Development of a Universal Approach for Measuring Servitization

*Tim Baines[a], Raveen R. Menon[a, *], Ali Bigdeli[a], Andreas Schroeder[b], Anwar Adem[a], Dipti Rathi[a], Mario Rapaccini[c], and Chris Raddats[d]*

[a] Aston Business School, Aston University, Birmingham, B4 7ET, UK.

[b] Lancaster University Management School, Lancaster University, Lancaster, LA1 4YX, UK.

[c] Department of Industrial Engineering, Università degli Studi di Firenze, Florence, Italy.

[d] University of Liverpool Management School, University of Liverpool, Liverpool, L69 3BX, UK.

[*] Corresponding Author: Aston Business School, Aston University, Birmingham, B4 7ET, UK.
E-mail address: r.ramachandranmenon@aston.ac.uk (Raveen R. Menon)

Declaration of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Development of a Universal Approach for Measuring Servitization

ABSTRACT

Although interest in servitization is growing, researchers and practitioners still lack a universally accepted, reliable, and valid approach for measuring it in industrial firms. In this paper, we develop and empirically validate a comprehensive measurement approach that addresses this gap. We start by defining servitization, followed by a critical review of existing studies that have attempted to measure it. Drawing on prior studies, we create and refine a three-test approach through pre-pilot and pilot studies with industrial executives, followed by a nationwide survey of 701 firms. Our approach measures servitization across three dimensions: revenue share between products and services, types of services offered, and revenue share from each of the service offerings. We address construct ambiguity in servitization measurement, enabling more reliable empirical analysis on the impact of servitiziation and supporting theory-building in business model innovation. We introduce the concept of servitization intensity, which quantifies a firm's 'service footprint' and enables meaningful comparisons across firms, sectors, and regions. Survey results confirm the robustness of the approach and reveal substantial variation in servitization adoption. Finally, we propose a fourth test that captures both the scope of service offerings and provider responsibility, offering a richer and more accurate assessment of servitization.

Keywords: Servitization, measurement, survey

1. INTRODUCTION

Servitization is the innovation of a firm's business model to compete through services rather than products alone, offering products-as-a-service and regularly earning revenue when the desired outcomes are achieved (Baines et al., 2024). It can offer industrial firms a pathway to both significantly improving economic productivity by creating greater value for their customers and delivering higher environmental performance through improved resource efficiency and dematerialisation within the supply chain (Li et al., 2022, Qi et al., 2020, Kastalli and Van Looy, 2013).

Numerous studies have attempted to quantify the extent to which manufacturers have adopted servitization. Amongst the most highly cited is Neely (2008), which examined data from 10,028 firms and identified a multifaceted relationship between servitization, firm size, profitability, and risks. Building on these findings, Crozet and Milet (2017) analysed a larger dataset of 44,324 French manufacturing firms and found a 0.4% profitability increase and a 0.6% sales boost upon diversification into services. Korkeamaki et al. (2021) differentiated between servitized and non-servitized firms by analysing 1,566 equipment manufacturing firms. All such studies have been invaluable to furthering a greater understanding of servitization performance, yet they are contingent on the validity and reliability of the measures used.

The principal reason why researchers have not yet adopted a more generic approach to measurement is that servitization is not a straightforward phenomenon to study. Analysis of the literature (which we explain in this paper) shows that the measurement systems used by researchers can be grouped into three categories: (i) product-service revenue distribution (ii) service offerings (types and numbers), and (iii) how a firm publicly describes itself in business description. Sometimes, these measurement systems are combined to strengthen insights and confidence in the data gathered. While each measurement system has been usefully

applied by researchers, there are nevertheless commonly recurring limitations with all three systems and the way in which they are applied by researchers.

A universally adopted system for measuring servitization would be highly valuable to the research community. It would mean that the insights revealed from unrelated studies could be more readily compared; for example, the extent to which firms in the UK have adopted servitization could be contrasted with those in Europe and beyond. Similarly, if such a measurement system could reveal greater details about the constitution of firms' service portfolios, this would allow better insights into the relative merits of different service types under different circumstances. In practice, this would also allow firms to be more readily benchmarked against each other, leading executives to improve their understanding of servitization, its adoption, and exploitation (Menon et al., 2024). Indeed, if a system for measuring servitization existed that could be equally applied to assess both the portfolio of services 'offered' by firms and also the portfolio of services 'consumed' by customers, this would enable more holistic studies of the servitization phenomenon.

Following the preceding analysis and the gaps in prior research, the aim of this study is *to develop an approach for measuring servitization in a firm*. The paper strives to answer the research question, 'how can servitization be reliably and validly measured within an industrial firm?' Developing a universal approach for measuring servitization requires thoroughly examining existing measurement systems and their relative merits. Our objective is to provide a means which is both acceptable to the wider research community and practical to apply in an industrial firm. To achieve this, the process of multi-item measurement and research instrument development must be grounded in a sound conceptual framework of the theoretically significant constructs being defined (Hinkin, 1998, Churchill, 1979).

This paper makes several key contributions. First, we address the long-standing lack of valid and reliable measures of servitization (Baines et al., 2017, Rabetino et al., 2018) by developing and validating a novel and holistic measurement framework. Second, in developing this approach, we build on our conceptual framing of servitization as an innovation in the customer value proposition of a business model and resolve the inconsistency and ambiguity in how the extent of servitization is conceptualised in the literature (Raddats et al., 2019, Kohtamaki et al., 2020) . Third, deyond theoretical clarity, we provide managers with a rigorous, evidence-based tool to assess the depth and breadth of servitization within manufacturing firms (Foss and Saebi, 2017). In doing so, we offer a theoretically grounded and empirically tested tool that enables managers to benchmark the extent of servitization and examine its relationship with performance outcomes. Fouth and finally, by building on our empirical findings we additionally propose another measurement apporach to capture the provider's responsibility for delivering customer outcomes. The concept of measuring business model innovation that explicitly uses a 'customer-centric' approach is the first of its kind in operations management (Sousa and da Silveira, 2017, Menon et al., 2022) and aligns closely with the outcome-based nature of servitization and advanced services.

Our study follows a four-step approach. First, we establish a definition of servitization to capture how the research community commonly understands the phenomenon. Second, using a literature review, we identify and evaluate existing studies that have measured servitization. Third, we draw on the findings of the literature review to develop a novel servitization measurement approach and validate it using pre-pilot and pilot tests. Finally, we empirically validate the measurement approach using a nationwide survey of 701 industrial firms. We operationalise the extent of servitization by measuring the proportion of a firm's total revenue that comes from services, assigning greater weight to more advanced service types. We refer to this weighted index as servitization intensity, which captures both the breadth of service

offerings and the revenue share from each service type. In simple terms, servitization intensity is a metric that quantifies the extent of servitization in a manufacturing firm. This approach captures the 'service footprint' of a firm, enabling meaningful comparison of servitization levels across firms.

2. RESEARCH METHODOLOGY

Developing a means to measure servitization is an involved process. There needs to be a reliable understanding of the phenomenon under investigation, an appreciation of what constitutes good measurement, and then an evaluation of previous measurement systems. Only with these insights can an alternative measurement system be proposed and then itself evaluated. The research described in this paper has been structured to reflect this process. This section now explains the research design.

2.1 Servitization: Defining the phenomenon

Servitization of an industrial firm is a transformation along a continuum from product-based offerings to service-oriented outcomes (Baines et al., 2020). Building on this notion, researchers measure this 'transformation' based on the number of service offerings (Gaiardelli et al., 2014) and the number of service offerings (Raddats and Burton, 2011). However, such a measurement approach based on service offerings is myopic because the extent of servitization is often a latent capability of services (Raddats and Kowalkowski, 2014). Thus, we conceptualise servitization as a business model innovation encompassing an organisation's capabilities, and subsequently measure the extent of servitization as a measure of outcome that includes the whole 'sophistication of services offered' (Baines et al., 2009).

Armed with this appreciation, we define servitization as: The process where a firm engages with business model innovations and organisational changes, to compete through providing business outcomes for customers rather than only producing and selling outputs (products). Building on the established notion of bundling or the integration of products and services (Vandermerwe and Rada, 1988), our definition is in line with recent literature that conceptualises servitization as a holistic move towards delivering outcomes (Schaefers et al., 2021, Batista et al., 2017, Kowalkowski et al., 2022, Gebauer et al., 2017) through business model innovations (Kastalli and Van Looy, 2013, Paiola and Gebauer, 2020). This definition also encompasses the concept of '*advanced services*', which is based on delivering outcomes that directly align with value creation and capture processes in a firm (Bigdeli et al., 2018).

A valid measurement approach has to be both valid and reliable. Forza (2002) emphasised that a measure achieves construct validity when its items faithfully represent the theoretical construct, without including aspects not inherent to the construct. Reliability, encompassing dependability, stability, predictability, consistency, and accuracy, is essential for trustworthy measurement (Carmines and Zeller, 1979, Kerlinger, 1966). The validity and reliability of the resulting measurement approaches are imperative to ensure the quality of empirical research. Our aim, therefore, is to establish a means of measuring servitization in an industrial firm which is both reliable (dependable and accurate) and valid (a faithful representation).

2.2 Prior studies: How servitization has been measured so far

A casual reflection on prior studies of servitization quickly reveals that a variety of measures have been used over the past 30 years. To evaluate these measures comprehensively, we first identified all relevant studies and grouped them based on their similarities. This approach allowed us to assess the popularity and influence of the measures, and then evaluate their reliability and validity. Therefore, in this study, we reviewed extant literature guided and informed by the systematic literature review (SLR) process (Tranfield et al., 2003). Our objective was to identify previous studies that incorporated measures of servitization. While

we were guided by the process of SLR, our literature review is not an SLR on its own since our objective was limited to identifying extant measures.

2.3 Development and validation of the servitization measurement system (pre-pilot and pilot tests)

The insights from prior research provided the foundation for the development of the measurement system. This process consisted of two stages: deciding *what to ask*, and then *how to ask*. Following the development, we validated our approach through a series of semi-structured interviews. We gathered feedback from senior executive representing firms that are at various stages of servitization. We conducted multiple sessions with these executives and encouraged them to raise any doubts or queries in order to evaluate the validity of the measures. After each sessions, we gathered feedback from the executives to amend and improve the measures. Following this, we developed a questionnaire and conducted a survey to measure the extent of servitization.

The reliability and validity of the proposed servitization measurement were established through a multi-stage validation process. Face validity and content validity were ensured through pre-pilot and pilot tests involving senior executives from industrial firms, whose expert feedback was used to assess the relevance, clarity, and completeness of the measurement approach and to refine question wording and structure accordingly. To assess reliability and robustness, we operationalised servitization intensity using two alternative but theoretically consistent weighting schemes. The resulting indices produced highly similar distributions and summary statistics, indicating that the measurement yields stable and consistent results under comparable conditions and is not unduly sensitive to specific weighting assumptions.

While procedures such as factor analysis and internal consistency tests are appropriate for reflective survey scales (Chan et al., 2016), they are not suitable for the present study, where servitization is operationalised as a composite construct reflecting heterogeneous but theoretically ordered dimensions of firms' business model innovation (Diamantopoulos and Winklhofer, 2001).

2.4 Operationalisation of servitization

Following the data collection using a questionnaire-based survey, we developed a weighted-aggregation method to operationalise the extent of servitization. We refer to this weighted index as servitization intensity, which captures both the breadth of service offerings and the revenue share from each service type. We categorised three maturity levels of servitization – base, intermediate, and advanced and assigned weights to these levels. This weighted aggregation approach follows established practices in operations management research, where composite constructs are often formed by differentially weighting component indicators. For example, Flynn et al. (2010) developed weighted indices for supply chain integration dimensions; Roth and Jackson (1995) weighted multiple dimensions of service quality; and Koufteros et al. (1998) applied structured weighting to capture time-based manufacturing capabilities. Similarly, Ward et al. (1998) and Peng et al. (2008) weighted priorities and routines to better reflect the nuanced contributions of underlying practices.

3. LITERATURE REVIEW

The objective of our literature review is to provide a transparent analysis of prior research (Boell and Cecez-Kecmanovic, 2015), focusing on the key insights and outcomes regarding servitization measurement (Paré et al., 2015). To achieve this, our review consisted of a five step process (Figure 1). First, we scoped our review to set boundaries. We relied on databases such as Scopus, Web of Science (WoS), and Google Scholar (Harzing and Alakangas, 2016, Martín-Martín et al., 2018). We used the keywords – "measur*", "apprais*", "estimat*",

"degree", "calc*", "performance", "survey", "secondary data", "archival" – to collect relevant research articles (Calabrese et al., 2019, Brax and Visintin, 2017).

