‘Business Model Innovation and Digital Servitization in UK Manufacturing Small and Medium Sized Enterprises’

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The full report and additional resources to support manufacturers in adopting digital servitization business models can be found at interact-hub.org and www.interact-digiserve.co.uk

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Executive Summary

This report is the main outcome of an 8-month, Made Smarter Innovation (MSI) funded project that investigated the potential of digital servitization for manufacturing Small-and-Medium-sized enterprises (SMEs) in the UK.

Digital servitization, *i.e.*, the utilisation of digital technologies such as the Internet-of-Things (IoT), Blockchain and Artificial Intelligence (AI) to enable innovative, service-based business models, constitutes an emerging business strategy, and has given rise to a growing academic research stream. However, to date, the focus has primarily remained on large firms, neglecting a vast sector of the economy: the manufacturing SMEs. This posits several challenges to principal decision-makers of these firms when contemplating a transition towards digital servitization. Key concerns relate to the conditions of applicability of digital servitization business models, when taking into consideration the business context the firm operates in. In addition, whether such a transition may generate financial rewards represents a reasonable point of scepticism in SMEs. These are important considerations that feed into the organisation design decisions that the top management team needs to take. Therefore, project's key objective was to identify configurations of contextual and organisational factors that are associated with high business performance of manufacturing SMEs following different business models.

Drawing from academic research, we developed, operationalised and pilot tested a typology of digital servitization business models, and identified seven environmental and organisational factors that could plausibly determine the success of such business models. These were the key building blocks of a survey instrument that was distributed to manufacturing SME owners and high-level managers in the UK, with the help of Qualtrics, a market research company with access to large panels of business practitioners willing to respond to surveys for a fee. Data cleaning resulted in 352 usable responses. Factor analysis followed, to validate the measures and generate factor scores. We then applied fuzzy-set Qualitative Comparative Analysis (fsQCA) to identify the 'highly performing' configurations of contextual and organisational factors.

Findings suggest that SMEs can achieve high performance through all digital servitization business models, depending on how well each model aligns with the organisation's context and design. Moreover, there exist multiple configurations for each business model that are equally effective in achieving high business performance. This indicates that there is no singular formula for success; SMEs operating in diverse contexts and possessing different organisational characteristics have an equal opportunity to successfully embark on the journey of digital servitization and excel in their performance. The results also suggest that SMEs should prioritize investment in digitisation; in today's business environment, this investment should probably take precedence over other considerations. Managers should also foster a strong service culture among employees, an endeavour that can yield significant benefits with minimal drawbacks.

The findings of this project have informed the development of a microsite that envisages to be a useful resource for SMEs interested in digital servitization. A key project output, and main pillar of the microsite, is a 'self-assessment toolkit' that aims to assist managers in

diagnosing the circumstances of their firm and making an informed decision as to whether digital servitization makes sense for their business, and if yes, which business model is more likely to generate financial rewards. The 'toolkit' is accompanied by a 'training manual', in the form of a set of educational videos. The microsite constitutes the primary means of impact on business practice of this project.

Besides its impact on practice, this work also contributes to academic knowledge by advancing the study of digital servitization in various ways. It also has important implications for policy makers, regarding incentivising and educating SMEs to adopt digital technologies and move toward advanced, digitally enabled business models.

Section 1 of the report introduces the context of the study, justifies its scope and approach, and explicates its objectives. Section 2 introduces the adopted methodology in a step-by-step manner. More specific methodological details are included in the Appendices. Section 3 comprises the results of this work, split between 'descriptive' and 'explanatory'. Section 4 briefly describes how the academic findings were re-packaged and communicated in a practitioner friendly manner through a microsite. Finally, section 5 details the multifarious implications of this project.

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1. Introduction

1.1. Context, Purpose and intended Audience

This report addresses the research gap concerning the implementation of Digital Servitization Business Models in the context of UK manufacturing Small and Medium-sized Enterprises (SMEs). This work is positioned at the intersection of entrepreneurship and operations management, providing synergetic insights between the two disciplines that foster interdisciplinary understanding of the application of digitalisation in the SME context. This is a timely addition to an emerging digital servitization research stream that has centred almost exclusively around large organisations (Rabetino et al., 2021). From an entrepreneurship perspective, this research relates to the innovative processes that underpin the relationship between business model implementation and firm outcomes. For operations management, it provides insights on the conditions of applicability of digital servitization business models, providing SMEs with an opportunity to understand the operational changes necessary for shifting traditional, product-centric business models to digitally-enabled, service-based ones.

The critical neglect of SMEs in the digital servitization agenda presented an actionable gap in terms of understanding the strategic, organisational and technological challenges (Verhoef et al., 2019) involved, and the practitioner tools critical to manage the transition towards digital servitization (Deshler & Smith, 2011; Evans & Johnson, 2013). Since extant research suggests that the process of digital servitization may result to changes in the entire business model (Chen et al., 2021), the study offers practitioners with an actionable toolkit, applicable to Manufacturing SMEs, that can assist decision making.

"SMEs represent organisations that employ less than 250 persons, with a turnover of up to EUR 50 million or a balance sheet total of no more than EUR 43 million" (Eurostat,

2022:p4). In the United Kingdom, SMEs account for nearly 99% of all private sector businesses at the start of 2022, which reflects a 1.5% decrease in the private sector business population compared to 2021 (GOV, 2022). UK SMEs are responsible for 61% of total employment (16.4 million) with an approximate total turnover of £2.1 trillion (GOV, 2022). When looking at the UK manufacturing SME landscape, this is consistent with the bigger picture, accounting for nearly 99% of all manufacturing enterprises and current contracted output (S&P Global, 2022), and comprising more than 130,000 firms (The Manufacturer, 2022). In this context, the importance of digitalisation is well understood, with the UK set to be the global leader in the creation, adoption and exportation of advanced digital technologies (Made Smarter, 2022). Despite this, the UK manufacturing sector is inherently diverse, with several large, leading manufacturing firms investing in digital technologies, and the remaining 99% of firms, the SMEs, not adopting these technologies at speed (Make UK, 2020). This dichotomy sets an unwelcome predicament, risking a digital divide where SMEs may struggle to compete in an increasingly digitalised marketplace.

To investigate these challenges, the project focussed on the strategy of digital servitization in the context of UK manufacturing SMEs. As a form of Business Model Innovation (BMI), servitization has become increasingly popular among manufacturers aiming to maintain their competitiveness and reduce their environmental impact (Kohtamaki et al., 2013). The concept reflects the transition of companies from selling standalone products and 'basic' services, to the provision of sophisticated product-service offerings (Chen et al., 2021). New technologies that enable management of information input and output at a distance, enable the provision of new types of services, fostering servitization through digitalisation (Coreynen et al., 2017). This has led to a research stream in "digital servitization", i.e., *"the transition toward smart product-service-software systems that enable value creation and*

capture through monitoring, control, optimization and autonomous function" (Kohtamaki et al., 2019).

The following stakeholders within the UK Manufacturing community may find the study's findings and this report useful:

1. ***SME principal decision-makers:*** The report provides evidence-based insights on the conditions of applicability and adoption outcomes of digital servitization business models.
2. ***Digitalisation consultants and industry practitioners*****:** The report provides thought leadership to professionals that advice firms on business model innovation and digital transformation respectively.
3. ***Policymakers:*** The report informs policy on the importance of digital adoption in SMEs and incentivises the adaptation of initiatives that support innovation and digitalisation in SMEs.
4. ***Academics***: The report and its constituent intellectual outputs contribute to the academic literature on digital servitization and its interdisciplinary applications. By championing a holistic interpretation of digital servitization business models, findings of this investigation provide a foundation for future research exploring the role of digital technologies for SME business ecosystems.

1.2. Project Objectives

The project had the following objectives:

- To develop and operationalise a digital servitization business model typology, and a data collection instrument that captures environmental and organisational antecedents of digital servitization adoption.
- To collect primary data via means of a survey distributed to a large sample of UK manufacturing SMEs.
- To identify configurations of contextual and organisational factors that are associated with high performance of manufacturing SMEs, adopting different digital servitization business models.
- To develop a practical, self-assessment "*Digital Servitization SME toolkit"* that can assist UK manufacturing SMEs in their servitization journey, taking into consideration their environmental and organisational conditions.

The report adheres directly to the overall aim of the MSI Challenge, i.e., to help UK manufacturers become more competitive through the innovation and diffusion of digital technologies. With respect to InterAct Hub, the project falls under the *Business model innovation* theme, since it provides insights on how innovative digital servitization business models contribute to manufacturing SME success. The project also relates tangentially to both the *Levelling up* and *Equality, diversity and inclusion* themes. The post-Brexit UK business environment with implicit and explicit barriers to trade with the EU, as well as the increasing energy and resource prices, are more likely to hinder SMEs than larger businesses. The adoption of digital technologies by SMEs might contribute to their survival and long-term business growth, sustaining a diverse and resilient business ecosystem.

1.3. Overview of Results

The study's empirical results suggest that SMEs can achieve high performance through a number of digital servitization business models, depending on how well each model aligns with their organisation's context and design. Across the six business models (four of which represent different forms of digital servitization), we found 19 "successful" configurations. Thus, there exist multiple configurations for each business model that are equally effective in achieving high business performance. This indicates that there is no singular formula for success; no "one size fits all" solution. SMEs operating in diverse contexts and possessing different organisational characteristics have an equal opportunity to successfully embark on the journey of digital servitization and excel in their performance.

Furthermore, it is important to note that while the context an SME faces might be somewhat beyond its control, there are elements of organisational design that SME owners or managers have the power to influence. Our results suggest that SMEs should prioritise investment in digitisation, given of course the inevitable resource constraints they face. In today's business environment, this investment should probably take precedence over other considerations. Second, managers should foster a strong service culture among employees. Prioritising the development of this aspect within SMEs can yield significant benefits with minimal drawbacks.

1.4. Impact Summary

The long-term vision of this project is to define the digital servitization agenda and provide thought leadership on the implications of digital servitization for the long-term future of UK Manufacturing. We envisage that this will be accomplished via output dissemination through an academic and a beneficiaries' pathway. This approach is consistent with the

guiding principles of knowledge valorisation for enhancing and optimising project outcomes (Europa, 2022). Through both pathways, the project aims to create essential connections among academic and practitioner audiences, reinforcing the importance of digital servitization business models as an innovation activity instrumental for manufacturing SMEs. The scholarly pathway represents the impact of the project's intellectual outputs on academic research, whereas the beneficiaries' pathway reflects the practical impact on SMEs i.e., the primary stakeholders of the project.

Scholarly Pathway: The scholarly pathway offers interdisciplinary thought leadership on digital servitization, as a form of business model innovation. This comprises of three academic conference publications and two academic journal article submissions, which enhance the credibility and potential influence of beneficiary impact activities. A straightforward measure of the academic impact of this project is the number of citations that the journal papers will manage to accrue.

Beneficiaries' Pathway: The beneficiaries' pathway measures impact through direct involvement with SMEs, who benefit directly from the project outcomes. Impact through this pathway will be measured through the degree of engagement of project recipients with the self-assessment SME toolkit, that can be found on the project's microsite. By promoting the toolkit to key beneficiaries, the project champions the implementation of digital servitization business models by manufacturing SMEs. The toolkit will help firms to understand the challenges of this transformation, assess its application to their operational context and evaluate whether this fits their overall strategic direction. To measure long-term impact, the project team will track the number of SMEs that engage with the self-assessment toolkit, and the number of SMEs that contact the project team for further clarification and research. Beyond the adoption of the toolkit, the project team's direct engagement with SMEs in the

stages of validating the survey instrument, acting upon the feedback during the survey pilot, and dissemination of the study's findings in networking and community events, represent a set of tangible impact activities.

This dual impact pathway ensures a nuanced and continuous influence on the phenomenon of digital transformation of UK SMEs, and on the study of digital servitization by the academic community.

1.5. Definition of Key Terms

Digital Servitization: *"the transition toward smart product-service-software systems that enable value creation and capture through monitoring, control, optimization and autonomous function"* (Kohtamaki et al., 2019).

Business Model: *"the design or architecture of the value creation, delivery and capture mechanisms of a firm"* (Teece, 2010:172)

Business Model Innovation: The reconfiguration of existing resources and capabilities and the redesign of nonprofitable routines within the activity system (Bock et al., 2012) that complements traditional product and process innovation (Spieth and Scneider, 2016)

Small and/or Medium Enterprise: A company is classified as SME if it has fewer than 250 employees and either a turnover not exceeding €50m, or a balance sheet total not exceeding €43m (Europa, 2016).

2. Methodology

This section summarises the key steps of the methodology followed to address the project's objectives. It begins with the development of an operationalisable typology of digital servitization business models. It continues with key details about the research instrument development process, and a summary of the data collection and analysis methods. Appendices A and B serve as helpful companions for readers interested in delving deeper in the research design of this project.

2.1. Development of the Digital Servitization Business Model Typology

A key intermediate methodological objective was to classify SMEs based on the digital servitization business models they follow. As such, we required a set of logically coherent, clear, and relevant textual descriptors, which respondents could use to *self-classify* their company. We thus embarked into developing a typology that comprehensively captures the different digital servitization business model landscape observed in practice.

