: A viable option for manufacturing companies with deteriorating financial performance? *Industrial Marketing Management*, 60, 101–111. <https://doi.org/10.1016/J.INDMARMAN.2016.04.007>
- Brinckmann, J., Grichnik, D., & Kapsa, D. (2010). Should entrepreneurs plan or just storm the castle? A meta-analysis on contextual factors impacting the business planning–performance relationship in small firms. *Journal of Business Venturing*, 25(1), 24–40.
<https://doi.org/10.1016/j.jbusvent.2008.10.007>
- Burns, T., & Stalker, G. M. (1961). *The Management of Innovation*. Tavistock.
- Calabrese, A., Levialdi Ghiron, N., Tiburzi, L., Baines, T., & Ziaee Bigdeli, A. (2019). The measurement of degree of servitization: literature review and recommendations. *Production Planning & Control*, 30(13), 1118–1135. <https://doi.org/10.1080/09537287.2019.1592260>
- Candi, M., & Kitagawa, F. (2022). Performance implications of business model centrality over technology-based firms' life courses. *Technovation*, 118, 102626.
<https://doi.org/10.1016/J.TECHNOVATION.2022.102626>
- Cavallo, A., Cosenz, F., & Noto, G. (2023). Business model scaling and growth hacking in digital entrepreneurship. *Journal of Small Business Management*, 62(4), 2058–2085.
<https://doi.org/10.1080/00472778.2023.2195463>
- Cavallo, A., Ghezzi, A., Dell'Era, C., & Pellizzoni, E. (2019). Fostering digital entrepreneurship from startup to scaleup: The role of venture capital funds and angel groups. *Technological Forecasting and Social Change*, 145, 24–35.
<https://doi.org/10.1016/J.TECHFORE.2019.04.022>
- Cenamor, J., Parida, V., & Wincent, J. (2019). How entrepreneurial SMEs compete through digital platforms: The roles of digital platform capability, network capability and ambidexterity. *Journal of Business Research*, 100, 196–206.
<https://doi.org/10.1016/J.JBUSRES.2019.03.035>
- Cenamor, J., Rönnerberg Sjödin, D., & Parida, V. (2017). Adopting a platform approach in servitization: Leveraging the value of digitalization. *International Journal of Production Economics*, 192, 54–65. <https://doi.org/10.1016/J.IJPE.2016.12.033>

- Chen, M.-J., & Hambrick, D. C. (1995). Speed, Stealth, and Selective Attack: How Small Firms Differ From Large Firms in Competitive Behavior. *Academy of Management Journal*, 38(2), 453–482.
- Chen, Y., Liu, H., & Chen, M. (2022). Achieving novelty and efficiency in business model design: Striking a balance between IT exploration and exploitation. *Information & Management*, 59(3), 103268. <https://doi.org/10.1016/j.im.2020.103268>
- Chen, Y., Visnjic, I., Parida, V., & Zhang, Z. (2021). On the road to digital servitization – The (dis)continuous interplay between business model and digital technology. *International Journal of Operations and Production Management*, 41(5), 694–722. <https://doi.org/10.1108/IJOPM-08-2020-0544/FULL/PDF>
- Cheng, C., & Wang, L. (2022). How companies configure digital innovation attributes for business model innovation? A configurational view. *Technovation*, 112, 102398. <https://doi.org/10.1016/J.TECHNOVATION.2021.102398>
- Choi, Y. R., Ha, S., & Kim, Y. (2022). Innovation ambidexterity, resource configuration and firm growth: is smallness a liability or an asset? *Small Business Economics* 2021 58:4, 58(4), 2183–2209. <https://doi.org/10.1007/S11187-021-00507-3>
- Clark, D. R., Pidduck, R. J., Lumpkin, G. T., & Covin, J. G. (2024). Is It Okay to Study Entrepreneurial Orientation (EO) at the Individual Level? Yes! *Entrepreneurship Theory and Practice*, 48(1), 349–391. <https://doi.org/10.1177/10422587231178885>
- Clauss, T. (2017). Measuring business model innovation: conceptualization, scale development, and proof of performance. *R&D Management*, 47(3), 385–403. <https://doi.org/10.1111/RADM.12186>
- Clauss, T., Abebe, M., Tangpong, C., & Hock, M. (2021). Strategic Agility, Business Model Innovation, and Firm Performance: An Empirical Investigation. *IEEE Transactions on Engineering Management*, 68(3), 767–784. <https://doi.org/10.1109/TEM.2019.2910381>
- Cohen, M. A., Agrawal, N., & Agrawal, V. (2006). Winning in the aftermarket. *Harvard Business Review*, 84(5), 129–138.
- Coreynen, W., Matthyssens, P., & Van Bockhaven, W. (2017). Boosting servitization through digitization: Pathways and dynamic resource configurations for manufacturers. *Industrial Marketing Management*, 60, 42–53. <https://doi.org/10.1016/J.INDMARMAN.2016.04.012>
- Coreynen, W., Matthyssens, P., Vanderstraeten, J., & van Witteloostuijn, A. (2020). Unravelling the internal and external drivers of digital servitization: A dynamic capabilities and contingency perspective on firm strategy. *Industrial Marketing Management*, 89, 265–277. <https://doi.org/10.1016/J.INDMARMAN.2020.02.014>
- Costello, A. B., & Osborne, J. (2005). Best practices in exploratory factor analysis: Four recommendations for getting the most from your analysis. *Practical Assessment, Research, and Evaluation*, 10(7), 1–9.
- Covin, J. G., Rigtering, J. P. C., Hughes, M., Kraus, S., Cheng, C.-F., & Bouncken, R. B. (2020). Individual and team entrepreneurial orientation: Scale development and configurations for success. *Journal of Business Research*, 112, 1–12. <https://doi.org/10.1016/j.jbusres.2020.02.023>
- Cusumano, M. A., Kahl, S. J., & Suarez, F. F. (2015). Services, industry evolution, and the competitive strategies of product firms. *Strategic Management Journal*, 36(4), 559–575. <https://doi.org/10.1002/smj.2235>
- Davies, A. (2004). Moving base into high-value integrated solutions: a value stream approach. *Industrial and Corporate Change*, 13(5), 727–756. <https://doi.org/10.1093/ICC/DTH029>
- Davis, P. E., & Bendickson, J. S. (2021). Strategic antecedents of innovation: Variance between small and large firms. *Journal of Small Business Management*, 59(1), 47–72. <https://doi.org/10.1111/JSBM.12478>
- Denicolai, S., Zucchella, A., & Magnani, G. (2021). Internationalization, digitalization, and sustainability: Are SMEs ready? A survey on synergies and substituting effects among