Our keyword search identified 1451 research articles from 1982 to 2025. To ensure quality, we limited our inclusion criteria to articles published in top-listed journals (based on ABS, ABDC, and ERA rankings) (Durach et al., 2017) and/or those with high citations. We then screened out those articles that did not focus on our objective of servitization measurement. Finally, we made sure that we adhered to search criteria through an iterative content analysis which resulted in a set of 88 research articles. These articles were analysed using a defined *a priori* coding structure to extract relevant data. In this way, we summarised, evaluated, and extracted the necessary insights as to how each study had measured servitization. Figure 1 illustrates the process of the literature review, and the data captured from each article (Step 4). We then evaluated this data to generate the findings presented in Section 3.1. We provide the full list of papers and data collected as a separate data file.

Although there is no consensus among researchers on how to measure servitization, there are three principal measurement systems used in the literature: (i) based on product–service revenue distribution (Fang et al., 2008, Crozet and Milet, 2017, Wang et al., 2023b, Suarez et al., 2013); (ii) service offerings, based on the number and types of services (Kohtamaki et al., 2013b, Sousa and da Silveira, 2017, Li et al., 2023); and (iii) business descriptions, based on keyword frequency reflecting product–service orientation. These three categories distinguish whether servitization is measured on revenue distribution or type of service offerings, or an organisational orientation (product–service emphasis reflected in business descriptions). This conceptual distinction is rooted in our conceptual definition of servitization as *the process through which a firm engages in business model innovations and organisational changes to compete by providing customer outcomes rather than merely producing and selling outputs (products)*. Occasionally, studies use a combination of measurement systems to identify and then evaluate a firm. This understading provided a foundation for developing a unified system for measuring servitization.

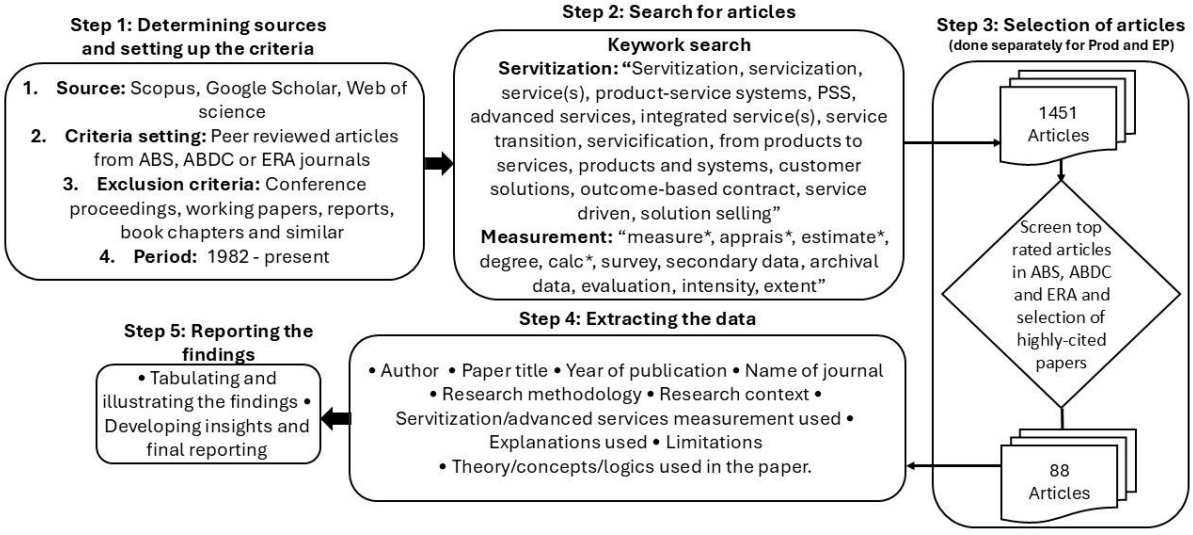

Figure 1: Literature review process

In the following sections, we first critique each measurement system in terms of reliability and validity when assessing servitization. Then, describe how we formed and tested the new measurement system through these insights.

Product–service revenue distribution

The first servitization measurement system is based on differentiating between products and services, and it draws on the financial characteristics of the firms (see Table 1). This method primarily examines key financial indicators of manufacturing firms reflecting the transition to a service-oriented business model. Central to this is the firm's service revenue as a proportion of its total revenue (Wang et al., 2023b, Li et al., 2022, Martín-Peña et al., 2020), as it directly quantifies the financial impact of service operations relative to the firm's overall business performance. Other financial indicators include the allocation of investments towards service-related resources and capabilities, or the profit margin derived from service operations compared to product sales (Kwak and Kim, 2016, Aas and Pedersen, 2011). For example, when examining the effect of servitization on various performance-related variables, some papers measure the degree of servitization as the share of the revenue from services (Crozet and Milet, 2017, Zhang et al., 2023a, Suarez et al., 2013) and the ratio of the provider's purchases to the provider's cost of goods sold (Benedettini and Neely, 2019).

Product–service orientation using share of revenue from services (or products) raises questions about the relevance of the complementarity of products and services in manufacturing firms. For many firms, the existence of services is simply an addition to the manufacturing process, as far as revenues are concerned; however, without services, the revenue from manufacturing can decline (Crozet and Milet, 2017). Crozet and Milet (2017) acknowledged that their revenue data did not provide information on the type of service sold by firms (or on the type of goods produced), and it could not explicitly distinguish between services that were complements to, or substitutes for, the goods. Li et al. (2022) focused on the reliability of the measurement system. They measured servitization using a percentage of sales from service segments. To ensure robustness, they conducted a test measuring servitization based on the breadth of servitization (i.e., the number of service segments for which the firm earned revenue). Even though they tested the reliability of the measurement system, the reliability was still based on the service types from which the firm earned revenue. Since this measurement relies primarily on revenue data, it poses challenges to the reliability of capturing the full scope and complexity of service offerings. Similar issues of validity and reliability are visible in other studies that measure servitization using a share of revenue.

A key limitation of these approaches is the implicit assumption that all service revenues are equivalent indicators of servitization. In practice, service revenues may originate from fundamentally different service businesses with distinct strategic roles, ranging from basic, product-oriented services to more advanced, customer-oriented or outcome-based offerings (Oliva and Kallenberg, 2003, Sjödin et al., 2020). Service portfolios and their associated value-creation mechanisms vary substantially across firms, industries, and stages of servitization (Baines et al., 2017; Bigdeli et al., 2018). Consequently, similar service revenue shares may reflect very different underlying business models, organisational commitments, and degrees of outcome orientation. Moreover, value created through servitization, particularly in advanced or outcome-based models, is not always proportionally captured in short-term service revenues, especially where services are bundled with products or designed to support long-term customer outcomes rather than immediate financial returns (Martinez et al., 2017, Rapaccini et al., 2023). As a result, revenue-based measures risk conflating financial outcomes with the strategic depth of servitization.

Table 1: Key papers measuring servitization based on firms' product–service revenue distribution

No.	Author Details	Paper Title	Journal
1	Martín-Peña et al. (2023)	The innovation antecedents behind the servitization–performance relationship	R&D Management
2	Chen et al. (2023)	Does regional services development enhance manufacturing firm productivity? A manufacturing servitization perspective	International Review of Economics & Finance
3	Zhang et al. (2023a)	The impact of servitization on manufacturing firms' market power: Empirical evidence from China	International Journal of Operations & Production Management
4	Wang et al. (2023b)	The impact of servitization on trade credit in manufacturing firms: A signaling theory perspective	International Journal of Operations & Production Management
5	Guedes et al. (2022)	Family business, servitization, and performance: Evidence from Portugal	Technological Forecasting and Social Change
6	Li et al. (2022)	Servitization and organizational resilience of manufacturing firms: Evidence from the COVID-19 outbreak	International Journal of Production Economics
7	Martín-Peña et al. (2020)	Servitization and digitalization in manufacturing: The influence on firm performance	Journal of Business & Industrial Marketing
8	Qi et al. (2020)	Manufacturing practices and servitization: The role of mass customization and product innovation capabilities	International Journal of Production Economics
9	Benedettini and Neely (2019)	Service providers and firm performance: Investigating the non-linear effect of dependence	Journal of Service Management
10	Valtakoski and Witell (2018)	Service capabilities and servitized SME performance: Contingency on firm age	International Journal of Operations & Production Management

Service offerings

The second servitization measurement system emphasises firms' service offerings and captures the number and types of services provided by manufacturing firms (see Table 2). This includes, for example, differentiating services based on whether they are basic, intermediate or advanced services (Sousa and da Silveira, 2017, Li et al., 2023), or according to orientation (product or customer) (Raddats and Kowalkowski, 2014). For example, Mathieu (2001) classified services as those supporting products (SSP) and those supporting customers (SSC). Baines and Lightfoot (2014) divided services into three service types, and Benedettini et al. (2015, 2017) classified services into 12 types.

The existing literature measuring servitization based on service offerings lacks consensus on how to define and classify services, as we can see from above. Even though these measures provide important insights into the breadth and scope of services provided by firms, they face significant challenges related to classification consistency and comparability (Baines et al., 2009, Kowalkowski et al., 2017). Existing studies employ widely varying service typologies, ranging from simple binary distinctions to highly granular classifications, often driven by

context-specific research objectives rather than a shared theoretical foundation (Gebauer et al., 2010; Rabetino et al., 2018). This heterogeneity limits comparability across studies and complicates cumulative theory development. In addition, counting the number or types of services offered does not necessarily capture the strategic importance, organisational implications, or value-creation logic associated with those services. Firms may offer similar service portfolios yet differ substantially in how services are integrated into their business models or leveraged to deliver customer outcomes (Kowalkowski et al., 2017; Bigdeli et al., 2018). As a result, service-offering–based measures risk overemphasising service presence while underrepresenting servitization as an organisational and business model transformation. These variations across studies make it challenging to compare different scenarios.

Table 2: Key papers measuring servitization based on firms' service offerings

No.	Author Details	Paper Title	Journal
1	Zhang et al. (2023b)	Service breadth or depth? A customer perspective	Supply Chain Management: An International Journal
2	Li et al. (2023)	Servitization and performance: The moderating effect of supply chain integration	Production, Planning & Control
3	Yang et al. (2023)	Leveraging digitalization and servitization to improve financial performance	Production Planning & Control
4	Karatzas et al. (2022)	Risky business? Shareholder value effects of service provision	International Journal of Production Economics
5	Wei et al. (2022)	When does servitization promote product innovation? The moderating roles of product modularization and organization formalization	Technovation
6	Raddats et al. (2022)	Creating value in servitization through digital service innovations	Industrial Marketing Management
7	Vendrell-Herrero et al. (2021)	Information technologies and product-service innovation: The moderating role of service R&D team structure	Journal of Business Research
8	Sousa and da Silveira (2020)	Advanced services and advantage: An empirical investigation	International Journal of Operations & Production Management
9	Huikkola et al. (2020)	Firm boundaries in servitization: Interplay and repositioning practices	Industrial Marketing Management
10	Ayala et al. (2019)	Managing servitization in product companies: The moderating role of service suppliers	International Journal of Operations & Production Management

Business description

The third servitization measurement system focuses on how industrial firms publicly describe their business, products, and services (See Table 3). This method encompasses analysing how manufacturing firms represent their business activities and service orientation in their

official communications, such as annual reports (Benedettini et al., 2017, Neely, 2008). The focus is on textual analysis discerning the strategic emphasis on services. Keywords, phrases, or discussions highlighting the firm's commitment to servitization are particularly instructive (Kharlamov and Parry, 2021) and could include references to service innovation, customer solutions, or the integration of products and services (Wang et al., 2023a, Xiao et al., 2022, Kohtamaki et al., 2021).

Relying on the firm-specific description of businesses, products, and services in annual reports, etc., to distinguish between servitized and non-servitized firms brings many challenges. Most of the studies using this measurement tool rely on qualitative content analysis of the existence versus non-existence of service-related content and the frequency of the occurrence of such information (Benedettini et al., 2017). While these studies focus on service portfolios in the textual descriptions, this methodology does not focus on the importance of different types of services and the length and breadth of services (Kharlamov and Parry, 2021).

Text-based analyses typically rely on keyword frequency or qualitative interpretation, which may reflect managerial rhetoric rather than actual service practices or value creation (Bowman et al., 2013, Wickert et al., 2021). These measures do not attribute to product-related services offered by manufacturing firms and, therefore, miss a critical aspect of outcomes as a result of servitization (Wang et al., 2023a, Kohtamaki et al., 2021). In addition, differences in disclosure practices, narrative styles, and reporting incentives across firms further challenge the reliability and comparability of business-description–based measures (Short et al., 2010). Consequently, these approaches may signal servitization intent without adequately capturing its operational depth or value-based manifestations. This, then, raises questions as to the validity of this measurement system. In addition, each study has adopted a different methodology of text analysis, which further exposes the reliability of these measures.