For this, we started by identifying previous similar attempts in the academic literature. As such, the main influences behind the creation of our typology were Suppatvech et al. (2019) and Kohtamäki et al. (2019). The authors of the first study conducted an extensive systematic literature review that resulted in the derivation of four 'archetypes' of IoT-enabled business models. Those business model archetypes were named: "*add-on*", "*sharing*", "*usage-based*", and "*solution-oriented*", which the authors describe in detail, specifying the distinguishing features of each. The advantage of this typology is that it takes into consideration a large literature corpus, that includes both theoretical insight and practical examples. The disadvantage is that it only focusses on a singular digital technology: the Internet-of-Things (IoT). Nevertheless, even though 'digital technologies' is a broader term

than Internet of Things (IoT), it was straightforward to extend and generalise the four types of Suppatvech et al. (2019) into 'digitally-enabled' business model types. When it comes to Kohtamäki et al. (2019), the authors derived their classification after reviewing four (grand) 'theories of the firm' and a few previous attempts to categorise (digital) servitization business models. However, we felt that the descriptions they provide were generic, and did not differentiate the models sufficiently. As such, we could not operationalise them by developing clear and distinct textual descriptors. That said, Kohtamäki et al. (2019) includes an archetype called "*platform provider*", which is exceedingly pertinent in the business world and a popular digital servitization path for entrepreneurial SMEs (Cenamor et al., 2019). As such, we included "*platform provider*" as a fifth category, to complement the categories of Suppatvech et al. (2019).

We then developed descriptors for each category, in lay language, which knowledgeable respondents from SMEs could understand and use to self-classify their firm. Drafts of the model descriptors were reviewed for clarity, relevance, and comprehensiveness by six academic experts. Their areas of expertise included servitization, digitalisation, and business models. Four SME practitioners with long 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 clearly relevant to SMEs. Crucially, the "*sharing*" category was absorbed in the description of the "*usage-based*" model descriptor, because it was agreed that the value creation and capture mechanisms of the underlying model was also based on 'usage'. As such we ended up with four digitally-enabled service-based business model types (and the respective descriptors). These cover the entire landscape of possible business models, we also added a *"pure-product*" (no services) category, as well as a "*servitized but not digital*"

category reflecting a situation where digital technologies played no role in the provision of services.

2.2. Final Business Model Descriptors

Table 1 presents the complete textual descriptors of the four digital servitization business models, plus the descriptors signifying a servitized SME that has not transitioned to digital servitization (*"servitized but not digital"*) and a *"pure product"* provider. The six-type classification is, at least in theory, exhaustive, i.e., we do not believe that it is possible for any manufacturing SME to follow a business model that does not belong to any of the six types. Nevertheless, in the survey instrument (section 2.3), we also provided a seventh option: "Other". The very few responses who chose the latter were removed from the analysis.

Add-on
Our company employs digital technologies to enable additional functions or add customised 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.
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.
Solution-oriented
Our company employs digital technologies to provide a contractually agreed outcome, such as a certain level of continuous utilisation 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.
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, optimising asset utilization or making processes more efficient.
Servitized but 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)
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.

Table 1 - The final business model descriptors

2.3. Factors Relevant to the Success of Digital Servitization Business Models

Having developed the textual descriptors for the business models and given that our objective was to *explain* the success of digital servitization business models, the next methodological step consisted in identifying a set of relevant contextual and organisational factors that could determine the performance of SMEs that have adopted different business models.

When it comes to the business *context* an SME operates in, the list of variables that capture different aspects is very long. We wanted to strike a balance between comprehensiveness (i.e., many factors) and parsimony (i.e., few factors), keeping also in mind the constraints imposed on us by the intended mode of data collection (online survey) and the data analysis technique (sections 2.5, 2.6). As such, following a comprehensive review of the digital servitization literature we discerned four factors that, we argue, would capture just enough relevant information about an SME's business context. These were *demand unpredictability, competitive intensity*, *technological turbulence*, and *product complexity*.

Demand unpredictability refers to the level of uncertainty and variability in customer demand for a product or service. It signifies the difficulty in accurately forecasting the quantity, timing, and pattern of customer orders or requests. Competitive intensity in an industry refers to the degree of rivalry and competition among firms operating within that industry. It reflects the level of aggressiveness, rivalry, and competitive behaviour among competitors fighting for market share, customers, and resources. Technological turbulence refers to the speed and unpredictability of changes, advancements, and disruptions in

technology within a particular industry. High technological turbulence reflects high levels of dynamism and volatility, where new technologies emerge, existing technologies evolve, and traditional practices and processes may become obsolete or significantly altered. Finally, product complexity refers to the level of intricacy and sophistication involved in the design, manufacturing, and functioning of a particular product. It represents the degree of difficulty in understanding, producing, operating, and maintaining the product.

We followed a more targeted approach to identify relevant *organisational* factors. Among the multitude of possibilities, we tried to account for characteristics that reflect servitization and digital maturity.

On the one hand, we arrived at two factors that have been widely investigated in the servitization literature, and saliently considered to be important. These were the *service orientation of employee culture*, and *product-service distinctiveness*. The former refers to the employees' mindset, attitude, and behaviour towards providing service to customers, while the latter reflects the extent to which the product and the service business in the organisation are separate from each other. High levels of both factors might suggest that services are prominent within the organisation. On the other hand, digital, or *digitisation maturity,* can reasonable be assumed to be an antecedent, or even a pre-requisite of digital servitization. It refers to the level of development and advancement in adopting and effectively utilising digital technologies and processes across the organisation's operations. It encompasses its ability to leverage digital tools and systems to optimize internal processes, enhance customer experiences and improve decision-making[1].

[1] It is worth noting that we tried to explicitly include *business model innovativeness* in the scope of the study, to reflect an organisational capability that could affect the choice and success of these innovative, digital servitization business models. However, the measure used to capture this factor did not prove to be reliable and has thus been excluded from the main data analysis. Please see Appendix A2 for details.

The main distinguishing feature between the two subsets of factors is that there is little that an SME can do about the context it faces; it should probably consider the four contextual aspects as given, and beyond its direct control. On the other hand, the three organisational factors are largely within its control, and are tied to definable strategic priorities, and decisions about organisation design and resource allocation.

2.4. Instrument development

Next came the development of the research instrument. This sought to collect four types of information:

- The type of business model followed by the SME.
- The levels and/or magnitude of the contextual and organisational factors determining business model success.
- The level of SME performance.
- Descriptive characteristics helpful to understand the sample and draw comparisons among different business models.

The following paragraphs provide some details for each of the four information types.

First, we asked respondents to carefully read the business model descriptors (Table 1) and consider their primary, or established, offering in terms of its importance for the company's revenues, and choose the one descriptor that best represents the business model. We also added a note for what the term 'digital technologies' refers to. In the note, we asked respondents to consider any of the following technologies: *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*, *Digital Marketplaces and Platforms*, *Application Programming Interface (API)*[2].

Second, we operationalized the contextual and organisational factors discussed in section 2.3 by adopting and/or adapting measures from published research, consistent with best practice. These came primarily in the form of multi-item scales. Their sources are included in Appendix A1, and the actual questions and items measuring all constructs and variables of interest can be found in Appendix B.

Third, as is common in the academic literature, we asked respondents to grade their business performance relative to their primary competitors (Appendix A1 and Appendix B).

Fourth, we asked respondents to indicate their SME's size (number of employees), age, primary industry of operation, and nature of customers.

A 'control' question was also added, asking respondents to rate their levels of knowledge, on a scale from 1 (*"not knowledgeable at all"*) to 7 (*"very knowledgeable"*), regarding the company's capabilities and internal processes, environmental context, and products/services. This was supplemented with a prompt to declare the level of their current position within the organisation. The entire instrument was first reviewed by two academics and two industry contacts with survey experience. We then transferred the instrument to the Qualtrics platform. Besides providing the options of manual survey development and distribution, the Qualtrics company has access to large and diverse panels of industry practitioners. We thus commissioned a short pilot-study with 38 responses to test the validity, clarity and relevance of the questionnaire. Respondents needed to be high-level employees

[2] These broad terms overlap considerably when it comes to what they represent in practice. However, we wanted to be as inclusive as possible and cover the entire digital technology spectrum, given that certain terms/technologies are more commonly employed in certain industries and contexts. We wanted to make sure that if a respondent's enterprise uses a digital technology to enable a service-based business model, he/she would be able to find it in this list.

or owners of UK manufacturing SMEs operating in manufacturing industries with products of medium and high technology intensity (e.g., electrical and electronic equipment, automotive etc., excluding industries such as jewellery, food and beverages, paper and packaging). In this pilot, respondents were asked to submit free text comments about the relevance of factors, the clarity of the questions and their overall experience with the survey (e.g., time taken). 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. Accordingly, discussions with Qualtrics led to slight modifications to their screening and recruitment strategy.

2.5. Data collection

After slight re-phrasing of a few items, modifications to the inclusion/exclusion criteria, and the addition of three attention checks, main phase data collection was commissioned through Qualtrics. This resulted in 422 responses, 38 of which were discarded for failing the attention checks, admitting low level of knowledge about their firm's processes and/or products/services, or not coming from SMEs from the specified industries. Another 23 observations were dropped as outliers during the Exploratory Factor Analysis (EFA) phase (see Appendix A2). Finally, 9 respondents who indicated that their primary business model does not fall under any of the six options provided were also removed. We thus ended up with a full sample of 352 SMEs, 42 of which were micro firms (1-9 employees), 158 were small, and 152 were medium-sized enterprises.

2.6. Data Analysis

A detailed, step-by-step treatment of the data analysis process can be found in Appendix A (A2 – A3). Briefly, to ensure scale validity and reliability, we conducted an exploratory factor analysis (EFA), and items with low loadings to their respective construct were removed.

Our objective was to identify the configurations of contextual and organisational factors that enabled SMEs following different business models to perform highly. Hence, the sample was split in subsets according to the chosen primary business model, and a configurational analytic technique was deployed. This was fuzzy-set Qualitative Analysis (fsQCA). FsQCA is suitable to deal with phenomena that are *causally complex*, as is the case with the phenomenon under study here: the relationship between a multitude of factors and the business performance of SMEs choosing to adopt different business models in their primary line of business. A configurational perspective, and fsQCA in particular, explicitly addresses three features of causal complexity (Misangyi et al., 2016): *Conjunction, equifinality* and *asymmetry.*

Conjunction suggests than an outcome (high business performance in this instance) is unlikely to have a sole cause, like, for example, a strong service orientation of employee culture; rather, high business performance is expected to result from the interdependence of multiple contextual and organisational factors. Equifinality simply signifies the possibility that these configurations, or constellations, associated with high SME performance, will be multiple and diverse. In other words, SMEs following a given business model might perform well even though they operate in different contexts and have made different organisational design decisions; there is not one single path to success. Finally, asymmetry implies that the presence of a condition, for example, competitive intensity, might be causally related with the outcome as part of one configuration, while its absence is *also* related to the outcome as

part of another configuration. In other words, for example, some SMEs facing an intensely competitive environment might perform as well as other SMEs facing a weakly competitive environment, depending on the presence or absence of other conditions.

The results, presented in section 3.2, vividly demonstrate all three properties.

3. Results

The results section is split in two parts. In the *descriptive* part (section 3.1), we draw comparisons among SMEs following the six different business models, based on certain variables of interest. In the *explanatory* part (section 3.2), we identify the configurations of contextual and organisational conditions that jointly lead to high performance of SMEs following the six business models.

3.1. Business Model Comparison

This section provides the results of the descriptive analysis, which involves comparing the six business models across key characteristics of interest. These comparisons serve a dual purpose: firstly, they enhance the reader's understanding of the sample of SMEs that participated in our research, and secondly, they highlight baseline differences among SMEs that have adopted the various business models.

3.1.1. Firm Size

Our sample consists of 42 *micro* (1-9 employees), 158 *small* (10-49 employees) and 152 *medium*-sized (50-249) enterprises. Figure 1 illustrates the distribution of these three types of SMEs across the six business models. Evidently, servitization, whether digital or not, is primarily adopted by small or medium-sized enterprises, indicating that servitization is contingent on scale. In addition, most ‘pure product’ providers are micro enterprises, and only a small fraction of micro enterprises has adopted a (digital) servitization business model. These points potentially suggest that micro firms might simply not have the resources to invest in services. Another noteworthy finding is that as one moves from an ‘Add-on’ to a ‘Platform’ business model, the percentage of small enterprises rises at the expense of the

percentage of medium-sized firms[3]. This might be because, comparatively speaking, the tangible product is much more central to the offering associated with an 'Add-on' business model than it is for a 'Platform' business model, where intangible features such as digital services and software increase in importance. This might make it easier for smaller, innovative firms from certain industries to adopt such business models.