- growth paths. *Technological Forecasting and Social Change*, 166, 120650.
<https://doi.org/10.1016/J.TECHFORE.2021.120650>
- Drnevich, P. L., & West, J. (2023). Performance implications of technological uncertainty, age, and size for small businesses. *Journal of Small Business Management*, 61(4), 1806–1841.
<https://doi.org/10.1080/00472778.2020.1867733>
- Dröge, C., Claycomb, C., & Germain, R. (2003). Does Knowledge Mediate the Effect of Context on Performance? Some Initial Evidence. *Decision Sciences*, 34(3), 541–568.
- Eggers, F. (2020). Masters of disasters? Challenges and opportunities for SMEs in times of crisis. *Journal of Business Research*, 116, 199–208. <https://doi.org/10.1016/J.JBUSRES.2020.05.025>
- Eller, R., Alford, P., Kallmünzer, A., & Peters, M. (2020). Antecedents, consequences, and challenges of small and medium-sized enterprise digitalization. *Journal of Business Research*, 112, 119–127. <https://doi.org/10.1016/J.JBUSRES.2020.03.004>
- Favoretto, C., Mendes, G. H. S., Oliveira, M. G., Cauchick-Miguel, P. A., & Coreynen, W. (2022a). From servitization to digital servitization: How digitalization transforms companies' transition towards services. *Industrial Marketing Management*, 102, 104–121. <https://doi.org/10.1016/J.INDMARMAN.2022.01.003>
- Favoretto, C., Mendes, G. H. S., Oliveira, M. G., Cauchick-Miguel, P. A., & Coreynen, W. (2022b). From servitization to digital servitization: How digitalization transforms companies' transition towards services. *Industrial Marketing Management*, 102, 104–121. <https://doi.org/10.1016/J.INDMARMAN.2022.01.003>
- Ferreras-Méndez, J. L., Olmos-Peñuela, J., Salas-Vallina, A., & Alegre, J. (2021). Entrepreneurial orientation and new product development performance in SMEs: The mediating role of business model innovation. *Technovation*, 108, 102325.
<https://doi.org/10.1016/J.TECHNOVATION.2021.102325>
- Forlano, C., Bullini Orlandi, L., Zardini, A., & Rossignoli, C. (2023). Technological orientation and organizational resilience to Covid-19: The mediating role of strategy's digital maturity. *Technological Forecasting and Social Change*, 188, 122288.
<https://doi.org/10.1016/J.TECHFORE.2022.122288>
- Foss, N. J., & Saebi, T. (2017). Fifteen Years of Research on Business Model Innovation: How Far Have We Come, and Where Should We Go? *Journal of Management*, 43(1), 200–227.
https://doi.org/10.1177/0149206316675927/ASSET/IMAGES/LARGE/10.1177_0149206316675927-FIG3.JPEG
- Frank, A. G., Mendes, G. H. S., Ayala, N. F., & Ghezzi, A. (2019). Servitization and Industry 4.0 convergence in the digital transformation of product firms: A business model innovation perspective. *Technological Forecasting and Social Change*, 141, 341–351.
<https://doi.org/10.1016/J.TECHFORE.2019.01.014>
- Friedrich, A., Lange, A., & Elbert, R. (2022). How additive manufacturing drives business model change: The perspective of logistics service providers. *International Journal of Production Economics*, 249, 108521. <https://doi.org/10.1016/J.IJPE.2022.108521>
- 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., Arzt, A., Kohtamäki, M., Lamprecht, C., Parida, V., Witell, L., & Wortmann, F. (2020). How to convert digital offerings into revenue enhancement – Conceptualizing business model dynamics through explorative case studies. *Industrial Marketing Management*, 91, 429–441. <https://doi.org/10.1016/J.INDMARMAN.2020.10.006>
- Gebauer, H., Edvardsson, B., Gustafsson, A., & Witell, L. (2010). Match or mismatch: Strategy–structure configurations in the service business of manufacturing companies. *Journal of Service Research*, 13(2), 198–215. <https://doi.org/10.1177/1094670509353933>

- 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., Paiola, M., Saccani, N., & Rapaccini, M. (2021). Digital servitization: Crossing the perspectives of digitization and servitization. *Industrial Marketing Management*, 93, 382–388.
<https://doi.org/10.1016/J.INDMARMAN.2020.05.011>
- Gherhes, C., Williams, N., Vorley, T., & Vasconcelos, A. C. (2016). Distinguishing micro-businesses from SMEs: a systematic review of growth constraints. *Journal of Small Business and Enterprise Development*, 23(4), 939–963. <https://doi.org/10.1108/JSBED-05-2016-0075/FULL/PDF>
- Gimenez-Fernandez, E. M., Sandulli, F. D., & Bogers, M. (2020). Unpacking liabilities of newness and smallness in innovative start-ups: Investigating the differences in innovation performance between new and older small firms. *Research Policy*, 49(10), 104049.
<https://doi.org/10.1016/J.RESPOL.2020.104049>
- Greif, H., Kühnis, N., & Warnking, P. (2016). *Digital transformation: How mature are Swiss SMEs?*
- Hall, W. K. (1980). Survival Strategies in a Hostile Environment. *Harvard Business Review*, 58(5), 75–85.
- Haug, A., Adsbøll Wickstrøm, K., Stentoft, J., & Philipsen, K. (2023). The impact of information technology on product innovation in SMEs: The role of technological orientation. *Journal of Small Business Management*, 61(2), 384–410. <https://doi.org/10.1080/00472778.2020.1793550>
- Heikkilä, M., Bouwman, H., & Heikkilä, J. (2018). From strategic goals to business model innovation paths: an exploratory study. *Journal of Small Business and Enterprise Development*, 25(1), 107–128. <https://doi.org/10.1108/JSBED-03-2017-0097/FULL/PDF>
- Hortovanyi, L., Morgan, R. E., Herceg, I. V., Djuricin, D., Hanak, R., Horvath, D., Mocan, M. L., Romanova, A., & Szabo, R. Z. (2023). Assessment of digital maturity: the role of resources and capabilities in digital transformation in B2B firms. *International Journal of Production Research*, 61(23), 8043–8061. <https://doi.org/10.1080/00207543.2022.2164087>
- Huikkola, T., & Kohtamäki, M. (2018). Business Models in Servitization. In M. Kohtamäki, T. Baines, R. Rabetino, & A. Z. Bigdeli (Eds.), *Practices and Tools for Servitization* (pp. 61–81). Palgrave Macmillan.
- Hult, G. T. M., & Ketchen Jr., D. J. (2001). Does market orientation matter?: a test of the relationship between positional advantage and performance. *Strategic Management Journal*, 22(9), 899–906.
- Jaworski, B. J., & Kohli, A. K. (1993). Market Orientation: Antecedents and Consequences. *Journal of Marketing*, 57(3), 53–70. <https://doi.org/10.1177/002224299305700304>
- Jovanovic, M., Bustinza, O. F., Davies, P., & Parry, G. (2023). The interplay of product modularity, service types, and servitization depth on firm performance: a moderated mediation model. *Production Planning and Control*.
<https://doi.org/10.1080/09537287.2023.2286276>
- Kamalaldin, A., Linde, L., Sjödin, D., & Parida, V. (2020). Transforming provider-customer relationships in digital servitization: A relational view on digitalization. *Industrial Marketing Management*, 89, 306–325. <https://doi.org/10.1016/J.INDMARMAN.2020.02.004>
- Kane, G. C., Palmer, D., Phillips, A. N., Kiron, D., & Buckley, N. (2015). Strategy, not technology, drives digital transformation: Becoming a digitally mature enterprise. *MIT Sloan Management Review*.
- Kastalli, I. V., & Van Looy, B. (2013). Servitization: Disentangling the impact of service business model innovation on manufacturing firm performance. *Journal of Operations Management*, 31(4), 169–180. <https://doi.org/10.1016/j.jom.2013.02.001>
- Khanra, S., Dhir, A., Parida, V., & Kohtamäki, M. (2021). Servitization research: A review and bibliometric analysis of past achievements and future promises. *Journal of Business Research*, 131, 151–166. <https://doi.org/10.1016/j.jbusres.2021.03.056>