Table 3: Key papers measuring servitization using firm-specific business description

No.	Author Details	Paper Title	Journal
1	Xiao et al. (2022)	What can satisfy customers in servitization? Service or goods innovation	Journal of Business & Industrial Marketing
2	Kharlamov and Parry (2021)	The impact of servitization and digitization on productivity and profitability of the firm: A systematic approach	Production Planning & Control
3	Kohtamaki et al. (2021)	The role of ambidextrous innovation in servitization: The non-linear relationship between servitization and company profitability and the moderating role of ambidextrous innovation	SSRN
4	Korkeamaki et al. (2021)	Worth the risk? The profit impact of outcome-based service offerings for manufacturing firms	Journal of Business Research

Data sources in the measurement of servitization

The above-mentioned three categories of meaurement systems largely corresponds to three distinct data sources, namely archival financial data, survey data, and textual business descriptions. However, there are some overlaps across categories, as certain studies combine multiple data sources or measurement logics. For example, product-service revenue

distribution could be measured using both financial data as well as survey data (Vaillant and Lafuente, 2024, Dachs et al., 2014).

Understanding what data sources are usually used in studies provides a valuable context for developing a unified system for measuring servitization. Data sources should be adaptable to different methods and purposes. The 88 papers reviewed indicate that a wide variety of primary and secondary data sources have been used in the literature for measuring servitization (see Appendix A). Among the studies focusing on primary data sources, a few of them rely on standard national surveys such as the International Manufacturing Strategy Survey (Li et al., 2023), the Global Manufacturing Research Group (GMRS) (Qi et al., 2020) and the European Manufacturing Survey (EMS) (Lay et al., 2010).

Secondary data sources are also widely used for measuring servitization. While UK-based samples predominantly use the FAME database (Kharlamov and Parry, 2021), COMPUSTAT is the most commonly used database for US-based samples (Benedettini and Neely, 2019). Chinese studies frequently refer to the CSMAR and WIND databases (Zhang et al., 2023a, Wang et al., 2023a, Suarez et al., 2013), while European research often draws data from OSIRIS, Orbis, CIS2006, and BRN (Crozet and Milet, 2017, Valtakoski and Witell, 2018, Korkeamaki et al., 2021). However, two main caveats exist with these databases. Firstly, the definitions of services vary across these databases, which can lead to confirmation bias. Secondly, despite the comprehensive data on public firms' service sales, there is potential selection bias due to the voluntary disclosure of service sales information.

Primary data sources in servitization studies often involve a variety of respondents. These respondents include managers (Kohtamaki et al., 2013a, Abou-foul et al., 2021, Ayala et al., 2019), key departmental executives (Rabetino et al., 2015, Belvedere et al., 2013), vice presidents, directors, and CEOs (Baines and Lightfoot, 2014, Zhang et al., 2023b, Partanen et al., 2017) of their respective departments and companies. However, these studies often rely on data from a single respondent at the department or company level, which can raise concerns about the breadth and representativeness of the data collected. Similarly, studies employing standard national surveys, such as the International Manufacturing Strategy Survey (IMSS) (Li et al., 2023, Sousa and da Silveira, 2020), GMRS (Qi et al., 2020), and EMS (Lay et al., 2010, Dachs et al., 2014), also contribute to primary data in servitization research. These surveys, conducted by global partners, typically depend on single respondents for data collection. Yet, this single-respondent survey-based approach does not eliminate the risk of common method bias and challenges the validity of the data collection technique.

3.1 Inconsistencies and challenges in extant measures of servitization

Inconsistencies across all three measurement approaches can be attributed to two key challenges (Calabrese et al., 2019). The first pertains to the undefined nature of the term 'extent of servitization'. This ambiguity complicates the quantitative assessment of measuring servitization. Specifically, it is unclear whether the 'extent' should be measured by the share of revenue generated from services or by the variety of services offered. The second challenge lies in the operationalisation of the measurement variable. Evidence of this can be seen in the myriad classification systems in place to quantify a firm's service offering, as documented in the existing literature (Benedettini et al., 2017, Rapaccini and Visintin, 2015, Ulaga and Reinartz, 2011, Mathieu, 2001). Similarly, in the case of using the share of revenue from services, it becomes unclear whether extant measures are measuring the servitization outcome or the servitization itself. This level of heterogeneity inevitably impedes the ability of researchers and practitioners to measure servitization.

In addition to the three measurement approaches, other financial indicators are also used to measure the servitization. These include the allocation of investments towards service-related

resources and capabilities, or the profit margin derived from service operations compared to product sales, or the share of the revenue from services (Crozet and Milet, 2017, Zhang et al., 2023a, Suarez et al., 2013). Other ratios are based on an evaluation of the provider's purchases to the provider's cost of goods sold (Benedettini and Neely, 2019). Similar ratios appear in the literature on business model innovation, for example, Wannakrairoj and Velu (2021), to evaluate a change in the net asset turnover ratio (NATO).

A wide-ranging limitation in all three established measurement systems is is a reliance on all those involved in servitization (be it researchers or practitioners) having the same understanding and usage of terms. We have discussed our definition of servitization above. However, other definitions can vary too. 'Product' can be understood differently, for example; these days it is mostly (but not always) defined as 'something that will hurt if it lands on your foot (Vargo and Lusch, 2004). Similarly, some scholars define servitization in terms of the risks apportioned to the provider on behalf of the customer. Nordin et al. (2011) argued that the transition from products to services presents unique risk implications for manufacturers, as it encompasses the provision of services with varied risk profiles. Emphasising this shift, Karatzas et al. (2022) underlined the importance of risk transfer in the progression from simple to complex services. They advocated for categorising services based on their distinct risk profiles, acknowledging the varying degrees of risk associated with different service types. Although such a measurement system can be resource-intensive to administer, when a firm is heavily engaged in servitization, this can provide a rich and detailed description.

A final limitation of existing systems in measuring servitization is that they target the change in the relationship between the provider and customer from the perspective of the provider; for example, studying the extent to which the provider is increasingly bundling products and services in its offering to the customer. The studies that look at servitization from a supply perspective are rare; for example, literature hardly explores the extent to which the customer increasingly acquires bundles of products and services. These issues place a further challenge to a valid measurement system for servitization, as it must be applicable from both customer and provider perspectives and capable of capturing both products and services offerings.

While each of the above measurement approaches exhibits limitations when applied in isolation, they also offer valuable and complementary insights into different aspects of servitization. Revenue-based measures provide a pragmatic indication of firms' financial exposure to services; service-offering measures capture the breadth and nature of service portfolios; and business-description–based measures reveal strategic orientation towards services (Fang et al., 2008, Baines et al., 2009, Li et al., 2005). Rather than discarding these approaches, this study integrates their respective strengths within a sequential measurement logic. The proposed three-test approach (Tests 1–3) is deliberately designed so that the limitations of one measure are mitigated by the insights generated in subsequent tests. This staged and interconnected structure aligns with prior calls to move beyond single-proxy measures of servitization (Rabetino et al., 2018, Bigdeli et al., 2018) and enables a more robust and theoretically consistent assessment of servitization as a business model and organisational transformation.

4. DEVELOPMENT OF THE SERVITIZATION MEASUREMENT SYSTEM

Our review of existing measurement systems for servitization established the following insights: (i) that three popular measurement systems exist, (ii) these tend to be used independently (but are sometimes used in combination), (iii) each approach, when used independently, has greater limitations in terms of validity and reliability compared to when they are used in combination and (iv) the most reliable are resource intensive to apply and only

useful for some firms. These tests do, however, provide a basis for creating a new servitization measurement system.

In line with our conceptual definition of servitization as a business model transformation toward delivering customer outcomes (Oliva and Kallenberg, 2003, Baines et al., 2017), the proposed instrument is designed to capture servitization intensity, rather than servitization adoption alone. Servitization intensity is conceptualised as a multidimensional construct reflecting (i) the extent to which firms engage in service activities, (ii) the breadth and depth of those service offerings, and (iii) the degree of responsibility assumed by the provider for delivering customer outcomes (Kowalkowski et al., 2017, Rabetino et al., 2018). While revenue splits provide an initial indication of service engagement, they do not, on their own, capture outcome orientation or business model change (Kastalli and Van Looy, 2013). The proposed measurement therefore combines revenue-based information with subsequent tests that progressively capture service footprint and outcome responsibility.

To improve conceptual clarity, we distinguish between servitization adoption, servitization intensity, and outcome orientation, which are related but not equivalent constructs. Servitization adoption refers to whether firms offer services at all, whereas servitization intensity captures the degree and nature of firms' engagement with services (Fang et al., 2008, Baines et al., 2009). Outcome orientation refers specifically to the extent to which firms assume responsibility for delivering customer outcomes rather than supporting product use (Oliva and Kallenberg, 2003, Sjödin et al., 2020). The conceptual mapping (Table 4) illustrates how the proposed measurement advances beyond single-proxy approaches by distinguishing between different dimensions of servitization through a structured sequence of tests.

Table 4: Conceptual mapping of servitization dimensions and measurement tests

Conceptual dimension	Conceptual meaning	What is distinguished	Measurement test
Servitization adoption	Whether a firm engages in services at all	Revenue from products vs. services	Test 1
Servitization intensity	How services are used within the business model	Services supporting products vs. services supporting customers	Test 2
Breadth and intensity of servitization	How firms structure and monetise different service-based customer value propositions	Revenue from differing service-based customer value propositions	Test 3

Using the insights gained from the literature, we propose that there are three plausible tests for servitization (Figure 2). Across all these tests, servitization is evaluated in terms of revenue. Although there are limitations with this, in practice, this is a pragmatic way to deal with servitization in an industrial setting.

These tests are:

Test 1: Distinguishing between revenue from products and services: By quantifying this revenue split, this test provides an initial indication as to whether a firm might exhibit any form of servitization.

Test 2: Distinguishing between revenue from groups of services supporting products and groups of services supporting customers: By quantifying this revenue split this test provides an indication of the general form and intensity of servitization.

Test 3: Distinguishing between revenue from differing services-based customer value propositions: By quantifying this revenue split this test reveals the breadth and intensity of servitization.

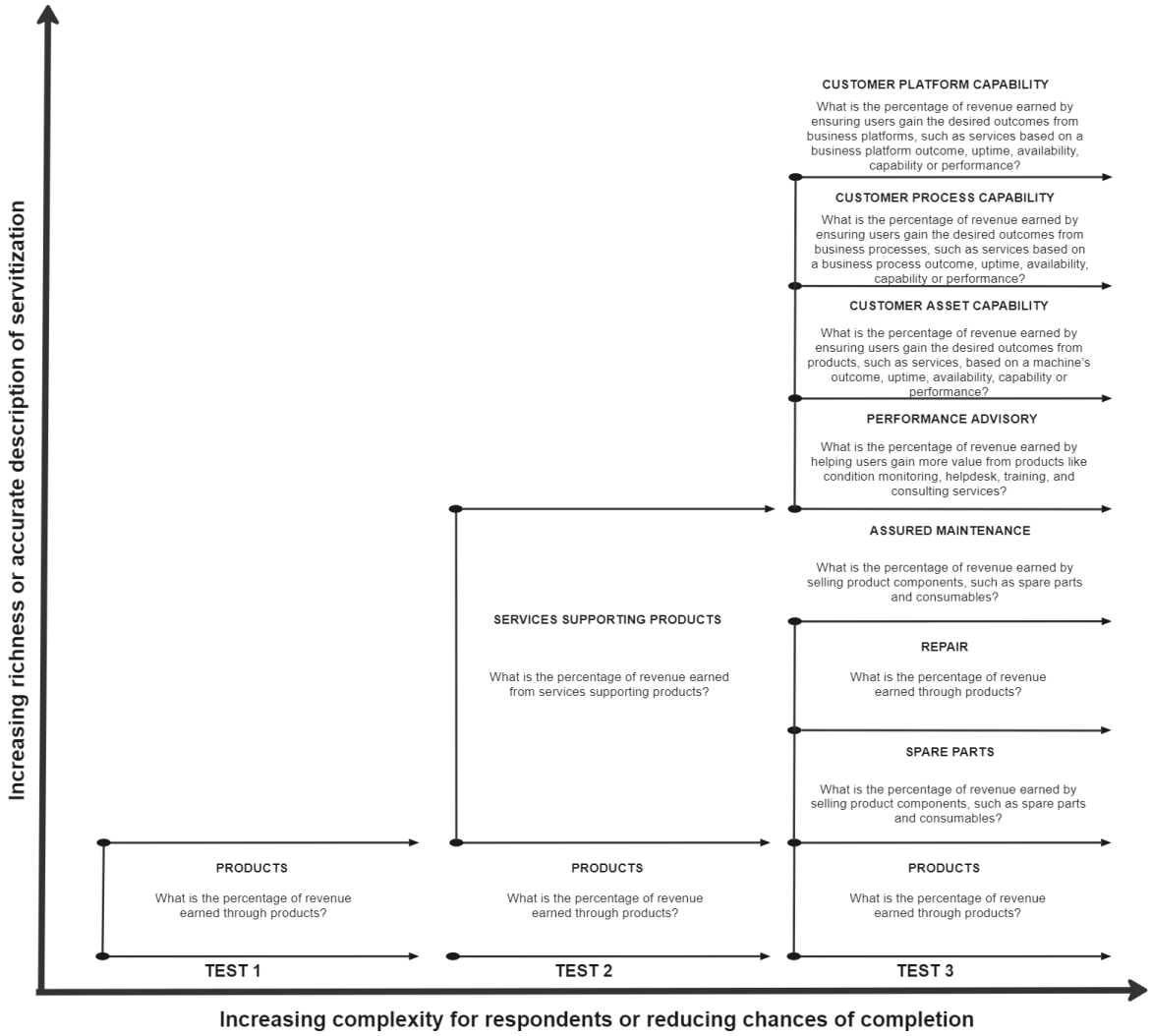

Figure 2: Three tests for measuring servitization and related questions with interdependencies and alignment of questions

The questions or discussion points for Tests 1 and 2 are not complex and commonly occur in the literature. This is not the case for Tests 3, however, as there are a wide variety of ways with which service offerings can be classified. Therefore, to make sure that the people associated with measurement exercise understood the tests (irrespective of what approach we adopt to administer the test), we shall include relatable examples. Such examples and descriptive vignette-based questions are commonly used in operations management research to convey to respondents about the scripted information about specific levels of factors of interest that are hypothesised (Rungtusanatham et al., 2011, Flynn et al., 1990).