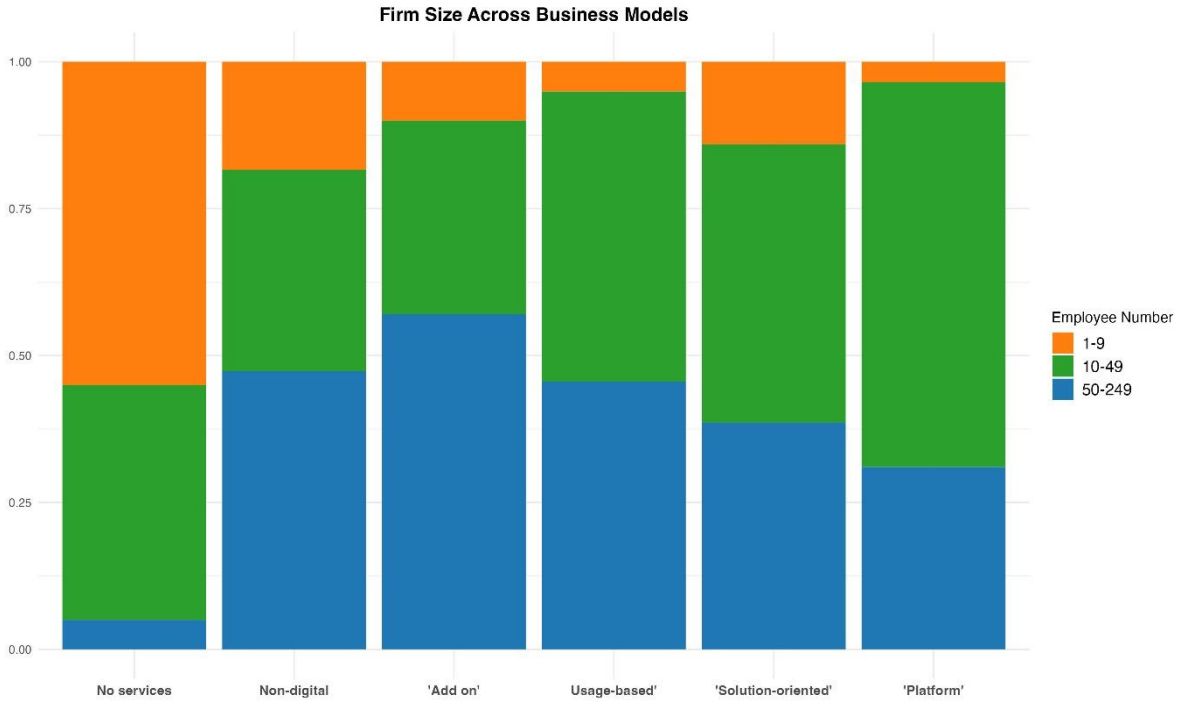

Figure 1 - Distribution of SME size by business model

3.1.2. Firm Age

Figure 2 presents a boxplot comparing the age distribution of SMEs based on their primary business models. The boxplot displays key statistics such as the mean, median, and interquartile range for each business model. It becomes evident that SMEs adopting a 'Platform' business model tend to be relatively younger. In fact, the mean age of 'Platform'

[3] The breakdown between small and medium-sized enterprises is 33%/57% for an 'Add-on', and 65.5%/31% for a 'Platform' business model.

business model adopters is statistically significantly lower than that of 'Add-on' business model adopters[4]. This suggests that platform providers are often young, entrepreneurial entrants with an innovative value proposition, centred primarily around digital features such as services and software, rather than tangible products. On the other hand, older SMEs seem to have remained focused on pure product offerings ('No services'). A question arises then, as to whether this choice has been a deliberate strategy yielding benefits, or a result of limited resources and capabilities that may negatively impact SME performance. Subsequent analyses provide further insights into this matter.

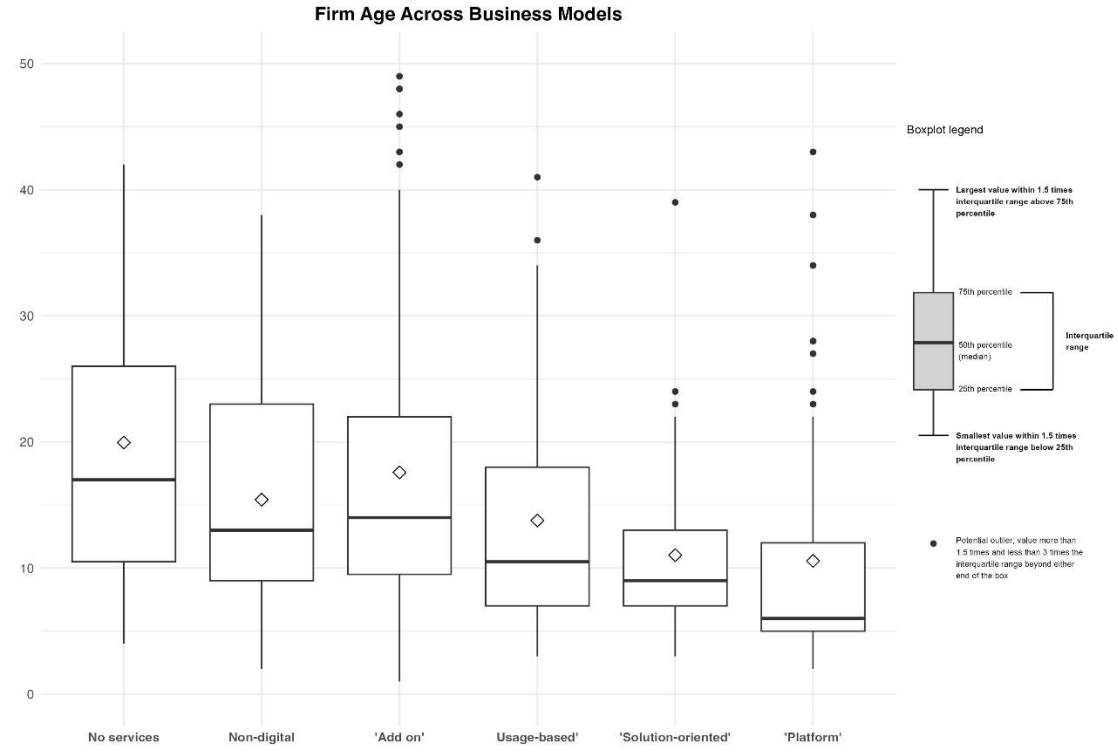

Figure 2 - Boxplot comparing firm age across business models

[4] This is, in fact, the result of a post-ANOVA pairwise comparison based on Tukey's Honestly Significant Difference (Tukey HSD) test. The SMEs adopting the two business models have a mean age difference of 8.38 years, which is statistically significant at the 5% level (p-value = 0.018). No other pairwise comparison based on Tukey HSD test produced a statistically significant difference. However, the non-parametric alternative (Dunn's test) that uses rank sums to compare the age distributions between two alternative business models, showed that 'Platform' providers are significantly younger (p-value < 0.05) than 'pure product' providers and 'servitized' ('non-digital') SMEs as well.

3.1.3. Nature of Customers

Figure 3 depicts the distribution of customers among the SMEs in the sample across different primary business models. It is evident that governments constitute a minor portion of the customer bases for all SMEs, while the consumer market remains the primary focus for most SMEs regardless of their chosen business model. However, in relative terms, SMEs adopting a 'Usage-based' or 'Solution-oriented' digital servitization business model are more inclined to also cater to business customers compared to SMEs that follow other business models.

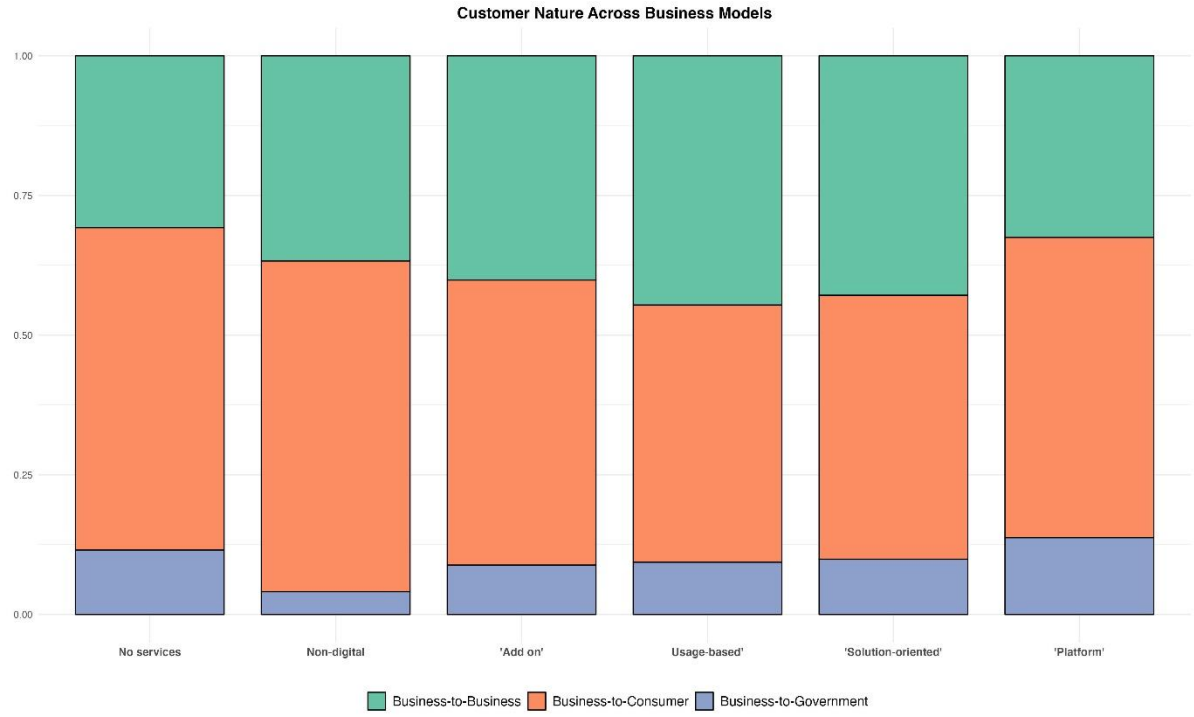

Figure 3 - Distribution of customers by business model

3.1.4. Primary Industry

Figure 4 illustrates the three most represented industries by business model. Unsurprisingly, almost 40% of SMEs that solely sell tangible goods come from the construction industry, where the relatively low product complexity might not facilitate the adoption of more sophisticated business models. When it comes to the digital servitization business models, around 20% of SMEs choosing any of the four models operate in the Information Technology industry. Consumer goods is another industry in which digital servitization business models are common. Notably, almost 40% of SMEs following a 'Platform' business model come from this industry. These might be innovative companies with a novel platform for consumers to buy and sell goods, or to get access to the company's products and services.

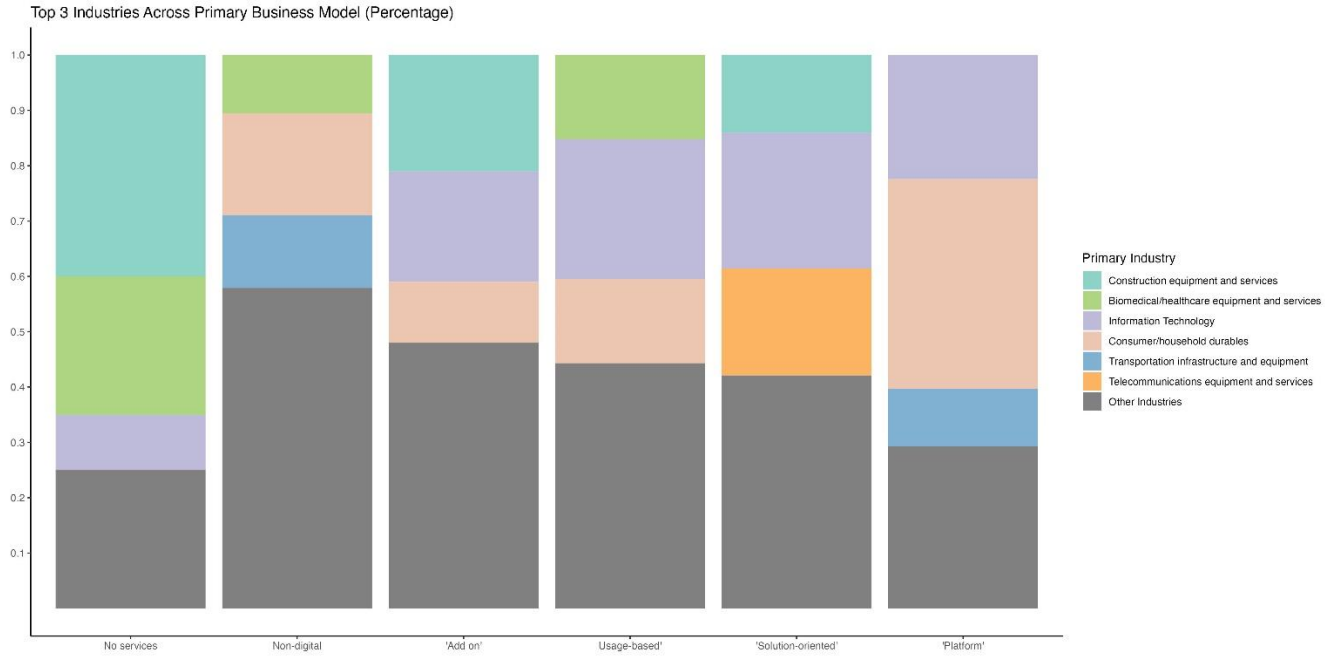

Figure 4 - Top three industries by business model

3.1.5. Business Model Innovation (BMI)

Figure 5 is a boxplot of BMI across business models. The results indicate that SMEs adopting digital servitization business models, specifically 'Usage-based,' 'Solution-oriented,' and 'Platform,' tend to have higher levels of BMI. The mean differences in BMI between these models and the 'Add-on' model are statistically significant at the 10% level[5]. Clearly, SMEs following these three models also demonstrate significantly higher BMI compared to both 'pure product' providers and servitized SMEs that have not embraced digital servitization. Interestingly, SMEs with an 'Add-on' business model do not exhibit statistically significant differences in BMI compared to those adopting non-digitally enabled business models. While causality cannot be established, the graph suggests that BMI, as a firm capability, promotes the transition towards digital servitization.