- Kindström, D., & Kowalkowski, C. (2015). Service-driven business model innovation: Organizing the shift from a product-based to a service-centric business model. In N. Foss & T. Saebi (Eds.), *Business Model Innovation: The Organizational Dimension* (pp. 191–216). Oxford University Press.
- Kohtamäki, M., Parida, V., Oghazi, P., Gebauer, H., & Baines, T. (2019). Digital servitization business models in ecosystems: A theory of the firm. *Journal of Business Research*, 104, 380–392. <https://doi.org/10.1016/J.JBUSRES.2019.06.027>
- Kohtamäki, M., Parida, V., Patel, P. C., & Gebauer, H. (2020). The relationship between digitalization and servitization: The role of servitization in capturing the financial potential of digitalization. *Technological Forecasting and Social Change*, 151, 119804. <https://doi.org/10.1016/J.TECHFORE.2019.119804>
- Kohtamäki, M., Rabetino, R., Parida, V., Sjödin, D., & Henneberg, S. (2022). Managing digital servitization toward smart solutions: Framing the connections between technologies, business models, and ecosystems. *Industrial Marketing Management*, 105, 253–267. <https://doi.org/10.1016/J.INDMARMAN.2022.06.010>
- Kolagar, M., Reim, W., Parida, V., & Sjödin, D. (2022). Digital servitization strategies for SME internationalization: the interplay between digital service maturity and ecosystem involvement. *Journal of Service Management*, 33(1), 143–162. <https://doi.org/10.1108/JOSM-11-2020-0428/FULL/PDF>
- Korkeamäki, L., Kohtamäki, M., & Parida, V. (2021). Worth the risk? The profit impact of outcome-based service offerings for manufacturing firms. *Journal of Business Research*, 131, 92–102. <https://doi.org/10.1016/J.JBUSRES.2021.03.048>
- Kowalkowski, C., Bigdeli, A. Z., & Baines, T. (2022). Guest editorial: the future of servitization in a digital era. *Journal of Service Management*, 33(1), 59–69. <https://doi.org/10.1108/JOSM-01-2022-450>
- Kowalkowski, C., Gebauer, H., Kamp, B., & Parry, G. (2017). Servitization and deservitization: Overview, concepts, and definitions. *Industrial Marketing Management*, 60, 4–10. <https://doi.org/10.1016/J.INDMARMAN.2016.12.007>
- Kowalkowski, C., Witell, L., & Gustafsson, A. (2013). Any way goes: Identifying value constellations for service infusion in SMEs. *Industrial Marketing Management*, 42(1), 18–30. <https://doi.org/10.1016/J.INDMARMAN.2012.11.004>
- Kreiser, P. M., Marino, L. D., Kuratko, D. F., & Weaver, K. M. (2013). Disaggregating entrepreneurial orientation: The non-linear impact of innovativeness, proactiveness and risk-taking on SME performance. *Small Business Economics*, 40(2), 273–291. <https://doi.org/10.1007/S11187-012-9460-X/FIGURES/2>
- Lamperti, S., Cavallo, A., & Sassanelli, C. (2024). Digital Servitization and Business Model Innovation in SMEs: A Model to Escape From Market Disruption. *IEEE Transactions on Engineering Management*, 71, 4619–4633. <https://doi.org/10.1109/TEM.2022.3233132>
- Lawrence, P. R., & Lorsch, J. W. (1967). *Organisation and Environment: Managing Differentiation and Integration*. Harvard University Press.
- Li, L., Su, F., Zhang, W., & Mao, J. Y. (2018). Digital transformation by SME entrepreneurs: A capability perspective. *Information Systems Journal*, 28(6), 1129–1157. <https://doi.org/10.1111/ISJ.12153>
- Long, J. S. (1997). *Regression models for categorical and limited dependent variables*. Sage Publications, Inc.
- Lumpkin, G. T., & Dess, G. G. (1996). Clarifying the Entrepreneurial Orientation Construct and Linking It to Performance. *The Academy of Management Review*, 21(1), 135. <https://doi.org/10.2307/258632>
- Make UK. (2021). *Start-up to scale-up: Supporting SMEs to grow. The Manufacturer's Organisation*.
- Markides, C. (2006). Disruptive Innovation: In Need of Better Theory*. *Journal of Product Innovation Management*, 23(1), 19–25. <https://doi.org/10.1111/J.1540-5885.2005.00177.X>

- Mihailova, I. (2023). Business model adaptation for realized international scaling of born-digitals. *Journal of World Business*, 58(2), 101418. <https://doi.org/10.1016/J.JWB.2022.101418>
- Mikalef, P., Boura, M., Lekakos, G., & Krogstie, J. (2019). Big data analytics and firm performance: Findings from a mixed-method approach. *Journal of Business Research*, 98, 261–276. <https://doi.org/10.1016/j.jbusres.2019.01.044>
- Miller, D. (1981). Toward a new contingency approach: The search for organizational gestalts. *Journal of Management Studies*, 18(1), 1–26. <https://doi.org/10.1111/j.1467-6486.1981.tb00088.x>
- Moeuf, A., Pellerin, R., Lamouri, S., Tamayo-Giraldo, S., & Barbaray, R. (2018). The industrial management of SMEs in the era of Industry 4.0. *International Journal of Production Research*, 56(3), 1118–1136. <https://doi.org/10.1080/00207543.2017.1372647>
- Moreno-Moya, M., & Munuera-Aleman, J.-L. (2016). The Differential Effect of Development Speed and Launching Speed on New Product Performance: An Analysis in SMEs. *Journal of Small Business Management*, 54(2), 750–770. <https://doi.org/10.1111/jsbm.12170>
- Morgan, T., Anokhin, S. A., & Wincent, J. (2019). New service development by manufacturing firms: Effects of customer participation under environmental contingencies. *Journal of Business Research*, 104, 497–505. <https://doi.org/10.1016/J.JBUSRES.2019.06.017>
- Naman, J. L., & Slevin, D. P. (1993). Entrepreneurship and the concept of fit: A model and empirical tests. *Strategic Management Journal*, 14(2), 137–153. <https://doi.org/10.1002/SMJ.4250140205>
- Neely, A. (2008). Exploring the financial consequences of the servitization of manufacturing. *Operations Management Research*, 1(2), 103–118. <https://doi.org/10.1007/s12063-009-0015-5>
- Nguyen, T. H., Newby, M., & Macaulay, M. J. (2015). Information technology adoption in small business: Confirmation of a proposed framework. *Journal of Small Business Management*, 53(1), 207–227. <https://doi.org/10.1111/JSBM.12058>
- Oliva, R., Gebauer, H., & Brann, J. M. (2012). Separate or Integrate? Assessing the Impact of Separation Between Product and Service Business on Service Performance in Product Manufacturing Firms. *Journal of Business-to-Business Marketing*, 19(4), 309–334. <https://doi.org/10.1080/1051712X.2012.647797>
- Oliva, R., & Kallenberg, R. (2003). Managing the transition from products to services. *International Journal of Service Industry Management*, 14(2), 160–172. <https://doi.org/10.1108/09564230310474138/FULL/PDF>
- O'Regan, N., & Ghobadian, A. (2004). Testing the homogeneity of SMEs: The impact of size on managerial and organisational processes. *European Business Review*, 16(1), 64–77. <https://doi.org/10.1108/09555340410512411/FULL/PDF>
- Ostmeier, E., & Strobel, M. (2022). Building skills in the context of digital transformation: How industry digital maturity drives proactive skill development. *Journal of Business Research*, 139, 718–730. <https://doi.org/10.1016/J.JBUSRES.2021.09.020>
- Paiola, M., & Gebauer, H. (2020). Internet of things technologies, digital servitization and business model innovation in BtoB manufacturing firms. *Industrial Marketing Management*, 89, 245–264. <https://doi.org/10.1016/j.indmarman.2020.03.009>
- Paiola, M., Saccani, N., Perona, M., & Gebauer, H. (2013). Moving from products to solutions: Strategic approaches for developing capabilities. *European Management Journal*, 31(4), 390–409. <https://doi.org/10.1016/J.EMJ.2012.10.002>
- Palmié, M., Parida, V., Mader, A., & Wincent, J. (2023). Clarifying the scaling concept: A review, definition, and measure of scaling performance and an elaborate agenda for future research. *Journal of Business Research*, 158, 113630. <https://doi.org/10.1016/J.JBUSRES.2022.113630>
- Paschou, T., Rapaccini, M., Adrodegari, F., & Saccani, N. (2020). Digital servitization in manufacturing: A systematic literature review and research agenda. *Industrial Marketing Management*, 89, 278–292. <https://doi.org/10.1016/J.INDMARMAN.2020.02.012>