Earlier in this paper, we examined different types of service offerings, each with its merits, limitations, and following in the research community. To provide a rational classification, we have chosen to root our distinction in the mainstream literature on business model innovation and provide a theory-informed distinction. This literature is particularly useful in distinguishing between value creation, delivery, and capture (Bigdeli et al., 2018). This means that the literature separates the offering to the customer from how that offering is delivered, and how value is captured from this. This draws us to focus on defining differing service-based customer value propositions.

The proposed measurement system is designed as a conceptually ordered sequence of tests rather than a set of independent measures. Each test captures a distinct but related dimension of servitization, with subsequent tests building on the insights generated by earlier ones. This sequencing reflects the progression from basic service activity to increasingly complex service-based customer value propositions and associated provider responsibilities.

While these tests are useful, they will vary in their appropriateness from one firm to the next. It would, for example, be entirely fruitless to attempt to apply Test 3 in an organisation which only produces products. The tests need to be arranged in a sequence as illustrated in Figure 2. The figure arranges the tests along the X-axis in order of their increasing complexity and effort to compete, and the Y-axis indicates progressively higher levels of validity and a deeper understanding of servitization.

The layout suggests a ‘process’ for sequencing the application of these tests to give the best chance of capturing results. Every attempt to measure servitization should commence with Test 1, and only where there is some revenue from services as well as products should Test 2 be enacted. Then, Test 3 is only worthwhile where there is clearly a range of services being offered; in other words, if a firm is only gaining services from spare-part sales then it is unlikely that executing Test 3 will be worthwhile or indeed completed by the interviewee. While TEST 2 distinguishes between services supporting products and services supporting customers, it does not capture differences in how firms structure and monetise distinct service-based customer value propositions. To address this limitation, TEST 3 further differentiates service revenues across base, intermediate, and advanced services. Arranging the tests in this way avoids asking overly complex and frankly irrelevant questions to a practitioner whose firm exhibits very little evidence of servitization.

The development of TEST 3 is informed by servitization and business model innovation literature that distinguishes between value creation, value delivery, and value capture (Teece, 2010; Osterwalder and Pigneur, 2010), as well as by frameworks such as the servitization staircase (Baines et al., 2024) that highlight increasing levels of provider responsibility and risk transfer across service types (Oliva and Kallenberg, 2003, Baines et al., 2009, Kowalkowski et al., 2017). Accordingly, TEST 3 distinguishes between revenue from base, intermediate, and advanced services to capture differences in service-based customer value propositions.

There is, though, a further advantage of arranging the tests in this way. It allows for the results gained from one test to be compared to those from others. For instance, the revenue earned from services in general (Test 1) should equal that of both services supporting the product and services supporting the customer (Test 2). Cross comparing and, if necessary, adjusting the revenue proportions associated with each helps to build a much more reliable picture of the extent of servitization.

The sequential and interconnected nature of these stages is crucial, as it enhances the overall validity and robustness of the servitization assessment method. The reliability of each

measure significantly improves when used in combination with others. This integrated approach ensures that the results from one stage reinforce and validate those from the subsequent stages, creating a cohesive and robust assessment. For instance, the revenue split analysis in the first stage sets the foundation, which is then enriched by the nuanced understanding of services in the second stage. Each stage builds upon the previous one, providing a comprehensive and validated view of a firm's servitization journey. This stacking of measures enhances the accuracy of each stage and ensures a holistic and reliable overall assessment of servitization within a firm. In the following section, we pilot this measurement system to test and demonstrate this in action.

4.1 Pre-pilot test

Prior to piloting the final servitization measurement approach, we conducted a pre-pilot test with senior executives from industrial firms to assess the content and construct validity of the proposed measurement system. The primary objective of this pre-pilot study was to evaluate whether the measurement approach adequately captured the concept of servitization and whether the items were clearly interpretable by practitioners.

Specifically, we organised a joint workshop involving executives from ten industrial firms known to operate at differing levels of servitization maturity (See Appendix B for sample demographics). All participating executives held senior roles and were directly involved in the design or implementation of servitization initiatives within their respective business units. During the workshop, participants were guided through the proposed measurement approach and asked to reflect on its clarity, relevance, and feasibility.

When discussing product–service revenue distribution, although most executives indicated that they were familiar with their firms' revenue structures, many found it difficult to clearly distinguish revenues generated as part of a deliberate servitization strategy from revenues associated with ad hoc or traditional service offerings. This challenge aligns with prior literature suggesting that revenue-based measures may oversimplify servitization and blur strategic intent, thereby reinforcing the need for more robust proxies of servitization (Burton et al., 2017, Han et al., 2013).

Similarly, when evaluating the service offering–based questions, only 60% of respondents were able to answer all items, while the remaining 40% provided partial responses. Executives who completed all items typically represented firms that had progressed further along their servitization journey, whereas partial responses were more common among firms at earlier stages. This observation is consistent with prior research indicating that firms' understanding and articulation of their service offerings tend to improve as servitization advances (Martinez et al., 2017, Rapaccini et al., 2023).

Following the workshop, we systematically collected feedback from participants to refine the measurement system. The executives broadly agreed that the proposed three-test approach offered an appropriate and meaningful assessment of servitization, thereby supporting its content validity. However, they also recommended simplifying the measurement process by refining the structure and wording of specific items, particularly those capturing provider responsibilities that inform firm activities across base, intermediate, and advanced services. In particular, questions relating to provider responsibilities posed comprehension challenges for respondents. In response to this feedback, we revised the questionnaire by incorporating clearer, formal definitions of base, intermediate, and advanced services.

4.2 Pilot test

Insights from the pre-pilot phase directly informed the refinement of the survey instrument prior to the pilot and final data collection. Specifically, feedback highlighted ambiguity in the wording

of service categories and difficulties in consistently allocating revenues across overlapping services. In response, we revised the structure of the questionnaire by simplifying question wording, clarifying service definitions, and introducing illustrative examples to support revenue allocation across base, intermediate, and advanced service categories. These revisions were incorporated into the pilot survey and subsequently retained in the final instrument, as pilot respondents reported no further comprehension or completion issues.

Building on the above inputs, we refined our measurement approach and conducted a pilot study with another set of ten executives from ten different firms. We arranged individual meetings with a small group of senior executives from each of these ten firms. Each session lasted around one hour. In this step, we focused on the service provision and revenue split in firms based on their provision of different services – advanced, intermediate, or base (integrating Tests 1, 2, and 3). To begin with, our administrator provided an explanation of advanced, intermediate, and base services and captured the revenue split across these services. Contrary to what we experienced in pre-pilot test, all the respondents could answer the questions on service provisions and revenue share. No material ambiguity was reported during the pilot or final survey stages, indicating that the revised instrument provided sufficient clarity for consistent interpretation across respondents. These numbers helped us to plot the firms' relative positions in the servitization staircase model and this indicated the extant of servitization in the firm. This exercise validated our measurement approach.

This interview-based approach relied on our administrator's explanation and examples of services – base, (focused on delivering the product and spare parts to customers) intermediate (focused on maintaining product condition, such as periodic maintenance, repairs, and overhauls) and advanced (focused on delivering customer-centric outcomes, such as mobility, power, or equipment uptime, often through performance- or outcome-based contracts). However, the feedback from executives suggested that to conduct a survey (different to interview) that could explain this revenue split (as well as service provision details), we have to modify the wordings and questions. The feedback from this pilot test suggested us to present examples of different service offerings to help respondents better understand the scope and content of base, intermediate and advanced services rather than definitions. This made it easy for the executives to differentiate between types of services and provide revenue splits accordingly. This ensured that the instrument captured the intended constructs precisely. These insights informed minor revisions to the wording and sequencing of items, thereby strengthening the construct validity of the final measurement approach without altering its underlying conceptual logic.

Therefore, with the validation we had on the content with our pilot test (content validity), we developed a survey questionnaire (Appendix C) aligning with the interview protocol and using the feedback we received.

5. SURVEY AND VALIDATION OF SERVITIZATION INTENSITY MEASURE

Following the development of the questionnaire-based survey, we collected data from UK-based firms using two modes: computer-assisted telephone interviews (CATI) and an online survey, both targeting senior-level respondents. The sampling frame was derived from the Inter-Departmental Business Register (IDBR), focusing on 17 manufacturing and service-intensive sectors likely to exhibit servitization activity. From an initial list of 22,845 firms, we obtained contact details for 13,336 of them through our data partner and used stratified sampling to select firms with demonstrable servitization engagement. We screened out firms reporting no engagement in service provision. Subsequently, after removing duplicates, invalid entries, and low-quality responses from the initial pool of 785, we obtained 701 usable

responses. Specifically, we gathered 133 responses (19%) via CATI and 568 responses (81%) via the online survey.

The sampling frame for this study focuses on UK-based manufacturing firms that report some degree of service provision. Firms reporting no service activity were excluded to ensure that the measurement captures variation in servitization intensity among engaged firms, rather than a binary distinction between manufacturers with and without services. This design choice has implications for the observed distribution of servitization intensity, as the exclusion of zero-service firms reduces mass at the lower bound of the scale. In a fully mixed sample including firms with no service provision, we would expect a more left-skewed distribution with a concentration at zero, while preserving the relative ordering and interpretive logic of servitization intensity among service-active firms. Importantly, the proposed measurement remains applicable in such settings, with zero-service firms naturally scoring at the lower bound of the index.

We operationalised servitization intensity through a two-stage approach in our survey combining firms' service adoption levels with the revenue share attributed to services. We define servitization intensity as the weighted share of a firm's revenue that comes from services, giving more importance to advanced services than basic and intermediate services. Consistent with the servitization staircase model (Baines et al., 2009, Oliva and Kallenberg, 2003, Kohtamäki and Helo, 2015), and as we mentioned earlier, firms can be categorised into three service maturity levels: base services (e.g., product spare parts), intermediate services (e.g., product break/fix, assured maintenance), and advanced services (e.g., outcome-based contracts). Service adoption was recorded using binary indicators derived from survey responses, while the proportion of revenue attributable to each service category was calculated based on firm-reported financial breakdowns (Neely, 2008). This method enabled a fine-grained, revenue-weighted evaluation of service activities, addressing limitations associated with binary classifications of servitization status (Baines et al., 2009, Kowalkowski et al., 2017).

We developed three composite indices using alternative plausible weights to synthesise the survey data into an interpretable servitization intensity measure. The rationale for the weighting is that services are not equally important in terms of their strategic and competitive advantages for a firm. These advantages can include product differentiation, market power, innovation inputs, and customer relations. For instance, a base service, such as a spare part, may not provide a strong competitive advantage compared with advanced services, such as predictive maintenance, even though the firm derives the same revenue share from both. Hence, the strategic value of some services is more important to the firm than that of others, and we reflect this by assigning different weights to different categories of services when constructing our index.

In the first two indices, we introduced two sets of alternate plausible weights for robustness check, maintaining the same ordinal structure while reducing the relative dispersion between service categories. The first index (Servitization Intensity 1) applied weights – 0.2 for base, 0.3 for intermediate, and 0.5 for advanced services – reflecting the increasing strategic complexity and revenue significance associated with higher levels of servitization. The second index (Servitization Intensity 2) normalised these weights (0.2333, 0.3333, and 0.4333, respectively) to ensure proportional contributions while preserving the ordinal importance of service categories. Additionally, we conducted a sensitivity check (Servitization Intensity 3) with equal weights for basic, intermediate and advanced services (0.33, 0.33 and 0.33 respectively). Altogether, these three measures allow us to assess whether the index is sensitive to moderate changes in weighting assumptions without altering the underlying

conceptual logic. It is to be noted that we use three weighting schemes to demonstrate the stability and robustness of the servitization intensity index, rather than to claim a single optimal weighting structure.