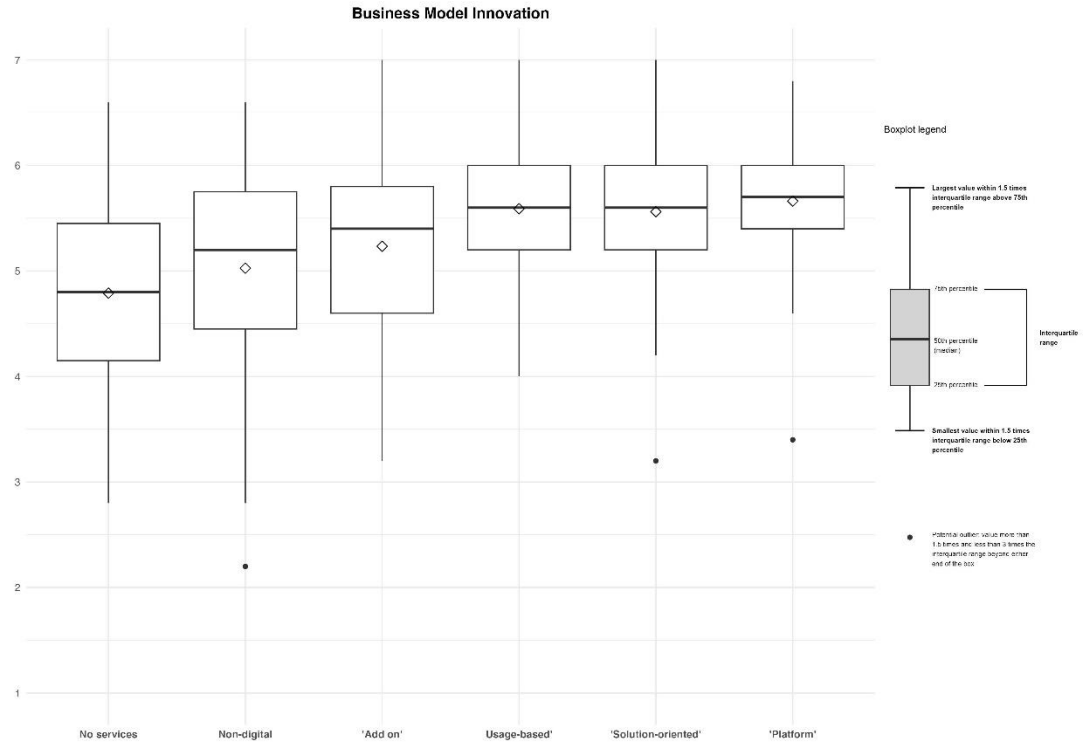

Figure 5 - Boxplot comparing BMI across business models

[5] As with firm age, these results are based on Tukey HSD tests after ANOVA, with all three p-values < 0.1. Equivalent non-parametric tests (Dunn's test) produce even more significant results.

3.1.6. Digital Maturity

Figure 6 presents a boxplot that compares the level of digital maturity among SMEs adopting the six different business models. As expected, SMEs embracing digital servitization business models demonstrate higher digital maturity compared to 'pure product' providers and servitized SMEs that haven't transitioned to digital servitization[6]. Furthermore, there are variations in digital maturity among the different digital servitization business models. Specifically, SMEs following an 'Add-on' model are less digitally mature compared to SMEs adopting a 'Usage-based,' 'Solution-oriented,' or 'Platform' model[7]. While we can't establish a causal relationship, the noticeable link between digital maturity and the choice of advanced digital servitization business models is noteworthy. It is reasonable to assume that a certain level of digital maturity is a prerequisite for SMEs to transition towards more advanced business models.

[6] Tukey HSD tests (post ANOVA) reveal that all mean differences between the digital maturity scores of SMEs adopting *any* digital servitization business model and those who have remained servitized (not digitally) or pure product providers are statistically significantly different to zero (at the 5% level). Non-parametric Dunn tests support these results.

[7] All tests produce results with p-values < 0.05.

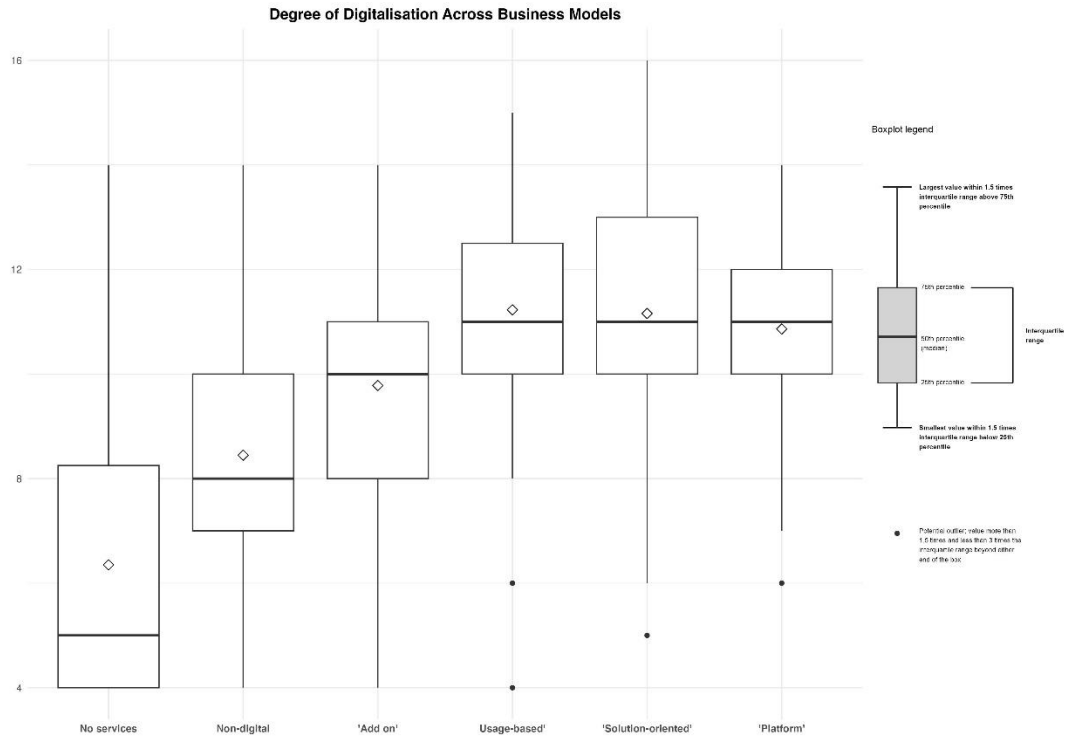

Figure 6 - Boxplot comparing digital maturity across business models

3.1.7. Financial Performance

The last and most important descriptive result is the comparison of financial performance across SMEs that follow different business models. Again, we present this in the form of a boxplot (Figure 7). It testifies that SMEs that have adopted digital servitization business models, especially 'Usage-based', 'Solution-oriented' and 'Platform', perform comparatively better than SMEs following the other business models. In fact, the mean performance difference between SMEs following *any* digital servitization business model and 'pure product' firms is statistically significant[8]. Notably, the SMEs following a 'Platform' business model perform statistically significantly better than both those following a servitized

[8] As previously, this is based on Tukey HSD pairwise tests (all p-values < 0.05) after a statistically significant ANOVA. Equivalent, non-parametric tests support these results.

but not digital business model, and those with an ‘Add-on’ business model, indicating that even among (digitally) servitized SMEs, there exist systematic performance differences.

The performance differences identified in the descriptive analysis are important, and the rest of the analysis (presented in the next section) effectively attempts to *explain* these differences by revealing configurations of contextual and organisational conditions that lead to superior performance of SMEs following each of the six business models.

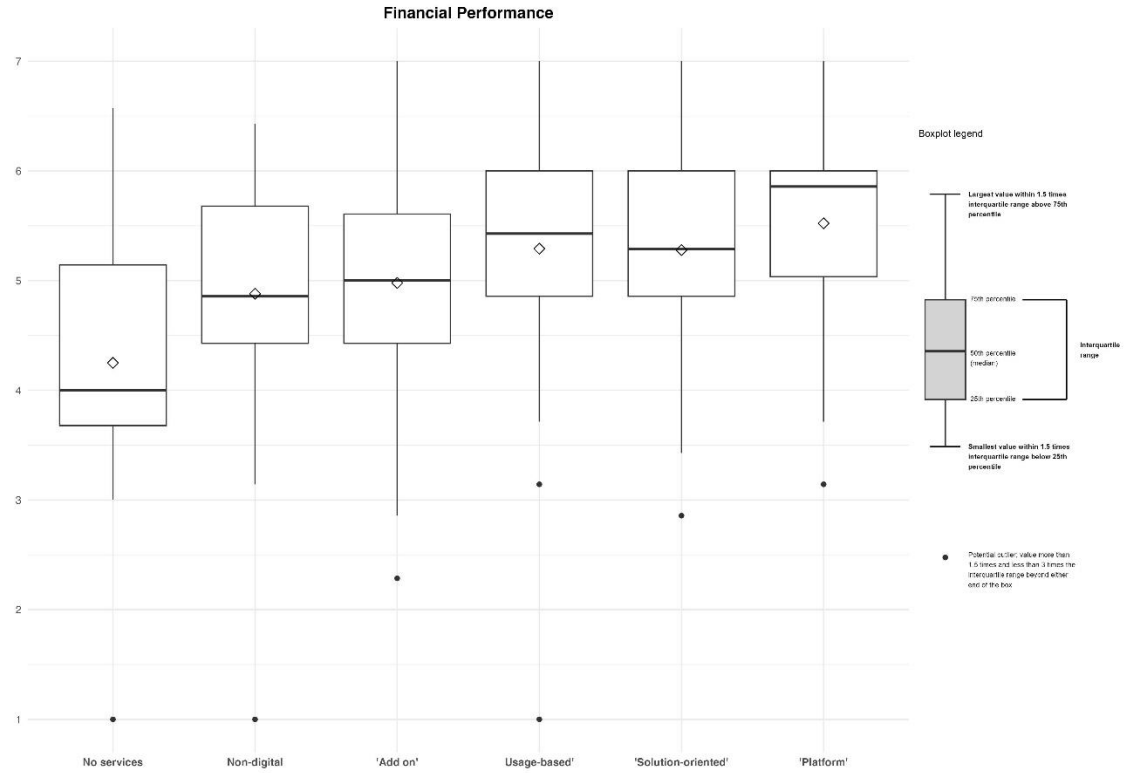

Figure 7 - Boxplot comparing financial performance across business models

3.2. Configurational Analysis and Results

The main objective of the primary analysis is to identify the specific combinations of conditions that lead to high business performance among SMEs adopting different business models. To achieve this, we employed fsQCA (fuzzy-set Qualitative Comparative Analysis). In fsQCA terminology, the results presented in the following section represent the *sufficiency* analysis outcomes. In other words, these results indicate the configurations of conditions that are *sufficient* for achieving high business performance. Typically, this analysis is preceded by the analysis of *necessity*, which identifies which conditions are *necessary* for the outcome to be present. In this case, the analysis would reveal if any contextual or organisational factor needs to always be present (or absent) when the outcome of high performance is present. However, the analysis showed quite convincingly that none of the seven conditions considered here was necessary. We thus do not present these results and continue to the analysis of sufficiency.

3.2.1. How to read the results

The following tables visually depict the configurations that are linked to high performance among SMEs adopting different business models in their primary line of business. The analytical approach utilised in this study (fsQCA) generates a "solution" for each business model, which can consist of multiple equally effective configurations for achieving high performance. This phenomenon, known as equifinality, is evident in the results tables, highlighting the interplay between contextual and organisational factors, and the financial performance of SMEs implementing digital servitization business models.

The tables feature four different symbols, each with its own meaning, which will be explained below. A large solid black dot indicates that the *presence* of a condition is *core* to a

configuration, whereas a large, crossed circle suggests that the *absence* of the condition is core. These core conditions serve as integral building blocks of the configurations. On the other hand, a small solid black dot represents the presence of a *contributing* condition, while a small, crossed circle signifies the absence of such a condition. Although the contributing conditions are not as crucial as the core conditions, they serve to enhance the interpretability and relevance of the configurations. They also give rise to permutations, where the core conditions remain constant, but the contributing ones vary. Each configuration is assigned a number (1-4), while permutations of each configuration are denoted with a letter (a-c). Any blank cell can be interpreted as "irrelevant"; meaning that the presence or absence of the condition in question does not play a role in determining the effectiveness of the corresponding configuration. To simplify the presentation, albeit with a slight compromise in accuracy, we take the presence of a condition to represent "high levels" of the corresponding factor, while the absence of a condition represents "low levels".

Each table also presents fit parameters for each configuration as well as the overall solution (*consistency* and *coverage*). For a detailed explanation of these parameters, please refer to Appendix A3.

3.2.2. The ‘Add-on’ Business Model

A. Add-on Business Model

Configurations for Achieving High Performance

	Solution		
	1a	**1b**	**2**
Context			
Demand Unpredictability	⊗		
Competitive Intensity	●	●	
Product Complexity	●	●	•
Technological Turbulence	●	●	
Organisation			
P-S Distinctiveness		⊗	●
Service Culture	•	•	•
Digitalisation Maturity			●
Consistency	0.852	0.890	0.897
Raw Coverage	0.327	0.247	0.268
Unique Coverage	0.080	0.030	0.066
Overall Solution Consistency		0.862	
Overall Solution PRI		0.760	
Overall Solution Coverage		0.446	

Table 2 - Configurations associated with high performance of SMEs following an ‘Add-on’ business model

Two distinct ‘recipes’ can lead to high performance for SMEs adopting an 'add-on' primary business model, as demonstrated in Table 2. These approaches are particularly suitable to manufacturers of complex products with a strong service culture. However, the first approach applies specifically to SMEs operating in challenging business environments characterised by high competitive intensity and technological turbulence. In contrast, the second approach is independent of the external environment and emphasizes the significance of organisational factors. Namely, high-performing SMEs demonstrate digital maturity and may have separated their service-related activities from their product-related ones. Both ‘successful’ paths indicate potentially mature manufacturers of complex products that became servitized, and then progressed to an add-on digital servitization business model.