- Pati, R. K., Nandakumar, M. K., Ghobadian, A., Ireland, R. D., & O'Regan, N. (2018). Business model design–performance relationship under external and internal contingencies: Evidence from SMEs in an emerging economy. *Long Range Planning*, 51(5), 750–769. <https://doi.org/10.1016/J.LRP.2018.01.001>
- Porter, C. O. L. H., Outlaw, R., Gale, J. P., & Cho, T. S. (2019). The Use of Online Panel Data in Management Research: A Review and Recommendations. *Journal of Management*, 45(1), 319–344. https://doi.org/10.1177/0149206318811569/ASSET/IMAGES/LARGE/10.1177_0149206318811569-FIG1.JPEG
- Porter, M. E., & Heppelmann, J. E. (2014). How smart, connected products are transforming competition. *Harvard Business Review*, 92(11), 64–88.
- Pucci, T., Nosi, C., & Zanni, L. (2017). Firm capabilities, business model design and performance of SMEs. *Journal of Small Business and Enterprise Development*, 24(2), 222–241. <https://doi.org/10.1108/JSBED-09-2016-0138/FULL/PDF>
- Rabetino, R., Harmsen, W., Kohtamäki, M., & Sihvonen, J. (2018). Structuring servitization-related research. *International Journal of Operations & Production Management*, 38(2), 350–371. <https://doi.org/10.1108/IJOPM-03-2017-0175>
- Rabetino, R., Kohtamäki, M., Kowalkowski, C., Baines, T. S., & Sousa, R. (2021). Guest editorial: Servitization 2.0: evaluating and advancing servitization-related research through novel conceptual and methodological perspectives. *International Journal of Operations and Production Management*, 41(5), 437–464. <https://doi.org/10.1108/IJOPM-05-2021-840/FULL/PDF>
- Raddats, C., Baines, T., Burton, J., Story, V. M., & Zolkiewski, J. (2016). Motivations for servitization: the impact of product complexity. *International Journal of Operations and Production Management*, 36(5), 572–591. <https://doi.org/10.1108/IJOPM-09-2014-0447>
- Raddats, C., Kowalkowski, C., Benedettini, O., Burton, J., & Gebauer, H. (2019). Servitization: A contemporary thematic review of four major research streams. *Industrial Marketing Management*, 83, 207–223. <https://doi.org/10.1016/J.INDMARMAN.2019.03.015>
- Raff, S., Wentzel, D., & Obwegeser, N. (2020). Smart Products: Conceptual Review, Synthesis, and Research Directions*. *Journal of Product Innovation Management*, 37(5), 379–404. <https://doi.org/10.1111/JPIM.12544>
- Randhawa, K., Wilden, R., & Gudergan, S. (2021). How to innovate toward an ambidextrous business model? The role of dynamic capabilities and market orientation. *Journal of Business Research*, 130, 618–634. <https://doi.org/10.1016/J.JBUSRES.2020.05.046>
- Ritala, P., Baiyere, A., Hughes, M., & Kraus, S. (2021). Digital strategy implementation: The role of individual entrepreneurial orientation and relational capital. *Technological Forecasting and Social Change*, 171, 120961. <https://doi.org/10.1016/J.TECHFORE.2021.120961>
- Rosenbusch, N., Brinckmann, J., & Bausch, A. (2011). Is innovation always beneficial? A meta-analysis of the relationship between innovation and performance in SMEs. *Journal of Business Venturing*, 26(4), 441–457. <https://doi.org/10.1016/J.JBUSVENT.2009.12.002>
- Saebi, T., Lien, L., & Foss, N. J. (2017). What Drives Business Model Adaptation? The Impact of Opportunities, Threats and Strategic Orientation. *Long Range Planning*, 50(5), 567–581. <https://doi.org/10.1016/J.LRP.2016.06.006>
- Sass, D. A., & Schmitt, T. A. (2010). A Comparative Investigation of Rotation Criteria Within Exploratory Factor Analysis. *Multivariate Behavioral Research*, 45(1), 73–103. <https://doi.org/10.1080/00273170903504810>
- Schreyögg, G., & Kliesch-Eberl, M. (2007). How dynamic can organizational capabilities be? Towards a dual-process model of capability dynamization. *Strategic Management Journal*, 28(9), 913–933. <https://doi.org/10.1002/SMJ.613>
- Schwer, K., Hitz, C., Wyss, R., Wirz, D., & Minonne, C. (2018). Digital maturity variables and their impact on the enterprise architecture layers. *Problems & Perspectives in Management*, 16(4), 141–154.

- Shen, L., Sun, W., & Parida, V. (2023). Consolidating digital servitization research: A systematic review, integrative framework, and future research directions. *Technological Forecasting and Social Change*, 191, 122478. <https://doi.org/10.1016/J.TECHFORE.2023.122478>
- Sirén, C., Hakala, H., Wincent, J., & Grichnik, D. (2017). Breaking the routines: Entrepreneurial orientation, strategic learning, firm size, and age. *Long Range Planning*, 50(2), 145–167. <https://doi.org/10.1016/J.LRP.2016.09.005>
- 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., Palmié, M., & Wincent, J. (2021). How AI capabilities enable business model innovation: Scaling AI through co-evolutionary processes and feedback loops. *Journal of Business Research*, 134, 574–587. <https://doi.org/10.1016/J.JBUSRES.2021.05.009>
- Storbacka, K. (2011). A solution business model: Capabilities and management practices for integrated solutions. *Industrial Marketing Management*, 40(5), 699–711. <https://doi.org/10.1016/J.INDMARMAN.2011.05.003>
- Suppatvech, C., Godsell, J., & Day, S. (2019). The roles of internet of things technology in enabling servitized business models: A systematic literature review. *Industrial Marketing Management*, 82, 70–86. <https://doi.org/10.1016/J.INDMARMAN.2019.02.016>
- Teece, D. J. (2010). Business models, business strategy and innovation. *Long Range Planning*, 43(2–3), 172–194.
- Tian, J., Coreynen, W., Matthyssens, P., & Shen, L. (2022). Platform-based servitization and business model adaptation by established manufacturers. *Technovation*, 118, 102222. <https://doi.org/10.1016/J.TECHNOVATION.2021.102222>
- Tronvoll, B., Sklyar, A., Sörhammar, D., & Kowalkowski, C. (2020). Transformational shifts through digital servitization. *Industrial Marketing Management*, 89, 293–305. <https://doi.org/10.1016/J.INDMARMAN.2020.02.005>
- Tukker, A. (2004). Eight types of product–service system: eight ways to sustainability? Experiences from SusProNet. *Business Strategy and the Environment*, 13(4), 246–260. <https://doi.org/10.1002/BSE.414>
- UKRI. (2023). *Manufacturing: The key to unlocking UK innovation*. Manufacturing: The Key to Unlocking UK Innovation. <https://www.ukri.org/blog/manufacturing-the-key-to-unlocking-uk-innovation/>
- Urbach, N., & Ahlemann, F. (2016). IT-Management im Zeitalter der Digitalisierung. In *IT-Management im Zeitalter der Digitalisierung*. Springer Berlin Heidelberg. <https://doi.org/10.1007/978-3-662-52832-7>
- van Dijk, J. (2020). *The Digital Divide*. John Wiley & Sons.
- 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](https://doi.org/10.1016/0263-2373(88)90033-3)
- Vickery, S. K., Koufteros, X., Dröge, C., & Calantone, R. (2016). Product Modularity, Process Modularity, and New Product Introduction Performance: Does Complexity Matter? *Production and Operations Management*, 25(4), 751–770. <https://doi.org/10.1111/poms.12495>
- Visnjic, I., Ringov, D., & Arts, S. (2019). Which Service? How Industry Conditions Shape Firms' Service-Type Choices. *Journal of Product Innovation Management*, 36(3), 381–407. <https://doi.org/10.1111/JPIM.12483>
- Visnjic, I., Wiengarten, F., & Neely, A. (2016). Only the Brave: Product Innovation, Service Business Model Innovation, and Their Impact on Performance. *Journal of Product Innovation Management*, 33(1), 36–52. <https://doi.org/10.1111/JPIM.12254>
- Wang, X., & Disney, S. M. (2016). The bullwhip effect: Progress, trends and directions. *European Journal of Operational Research*, 250(3), 691–701. <https://doi.org/10.1016/J.EJOR.2015.07.022>