5.1 Survey results

Our results of servitization intensity measures show the validity of the proposed measurement system. While the descriptive statistics revealed substantial heterogeneity in both service adoption rates and service-derived revenue shares, the intensity measures with two different sets of weights revealed almost similar values, indicating the robustness and generalisability of our measurement approach (Table 5).

All three servitization intensity indices demonstrate comparable range and distribution, supporting the robustness of the measurement model. As shown in Figure 3, Servitization intensity 1 values range from 0 to 38.4, Servitization intensity 2 spans from 0 to 33.86, and Servitization intensity 3 spans from 0 to 33.33. The indices also exhibit nearly identical mean values (M_1 = 10.11; M_2 = 10.37; M_3 = 10.59) and standard deviations (SD_1 = 7.24; SD_2 = 7.24, SD_3 = 7.16), suggesting that despite the use of different weighting schemes, all three indices capture comparable underlying variation in firm-level servitization intensity. This consistency is indicative of internal robustness and supports the convergent validity of the measurement approach (Flynn et al., 1990).

The broad heterogeneity in index values across the 701 firms signals meaningful variation in servitization practices, consistent with prior findings that servitization adoption is contingent on sectoral and strategic factors (Baines et al., 2009, Kohtamaki et al., 2015). The distributional similarity across two independently weighted constructs indicates the strength and reliability of the index design, and aligns with established practices in operations research where alternative specifications of multi-indicator constructs are used to assess robustness (Ward et al., 1998, Peng et al., 2008). The additional sensitivity check with equal weights show similar distribution pattern with comparable mean and range. Although this equal-weight specification does not align with the conceptual assumption that advanced services represent higher servitization intensity than base or intermediate services, the observed similarity in distributional properties further demonstrates the sensitivity of the measurement approach. Taken together, these results provide strong empirical support for the validity of our approach to quantifying servitization intensity and justify its application in subsequent analyses and future research.

Table 5: Servitization intensity measures

Component	Description	Formula or Definition	Mean	Std. Dev.	Min	Max
Base services	Basic after-sales and product-attached services	1 if any one of base services are offered; 0 otherwise	0.986	0.115	0	1
Intermediate services	Value-added service offerings (e.g., consulting, optimisation)	1 if any one of intermediate services are offered; 0 otherwise	0.775	0.418	0	1
Advanced services	Outcome-based solutions and	1 if any one of advanced services	0.776	0.418	0	1

	full-service models	are offered; 0 otherwise				
Service revenue share	Percentage revenue from services	[Service revenue/(Product revenue + Service revenue)] x 100	35.80%	21.03%	0%	100%
Servitization intensity 1	Weighted index based on service revenue shares	0.2 × Revenue share from base services + 0.3 × Revenue share from intermediate services + 0.5 × Revenue share from advanced services	10.11	7.24	0	38.40
Servitization intensity 2	Normalised proportional weights	0.2333 × Revenue share from base services + 0.3333 × Revenue share from intermediate services + 0.4333 × Revenue share from advanced services	10.37	7.24	0	33.86
Servitization intensity 3	Sensitivity check with equal weights	0.33 × Revenue share from base services + 0.33 × Revenue share from intermediate services + 0.33 × Revenue share from advanced services	10.59	7.16	0	33.33

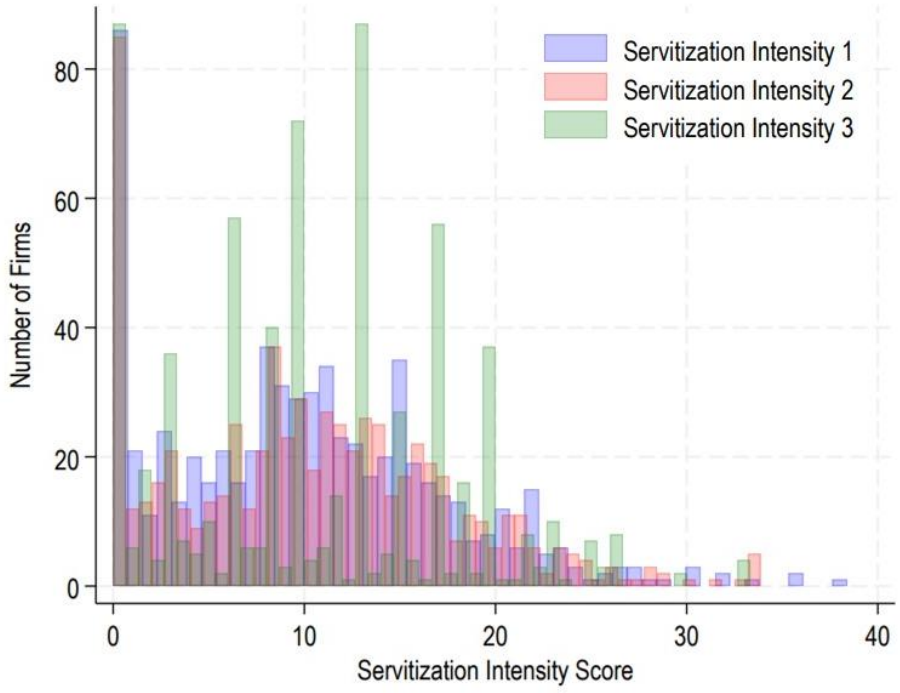

Figure 3: Servitization intensity measures

5.2 Interpreting servitization intensity measure

Our concept of servitization intensity captures how far a firm has progressed from product-based operations to outcome-based service models. Servitization intensity is not only a quantitative indicator but also a diagnostic construct that reveals the strategic positioning of a firm along its servitization journey. It combines two dimensions - the proportion of total revenue derived from services and the relative sophistication of these services - to create a single, weighted score that reflects both scale and maturity.

Higher servitization intensity typically indicates that a firm has transitioned beyond basic product-attached services toward more complex, customer-oriented solutions. Firms with elevated intensity scores often exhibit stronger customer relationships, stable recurring revenue streams, and enhanced differentiation, but they also assume greater responsibility and risk in assuring customer outcomes. In contrast, firms with low servitization intensity remain product-centric, with limited service diversification and a transactional revenue base.

Figure 4 illustrates how servitization intensity increases as firms ascend the service staircase, a conceptual model linking the progression from base services (e.g., repairs, spare parts) to intermediate services (e.g., maintenance contracts, advisory) and advanced services (e.g., outcome-based contracts and performance guarantees). Each stage represents a higher level of customer integration and business model transformation, offering both opportunities and challenges for providers.

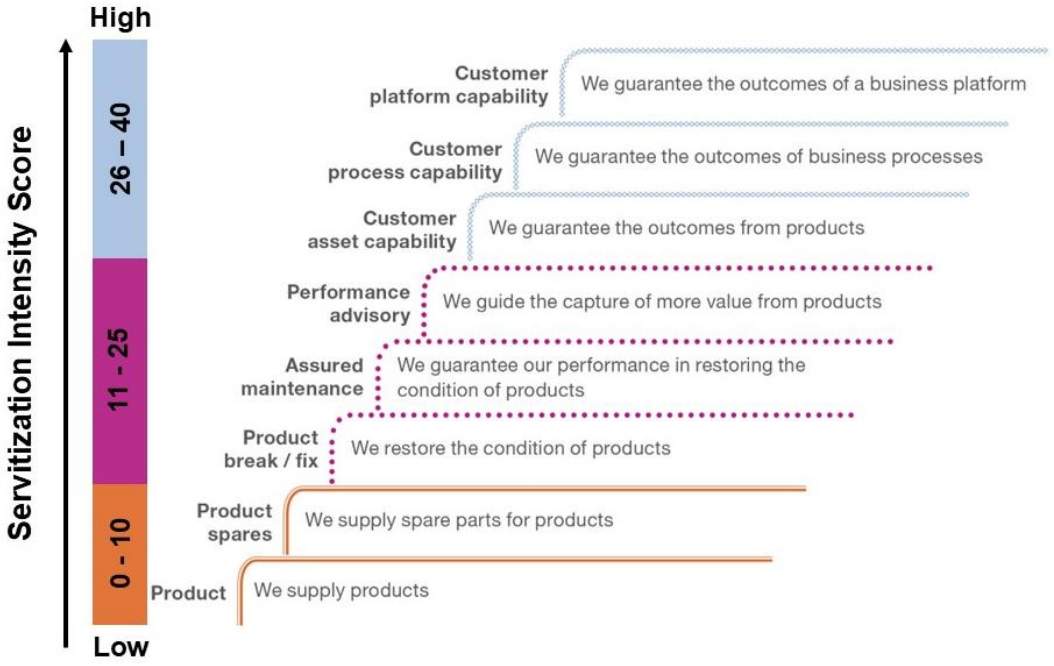

Figure 4: The Service Staircase Model illustrating increasing servitization intensity from product-based offerings to advanced outcome-based services.

6. CONTRIBUTIONS

6.1 Theoretical contributions

We contribute to the servitization literature by offering a novel, validated, and multidimensional measurement approach that addresses longstanding limitations around construct validity, reliability, and comparability (Baines et al., 2017, Raddats et al., 2019). We make four key

contributions to the servitization and business model innovation literature by addressing critical gaps in how servitization is measured and understood.

First, we address the absence of a holistic and universally accepted framework in servitization research and contribute to the development of a robust and reliable measurement system. Prior studies often rely on singular, unidimensional proxies, such as service revenue or binary categorisations – which offer limited construct validity and lack reliability when applied across contexts (Baines et al., 2017, Rabetino et al., 2018). Our three-test system responds to this by offering a multidimensional, empirically validated approach that captures both structural and financial indicators of servitization intensity. This enhances the rigour and replicability of future research, while enabling consistent benchmarking across firms and industries.

Second, we address the conceptual and operational ambiguity surrounding the measurement of servitization extent. Existing approaches often employ vague or inconsistent scales that hinder meaningful comparisons and theoretical advancement (Raddats et al., 2019, Kohtamaki et al., 2020). Our measurement approach systematically differentiates between types of services, and value propositions, and provides a clearer and more actionable definition of servitization intensity. This precision enables a more effective empirical analysis of the relationship between servitization and firm outcomes, supporting the development of mid-range theory. Furthermore, our empirical validation, based on survey data, illustrates how changes in customer value propositions and revenue models can be systematically operationalised (Foss and Saebi, 2017), offering a practical foundation for future empirical research. This contribution is particularly significant for advancing business model innovation theory by providing measurable constructs that link servitization to firm-level outcomes.

Third, our concept of servitization intensity is a more objective and customer-oriented understanding of servitization by moving beyond subjective, provider-centric interpretations. Much of the existing literature relies on managerial perceptions or internal classifications of service strategies, which can introduce bias and overlook how value is actually delivered to customers (Sousa and da Silveira, 2017). Our approach shifts focus towards indicators based on revenue allocation across service categories, including customer value propositions and levels of responsibility assumed by the provider. This enables a more balanced and theory-informed perspective on servitization, aligned with business model innovation and the co-creation of value in industrial settings.

Fourth, while our three-test approach offers a comprehensive framework for measuring servitization, another measure to assess differing responsibilities taken by the service provider on behalf of the customer presents a promising avenue for future research. Unlike Tests 1–3, which focus on service types, revenue sources, and customer value propositions, another Test to evaluate the degree of responsibility assumed by providers – an inherently more abstract and cognitively demanding construct – focusing on different customer value propositions and revenue associated with each responsibilities would provide a customer centric approach to measuring servitization. Therefore, in addition to our empirically validated three tests, we propose another test:

Test 4: Distinguishing between revenue from differing responsibilities taken by the service provider on behalf of the customer: By quantifying this revenue split this test reveals a granular and flexible indication of the breadth and intensity of servitization.

Although grounded in established frameworks (e.g., the services staircase and business model innovation literature), the complexity of this test poses challenges in a survey-based data collection, including increased ambiguity and response fatigue during pilot testing. Therefore, our final proposed measurement approach is shown in Figure 5.