3.2.3. The 'Usage-based' Business Model

B. Usage-based Business Model

Configurations for Achieving High Performance

	Solution			
	1	2	3	4
Context				
Demand Unpredictability		●		⊗
Competitive Intensity	●		●	
Product Complexity	●	●	●	●
Technological Turbulence		⊗	⊗	●
Organisation				
P-S Distinctiveness		⊗	•	⊗
Service Culture	●			●
Digitalisation Maturity		•	⊗	●
Consistency	0.863	0.892	0.869	0.933
Raw Coverage	0.541	0.188	0.270	0.195
Unique Coverage	0.269	0.020	0.044	0.030
Overall Solution Consistency		0.848		
Overall Solution PRI		0.773		
Overall Solution Coverage		0.668		

Table 3 - Configurations associated with high performance of SMEs following a 'Usage-based' business model

There are four distinct approaches that can lead to high performance for SMEs adopting a 'usage-based' business model, reflecting the diverse applicability of this model across different contexts. As shown in Table 3, the common factor among all these approaches is the presence of relatively complex products. The first approach combines product complexity with an intensely competitive environment, where the organisation has successfully nurtured a strong service culture. The second path involves SMEs operating in an environment with unpredictable demand but relatively stable technology. In this scenario, the SMEs choose to integrate their product and service-related activities while leveraging digitisation. The third configuration stands out as it involves limited digitisation. This lack of digital maturity may be justifiable in industries with stable technology, where SMEs with separate service organisations can compete based on price or by enhancing the product's accessibility and

service features. On the contrary, the fourth approach is almost the opposite of the third one. It involves SMEs operating in technologically turbulent environments that have invested considerably in digitisation. These organisations possess a strong service culture, which permeates their integrated product-service business. Overall, these four approaches demonstrate how SMEs that have adopted a 'usage-based' business model can achieve high performance in diverse contexts by leveraging different organisational factors.

3.2.4. The 'Solution-oriented' Business Model

C. Solution-oriented Business Model

Configurations for Achieving High Performance

	Solution		
	1a	**1b**	**2**
Context			
Demand Unpredictability	⊗	⊗	⊗
Competitive Intensity	●	●	
Product Complexity	•	•	•
Technological Turbulence	●	●	●
Organisation			
P-S Distinctiveness	•		●
Service Culture	●	●	●
Digitalisation Maturity		•	●
Consistency	0.884	0.895	0.892
Raw Coverage	0.441	0.412	0.402
Unique Coverage	0.085	0.055	0.046
Overall Solution Consistency		0.899	
Overall Solution PRI		0.843	
Overall Solution Coverage		0.542	

Table 4 - Configurations associated with high performance of SMEs following a 'Solution-oriented' business model

There are two distinct yet closely related configurations that lead to high-performing SMEs adopting a solution-oriented business model (see Table 4). Both configurations align with the context commonly associated with integrated product-service solutions, characterized by complex products and rapidly changing technology within the industry.

Unsurprisingly, both configurations require a strong service orientation of employees to be successful. Another shared characteristic is the absence of demand unpredictability, indicating a predictable demand environment for high-performing SMEs. This can be attributed to two possible reasons. Firstly, due to resource constraints and the need for investment in the buyer-supplier relationship, SMEs may be hesitant to pursue a solution-oriented approach unless they can anticipate a predictable demand from potential solution customers. Secondly, the absence of demand unpredictability may be a result of the tailored nature of most solutions, which requires a deep understanding of customer business, thus enabling SMEs to predict demand more effectively. The configurations differ slightly in the following manner: the first configuration encompasses permutations involving a highly competitive environment and either a separate service unit or a digitally mature organisation. In contrast, the second configuration exclusively consists of SMEs with high levels of digital maturity. In summary, it is important to recognise that a solution-oriented business model is not widely applicable and can lead to high performance only among specific SMEs within limited contexts.

3.2.5. The 'Platform' Business Model

D. Platform Business Model

Configurations for Achieving High Performance

	Solution				
	1a	**1b**	**2a**	**2b**	**2c**
Context					
Demand Unpredictability	⊗	⊗	●	●	●
Competitive Intensity	⊗	⊗	●	●	●
Product Complexity	●		•	•	•
Technological Turbulence	●	●	⊗		
Organisation					
P-S Distinctiveness		⊗	●	●	●
Service Culture	●	●		•	
Digitalisation Maturity					•
Consistency	0.921	0.928	0.942	0.962	0.956
Raw Coverage	0.204	0.185	0.304	0.430	0.387
Unique Coverage	0.037	0.026	0.011	0.087	0.032
Overall Solution Consistency		0.948			
Overall Solution PRI		0.931			
Overall Solution Coverage		0.646			

Table 5 - Configurations associated with high performance of SMEs following a 'Platform' business model

Two distinct and contrasting configurations are linked with superior performance of SMEs adopting a platform business model (Table 5). The first configuration involves SMEs characterised by a strong service culture, operating in a technologically turbulent industry. Both of its permutations involve a predictable demand and weak competition. In this scenario, the market is relatively stable, and advancements in technology, such as sensors, software, and the Internet of Things (IoT), might have enabled service-oriented SMEs to continuously gather customer data and provide valuable information and services through a platform. On the other hand, the second configuration involves a relatively complex product, and an unpredictable demand coupled with strong competition. This configuration may apply to products that have become commodities, like standard household goods, where SMEs compete against large and powerful firms. In this case, the configuration suggests that these

SMEs require a separate service unit to achieve strong performance. Additionally, they either need to establish a service culture within the organisation or have a digitally mature setup to effectively compete in the market.

3.2.6. The 'Servitized, but not Digital' Business Model

E. Non-DS Business Model			
Configurations for Achieving High Performance			
	Solution		
	1a	**1b**	**2**
Context			
Demand Unpredictability	⊗		
Competitive Intensity			
Product Complexity	●	●	⊗
Technological Turbulence		⊗	⊗
Organisation			
P-S Distinctiveness		•	⊗
Service Culture	●	●	●
Digitalisation Maturity			⊗
Consistency	0.835	0.902	0.702
Raw Coverage	0.409	0.370	0.229
Unique Coverage	0.142	0.071	0.058
Overall Solution Consistency		0.764	
Overall Solution PRI		0.621	
Overall Solution Coverage		0.582	

Table 6 - Configurations associated with high performance of SMEs following a 'Servitized but not Digital' business model

The high performance of SMEs that have adopted a servitized approach but have *not* transitioned to a digitally enabled business model is associated with two significantly distinct configurations. Table 6 shows that the first configuration comprises two permutations, where manufacturing SMEs of a complex product have established a strong service culture. These characteristics are complemented by either a predictable demand or a relatively stable technology (and a separate service organisation). In the second configuration, SMEs also exhibit a developed service culture; however, they have not separated their service from their product business and have not made substantial investments in digitisation. The product they

offer is simple and does not involve any ground-breaking technological advancements. Both configurations seem to depict SMEs that might be content with their competitive position within their business environment. Consequently, they may consider a move towards digital servitization as unnecessary or impractical, given their current circumstances

3.2.7. The 'Pure Product' Business Model

F. Non-servitized Business Model	
Configurations for Achieving High Performance	
	Solution
	1
Context	
Demand Unpredictability	
Competitive Intensity	
Product Complexity	●
Technological Turbulence	
Organisation	
P-S Distinctiveness	●
Service Culture	●
Digitalisation Maturity	⬤
Consistency	0.833
Raw Coverage	0.266
Unique Coverage	-
Overall Solution Consistency	0.833
Overall Solution PRI	0.764
Overall Solution Coverage	0.266

Table 7 - Configurations associated with high performance of SMEs following a 'Pure product provider' business model

Table 7 suggests that only one configuration has been found to be associated with high performance among pure product providers. The key factor in this configuration is the presence of digital maturity, emphasising the value of investing in digitisation even if SMEs do not adopt a servitized business model. Interestingly, digital maturity is complemented by a strong service orientation among employees, as well as a tendency to consider service activities separately. Given that these SMEs do not follow a servitized business model in their *primary* line of business, this configuration might initially seem paradoxical or raise concerns about data collection. However, this is not necessarily the case, as these high-performing

SMEs may be experimenting with (digital) servitization business models in secondary lines of business. Thus, what we observe here could be spill-over effects. It is important to note that, relatively speaking, these SMEs that have not adopted a digital servitization business model perform significantly worse, on average, compared to those who have, as shown in Section 3.1. Therefore, the identification of a single configuration is not surprising. Non-servitized SMEs can indeed achieve success, but their avenues for success are more limited. The analysis suggests that one consistent pathway to superior performance involves attaining digital maturity and fostering a service culture.

4. Website and SME self-assessment toolkit

4.1. Project website

A key deliverable of this project is a microsite, which can be accessed through www.interact-digiserve.co.uk. The website conveys the findings in an illustrative and concise manner, using graphs and videos[9]. However, it is much more than just a summary; it comprises a resource that SME practitioners can engage with to understand digital servitization and the various business models. The pinnacle of the website though is our 'SME toolkit', which we detail in what follows.

Figure 8 - microsite landing page

[9] The website was developed by a local SME called STUDIOUS (https://studious.org.uk/). STUDIOUS collaborated with EYE FILM (www.eyefilm.co.uk) to produce the videos, and with Foresight Mobile (https://foresightmobile.com) to build and optimise the functionality of the website's back-end.

4.2. Toolkit

The 'SME Toolkit' is constituted by three parts. First, a 'training manual' introduces the SME practitioner to the toolkit itself, the organisational and contextual conditions, and the outcome to expect after completing the questionnaire. Second, the questionnaire that gathers the necessary information. Third, a recommendation to the toolkit user as to which business model *might* be the most appropriate for his or her business.

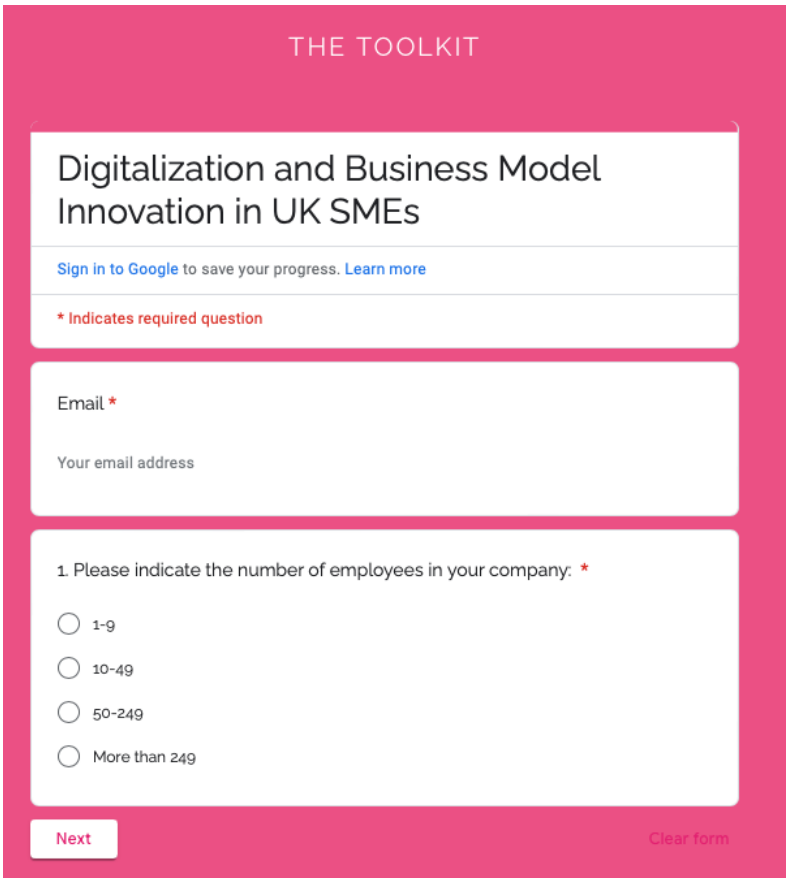

Figure 9 - Toolkit landing page

i. Training Manual

The 'Training Manual' comprises of two pre-recorded videos that take the user through the toolkit step-by-step. In the videos, the narrator (a native English speaker with neutral accent) defines the key terms of interest and explains the process of answering the questions. The narrator also emphasises that there are no right and wrong answers, and that the recommendation that the user will receive after completing the questionnaire should not be considered binding or 'correct'. Instead, any recommendation should be carefully evaluated by the person with the most knowledge of the SME's business environment and organisational resources and strategy: the user of the toolkit.

ii. Questionnaire

The questionnaire is essentially the instrument we used in our research. It can be found in Appendix B. It has been embedded on the website using Google forms. No personal data is collected or stored. The responses are temporarily stored on the back end, and some elementary operations are taking place that classify the response as 'high' or 'low' across all conditions (environmental and organisational factors) by comparing the user's responses with the factor means from our study sample. Then, an algorithm is applied to match the given constellation with one of the 19 'ideal' types/configurations that our research found to be associated with high financial performance (section 3.2).

iii. Business model recommendation

After the matching process, the user receives an e-mail with a recommendation as to which of the six business models *might* represent the best chances for his or her SME to achieve high-performance given the context the SME's circumstances with respect to the

seven contextual and organisation factors. The matching process will not always find a 'perfect' match among the 19 'ideal' configurations. When this is the case, the e-mail reports this, and assures the user that this has not been an exact process, suggesting that the SME can achieve high performance regardless.