- Wiklund, J., & Shepherd, D. (2003). Aspiring for, and Achieving Growth: The Moderating Role of Resources and Opportunities*. *Journal of Management Studies*, 40(8), 1919–1941.
<https://doi.org/10.1046/J.1467-6486.2003.00406.X>
- Zhang, W., & Banerji, S. (2017). Challenges of servitization: A systematic literature review. *Industrial Marketing Management*, 65, 217–227.
<https://doi.org/10.1016/j.indmarman.2017.06.003>
- Zott, C., & Amit, R. (2007). Business Model Design and the Performance of Entrepreneurial Firms. *Organization Science*, 18(2), 181–199. <https://doi.org/10.1287/orsc.1060.0232>
- Zott, C., & Amit, R. (2013). The business model: A theoretically anchored robust construct for strategic analysis. *Strategic Organization*, 11(4), 403–411.
<https://doi.org/10.1177/1476127013510466>
- Zott, C., Amit, R., & Massa, L. (2011). The Business Model: Recent Developments and Future Research. *Journal of Management*, 37(4), 1019–1042.
<https://doi.org/10.1177/0149206311406265>

APPENDIX A1: Business model descriptors

We asked respondents to “*please carefully read the following business model descriptions. Consider your primary/established offering in terms of its importance for your company’s revenues and choose the one descriptor that best represents the business model*”. As part of this prompt, they could also see the following note: “*Note that the term ‘digital technologies’ might refer to any of the following: Additive Manufacturing/ 3D-Printing, Cyber-physical systems and collaborative robots, Artificial Intelligence (including machine learning), Big data and analytics, The ‘Cloud’ (e.g., Cloud computing), Cyber security, Systems integration, Internet of Things (IoT) and Internet of People (IoP), Mixed (virtual and augmented) Reality, Simulation of connected machines, Blockchain technology, Digital marketplaces and platforms, Application Programming Interface (API)*”.

1. [Pure product] Our company does not provide any services associated with the product (e.g., maintenance), or services that support the customer(s) (e.g., customer helpdesk, training).
2. [Just servitized – Not digital] Our company provides some services, but digital technologies have little or no role to play in enabling these services. (Note: Selling your product through digital channels (the internet) is NOT considered a service).
3. [Add-on] Our company employs digital technologies to enable additional functions or add customized services to our existing physical product or service. Here, technology embedded in the product (such as sensors, actuators, software, connectivity components) enables the provision of digital features such as software applications, and/or services (e.g., continuous, or on-demand access to information, feedback and/or reports), that help the customer make their use of the product, or their process/operation, more efficient.
4. [Usage-based] Our company employs digital technologies to enable customers to use our product, while the ownership of the product remains with our company (or a third party). Customers pay based either on a negotiated plan, or on the actual usage of the product. Technology embedded in the product measures and monitors its usage/consumption to enable ‘pay-per-use’, or to make a service/product available for a restricted, contractually agreed, time span. The product(s) can either be cycled among customers, (i.e., a ‘leasing’ model where digital technology is used to monitor and grant access, schedule product maintenance, etc.) or remain exclusive to a single customer for the duration of a contract.
5. [Solution-oriented] Our company employs digital technologies to provide a contractually agreed outcome, such as a certain level of continuous utilization and uninterrupted usage (i.e., availability), or performance of the product, to a specific customer. Here digital technology allows our company to access real-time information on the product's status and/or pattern of its operation, in order to offer more effective maintenance, repair and operational support services (e.g., advice, consulting) to ensure the agreed outcome, and in extension, to optimize a core process/operation of the customer.
6. [Platform] Our company provides and manages a digital ‘platform’ that enables access to our company’s product(s) and/or service(s), or facilitates the exchange of products, services and information between providers and customers, aiming to create value for all parties, by, for example, optimizing asset utilization or making processes more efficient.
7. Other. Please describe your primary business model in a few words.

1320 **APPENDIX A2: Survey instrument**

1321

1322 *Size*

1323 Please indicate the number of employees in your company:

- 1324 • 1-9
- 1325 • 10-49
- 1326 • 50-249
- 1327 • More than 249 [filtered out]

1328

1329 *Age*

1330 Please specify the year of establishment of your company:

1331 _____

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1333 *Nature of customers*

1334 Please specify the nature of your customers (tick all that apply):

- 1335 • Other organizations or businesses ('Business-to-Business')
- 1336 • Individual consumers ('Business-to-Consumer')
- 1337 • Public sector ('Business-to-Government')

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1339 *Industry*

1340 Please indicate the primary industry in which your company operates:

- 1341 • Power generation (equipment and services)
- 1342 • Aerospace and defense
- 1343 • Shipbuilding & maritime equipment
- 1344 • Construction equipment and services
- 1345 • Consumer/household durables (e.g., electronics, appliances)
- 1346 • Biomedical/healthcare equipment and services
- 1347 • Transportation infrastructure and equipment
- 1348 • Automobiles and automotive components
- 1349 • Information Technology (hardware, software, services)
- 1350 • Engineering equipment and tools
- 1351 • Telecommunications equipment and services
- 1352 • Industrial machinery
- 1353 • Other electrical or mechanical equipment
- 1354 • Food, beverage and tobacco [filtered out]
- 1355 • Financial services [filtered out]
- 1356 • Textiles and apparel [filtered out]
- 1357 • Other [filtered out]

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1359 *Role*

1360 Please indicate your current position/role:

- 1361 • Top executive / Business owner
- 1362 • Senior management
- 1363 • Middle management
- 1364 • Junior management [filtered out]
- 1365 • Ordinary employee / worker [filtered out]