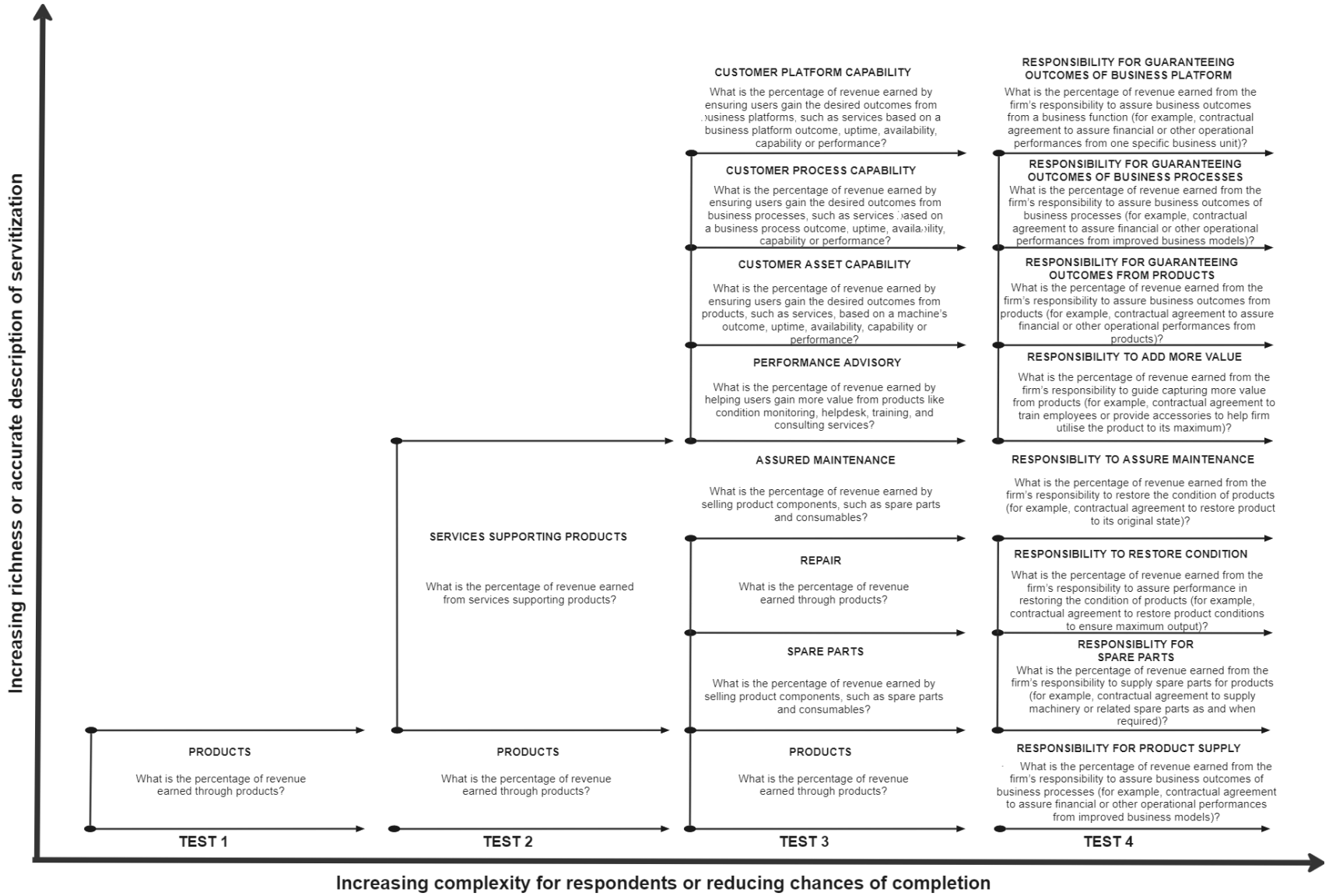

Figure 5: Four tests for measuring servitization and related questions with interdependencies and alignment of questions

Test 4 captures variation in providers' responsibility for delivering customer outcomes, rather than treating servitization as a uniform shift towards services. Provider responsibility refers to the extent to which firms assume responsibility for service performance, operational continuity, and outcome achievement, including the associated risks and coordination requirements (Oliva and Kallenberg, 2003; Kowalkowski et al., 2017). By distinguishing between service offerings that primarily support product use and those that commit the provider to delivering specified customer outcomes, the proposed measurement captures meaningful differences in the depth and nature of servitization (Visnjic et al., 2019; Baines et al., 2017).

Importantly, this measurement enables more precise empirical examination of servitization through a dynamic capabilities lens. Higher levels of provider responsibility imply greater requirements for firms to integrate, reconfigure, and redeploy resources across organisational boundaries, including operational processes, digital infrastructures, and customer-relational capabilities (Kowalkowski et al., 2015, Bigdeli et al., 2018). By operationalising servitization as a progression in outcome responsibility rather than merely service intensity, the measure supports empirical research on how firms develop and leverage dynamic capabilities to reconfigure resources and sustain competitive advantage through servitization (Teece, 2007). This provides a clearer theoretical bridge between servitization measurement and capability-based perspectives, addressing a key limitation of prior empirical work.

6.2 Practical contributions

Our findings provide significant practical contributions. In a practical context, our measurement approach can provide more detailed insights into the composition of firms' service portfolios, and a better understanding of the relative advantages of different service types under varying circumstances. Most importantly, this is expected to yield significant environmental and social benefits (Menon et al., 2024, Parida et al., 2019, Kazakova and Lee, 2022). Additionally, the servitization measurement index would enable executives of leading firms to benchmark the degree of servitization across business divisions, firms, regions, and value networks. This could enhance their comprehension, adoption and leverage of servitization-related business outcomes, as discussed by Baines et al. (2009). For instance, this approach could enable the assessment of the extent of servitization adoption among firms in the UK, and allow for comparative analysis with firms in France, Germany, Italy, and other countries (similarly among sectors, networks, and such). Consequently, the widespread adoption of our approach to servitization measurement could serve as a basis for policymakers, aiding in a comprehensive understanding of servitization nuances in key sectors crucial to the prosperity of local and global economies, as highlighted by the European et al. (2018).

For managers, servitization intensity measure is both a benchmarking and developmental tool. Increasing servitization intensity can be achieved through two primary levers: shifting a greater share of revenue from products to services, and advancing the service offering by moving higher up the staircase towards advanced services. Since the index is revenue-weighted, small adjustments can have notable effects, for instance, a 2–3% shift of total revenue from products to services or introducing a modest proportion of advanced service offerings can increase the intensity score by one point. Firms can therefore progress by expanding maintenance and optimisation contracts, integrating remote monitoring, or developing outcome-based offerings such as uptime or performance guarantees.

7. LIMITATIONS AND FUTURE RESEARCH

Although the empirical analysis is based on UK manufacturing firms, the proposed measurement is designed to be scalable across national contexts and industrial sectors. While institutional environments, market maturity, and regulatory conditions may influence the composition and prevalence of service offerings, the underlying measurement logic

(distinguishing between base, intermediate, and advanced services based on increasing outcome responsibility) remains conceptually generalisable. Future research can adapt service classifications and different weighting schemes to reflect country- or sector-specific characteristics while retaining the sequential structure of the measurement, thereby enabling comparative studies and broader benchmarking applications.

More broadly, our survey reflects a deliberate trade-off between theoretical rigour and practical applicability. While the four-test approach that integrates differing responsibilities taken by the service provider offers a conceptually robust and comprehensive system for measuring servitization, its full implementation at scale is resource-intensive and may not be feasible for all firms or research settings. As such, we recommend a pragmatic approach – adopting the tests selectively, depending on methodology, data availability, and implementation constraints. Future studies could explore alternative methods – such as interviews, case studies, or digital trace data – to refine and validate Test 4, thereby enhancing the granularity and depth of servitization measurement.

8. ACKNOWLEDGEMENTS

This work was supported by UKRI – Economic and Social Research Council (ESRC) Grants Ref ES/W010194/1, 'Understanding how Servitization Can Impact UK Economic Productivity and Environmental Performance', an Aston University and Warwick University joint project.

9. REFERENCES

Aas, T. H. & Pedersen, P. E. 2011. The impact of service innovation on firm-level financial performance. *The Service Industries Journal,* Vol. 31**,** No. 13. pp. 2071-2090.

Abou-Foul, M., Ruiz-Alba, J. L. & Soares, A. 2021. The impact of digitalization and servitization on the financial performance of a firm: An empirical analysis. *Production Planning & Control,* Vol. 32**,** No. 12. pp. 975-989.

Ayala, N. F., Gerstlberger, W. & Frank, A. G. 2019. Managing servitization in product companies: the moderating role of service suppliers. *International Journal of Operations & Production Management,* Vol. 39**,** No. 1. pp. 43-74.

Baines, T. & Lightfoot, H. 2014. Servitization of the manufacturing firm. *International Journal of Operations & Production Management,* Vol. 34**,** No. 1. pp. 2-35.

Baines, T., Lightfoot, H. W., Benedettini, O. & Kay, J. M. 2009. The servitization of manufacturing. *Journal of Manufacturing Technology Management,* Vol. 20**,** No. 5. pp. 547-567.

Baines, T., Ziaee Bigdeli, A., Bustinza, O. F., Shi, V. G., Baldwin, J. & Ridgway, K. 2017. Servitization: Revisiting the state-of-the-art and research priorities. *International Journal of Operations & Production Management,* Vol. 37**,** No. 2. pp. 256-278.

Baines, T., Ziaee Bigdeli, A. & Kapoor, K. 2024. Servitization, Advanced Services and Outcomes. *In:* BAINES, T., ZIAEE BIGDELI, A. & KAPOOR, K. (eds.) *Servitization Strategy: Delivering Customer-Centric Outcomes Through Business Model Innovation.* Cham: Springer Nature Switzerland.

Baines, T., Ziaee Bigdeli, A., Sousa, R. & Schroeder, A. 2020. Framing the servitization transformation process: A model to understand and facilitate the servitization journey. *International Journal of Production Economics,* Vol. 221**,** No. pp. 107463.

Batista, L., Davis-Poynter, S., Ng, I. & Maull, R. 2017. Servitization through outcome-based contract – A systems perspective from the defence industry. *International Journal of Production Economics,* Vol. 192**,** No. pp. 133-143.

Belvedere, V., Grando, A. & Bielli, P. 2013. A quantitative investigation of the role of information and communication technologies in the implementation of a product-

service system. *International Journal of Production Research,* Vol. 51**,** No. 2. pp. 410-426.
Benedettini, O. & Neely, A. 2019. Service providers and firm performance: Investigating the non-linear effect of dependence. *Journal of Service Management,* Vol. 30**,** No. 6. pp. 716-738.
Benedettini, O., Neely, A. & Swink, M. 2015. Why do servitized firms fail? A risk-based explanation. *International Journal of Operations & Production Management,* Vol. 35**,** No. 6. pp. 946-979.
Benedettini, O., Swink, M. & Neely, A. 2017. Examining the influence of service additions on manufacturing firms' bankruptcy likelihood. *Industrial Marketing Management,* Vol. 60**,** No. pp. 112-125.
Bigdeli, A. Z., Baines, T., Schroeder, A., Brown, S., Musson, E., Guang Shi, V. & Calabrese, A. 2018. Measuring servitization progress and outcome: The case of 'advanced services'. *Production Planning & Control,* Vol. 29**,** No. 4. pp. 315-332.
Boell, S. K. & Cecez-Kecmanovic, D. 2015. On being 'Systematic' in literature reviews in IS. *Journal of Information Technology,* Vol. 30**,** No. 2. pp. 161-173.
Bowman, G., Mackay, R. B., Masrani, S. & Mckiernan, P. 2013. Storytelling and the scenario process: Understanding success and failure. *Technological Forecasting and Social Change,* Vol. 80**,** No. 4. pp. 735-748.
Brax, S. A. & Visintin, F. 2017. Meta-model of servitization: The integrative profiling approach. *Industrial Marketing Management,* Vol. 60**,** No. pp. 17-32.
Burton, J., Story, V. M., Raddats, C. & Zolkiewski, J. 2017. Overcoming the challenges that hinder new service development by manufacturers with diverse services strategies. *International Journal of Production Economics,* Vol. 192**,** No. pp. 29-39.
Calabrese, A., Levialdi Ghiron, N., Tiburzi, L., Baines, T. & Ziaee Bigdeli, A. 2019. The measurement of degree of servitization: literature review and recommendations. *Production Planning & Control,* Vol. 30**,** No. 13. pp. 1118-1135.
Carmines, E. G. & Zeller, R. A. 1979. *Reliability and validity assessment*, Sage publications.
Chan, T. Y., Wong, C. W. Y., Lai, K. H., Lun, V. Y. H., Ng, C. T. & Ngai, E. W. T. 2016. Green Service: Construct Development and Measurement Validation. *Production and Operations Management,* Vol. 25**,** No. 3. pp. 432-457.
Chen, G., Liu, Y., Gao, Q. & Zhang, J. 2023. Does regional services development enhance manufacturing firm productivity? A manufacturing servitization perspective. *International Review of Economics & Finance,* Vol. 86**,** No. pp. 451-466.
Churchill, G. A. 1979. A paradigm for developing better measures of marketing constructs. *Journal of Marketing Research,* Vol. 16**,** No. 1. pp. 64-73.
Crozet, M. & Milet, E. 2017. Should everybody be in services? The effect of servitization on manufacturing firm performance. *Journal of Economics & Management Strategy,* Vol. 26**,** No. 4. pp. 820-841.
Dachs, B., Biege, S., Borowiecki, M., Lay, G., Jäger, A. & Schartinger, D. 2014. Servitisation of European manufacturing: Evidence from a large scale database. *The Service Industries Journal,* Vol. 34**,** No. 1. pp. 5-23.
Diamantopoulos, A. & Winklhofer, H. M. 2001. Index Construction with Formative Indicators: An Alternative to Scale Development. *Journal of Marketing Research,* Vol. 38**,** No. 2. pp. 269-277.
Durach, C. F., Kembro, J. & Wieland, A. 2017. A New Paradigm for Systematic Literature Reviews in Supply Chain Management. *Journal of Supply Chain Management,* Vol. 53**,** No. 4. pp. 67-85.
European, C., Executive Agency For, S. & Medium-Sized, E. 2018. *Study on the potential of servitisation and other forms of product-service provision for EU SMEs – Final report. Part A, Main report*, Publications Office.
Fang, E., Palmatier, R. W. & Steenkamp, J. 2008. Effect of service transition strategies on firm value. *Journal of Marketing,* Vol. 72**,** No. 5. pp. 1-14.