4.3. Ex-Post webinar

The project team delivered the first ex-post webinar in early August 2023 to introduce the project, disseminate its findings and raise awareness about the publication of the project report and the SME toolkit. The promotion of the webinar was conducted through several online channels (e.g., InterAct, NAAME, NBS). Of the 33 individuals who registered on Eventbrite, 17 attended the event. The attendees came from both academic and practice (including manufacturing SME practitioners and consultants).

5. Conclusions, Implications and Recommendations

5.1. Summary of Key Findings

The main finding of this work is that SMEs can achieve high performance through different business models, depending on how well each one aligns with their organisation's context and design. Across the six different options, four of which represent different forms of digital servitization, the project empirically identified 19 “successful” configurations. For SMEs adopting a particular model, there exist multiple configurations that are equally effective in achieving high business performance. This phenomenon is often called *equifinality*, suggesting that there is no singular formula for success. SMEs operating in diverse contexts and possessing different organisational characteristics could successfully embark on the transition towards digital servitization and excel in their performance.

Besides this key finding, there are a few salient points that emerged from the analysis:

- There is noticeable variation *between* business models with respect to the configurations that lead to high financial performance. Compare for example the configurations leading to superior performance of SMEs adopting the ‘Solution-oriented’ business model, to the 2nd configuration for the ‘Platform’ business model. Such observations emphasize the differences in the inherent nature of the four digital servitization business models, indirectly validating our business model typology and providing credence to the idea that digital servitization can manifest in various forms that warrant systematic study (Kohtamäki et al., 2022).
- However, there is also variation *within* business models. Take for example the four distinct configurations leading to superior performance of SMEs adopting

a ‘Usage-based’ business model, or the striking differences between the two configurations of the ‘Platform’ business model. This demonstrates the usefulness of the method deployed here (fsQCA), since such intricacies might have been overlooked had we used a mainstream statistical analysis approach. It also demonstrates that digital servitization business models have broad applicability and are associated with high performance across multiple contexts.

- The widespread presence of product complexity in almost all configurations emphasizes that servitization, including digital servitization, relies on products of sufficient complexity that can support sophisticated business models. Digital servitization may not be suitable for products that cannot be effectively ‘connected’ (Porter and Heppelmann, 2015).
- A strong service orientation among employees emerges as a key component within many successful configurations. As such, nurturing a service culture is not limited to large firms; it is equally important for SMEs to embrace this mindset.

5.2. Contribution to the InterAct Network

The InterAct Network is part of the wider Made Smarter Innovation (MSI) initiative and represents an interdisciplinary community of researchers, UK Manufacturing firms and digital technology providers, aspiring to address the human issues resulting from the diffusion of new technologies in industry. The network supports this ambitious vision by providing a facilitating platform that informs manufacturing SMEs about the characteristics and benefits of digital adoption (Interact, 2022). The platform can be accessed through https://interact-hub.org/about/. The project's research findings and subsequent intellectual outputs contribute to InterAct, in the following ways:

- By introducing the discussion of digital servitization in SMEs, within the InterAct community.
- By promoting digital servitization business models to UK manufacturing SMEs through the project's dedicated microsite.
- By providing InterAct with a tangible, SME-focused toolkit which can be used as a diagnostic tool and at the disposal of industrial collaborators within the network.

The project team remains unanimously committed to contribute to InterAct's future work in defining the community's digital servitization agenda through a series of planned impact activities regarding educational seminars and participation to thinktank and panel discussions. In addition, by monitoring the toolkit adoption by network participants, the project team would be able to provide updates on the progress of digital servitization transition in SMEs. It is envisaged that such engagement with SMEs will form the basis for future research work, maximising the contribution of this project to the InterAct network.

5.3. Implications for Business Practice

Digital servitization business models represent an emerging opportunity for supporting the manufacturing industry's competitiveness. This study demonstrated that digital servitization represents a viable strategy for manufacturing SMEs (e.g., Minaya et al., 2023), leading to specific, timely implications. On the one hand, the project directly addressed the scholarly neglect regarding the concept's applicability in SMEs (Rabetino et al., 2021). By identifying the conditions of applicability (and success) of different digital servitization business models for SMEs, the project provides practitioners with an evidence-base for understanding the central role of digital technologies in contemporary manufacturing. Moreover, the project's demonstration of the link between digital servitization business models and SME financial performance, suggests that digital servitization makes financial sense for manufacturing firms in a variety of contexts. These two important implications are further discussed below.

5.3.1. Centrality of Digitisation

Digital servitization makes financial sense for SMEs in a variety of contexts, and digital maturity emerged as a fundamental component in many successful configurations. This result empirically supports the idea that digitisation represents a critical success factor for the future of manufacturing (Schroeder et al., 2022). The effect of digitisation is perhaps even more pronounced in SMEs, indicating that these firms should prioritise related investments. Although liabilities of smallness and associated resource constraints may limit their ability to do so, in today's business environment, wherever possible, investing in digitisation should take precedence over other considerations to avoid falling behind the competition.

5.3.2. Contextual and Organisational Interdependence of Configurations

We advocate for the transition towards digital servitization business models for manufacturing SMEs that are seeking to move beyond product-centric offerings and address the evolving needs of their customers by providing advanced services and solutions. Such business models may be of added relevance to those SMEs that are still either pure product providers, or have servitized, but without taking full advantage of the emancipatory potential that digital technologies can offer. This is because these two types of SMEs were found to underperform compared to SMEs that have adopted a digital servitization business model. However, this is not a straightforward endeavour, and as this report suggests, it should not be attempted without a thorough investigation of the *context* in which SMEs operate, and a consideration of *organisation design* parameters. The project's microsite and toolkit can assist and inform business practice to determine the conditions of applicability. However, the toolkit should not be the *sole* consideration of SME principal decision-makers interested in digital servitization; it comprises just one tool among a wider spectrum of tools and methods that can help decision makers address the challenges faced by SMEs.

5.4. Recommendations for Manufacturing SMEs

The project's exposition of digital servitization and the accompanying business model typology and SME toolkit, provide firms with an evidence-based framework that supports decision-making. Manufacturing firms that embrace digital technologies, tend to reap the benefits of these investments in terms of productivity and efficiency gains (MAKE UK, 2021), and may even increase their international footprint (Blesa-Perez et al., 2023). However, these depend on the availability and efficacy of human, material and capital assets (Bosman et al., 2020). As such, manufacturing SMEs face strategic, technological and organisational

challenges in their quest to smoothly transition from product-focused to digitally servitized offerings (Verhoef et al., 2019; Deschler & Smith, 2011).

5.4.1. Challenges related to Business Model Innovation

The practitioner literature acknowledges that digitalisation is more difficult than other organisational change processes, as it relates to the reconfiguration of key firm assets (de la Boutetière et al., 2018). This is inherently true for SMEs that embrace sophisticated business models (e.g., Cavallo et al., 2023). The descriptive results of this study point towards the important role of business model innovation (BMI), a finding that is consistent with relevant literature (e.g., Karami et al., 2022; Lamperti et al., 2023). BMI has been found to be significantly higher in SMEs that have adopted digital servitization business models, when compared to 'just servitized' or pure product providers. This suggests that the transition towards digital servitization can be promoted via BMI. However, this posits a set of fundamental challenges for firms in their pursuit of digital servitisation, given that SMEs typically utilise different innovations in their value propositions (Muller et al., 2018). To this end, challenges relate to the reconfiguration of existing business models to accommodate new technologies and the means of extracting value from digital servitization (Schroeder et al., 2022; Linde et al., 2021). To overcome these challenges, manufacturing SMEs need to take stock and audit their existing business model, to identify *how* digital servitization can reshape their value propositions and *which* digital servitization business model could suitably address changes in customer needs and their overall market.

5.4.2. Digital Servitization Adoption and Product Complexity

The study identified that digital servitization business models may be more suitable in SMEs that offer complex products. This finding moves beyond the assertion that servitization is motivated by product complexity (Raddats et al., 2016) to suggest that digital servitization benefits may be more pronounced in firms providing products emphasising connectivity. As such, the firm-level recommendations related to this important point are twofold. On the one hand, product complexity may in *itself* become a source of competitiveness, safeguarding the firm's business model from imitation due to the technological expertise that is difficult to be replicated by competitors. On the other hand, the tailored value proposition offered via digital servitization, can provide SMEs with profound technological advantages associated with research and development, production, and maintenance.

5.4.3. Strengthening service orientation in manufacturing SMEs

The study's demonstration of service orientation as an instrumental condition for the success of digital servitization suggests that by championing such an orientation, principal decision makers in manufacturing SMEs can unlock significant benefits. In a digital servitization context, this implies the importance of understanding customer needs and a subsequent development of a holistic approach to complement core offerings. By emphasizing service excellence, manufacturing SMEs expand their capacity to deliver value and develop new revenue streams. The long-term outcomes of this recommendation relate to customer satisfaction, enduring customer relationships and the establishment of brand loyalty to reinforce the firm's position in the marketplace.

5.5. Implications for Policy

The Made Smarter Review strongly advocated for accelerated adoption of digital technologies in manufacturing, and indicated that SMEs perceive significant barriers to adoption (Maier, 2017:9). To this end, in a recent study of over 5,000 firms, manufacturing SMEs reported their belief in the importance of technology for reaching their business goals, with particular focus on understanding what technologies work well, and accessing and understanding data about their business (Sage, 2022).

The study's findings add further evidence into the nature of these challenges. Results suggest that to fully realise the benefits of digital servitization, manufacturing SMEs need to overcome strategic, technological and organisational issues as discussed in the previous section. As such, these considerations dictate policy interventions to empower manufacturing SMEs and facilitate digital transformation.

5.5.1. Accelerate Digitalisation in Micro-SME Manufacturers

In our sample, digital servitization business models were not generally adopted by micro-SMEs. This is a critical point to address, considering that micro-SMEs represent a rapidly growing segment within UK manufacturing (Make UK, 2021), yet achieve only 60% the productivity level of their larger counterparts (UKRI, 2023). Such firms are characterised by liabilities of smallness (Drnevich and West, 2023) which include limited access to financial capital and lack of technological and strategic skills. As such, policymakers need to prioritise actions aimed at overcoming these constrains to facilitate digital servitization. By designing policy directed towards financial incentives for digital servitization initiatives, shared resources to overcome technological deficiencies and programmes that enhance the strategic

capability of micro-SME manufacturers, these firms can be empowered to adopt more advanced business models.

5.5.2. Incentivise Digital Upskilling

To fully realise the advantages of digital servitization business models, SMEs require the development of a broader digital upskilling mindset. This is crucial, considering the pace of technological change that characterises the manufacturing sector. The report highlighted the central role of a service-centric culture for successful implementation of digital servitisation which in turn underlies the need for policy aimed at developing specialised knowledge and training on both digital technologies and service management.

5.6. Project Limitations

Our project has some limitations due to its short timeframe of 8 months. A crucial aspect of the project was the development of an operationalisable digital business model typology applicable to SMEs. This involved engaging with knowledgeable informants and refining the respective textual descriptors through an iterative process (see Table 1). Data collection was dependent on completing this important step. Additionally, like all InterAct projects, it was essential to produce measurable impact for the target population, emphasising the significance of developing the website and toolkit.

These factors led us to conduct a rapid data collection process using Qualtrics, a market research company with a large panel of practitioners willing to respond to academic surveys for a fee. However, this data collection process has certain limitations. Firstly, it was not possible to link each respondent to their respective SME and validate information such as financial performance and primary industry, using external data sources like business databases. Secondly, despite applying appropriate filters to access the specific population of

interest (owners or high-level managers from UK manufacturing SMEs), we cannot guarantee that inappropriate respondents did not participate. Due to the monetary incentive, shrewd individuals may have strategically answered the survey to receive the financial reward. To mitigate these risks, we implemented measures outlined in Section 2, including a pilot study, stricter filters, and removal of outliers and individuals who completed the questionnaire too quickly. Ultimately, out of the 422 completed responses received from Qualtrics, only 352 were utilized in the analysis. However, we cannot be certain that all 352 responses are from individuals within the target population.

To enhance the robustness of our study, we aimed to build a second sample through alternative means such as personal contacts, LinkedIn groups, and regional manufacturing groups. Unfortunately, as of the report's writing, this process did not yield a sufficient sample, but our efforts are ongoing.

Another approach to strengthen our results would be to supplement this work with a qualitative component, involving interviews with managers from SMEs that have adopted different business models. By triangulating data collection and analysis methods, we could validate the existence of configurations leading to high performance and gain insights into the *processes* driving this outcome. Currently, we are exploring this avenue through collaborations with academics who have relevant industry connections and the necessary expertise.

It is important to note that the findings in this report are not definitive and represent only the beginning of a larger process. We encourage academics interested in studying digital servitization in the context of SMEs to design and conduct studies that can test and expand upon our findings. We also invite practitioners to share their perspectives with us or engage further with the project website and the SME toolkit.

References

Blesa-Pérez, A., Ripollés-Meliá, M., Rialp-Criado, A., & Rialp-Criado, J. (2023). Introduction to the special issue: Digitalisation and servitisation in international entrepreneurship. *Journal of International Entrepreneurship*, 1-7.