1366

1367 *Company experience*

1368 For how many years have you worked in this company?

1369 _____

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1371 *Level of knowledge*

- 1372 Please indicate the extent to which you consider yourself knowledgeable about the following (1 = “not
 1373 knowledgeable at all” / 7 = “very knowledgeable”):
- 1374 • The context/environment the company is facing (e.g., market trends, competitors, customer
 1375 requirements)
 - 1376 • The company’s products and/or services
 - 1377 • The company’s capabilities and internal processes
- 1378
- 1379 *Demand unpredictability*
- 1380 In our primary line of business,
- 1381 • Sales are:
 1382 Predictable 1 2 3 4 5 6 7 Unpredictable
 - 1383 • Product and/or service failures are:
 1384 Easy to predict 1 2 3 4 5 6 7 Hard to predict
 - 1385 • Market trends are:
 1386 Easy to monitor 1 2 3 4 5 6 7 Hard to monitor
 - 1387 • Sales forecasts are likely to be:
 1388 Accurate 1 2 3 4 5 6 7 Inaccurate
- 1389
- 1390 *Competition intensity*
- 1391 Please indicate the degree to which you agree or disagree with each statement (1 = “Strongly disagree” / 7 =
 1392 “Strongly agree”):
- 1393 • Competition in our primary industry is cutthroat.
 - 1394 • There are many "promotion wars" in our primary industry.
 - 1395 • Anything that one competitor can offer, others can match readily.
 - 1396 • Price competition is a hallmark of our primary industry.
 - 1397 • One hears of a new competitive move almost every day.
 - 1398 • Our competitors are relatively weak. [reverse coded & discarded]
- 1399
- 1400 *Product complexity*
- 1401 Please indicate the degree to which you agree or disagree with each statement (1 = “Strongly disagree” / 7 =
 1402 “Strongly agree”):
- 1403 • Our products are highly complex.
 - 1404 • The secondary functions that combine (or interact) to produce our products’ primary functions are
 1405 quite different from one another.
 - 1406 • Our products are very sophisticated in terms of structure.
 - 1407 • Our products are very sophisticated in terms of function.
 - 1408 • Our production system is very sophisticated in terms of structure/layout.
 - 1409 • Our production system is very sophisticated in terms of operation.
 - 1410 • Our production system is very complex.
 - 1411 • I would characterize the structure of our typical finished products as:
 1412 Very simple (i.e., few connections among components) 1 2 3 4 5 6 7 Very intricate
 - 1413 • In a given product, the number of secondary functions that combine (or interact) to produce the
 1414 product’s primary function is:
 1415 Very low (like in a toaster) 1 2 3 4 5 6 7 Very complex (like an airplane)
- 1416
- 1417 *Entrepreneurial orientation*
- 1418 Please indicate the degree to which you agree or disagree with each statement (1 = “Strongly disagree” / 7 =
 1419 “Strongly agree”):
- 1420 • We believe that wide-ranging acts are necessary to achieve our objectives.
 - 1421 • We initiate actions to which other organizations respond.
 - 1422 • We are fast to introduce new products and services to the marketplace.
 - 1423 • We have a strong proclivity for high-risk projects. [discarded]
 - 1424 • We are bold in our efforts to maximize the probability of exploiting opportunities. [discarded]

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Digital maturity

Please indicate the degree of digitization in your firm in terms of:

Process and infrastructure	Some of our internal processes are rudimentarily digital, some manual.	Internal processes are digital and, in some cases, interconnected.	Internal processes are digital and, in most cases, interconnected.	All processes are on a single digital platform.
Digital sales	We have a standardized website for sales.	We have accompanying measures and digital services augmenting online sales.	We use big data to create offerings for individual customers.	We have used digitization to fundamentally change our business model.
Customer involvement	Customers can give feedback on a standardized basis via digital channels.	Customer feedback is automatically processed and analyzed.	Customers are involved digitally in isolated business processes (e.g., sales and development).	Customers are involved digitally in all business processes (sales, development, etc.).
People and Culture	Digitization hardly concerns our staff.	We make sure staff use digital tools.	We provide training and experts to further the digital development of our staff.	We promote innovation by including digital skills in our hiring criteria.

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Tables

Table 1:
Comparison of the three typologies from the literature that influenced this work

Kohtamäki et al. (2019; 2022)	Gebauer et al. (2020)	Suppatvech et al. (2019)	This paper
<i>Product</i>			<i>Pure' product</i>
<i>Industrializer</i>	<i>Hardware-plus</i>		<i>Just' servitized</i>
		<i>Add-on</i>	<i>Add-on</i>
		<i>Sharing</i>	
		<i>Usage-based</i>	<i>Usage-based*</i>
<i>Integrated solution provider</i>		<i>Solution-oriented</i>	<i>Solution-oriented</i>
	<i>Outcome-based</i>		
<i>Outcome provider</i>			
	<i>Software</i>		
			<i>Platform</i>
<i>Platform orchestrator</i>	<i>Platform</i>		

* As discussed in the Methodology section, the *sharing* category of Suppatvech et al. (2019) was 'absorbed' in the *usage-based* one in the process of the development and validation of the business model descriptors through interviews with practitioners.

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Table 2:
Digital servitization business model types and definitions

Type	Original definitions
Add-on	<i>"...a business model that uses IoT in enabling additional functions or adding personalized services to the existing physical products or service. This corresponds to product-oriented business models in the traditional PSS categorization, where the provider offers services that are added to a physical product to support its function (Tukker, 2004)." (Suppatvech et al., 2019: p.74).</i>
Sharing*	<i>"...the customers pay for using or accessing a product for a limited amount of time, which allows different users to continue using the product when it is available – this corresponds to a type of use-oriented PSS according to Tukker's (2004) classification. From the perspective of the provider, this increases asset utilization, but the provider is responsible for making sufficient products available for the customers to access. As ownership of the physical good providing utility to the customer remains with the provider and users change, this business model is conceptually close to renting." (Suppatvech et al., 2019: p.74).</i>
Usage-based	<i>"...use IoT to measure the amount of product usage and allow customers to pay for or subscribe to the plan, based on their actual usage and needs. The provider is then responsible for delivering the expected utility in use. This can be considered as a result-oriented model in a traditional PSS business model as the service that firms offer to the customer has a certain result or outcome (Tukker, 2004)." (Suppatvech et al., 2019: p.76).</i>
Solution-oriented	<i>"...that utilize IoT in enabling the provision of solutions to customers. With the aid of IoT technology, providers can offer integrated solutions to customers' needs, which in B2B practice relate to supporting customers' core operations and increases in efficiency and expanding business capabilities. Hence, this business model corresponds to the result-oriented PSS, where firms make agreements with customers to deliver a specified outcome or result (Tukker, 2004)." (Suppatvech et al., 2019: p.76).</i>
Platform	<i>"...products, services, or technologies that act as a foundation upon which external innovators, organized as an innovative business ecosystem, can develop their complementary products, technologies, or services." (Gawer and Cusumano, 2014). A platform enables connections and exchange between actors (e.g., multiple suppliers and customers) creating value for all parties (Kohtamäki et al., 2019).</i>
<i>*The sharing category was absorbed in the usage-based one upon feedback by academic and practitioner experts.</i>	

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Table 3:
Descriptive statistics