Flynn, B. B., Huo, B. & Zhao, X. 2010. The impact of supply chain integration on performance: A contingency and configuration approach. *Journal of Operations Management,* Vol. 28**,** No. 1. pp. 58-71.
Flynn, B. B., Sakakibara, S., Schroeder, R. G., Bates, K. A. & Flynn, E. J. 1990. Empirical research methods in operations management. *Journal of Operations Management,* Vol. 9**,** No. 2. pp. 250-284.
Forza, C. 2002. Survey research in operations management: A process-based perspective. *International Journal of Operations & Production Management,* Vol. 22**,** No. 2. pp. 152-194.
Foss, N. J. & Saebi, T. 2017. Fifteen years of research on business model innovation: How far have we come, and where should we go? *Journal of Management,* Vol. 43**,** No. 1. pp. 200-227.
Gaiardelli, P., Resta, B., Martinez, V., Pinto, R. & Albores, P. 2014. A classification model for product-service offerings. *Journal of Cleaner Production,* Vol. 66**,** No. pp. 507-519.
Gebauer, H., Saul, C. J., Haldimann, M. & Gustafsson, A. 2017. Organizational capabilities for pay-per-use services in product-oriented companies. *International Journal of Production Economics,* Vol. 192**,** No. pp. 157-168.
Guedes, M. J., Patel, P. C., Kowalkowski, C. & Oghazi, P. 2022. Family business, servitization, and performance: Evidence from Portugal. *Technological Forecasting and Social Change,* Vol. 185**,** No. pp. 122053.
Han, S., Kuruzovich, J. & Ravichandran, T. 2013. Service expansion of product firms in the information technology industry: An empirical study. *Journal of Management Information Systems,* Vol. 29**,** No. 4. pp. 127-158.
Harzing, A.-W. & Alakangas, S. 2016. Google Scholar, Scopus and the Web of Science: A longitudinal and cross-disciplinary comparison. *Scientometrics,* Vol. 106**,** No. 2. pp. 787-804.
Hinkin, T. R. 1998. A brief tutorial on the development of measures for use in survey questionnaires. *Organizational Research Methods,* Vol. 1**,** No. 1. pp. 104-121.
Huikkola, T., Rabetino, R., Kohtamäki, M. & Gebauer, H. 2020. Firm boundaries in servitization: Interplay and repositioning practices. *Industrial Marketing Management,* Vol. 90**,** No. pp. 90-105.
Karatzas, A., Daskalakis, G., Bastl, M. & Johnson, M. 2022. Risky business? Shareholder value effects of service provision. *International Journal of Production Economics,* Vol. 244**,** No. pp. 108369.
Kastalli, I. V. & Van Looy, B. 2013. Servitization: Disentangling the impact of service business model innovation on manufacturing firm performance. *Journal of Operations Management,* Vol. 31**,** No. 4. pp. 169-180.
Kazakova, E. & Lee, J. 2022. Sustainable manufacturing for a circular economy. *Sustainability,* Vol. 14**,** No. 24. pp. 17010.
Kerlinger, F. N. 1966. *Foundations of behavioral research,* Holt, Rinehart and Winston, New York.
Kharlamov, A. A. & Parry, G. 2021. The impact of servitization and digitization on productivity and profitability of the firm: A systematic approach. *Production Planning & Control,* Vol. 32**,** No. 3. pp. 185-197.
Kohtamaki, M., Bhandari, K. R., Ranta, M. & Salo, J. 2021. The role of ambidextreous innovation in servitization: The nonlinear relationship between servitization and company profitability and the moderating role of ambidextreous innovation. *SSRN,* https://ssrn.com/abstract=3845255
Kohtamaki, M., Hakala, H., Partanen, J., Parida, V. & Wincent, J. 2015. The performance impact of industrial services and service orientation on manufacturing companies. *Journal of Service Theory and Practice,* Vol. 25**,** No. 4. pp. 463-485.
Kohtamäki, M. & Helo, P. 2015. Industrial services – the solution provider's stairway to heaven or highway to hell? *Benchmarking: An International Journal,* Vol. 22**,** No. 2. pp. 170-185.

Kohtamaki, M., Parida, V., Patel, P. C. & Gebauer, H. 2020. The relationship between digitalization and servitization: The role of servitization in capturing the financial potential of digitalization. *Technological Forecasting and Social Change,* Vol. 151**,** No. pp. 119804.

Kohtamaki, M., Partanen, J. & Möller, K. 2013a. Making a profit with R&D services — The critical role of relational capital. *Industrial Marketing Management,* Vol. 42**,** No. 1. pp. 71-81.

Kohtamaki, M., Partanen, J., Parida, V. & Wincent, J. 2013b. Non-linear relationship between industrial service offering and sales growth: The moderating role of network capabilities. *Industrial Marketing Management,* Vol. 42**,** No. 8. pp. 1374-1385.

Korkeamaki, L., Kohtamaki, M. & Parida, V. 2021. Worth the risk? The profit impact of outcome-based service offerings for manufacturing firms. *Journal of Business Research,* Vol. 131**,** No. pp. 92-102.

Koufteros, X. A., Vonderembse, M. A. & Doll, W. J. 1998. Developing measures of time-based manufacturing. *Journal of Operations Management,* Vol. 16**,** No. 1. pp. 21-41.

Kowalkowski, C., Bigdeli, A. Z. & Baines, T. 2022. Guest editorial: The future of servitization in a digital era. *Journal of Service Management,* Vol. 33**,** No. 1. pp. 59-69.

Kowalkowski, C., Gebauer, H., Kamp, B. & Parry, G. 2017. Servitization and deservitization: Overview, concepts, and definitions. *Industrial Marketing Management,* Vol. 60**,** No. pp. 4-10.

Kowalkowski, C., Windahl, C., Kindström, D. & Gebauer, H. 2015. What service transition? Rethinking established assumptions about manufacturers' service-led growth strategies. *Industrial Marketing Management,* Vol. 45**,** No. pp. 59-69.

Kwak, K. & Kim, W. 2016. Effect of service integration strategy on industrial firm performance. *Journal of Service Management,* Vol. 27**,** No. 3. pp. 391-430.

Lay, G., Copani, G., Jager, A. & Biege, S. 2010. The relevance of service in European manufacturing industries. *Journal of Service Management,* Vol. 21**,** No. 5. pp. 715-726.

Li, H., Pournader, M. & Fahimnia, B. 2022. Servitization and organizational resilience of manufacturing firms: Evidence from the COVID-19 outbreak. *International Journal of Production Economics,* Vol. 250**,** No. pp. 108685.

Li, H., Yang, Y., Singh, P., Sun, H. & Tian, Y. 2023. Servitization and performance: The moderating effect of supply chain integration. *Production Planning & Control,* Vol. 34**,** No. 3. pp. 242-259.

Li, S., Rao, S. S., Ragu-Nathan, T. S. & Ragu-Nathan, B. 2005. Development and validation of a measurement instrument for studying supply chain management practices. *Journal of Operations Management,* Vol. 23**,** No. 6. pp. 618-641.

Martín-Martín, A., Orduna-Malea, E., Thelwall, M. & Delgado López-Cózar, E. 2018. Google Scholar, Web of Science, and Scopus: A systematic comparison of citations in 252 subject categories. *Journal of Informetrics,* Vol. 12**,** No. 4. pp. 1160-1177.

Martín-Peña, M.-L., Sánchez-López, J.-M. & Díaz-Garrido, E. 2020. Servitization and digitalization in manufacturing: The influence on firm performance. *Journal of Business & Industrial Marketing,* Vol. 35**,** No. 3. pp. 564-574.

Martín-Peña, M.-L., Sánchez-López, J.-M., Kamp, B. & Giménez-Fernández, E. M. 2023. The innovation antecedents behind the servitization–performance relationship. *R&D Management,* Vol. 53**,** No. 3. pp. 459-480.

Martinez, V., Neely, A., Velu, C., Leinster-Evans, S. & Bisessar, D. 2017. Exploring the journey to services. *International Journal of Production Economics,* Vol. 192**,** No. pp. 66-80.

Mathieu, V. 2001. Service strategies within the manufacturing sector: Benefits, costs and partnership. *International Journal of Service Industry Management,* Vol. 12**,** No. 5. pp. 451–475.

Menon, R. R., Bigdeli, A., Adem, A., Schroeder, A., Awais, M., Baines, T., Battisti, G., Driffield, N., Fouad, S. & Roeder, M. 2024. Unpacking the triple Nexus: Environmental performance, economic performance and servitization – A systematic review and theoretical reflections. *Journal of Cleaner Production,* Vol. 457**,** No. pp. 142459.

Menon, R. R., Niranjan, T. T. & Simpson, D. 2022. Service Supply Chain Fit: Consistency Between Operant Resources and Service Supply Chains. *Service Science,* Vol. 14**,** No. 2. pp. 156-178.
Neely, A. 2008. Exploring the financial consequences of the servitization of manufacturing. *Operations management research,* Vol. 1**,** No. 2. pp. 103-118.
Nordin, F., Kindström, D., Kowalkowski, C. & Rehme, J. 2011. The risks of providing services. *Journal of Service Management,* Vol. 22**,** No. 3. pp. 390-408.
Oliva, R. & Kallenberg, R. 2003. Managing the transition from products to services. *International Journal of Service Industry Management,* Vol. 14**,** No. 2. pp. 160-172.
Paiola, M. & Gebauer, H. 2020. Internet of things technologies, digital servitization and business model innovation in BtoB manufacturing firms. *Industrial Marketing Management,* Vol. 89**,** No. pp. 245-264.
Paré, G., Trudel, M.-C., Jaana, M. & Kitsiou, S. 2015. Synthesizing information systems knowledge: A typology of literature reviews. *Information & Management,* Vol. 52**,** No. 2. pp. 183-199.
Parida, V., Sjödin, D. & Reim, W. 2019. Reviewing literature on digitalization, business model innovation, and sustainable industry: Past achievements and future promises. *Sustainability,* Vol. 11**,** No. 2. pp. 391.
Partanen, J., Kohtamäki, M., Parida, V. & Wincent, J. 2017. Developing and validating a multi-dimensional scale for operationalizing industrial service offering. *Journal of Business & Industrial Marketing,* Vol. 32**,** No. 2. pp. 295-309.
Peng, D. X., Schroeder, R. G. & Shah, R. 2008. Linking routines to operations capabilities: A new perspective. *Journal of Operations Management,* Vol. 26**,** No. 6. pp. 730-748.
Qi, Y., Mao, Z., Zhang, M. & Guo, H. 2020. Manufacturing practices and servitization: The role of mass customization and product innovation capabilities. *International Journal of Production Economics,* Vol. 228**,** No. pp. 107747.
Rabetino, R., Harmsen, W., Kohtamäki, M. & Sihvonen, J. 2018. Structuring servitization-related research. *International Journal of Operations & Production Management,* Vol. 38**,** No. 2. pp. 350-371.
Rabetino, R., Kohtamäki, M., Lehtonen, H. & Kostama, H. 2015. Developing the concept of life-cycle service offering. *Industrial Marketing Management,* Vol. 49**,** No. pp. 53-66.
Raddats, C. & Burton, J. 2011. Strategy and structure configurations for services within product-centric businesses. *Journal of Service Management,* Vol. 22**,** No. 4. pp. 522-539.
Raddats, C. & Kowalkowski, C. 2014. A reconceptualization of manufacturers' service strategies. *Journal of Business-to-Business Marketing,* Vol. 21**,** No. 1. pp. 19-34.
Raddats, C., Kowalkowski, C., Benedettini, O., Burton, J. & Gebauer, H. 2019. Servitization: A contemporary thematic review of four major research streams. *Industrial Marketing Management,* Vol. 83**,** No. pp. 207-223.
Raddats, C., Naik, P. & Bigdeli, A. Z. 2022. Creating value in servitization through digital service innovations. *Industrial Marketing Management,* Vol. 104**,** No. pp. 1-13.
Rapaccini, M., Paiola, M., Cinquini, L. & Giannetti, R. 2023. Digital servitization journey in small- and medium-sized enterprises: The contribution of knowledge-intensive business firms. *Journal of Business & Industrial Marketing,* Vol. 38**,** No. 6. pp. 1362-1375.
Rapaccini, M. & Visintin, F. 2015. Devising hybrid solutions: An exploratory framework. *Production Planning & Control,* Vol. 26**,** No. 8. pp. 654-672.
Roth, A. V. & Jackson, W. E. 1995. Strategic Determinants of Service Quality and Performance: Evidence from the Banking Industry. *Management Science,* Vol. 41**,** No. 11. pp. 1720-1733.
Rungtusanatham, M., Wallin, C. & Eckerd, S. 2011. The vignette in a scenario-based role-playing experiment. *Journal of Supply Chain Management,* Vol. 47**,** No. 3. pp. 9-16.
Schaefers, T., Ruffer, S. & Böhm, E. 2021. Outcome-based contracting from the customers' perspective: A means-end chain analytical exploration. *Industrial Marketing Management,* Vol. 93**,** No. pp. 466-481.