Bock, A. J., Opsahl, T., George, G., & Gann, D. M. (2012). The effects of culture and structure on strategic flexibility during business model innovation. *Journal of Management studies*, *49*(2), 279-305.

Bosman, L., Hartman, N., & Sutherland, J. (2020). How manufacturing firm characteristics can influence decision making for investing in Industry 4.0 technologies. *Journal of Manufacturing Technology Management*, *31*(5), 1117-1141.

Cavallo, A., Cosenz, F., & Noto, G. (2023). Business model scaling and growth hacking in digital entrepreneurship. *Journal of Small Business Management*, 1-28.

Cenamor, J., V. Parida, and J. Wincent. 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.

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 & Production Management*, *41*(5), 694-722

de la Boutetière, H., Montagner, A., & Reich, A. (2018). Unlocking success in digital transformations *McKinsey & Company*, *29*.

Deshler, R., & Smith, K. (2011). Making business model innovation stick. *People and Strategy*, *34*(4), 18.

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.

Europa, 2022. Retrieved from: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/wp-call/2021-2022/wp-11-widening-participation-and-strengthening-the-european-research-area_horizon-2021-2022_en.pdf

Europa, 2016. *SME definition* (no date) *Internal Market, Industry, Entrepreneurship and SMEs*. Retrieved from: https://single-market-economy.ec.europa.eu/smes/sme-definition_en

Eurostat, 2022. *Small and medium-sized enterprises (SMEs) - Structural business statistics - Eurostat*. Retrieved from: https://ec.europa.eu/eurostat/web/structural-business-statistics/information-on-data/small-and-medium-sized-enterprises

Evans, J. D., & Johnson, R. O. (2013). Tools for managing early-stage business model innovation. *Research-Technology Management*, *56*(5), 52-56.

GOV, (2022). *Business population estimates for the UK and Regions 2022: Statistical release (HTML)* (no date) *GOV.UK*. Retrieved from: http://www.gov.uk/government/statistics/business-

population-estimates-2022/business-population-estimates-for-the-uk-and-regions-2022-statistical-release-html#:~:text=Composition%20of%20the%202022%20business%20population

Interact (2022). *InterAct Hub*. Retrieved from https://interact-hub.org/about/

Karami, M., Baber, W. W., & Ojala, A. (2022). The effectual process of business model innovation for seizing opportunities in frontier markets. *Technovation*, *117*, 102595.

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.

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.

Kohtamäki, M., Partanen, J., Parida, V. & Wincent, J. (2013), Non-linear relationship between industrial service offering and sales growth: the moderating role of network capabilities., *Industrial Marketing Management*, 42(8), 1374-1385.

Lamperti, S., Cavallo, A., & Sassanelli, C. (2023). Digital servitization and business model innovation in SMEs: A model to escape from market disruption. *IEEE Transactions on Engineering Management*.

Linde, L., Frishammar, J., & Parida, V. (2021). Revenue models for digital servitization: a value capture framework for designing, developing, and scaling digital services. *IEEE Transactions on Engineering Management*, *70*(1), 82-97.

Maier, J. (2017). Made smarter review. *UK Industrial Digitalisation Review*.

Make UK (2021) *Start-up to scale-up: Supporting smes to grow* (no date) *Make UK*. *The Manufacturer's Organisation*. Retrieved from: https://www.makeuk.org/insights/reports/start-up-to-scale-up-supporting-smes-to-grow?utm_source=makeuk&utm_medium=email&utm_campaign=Report-StartUp-To-ScaleUp2021&utm_content=Report-StartUp-To-ScaleUp-2021

Make UK (2020) Bouncing Back Smarter: Innovation Monitor 2020. *MAKEUK; The Manufacturer's Organisation*. https://www.makeuk.org/insights/reports/innovation-monitor-2020 .

Manufacturer (2022). *Digitalising SMEs is critical to the future of UK manufacturing* (2022a) *The Manufacturer*. Retrieved from: https://www.themanufacturer.com/articles/digitalising-smes-is-critical-to-the-future-of-uk-manufacturing/

Minaya, P. E., Avella, L., & Trespalacios, J. A. (2023). The effects of digital servitization on business competitiveness: A case study of Spanish manufacturers. *Journal of International Entrepreneurship*, 1-34.

Müller, J. M., Buliga, O., & Voigt, K. I. (2018). Fortune favors the prepared: How SMEs approach business model innovations in Industry 4.0. *Technological forecasting and social change*, *132*, 2-17.

Porter, M. E., & Heppelmann, J. E. (2015). How smart, connected products are transforming companies. *Harvard Business Review*, *93*(10), 96–114. Retrieved from https://hbr.org/2015/10/how-smart-connected-products-are-transforming-companies

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 & Production Management*, *41*(5), 437–464

Raddats, C., Kowalkowski, C., Benedettini, O., Burton, J. and Gebauer, H. (2019). Servitization: a contemporary thematic review of four major research streams. *Industrial Marketing Management*, 83, 207-223.

Sage (2022). *Untapped tech adoption could boost UK economy by £232 billion ... - sage*. Retrieved from https://www.sage.com/investors/investor-downloads/press-releases/2022/06/untapped-tech-adoption-could-boost-uk-economy-by-232-billion-annually/

Schroeder et al 2021 - Digital investment for manufacturers: A literature review of challenges and good practices. Retrieved from https://interact-hub.org/wp-content/uploads/2022/12/InterAct_BusinessCaseDigitalisation_Report_submitted.pdf

Spieth, P., & Schneider, S. (2016). Business model innovativeness: designing a formative measure for business model innovation. *Journal of business Economics*, *86*, 671-696.

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.

S&P Global / Cips UK manufacturing PMI. Retrieved from: https://www.pmi.spglobal.com/Public/Home/PressRelease/1a518ba2bdee441297815995745d0f90

Teece, D. J. (2010). Business models, business strategy and innovation. *Long range planning*, *43*(2-3), 172-194.

UKRI (2023). *Manufacturing: The key to unlocking UK innovation* (no date a) *UKRI*. Retrieved from: https://www.ukri.org/blog/manufacturing-the-key-to-unlocking-uk-innovation/

Verhoef, P. C., Broekhuizen, T., Bart, Y., Bhattacharya, A., Dong, J. Q., Fabian, N., & Haenlein, M. (2021). Digital transformation: A multidisciplinary reflection and research agenda. *Journal of business research*, *122*, 889-901.

Appendix A – Methodological Details

Appendix A. Methodological Appendix

A1. Data and measures

The scales used to measure the contextual and organisational factors of interest can be found in Appendix B of the report. All items were measured on a 7-point Likert scale. We operationalised competitive intensity and technological turbulence by adopting the original scales of Jaworski and Kohli (1993). The scale reflecting product complexity comes from Vickery et al. (2016). To capture demand unpredictability, we adopted the 3-item scale of Droge 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.

To capture Business Model Innovation (BMI), we adopted the 5-item scale of Asemokha et al. (2019). Service orientation of corporate values and organisational distinctiveness between product and service businesses were measured through the respective scales from Gebauer et al. (2010). For digital maturity, we used the four-item digital maturity scale developed by PwC (Greif et al., 2016) that considers the degree of digitisation of process and infrastructure, people and culture, sales, and customer involvement. It is treated as formative; all other measures are treated as reflective, as originally conceptualised. The scale to capture business performance comes from Flynn et al. (2010), and we also considered non-financial performance using a scale from Oliva et al. (2012).

The entire instrument was first reviewed by two academics and two industry contacts with survey experience. A short pilot-study, with 38 responses commissioned through Qualtrics, was duly conducted. Respondents were asked to submit comments about the relevance of factors, the clarity of the questions and their overall experience with the survey (e.g., time taken). The feedback was overall excellent. A careful skimming through the data led to the exclusion of eight responses that were completed in an abnormally short period of time, suggesting insufficient engagement and/or random answers. Accordingly, discussions with Qualtrics led to slight modifications to their screening and recruitment strategy. Main phase data collection followed, again commissioned through Qualtrics, with the following criteria: Respondents needed to be high-level employees or owners of UK manufacturing SMEs operating in manufacturing industries with products of medium and/or high technology intensity (e.g., electrical and electronic equipment, automotive etc., excluding industries such as jewellery, food and beverages, paper and packaging). This resulted in 422 responses, 47 of which had to be discarded for failing the attention checks, admitting low level of knowledge about their firm's processes and/or products/services, not coming from SMEs from the specified industries or declaring that none of the six business models types reflected their primary line of business.

A2. Factor analysis

The next step was to subject all reflective scales to an Exploratory Factor Analysis (EFA), in order to ensure scale validity and reliability. Prior to this, a test for outlying observations based on Mahalanobis distance led us to discard another 23 observations. The final sample on which the EFA was run was 352. Bartlett's test for sphericity was rejected (Chi-squared test statistic: 10255, df = 1953, p-value < 0.001), suggesting that the observed variables in the dataset are sufficiently correlated among them to conduct a factor analysis. The Kaiser-Meyer-Olkin (KMO) test for sampling adequacy returned a value of 0.91, indicating that the variables share enough common variance to proceed with factor analysis. A 'parallel analysis',

which determines the optimal number of factors that account for significant variance in the data after comparing the eigenvalues from the actual data, with those obtained from randomly generated datasets with the same properties, suggested 8 factors. This was one less than what we expected (4 contextual and 3 organisational factors, plus 2 performance outcomes). An initial EFA run with maximum likelihood estimation and an oblimin rotation revealed that the main problem was the BMI scale, whose items loaded on other factors. After multiple runs, it became obvious that there was no way to maintain BMI as a construct in our dataset, hence, all 5 items were removed. BMI was also omitted from the analytical story and was only treated as a comparative descriptive characteristic of SMEs choosing different business models. Having removed BMI, we proceeded to scale purification based on an iterative process of EFA after removing problematic items one by one. The final factor solution showed a Tucker Lewis Index (TLI) of factoring reliability of 0.944, and an RMSEA of 0.033. The resulting Cronbach alphas ranged from 0.63 (for product-service distinctiveness which was based on only two items) to 0.90 (business performance). The items that survived this process can be found in Appendix B.

Subsequently, we calculated the factor scores for each respondent by averaging across the items of each factor. In addition, for the only formative construct in the analysis (digital maturity), we constructed a multiplicative index by multiplying the scores of the four aspects. As such, for each respondent, the index took a value between a theoretical minimum of 1 (1 x 1 x 1 x 1) and a maximum of 256 (4 x 4 x 4 x 4). This, together with the factor scores of the reflective constructs, were the inputs for the next (and main) analysis stage.

A3. Fuzzy-set Qualitative Comparative Analysis (fsQCa)

The report's scope does not include a detailed explication of fsQCA. What follows assumes at least a basic familiarity with the method. Interested readers can refer to thorough and accessible treatments of fsQCA, like Ragin (2008), Schneider and Wageman (2012), Oana et al. (2021) and Dusa (2022). The last two sources acted as guides for this work, since they include a step-by-step application of all fsQCA stages in R, using the packages 'QCA' and 'SetMethods'.

In a few words, fsQCA applies set theory and a configurational logic to identify combinations of conditions leading to a specified outcome. In this work, the conditions comprise the constructs discussed in the previous section – demand unpredictability, competitive intensity, technological turbulence, product complexity, organisational product-service distinctiveness, service orientation of employee culture and digital maturity – while SME financial performance constitutes the outcome.

FsQCA is characterised by a set of properties that make it an appropriate and fruitful technique when investigating a phenomenon that is expected to be causally complex. The performance of SMEs adopting digital servitization business models is one such phenomenon. The class of manufacturing SMEs includes vastly heterogenous firms regarding size, age, resource endowment, capabilities etc. Such firms also operate in different industry contexts, facing varying levels of competition and demand unpredictability. Their approach towards, and stage of, servitization might also vary considerably, while they might have also chosen a different digital servitization business model. All these make it extremely unlikely that the road to successful implementation of such business models (i.e., high performance) will be unique, or a simple matter of an 'increase' or 'decrease' in a certain variable.

Calibration

Calibration is a fundamental step of any fsQCA analysis. It starts with the definition of sets corresponding to the variables/conditions and outcome and continues with the assignment of a fuzzy membership score in each set for each case. We defined all sets to reflect high levels of a given condition. For example, the factor score of demand unpredictability was calibrated to denote 'degree of membership in the set of SMEs facing a highly predictable demand'. All measures were calibrated using the 'direct' method, which requires the specification of three thresholds: the point denoting 'full inclusion' in the set, the point denoting 'full exclusion' from the set, and the 'cross-over' point. For each measure, the 10^{th} percentile of the distribution in the entire sample acted as the threshold for full exclusion, and the 90^{th} percentile as the threshold for full inclusion in the designated set. The sample mean acted as the cross-over point.

It is generally not advisable to crudely use distributional properties to calibrate the measures, and instead apply external, qualitative knowledge (Schneider and Wagemann, 2012). However, such qualitative knowledge is often absent in applied, large-N fsQCA studies, so authors routinely use percentiles of the empirical distribution to denote the thresholds (e.g., Meuer, 2016; Zaefarian et al., 2017). It is worth noting that in our case, and as mentioned in the previous paragraph, measure calibration took place considering the distributions of measures in the *entire sample* (N=352). However, and as detailed later, the analysis took place separately for each sub-sample of SMEs according to their primary business model choice. This means that in each sub-sample, the calibration thresholds are effectively 'external' to the sub-sample. For instance, the score that signifies full inclusion in the 'set of SMEs exhibiting high business performance' (or more simply, 'high levels of performance') is the same irrespective of whether an SME has adopted an 'Add-on' or any other primary BM. As such, our calibration scheme accounts for systematic differences between SMEs following different BMs, like for instance the fact that SMEs that follow 'pure product provision' BM significantly underperform compared to all of those that have adopted digital servitization BMs (see Section 3.1 of the report).