	Non-DS	Add-on	Usage-based	Solution-Oriented	Platform	All
	<u>Mean (std)</u>					
DU	3.91 (1.21)	3.47 (1.06)	3.23 (1.17)	2.77 (1.16)	3.91 (1.28)	3.44 (1.22)
CI	4.93 (0.92)	4.77 (1.02)	5.3 (0.93)	5.14 (0.9)	5.19 (0.88)	5.04 (0.96)
Age in years	19.79 (16.92)	20.93 (17.21)	15.61 (13.71)	14.51 (15.16)	12.81 (12.97)	17.16 (15.7)
DIG	24.13 (35.45)	40.23 (34.42)	64.44 (43.52)	65.01 (54.33)	55.5 (40.66)	49.48 (44)
PPC	4.41 (1.22)	4.78 (0.83)	5.28 (0.63)	5.39 (0.69)	5.19 (0.87)	5 (0.92)
EO	4.62 (1.23)	5 (0.97)	5.45 (0.77)	5.46 (1.01)	5.66 (0.82)	5.22 (1.02)
B2B	0.42 (0.49)	0.55 (0.49)	0.76 (0.43)	0.672 (0.47)	0.46 (0.5)	0.58 (0.49)
	<u>Number (proportion)</u>					
Size						
<i>Micro</i>	17 (31.5%)	10 (10.8%)	4 (6.0%)	8 (13.8%)	2 (3.7%)	41 (12.6%)
<i>Small</i>	19 (35.2%)	31 (33.3%)	32 (47.8%)	29 (50.0%)	35 (64.8%)	146 (44.8%)
<i>Medium</i>	18 (33.3%)	52 (55.9%)	31 (46.3%)	21 (36.2%)	17 (31.5%)	139 (42.6%)
Industry						
<i>Transport</i>	12 (22.2%)	14 (15.1%)	13 (19.4%)	8 (13.8%)	5 (9.3%)	52 (16.0%)
<i>Industrials</i>	18 (33.3%)	36 (38.7%)	8 (11.9%)	16 (27.6%)	9 (16.7%)	87 (26.7%)
<i>Healthcare</i>	9 (16.7%)	11 (11.8%)	11 (16.4%)	7 (12.1%)	4 (7.4%)	42 (12.9%)
<i>Cons goods</i>	7 (13.0%)	10 (10.8%)	9 (13.4%)	2 (3.4%)	22 (40.7%)	50 (15.3%)
<i>IT/Telecoms</i>	8 (14.8%)	22 (23.7%)	26 (38.8%)	25 (43.1%)	14 (25.9%)	95 (29.1%)
N	54 (16.6%)	93 (28.5%)	67 (20.6%)	58 (17.8%)	54 (16.6%)	326 (100%)

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Table 4:
Pearson correlation coefficients

Variables	DU	CI	Age	DIG	PPC	EO
DU	1					
CI	0.042	1				
Age	-0.017	-0.176***	1			
DIG	-0.155***	0.107**	-0.075	1		
PPC	-0.109**	0.498***	-0.178***	0.279***	1	
EO	-0.191***	0.393***	-0.119**	0.275***	0.571***	1
Notes: N = 326						
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$						

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MODEL (1)	Business model (base outcome: Non-DS)			
Variables	Add-on	Usage-based	Solution-oriented	Platform
DU	-0.286*	-0.371**	-0.808***	-0.0125
	(0.151)	(0.169)	(0.186)	(0.171)
CI	-0.184	0.393*	0.164	0.0899
	(0.188)	(0.223)	(0.219)	(0.229)
B2B dummy ($Yes = 1$)	0.431	1.471***	0.780*	0.503
	(0.361)	(0.427)	(0.424)	(0.425)
Industry (base-level: <i>Transport</i>)				
<i>Industrials</i>	0.426	-0.805	0.306	0.176
	(0.497)	(0.611)	(0.612)	(0.675)
<i>Healthcare</i>	-0.151	0.260	-0.0307	0.181
	(0.621)	(0.663)	(0.738)	(0.825)
<i>Consumer Goods</i>	0.346	0.606	-0.610	2.133***
	(0.652)	(0.690)	(0.965)	(0.707)
<i>IT & Telecoms</i>	0.758	1.130*	1.416**	1.447**
	(0.580)	(0.599)	(0.647)	(0.698)
<i>Constant</i>	1.966*	-1.606	1.055	-1.553
	(1.176)	(1.450)	(1.444)	(1.459)
<i>N</i>			326	
Pseudo R-squared			0.110	

Notes: Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

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Table 6: Multinomial logistic regression results for organizational determinants

Table 6: Multinomial Logistic Regression Results for Organizational Determinants				
MODEL (2)	Business Models (base outcome: Non-DS)			
Variables	Add-on	Usage-based	Solution-oriented	Platform
Firm Age	-0.000319 (0.0112)	-0.00444 (0.0141)	-0.00832 (0.0152)	-0.0165 (0.0162)
Firm Size (base-level: <i>Micro-business</i>)				
<i>Small</i>	0.724 (0.548)	0.745 (0.747)	-0.114 (0.651)	1.810** (0.893)
<i>Medium</i>	1.225** (0.555)	1.026 (0.759)	-0.505 (0.674)	1.293 (0.927)
DIG	0.0107 (0.00671)	0.0213*** (0.00688)	0.0215*** (0.00692)	0.0170** (0.00717)
PPC	0.0892 (0.225)	0.494 (0.301)	1.113*** (0.327)	0.115 (0.295)
EO	0.144 (0.197)	0.446* (0.250)	0.175 (0.256)	0.752*** (0.276)
B2B dummy (<i>Yes</i> = 1)	0.590 (0.376)	1.663*** (0.457)	0.948** (0.451)	0.625 (0.463)
Industry (base-level: <i>Transport</i>)				
<i>Industrials</i>	0.376 (0.533)	-0.918 (0.680)	0.578 (0.667)	0.236 (0.753)
<i>Healthcare</i>	0.00334 (0.634)	0.160 (0.706)	0.0400 (0.769)	-0.121 (0.872)
<i>Consumer Goods</i>	-0.0355 (0.671)	0.151 (0.735)	-1.008 (0.995)	1.488* (0.777)
<i>IT & Telecoms</i>	0.524 (0.615)	0.689 (0.659)	1.308* (0.697)	1.022 (0.765)
Constant	-2.226* (1.145)	-7.053*** (1.602)	-7.844*** (1.668)	-7.195*** (1.776)
N	326			
Pseudo R-squared	0.167			
Notes: Standard errors in parentheses				
* $p < 0.10$. ** $p < 0.05$. *** $p < 0.01$				

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Table 7: Multinomial logistic regression results for environmental and organizational determinants

Determinants				
MODEL (3)	Business Models (base outcome: Non-DS)			
Variables	Add-on	Usage-based	Solution-oriented	Platform
DU	-0.224 (0.168)	-0.211 (0.191)	-0.625*** (0.208)	0.210 (0.199)
CI	-0.647** (0.253)	-0.279 (0.298)	-0.587** (0.290)	-0.765** (0.309)
Firm Age	-0.00432 (0.0118)	-0.00699 (0.0147)	-0.0132 (0.0158)	-0.0180 (0.0163)
Firm Size (base-level: <i>Micro-business</i>)				
<i>Small</i>	0.944 (0.579)	0.868 (0.764)	-0.0789 (0.685)	2.191** (0.921)
<i>Medium</i>	1.333** (0.577)	1.114 (0.766)	-0.392 (0.695)	1.442 (0.945)
DIG	0.00868 (0.00696)	0.0200*** (0.00710)	0.0180** (0.00720)	0.0168** (0.00736)
PPC	0.381 (0.256)	0.617* (0.331)	1.272*** (0.351)	0.397 (0.341)
EO	0.159 (0.221)	0.401 (0.270)	0.0895 (0.279)	0.907*** (0.297)
B2B dummy (<i>Yes</i> = 1)	0.604 (0.387)	1.662*** (0.463)	0.897* (0.466)	0.738 (0.476)
Industry (base-level: <i>Transport</i>)				
<i>Industrials</i>	0.423 (0.552)	-0.823 (0.689)	0.584 (0.685)	0.157 (0.767)
<i>Healthcare</i>	-0.445 (0.662)	-0.0972 (0.729)	-0.502 (0.796)	-0.439 (0.897)
<i>Consumer Goods</i>	-0.0410 (0.682)	0.165 (0.739)	-0.780 (0.996)	1.431* (0.779)
<i>IT & Telecoms</i>	0.717 (0.641)	0.937 (0.680)	1.429** (0.728)	1.233 (0.787)
Constant	0.354 (1.530)	-5.258*** (1.965)	-2.837 (2.059)	-6.539*** (2.120)
N			326	
Pseudo R-squared			0.198	
Notes: Standard errors in parentheses				
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$				

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Table 8: Wald-test (chi-squared) statistics for tests of joint significance			
	MODEL (1)	MODEL (2)	MODEL (3)
Variables			
Industry (dummies)	43.35***	31.45**	30.47**
B2B (dummy)	12.97**	14.35***	13.43***
DU	23.63***		18.04***
CI	9.89**		9.89**
Firm Age		1.51	1.61
Firm Size (dummies)		18.09**	20.04**
DIG		13.84***	11.81**
PPC		14.04***	13.53***
EO		8.99*	11.30**
Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$			

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Table 9: Predicted probabilities of each business model for a ‘typical’ micro, small and medium-sized business operating in five different environments.