Short, J. C., Broberg, J. C., Cogliser, C. C. & Brigham, K. H. 2010. Construct Validation Using Computer-Aided Text Analysis (CATA):An Illustration Using Entrepreneurial Orientation. *Organizational Research Methods,* Vol. 13**,** No. 2. pp. 320-347.

Sjödin, D., Parida, V., Jovanovic, M. & Visnjic, I. 2020. Value Creation and Value Capture Alignment in Business Model Innovation: A Process View on Outcome-Based Business Models. *Journal of Product Innovation Management,* Vol. 37**,** No. 2. pp. 158-183.

Sousa, R. & Da Silveira, G. J. C. 2017. Capability antecedents and performance outcomes of servitization. *International Journal of Operations & Production Management,* Vol. 37**,** No. 4. pp. 444-467.

Sousa, R. & Da Silveira, G. J. C. 2020. Advanced services and differentiation advantage: An empirical investigation. *International Journal of Operations & Production Management,* Vol. 40**,** No. 9. pp. 1561-1587.

Suarez, F. F., Cusumano, M. A. & Kahl, S. J. 2013. Services and the business models of product firms: An empirical analysis of the software industry. *Management Science,* Vol. 59**,** No. 2. pp. 420-435.

Teece, D. J. 2007. Explicating Dynamic Capabilities: The Nature and Microfoundations of (Sustainable) Enterprise Performance. *Strategic Management Journal,* Vol. 28**,** No. 13. pp. 1319-1350.

Tranfield, D., Denyer, D. & Smart, P. 2003. Towards a methodology for developing evidence-informed management knowledge by means of systematic review. *British Journal of Management,* Vol. 14**,** No. 3. pp. 207-222.

Ulaga, W. & Reinartz, W. J. 2011. Hybrid offerings: How manufacturing firms combine goods and services successfully. *Journal of Marketing,* Vol. 75**,** No. 6. pp. 5-23.

Valtakoski, A. & Witell, L. 2018. Service capabilities and servitized SME performance: Contingency on firm age. *International Journal of Operations & Production Management,* Vol. 38**,** No. 4. pp. 1144-1164.

Vandermerwe, S. & Rada, J. 1988. Servitization of business: Adding value by adding services. *European management journal,* Vol. 6**,** No. 4. pp. 314-324.

Vargo, S. L. & Lusch, R. F. 2004. Evolving to a new dominant logic for marketing. *Journal of Marketing,* Vol. 68**,** No. 1. pp. 1-17.

Vendrell-Herrero, F., Bustinza, O. F. & Opazo-Basaez, M. 2021. Information technologies and product-service innovation: The moderating role of service R&D team structure. *Journal of Business Research,* Vol. 128**,** No. pp. 673-687.

Wang, J., Wang, W., Wu, H. & Liu, Y. 2023a. Exploring the effects of manufacturing servitization on enterprise energy conservation and emissions reduction moderated by digital transformation. *Energy Economics,* Vol. 122**,** No. pp. 106706.

Wang, W., Chen, S., Shao, J., Chu, J. & Yuan, Z. 2023b. The impact of servitization on trade credit in manufacturing firms: A signaling theory perspective. *International Journal of Operations & Production Management,* Vol. 43**,** No. 2. pp. 373-398.

Wannakrairoj, W. & Velu, C. 2021. Productivity growth and business model innovation. *Economics Letters,* Vol. 199**,** No. pp. 109679.

Ward, P. T., Mccreery, J. K., Ritzman, L. P. & Sharma, D. 1998. Competitive priorities in operations management. *Decision Sciences,* Vol. 29**,** No. 4. pp. 1035-1046.

Wei, Z., Huang, W., Wang, Y. & Sun, L. 2022. When does servitization promote product innovation? The moderating roles of product modularization and organization formalization. *Technovation,* Vol. 117**,** No. pp. 102594.

Wickert, C., Post, C., Doh, J. P., Prescott, J. E. & Prencipe, A. 2021. Management Research that Makes a Difference: Broadening the Meaning of Impact. *Journal of Management Studies,* Vol. 58**,** No. 2. pp. 297-320.

Xiao, X., Zhou, C. & Mao, H. 2022. What can satisfy customers in servitization? Service or goods innovation. *Journal of Business & Industrial Marketing,* Vol. ahead-of-print**,** No. ahead-of-print. pp.

Yang, Z., Zhang, Y. & Zhang, T. 2023. Leveraging digitalization and servitization to improve financial performance. *Production Planning & Control,* Vol.**,** No. pp. 1-14.

Zhang, J. N., Sun, X. H., Dong, Y., Fu, L. & Zhang, Y. W. 2023a. The impact of servitization on manufacturing firms' market power: empirical evidence from China. *Journal of Business & Industrial Marketing,* Vol.**,** No. pp.
Zhang, Y., Wei, Z. & Gao, J. 2023b. Service breadth or depth? A customer perspective. *Supply Chain Management: An International Journal,* Vol. 28**,** No. 4. pp. 666-681.

10. APPENDIX A: Research articles and their data sources

SERVICE OFFERINGS				
Data Source	Data Collection Method	Data Collection Technique	Region	Sample Size*
Firm respondents	International Manufacturing Strategy Survey	Self-administered questionnaire	IMSS Partners*	414–586
	European Manufacturing Survey	Self-administered questionnaire	Europe	3,376
	Independent surveys	Structured interview	France, China, Europe, Global**	55–11
		Semi-structured interview	Sweden, UK, Finland, Europe, Germany, Global**	3–84
		Self-administered questionnaire	UK, Finland, Brazil, Italy, Korea, China, Europe, USA, Germany, Global**	8–37
Company websites		Document review	Global**	7
Company annual reports	OSIRIS	Document review	Global**	129–10,634
	COMPUSTAT		USA	
*Sample size provides minimum and maximum numbers used for a specific data collection method. **Global includes data from developed countries.				
PRODUCT–SERVICE ORIENTATION				
Data Source	Data Collection Method	Data Collection Technique	Region	Sample Size*
Financial statements	FAME	Database interrogation	UK	30–44,324
	INFORMA D&B		Portugal	

	GMR		Australia, Ireland, United States, China, Croatia, Hungary, India, Poland, Taiwan, Vietnam	
	COMPUSTAT		USA	
	China stock market & accounting research database		China	
	OSIRIS		Developed countries	
	World Input - Output Database		China	
	ORBIS		Finland	
	Mergent		USA	
	CIS2006		Norway	
	European Manufacturing Survey		Europe	
	Bénéfice Réels Normaux		France	
*Sample size provides minimum and maximum numbers used for a specific data collection method.				
BUSINESS DESCRIPTIONS				
Data Source	Data Collection Method	Data Collection Technique	Region	Sample Size***
Company annual reports/Form-10K	COMPUSTAT	Keywords extractions	USA	273–13,775
	OSIRIS		Global**	
	China stock market & accounting research database		China	
Industry codes*	FAME	Business segments	UK	
	SEC EDGAR		USA	
*Standard Industrial Classification (SIC) Codes.				
**Data collected from around the world.				
***Sample size provides minimum and maximum numbers used for a specific data collection method.				

11. Appendix B: Pre-pilot and pilot study: Participant demographics

Table B1: Pre-pilot study - Participant Demographics

Participant ID	Job role	Seniority level	Functional responsibility	Sector	Indicative business model orientation	Firm size
P1	Managing Director	Executive	Overall strategy, business model decisions	Capital goods	Product-centric transitioning to services	Medium
P2	Commercial Director	Executive	Revenue management, service pricing	Industrial equipment	Product–service hybrid	Medium
P3	Service Director	Senior management	Service strategy, service portfolio design	Industrial equipment	Service-led	Large
P4	Operations Director	Senior management	Service delivery, operations	Transport systems	Product–service hybrid	Large
P5	Strategy Lead	Senior management	Business model innovation, growth strategy	Automation technologies	Advanced services	Large
P6	Technical Director	Senior management	Product–service integration, engineering	Capital goods	Product-centric with services	Medium
P7	Finance Director	Senior management	Revenue allocation, financial reporting	Industrial equipment	Product–service hybrid	Medium
P8	Head of Services	Senior management	Lifecycle services, customer solutions	Transport systems	Service-led	Large
P9	Business Development Director	Senior management	Service growth, customer value propositions	Automation technologies	Advanced services	Large
P10	Sales Director	Senior management	Solution selling, service contracts	Capital goods	Product–service hybrid	Large

Table B2: Pilot study - Participant Demographics

Participant ID	Job role	Seniority level	Functional responsibility	Sector	Indicative business model orientation	Firm size
PP1	Services Director	Senior management	Service portfolio strategy, lifecycle services	Industrial machinery	Service-led	Large
PP2	Managing Director	Executive	Overall business strategy, service growth	Industrial systems	Product–service hybrid	Medium
PP3	Senior Services Manager	Senior management	Aftermarket services, customer support	Heavy equipment	Service-led	Large
PP4	Product & Services Manager	Senior management	Integration of products and advanced services	Industrial printing/ automation	Advanced services	Large
PP5	Commercial Director	Senior management	Revenue allocation, service contracts	Automotive/ transport	Product–service hybrid	Large
PP6	Head of Engineering Services	Senior management	Engineering-led services, project delivery	Rail and transport	Outcome-oriented services	Large
PP7	Advanced Services Lead	Senior management	Performance-based services, analytics	Industrial equipment	Advanced services	Large
PP8	Services Executive	Senior management	Service operations, dealer services	Construction equipment	Product–service hybrid	Large
PP9	Business Development Manager (Services)	Senior management	Service business development, solutions	Industrial automation	Service-led	Large

12. Appendix C: Survey questionnaire

A1_A. Does your company provide any services in the UK?

Column list	Response
Yes	
No	
Don't know	
Prefer not to say	

Note: SKIP the remaining questions and end the survey if the firm does not provide any services.

A1_B. Can you give me an approximate percentage breakdown of your company's revenue split by products and services?

This includes any sales via distribution. Please also ensure you are answering regarding company operations at a national, UK level (not just the site you are at).

Products (%) [_____]

Services (%) [_____]

[SUM TO 100%]

A1_C. Which of the following services does your company currently offer?

Column list	Respone (Yes/No)
Spare parts and consumables for products	
Installation and/or commissioning	
Product break/fix, repair, overhauling	
Periodic servicing and regular maintenance checks	
Help, training, or advice	
Dashboards and alerts around product use, performance or replacement, and preventative / proactive maintenance	
Programmes, agreements, plans, contracts for longer terms maintenance assuring product financing, condition, upgrades, performance or outcomes	
Other services	

A2. Now thinking only about the revenue your company gets from services, what proportion of this is accounted for by this service?

- Spare parts and consumables for products

[_____] %

A3. And what proportion of your service revenue is accounted for by these services collectively/ this service?

- Installation and/or commissioning
- Product break/fix, repair, overhauling
- Periodic servicing and regular maintenance checks
- Help, training, or advice

[_____] %

A4. And what proportion of your service revenue is accounted for by these services collectively/ this service?

- Dashboards and alerts around product use, performance or replacement, and preventative / proactive maintenance
- Programmes, agreements, plans, contracts for longer terms maintenance assuring product financing, condition, upgrades, performance or outcomes

[_____] %

A5. And what proportion of this is accounted for by other services?

[_____] %