As already alluded to, the analysis was conducted separately in each sub-sample. Since there are four digital servitization BMs on the one hand, a pure product provision (non-servitized) BM, and a servitized but not digital one (servitized/non-DS), six separate analyses were run.

Notes on the truth table minimization process

For consistency purposes, and to be able to compare high-performing configurations across Digital Servitization business models, we applied the same thresholds in the analysis for sufficiency for each business model. Namely, a consistency threshold of 0.85 and a PRI (Proportional Reduction in Inconsistency) score of 0.6[10]. In addition, since this work aims to remain as empirically relevant as possible, and to make recommendations to practitioners with as high level of confidence as possible, we took the 'conservative' stance of applying a frequency cut-off of 2. This means that any empirically observed configuration with only 1

[10] As defined in Ragin (2008), consistency captures the degree to which the cases sharing a combination of conditions (in this case, contextual and organisational factors) agree in demonstrating the outcome in focus (in this case, high performance); in other words, it shows "how closely a perfect subset relation is approximated" (p.44). PRI is accounts for simultaneous subset relations, i.e., the extent to which a combination of conditions is a subset of both the presence of the outcome *and* its absence. See Dusa (2022) for details and examples.

case was treated as a logical remainder (like the unobserved configurations), under the assumption that evidence for the empirical presence of such a configuration is slim.

Given the aforementioned, and taking into account the 'universal' nature of the calibration (see earlier sub-section) and the fact that there are clear differences in the mean and median performance of SMEs adopting these BMs, it was expected that the coverage scores of the solutions would vary across models[11]. As a result, our configurations are slightly 'better' at explaining high-performance of SMEs pursuing a 'usage-based' or a 'platform' BM (solution coverages of 0.668 and 0.646, respectively) than high-performance for 'add-on' and 'solution-oriented' BMs (coverages of 0.446 and 0.542, respectively).

The results are presented in a graphical manner in Section 3.2 of the report.

References

Asemokha, A., J. Musona, L. Torkkeli, and S. Saarenketo. 2019. Business model innovation and entrepreneurial orientation relationships in SMEs: Implications for international performance. *Journal of International Entrepreneurship* 17:425-453.

Dusa, A. 2022. *QCA with R: A Comprehensive Resource*, R bookdown available at: https://bookdown.org/dusadrian/QCAbook/.

Dröge, C., C. Claycomb, and R. Germain. 2003. Does Knowledge Mediate the Effect of Context on Performance? Some Initial Evidence. *Decision Sciences* 34:541–568.

Flynn, B.B., B. Huo, and X. Zhao. 2010. The impact of supply chain integration on performance: A contingency and configuration approach. *Journal of Operations Management* 28:58–71.

Gebauer, H., B. Edvardsson, A. Gustafsson, and L. Witell. 2010. Match or Mismatch: Strategy-Structure Configurations in the Service Business of Manufacturing Companies. *Journal of Service Research* 13:198–215.

Greif, H., N. Kühnis, and P. Warnking. 2016. *Digital transformation: How mature are Swiss SMEs?* PwC. https://www.pwc.ch/en/publications/2016/pwc_digital_transform_how_mature_are_swiss_smes_survey_16_en.pdf.

Jaworski, B.J., and A.K. Kohli. 1993. Market Orientation: Antecedents and Consequences. *Journal of Marketing* 57:53–70.

Meuer, J. 2017. Exploring the complementarities within high-performance work systems: A set-theoretic analysis of UK firms. *Human Resource Management* 56:651-672.

Oana, I-E., C.Q. Schneider, and Thomann, E. 2021. *Qualitative Comparative Analysis using R: A Beginner's guide*. Cambridge University Press.

Oliva, R., H. Gebauer, and J.M. Brann. 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* 19:309–334.

Ragin, C.C. 2008. *Redesigning social inquiry: Fuzzy sets and beyond*. Chicago, IL: University of Chicago Press.

Schneider, C.Q., and C. Wagemann. 2012. *Set-theoretic methods for the social sciences: A guide to qualitative comparative analysis*. New York, NY: Cambridge University Press.

[11] Here coverage refers to the extent of empirical relevance of the solution, in other words, it shows how 'good' is a solution at explaining the outcome, and can be considered to be equivalent to the R^2 in regression analysis (se Ragin, 2008).

Vickery, S.K., X. Koufteros, C. Dröge, and R. Calantone. 2016. Product Modularity, Process Modularity, and New Product Introduction Performance: Does Complexity Matter? *Production and Operations Management* 25:751–770.

Zaefarian, G., C. Thiesbrummel, S.C. Henneberg, and P. Naudé. 2017. Different recipes for success in business relationships. *Industrial Marketing Management* 63:69–81.

Appendix B – Toolkit Questions

Appendix B – Survey Instrument (Toolkit questions)

For brevity, we only present the questions and scales that were utilized to measure the variables and constructs of direct interest, i.e., those that were informative for this report. These include the questions that constitute the 'toolkit', plus the two outcomes (financial performance and non-financial performance). SME managers or owners can make full use of the 'toolkit' by accessing the project's website: www.interact-digiserve.co.uk

As a note, only the items/questions that survived the process of scale purification (see Appendix A) are presented, so problematic items of the original scales have been omitted.

1. Firm size

Please indicate the number of employees in your company:

- 1-9
- 10-49
- 50-249
- More than 249

"Please be aware that this study was specifically conducted within the context of Small-to-Medium sized enterprises (<250 employees) in the UK. While you are welcome to utilize this toolkit, it is important to note that the results and recommendations from our study may not directly apply to larger companies. Therefore, please exercise caution when considering the applicability of our recommendations within the specific context of your organisation."

2. Firm age

Please specify the year of establishment of your company.

_____

3. Nature of customers

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

- Other organisations or businesses ('Business-to-Business')
- Individual consumers ('Business-to-Consumer')
- Public sector ('Business-to-Government')

4. Primary Industry

Please indicate the primary industry in which your company operates:

- Power generation (equipment and services)
- Aerospace and defense
- Shipbuilding & maritime equipment
- Construction equipment and services
- Consumer/household durables and (e.g., electronics, appliances)
- Biomedical/healthcare equipment and services
- Transportation infrastructure and equipment
- Automobiles and automotive components
- Information Technology (hardware, software, services)
- Engineering equipment and tools
- Telecommunications equipment and services
- Industrial machinery
- Other electrical or mechanical equipment
- Other

"Please note that the sample for this study consisted exclusively of SMEs from the specified industries, selected due to their tangible products with at least low-to-medium complexity. While you are encouraged to make use of this toolkit, it is crucial to acknowledge that the findings and recommendations may not directly translate to SMEs operating in different industries (such as the food and beverage sector or the financial sector). Therefore, exercise caution and carefully consider the relevance and applicability of our recommendations within the unique context of your organisation."

5. Current position/role

Please indicate your current position/role:

- Top executive / business owner
- Senior management
- Middle management
- Junior management
- Ordinary employee / worker

6. Level of Knowledge

Please indicate the extent to which you consider yourself knowledgeable about the following, where 1 stands for *"not knowledgeable at all"* and 7 stands for *"very knowledgeable"*:

- The context/environment the company is facing (e.g., market trends, competitors, customer requirements)
- The company's products and/or services
- The company's capabilities and internal processes

5. Demand Unpredictability

The following four questions aim at capturing the extent to which your company faces an unpredictable customer demand.

In our primary line of business,

- Sales are:

Predictable (1) … (2) … (3) … (4) … (5) … (6) … (7) Unpredictable

- Product and/or service failures:

Easy to predict (1) … (2) … (3) … (4) … (5) … (6) … (7) Hard to predict

- Market trends:

Easy to monitor (1) … (2) … (3) … (4) … (5) … (6) … (7) Difficult to monitor

- Sales forecasts are likely to be:

Accurate (1) … (2) … (3) … (4) … (5) … (6) … (7) Inaccurate

6. Technological Turbulence

The following three questions are designed to assess the pace of technological advancements within your company's industry. Please indicate the extent to which you agree with the following statements, where 1 stands for *"Strongly disagree"* and 7 stands for *"Strongly Agree"*:

- The technology in our primary industry is changing rapidly
- Technological changes provide big opportunities in our primary industry
- A large number of new product ideas have been made possible through technological breakthroughs in our primary industry

7. Competition intensity

The following set of questions aims at capturing the level of competition in the primary industry you operate in. Please indicate the extent to which you agree with the following statements, where 1 stands for *"Strongly disagree"* and 7 stands for *"Strongly Agree"*:

- Competition in our primary industry is cutthroat
- There are many "promotion wars" in our primary industry
- Anything that one competitor can offer, others can match readily
- Price competition is a hallmark of our primary industry
- One hears of a new competitive move almost every day

Please indicate the degree to which you agree or disagree with each statement:

8. Product complexity

The following questions pertain to the level of complexity associated with your product within your primary business model. Please indicate the extent to which you agree with the

following statements, where 1 stands for *"Strongly disagree"* and 7 stands for *"Strongly Agree"*:

- Our products are highly complex
- The secondary functions that combine (or interact) to produce our products' primary functions are quite different from one another
- Our products are very sophisticated in terms of structure
- Our products are very sophisticated in terms of function
- Our production system is very sophisticated in terms of structure/layout
- Our production system is very sophisticated in terms of operation
- Our production system is very complex

- I would characterize the structure of our typical finished products as:

Very simple (1) … (2) … (3) … (4) … (5) … (6) … (7) Very intricate

- In a given product, the number of secondary functions that combine (or interact) to produce the product's primary function is:

Very low (1) … (2) … (3) … (4) … (5) … (6) … (7) Very high

9. Digital maturity

The following statements are intended to evaluate the digital maturity of your company across four distinct dimensions: internal processes, sales, customer interface, and employee culture. Please indicate the degree of digitisation in your firm in terms of:

Process and infrastructure	Some of our internal processes are rudimentarily digital, some manual. (1)	Internal processes are digital and in some cases interconnected. (2)	Internal processes are digital and in most cases interconnected. (3)	All processes are on a single digital platform. (4)
Digital sales	We have a standardised website for sales. (1)	We have accompanying measures and digital services augmenting online sales. (2)	We use big data to create offerings for individual customers. (3)	We have used digitisation to fundamentally change our business model. (4)
Customer involvement	Customers can give feedback on a standardised basis via digital channels. (1)	Customer feedback is automatically processed and analysed. (2)	Customers are involved digitally in isolated business processes (e.g. sales and development). (3)	Customers are involved digitally in all business processes (sales, development, etc.). (4)
People and Culture	Digitisation hardly concerns our staff. (1)	We make sure staff use digital tools. (2)	We provide training and experts to further the digital development of our staff. (3)	We promote innovation by including digital skills in our hiring criteria. (4)

10. Product/Service business distinctiveness

The following two questions aim to evaluate the extent to which the service business within your organisation is treated as separate and distinct from the product business. Please indicate the extent to which you agree with the following statements, where 1 stands for *"Strongly disagree"* and 7 stands for *"Strongly Agree"*:

- The service business is separated from the product business
- The service organisation runs with its own profit-and-loss responsibility

11. Service orientation of employee culture

The following set of questions attempts to understand how the employees of your organisation perceive services. Please indicate the extent to which you agree with the following statements, where 1 stands for *"Strongly disagree"* and 7 stands for *"Strongly Agree"*:

- Employees understand the marketing opportunities of services
- Employees are aware of the financial potential of services
- Employees recognize the strategic opportunities of services
- Employees consider services as the main part of value creation

12. Business performance (financial)

Considering the last 3 years, please evaluate your company's performance in the following areas relative to your primary/major competitors (where 1 stands for *"significantly lower"* and 7 stands for *"significantly higher"*.

- Growth in sales
- Return on sales
- Growth in return on sales
- Growth in profit
- Growth in market share
- Return on investment
- Growth in return on investment

13. Business performance (non-financial)

Please indicate the extent to which you agree with the following statements, where 1 stands for *"Strongly disagree"* and 7 stands for *"Strongly Agree"*:

- Customers are very satisfied with the quality of our offerings
- The collaboration with our customers is smooth
- We regularly satisfy our customers
- We are able to retain the majority of our customers

Authors Bio

Dimitrios Dousios joined University of East Anglia (UEA) as a Lecturer in Entrepreneurship in September 2011 and is a member of the Strategy and Entrepreneurship group. He previously completed his postgraduate and doctoral studies at Norwich Business School. In his doctoral research, he empirically investigated the linkages between entrepreneurship, dynamic capabilities and small business growth, and was fully funded by the Greek State Scholarship Foundation (IKY). His research revolves around digital entrepreneurship and venture creation with particular focus on the entrepreneurial enablement of digital technologies and the nature of entrepreneurial communication in a technology entrepreneurship context.

Antonios (Tony) Karatzas studied Industrial Management and Technology at the University of Piraeus, Greece, and then acquired an MSc in Strategic Supply Chain Management and an MA in International Business Economics from the UEA. His PhD was at Cranfield School of Management and focussed on service networks and inter-organisational relationships in advanced manufacturing and servitized contexts. Concurrently, he served as a research associate at the Centre for Competition Policy (CCP), UEA. After 3 years of postdoctoral research at WMG, University of Warwick, he returned to UEA in September 2017 as a Lecturer in Supply Chain Management. His primary research interests include servitization of manufacturing and service operations management, and the interface between operations and human resource management.