Environment ¹	<i>Avg</i> DU <i>Avg</i> CI	<i>High</i> DU <i>High</i> CI	<i>High</i> DU <i>Low</i> CI	<i>Low</i> DU <i>High</i> CI	<i>Low</i> DU <i>Low</i> CI
<i>Micro businesses</i>					
Non-DS ²	47.60%	69.27%	42.34%	50.48%	25.16%
Add-on	25.49%	15.11%	32.15%	19.07%	33.08%
Us-based	8.24%	7.07%	7.40%	8.66%	7.39%
Sol-oriented	15.97%	6.12%	11.61%	20.74%	32.06%
Platform ²	2.70%	2.43%	6.49%	1.06%	2.30%
<i>Small businesses</i>					
Non-DS	9.02%	16.84%	5.87%	11.42%	4.21%
Add-on	25.74%	19.59%	23.76%	23.00%	29.48%
Us-based	22.52%	24.81%	14.81%	28.25%	17.82%
Sol-oriented	16.02%	7.88%	8.52%	24.83%	28.37%
Platform	26.70%	30.86%	47.04%	12.50%	20.13%
<i>Medium-sized enterprises</i>					
Non-DS	9.90%	19.36%	7.40%	11.87%	4.45%
Add-on	42.73%	34.03%	45.25%	36.12%	47.12%
Us-based	23.17%	26.71%	17.48%	27.49%	17.65%
Sol-oriented	13.49%	6.95%	8.23%	19.78%	23.01%
Platform	10.71%	12.95%	21.64%	4.74%	7.77%

Notes: 1. ‘*Avg*’ refers to the mean of the distribution of a factor in the entire sample, while ‘*high*’ and ‘*low*’ denote 1 standard deviation larger and smaller than the mean, respectively. 2. In each of the five environmental contexts, and for a ‘typical’ micro, small and medium business separately, the model-generated predicted probability that is **bolded** denotes the most likely business model choice, while the *italicized* one denotes the least likely choice.

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1481 **Figures**

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1483 **Figure captions (as a list)**

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1485 Figure 1: Predicted probabilities of business models for different levels of product complexity

1486 Figure 2: Predicted probabilities of business models for different levels of digitization

1487 Figure 3: Predicted probabilities of business models for different levels of entrepreneurial
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Figure 1:
Predicted probabilities of business models for different levels of product complexity

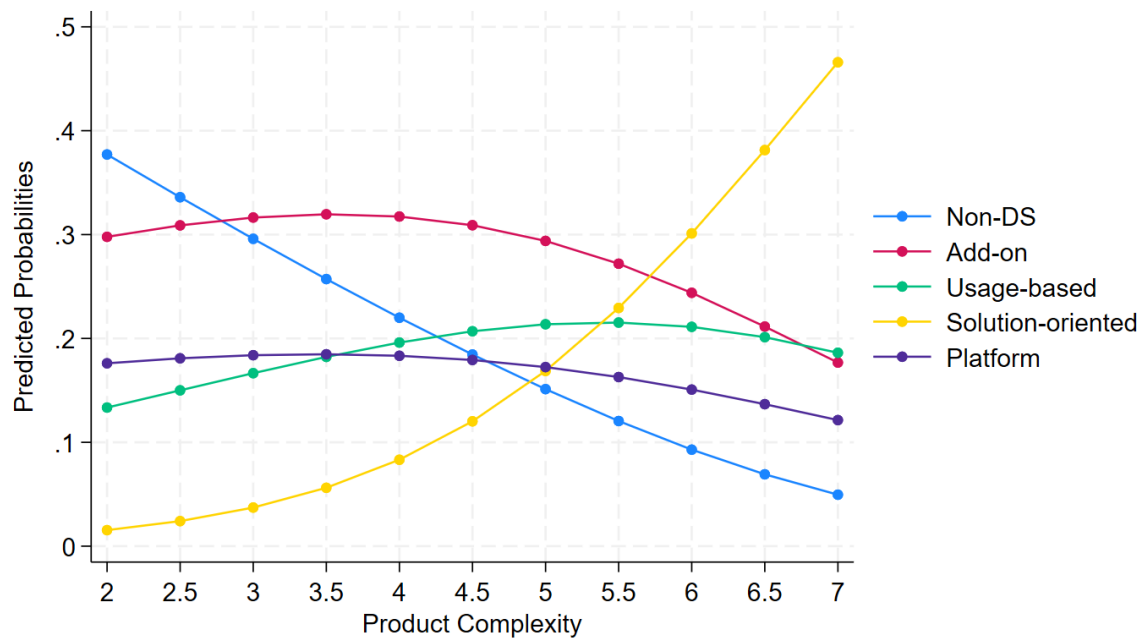


Figure 2:
Predicted probabilities of business models for different levels of digitization

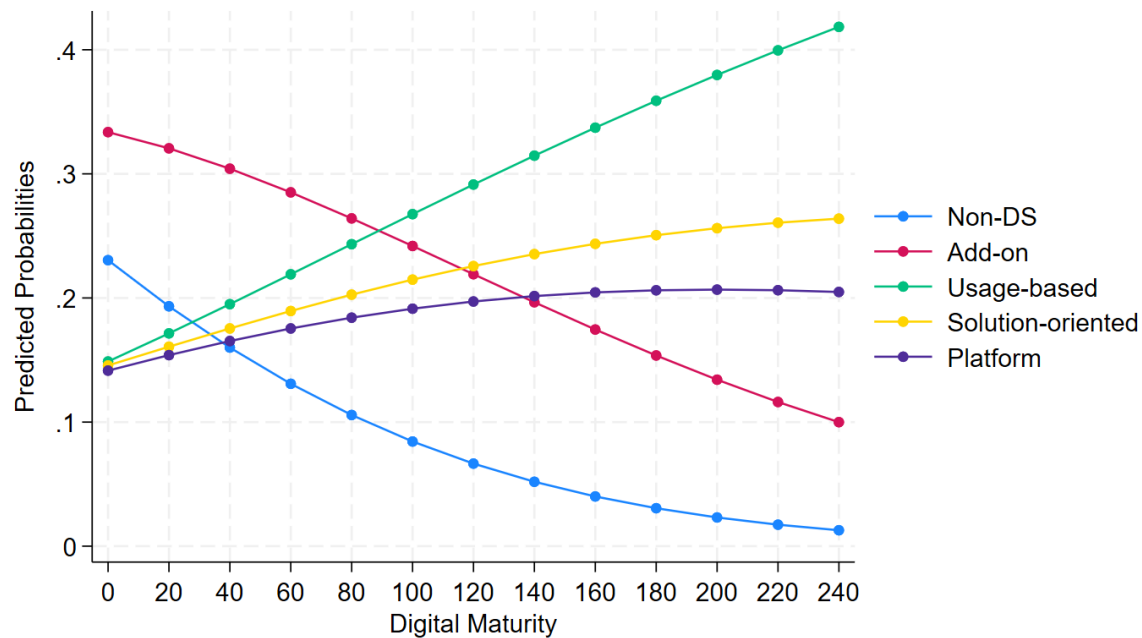


Figure 3:
Predicted probabilities of business models for different levels of entrepreneurial orientation

