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Descriptive Maturity Model for Digital Servitization of SMEs

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Abstract

Purpose- This study develops a descriptive maturity model (MM) to assess and guide the servitization progression of manufacturing SMEs through consensus building with both industry and academic practitioners.

Design/Methodology- The maturity model was developed through a Systematic Literature Review (SLR), validated via the Delphi Survey Method with experts in servitization, and tested with two SMEs in the manufacturing sector.

Findings- The study identifies 7 core maturity dimensions and 21 sub-dimensions, each mapped to basic, intermediate, and advanced servitization levels. The resulting model provides a structured and detailed diagnostic framework.

Research Implications-Advances existing literature by providing a detailed, empirically tested model that differentiates capabilities across servitization levels. The collaboration between industry and academic practitioners addresses a gap in previous research.

Practical implications- The model serves as a diagnostic and strategic planning tool for SMEs aiming to transition toward higher levels of servitization. The model supports this strategic transformation by defining the needed capabilities.

Originality- This is among the first studies to use a Delphi method to build consensus between academics and industry practitioners for a digital servitization MM. Additionally, results of testing and refinement of the developed model through practical application with two SME businesses are shown, bridging the gap between theory and real-world implementation.

Keywords: Servitization, Product-service systems, Capability, Maturity model, Delphi Method

Interesting because: This study presents the first descriptive maturity model that explicitly maps the capabilities required at each servitization level: Level 0, Basic, Intermediate, and Advanced, providing a structured pathway for digital servitization, particularly for SMEs. While prior studies have explored servitization maturity conceptually, none have used servitization level typologies to guide capability development.

Theoretical value: The study contributes to the servitization literature by defining and operationalizing 7 maturity dimensions along with 21 sub-dimensions and detailing how each evolves across four distinct levels. By integrating digital considerations within each maturity dimension the model extends existing maturity frameworks that have often overlooked digital-specific requirements. Furthermore, the Delphi process revealed differences in how academics and practitioners conceptualize servitization, offering new insights into field-level variation and interpretive alignment.

Practical value: For practitioners, the model functions as a diagnostic and strategic planning tool, enabling companies, particularly SMEs, to assess their current maturity level and identify targeted improvement areas. Managers can benchmark their progress and prioritize capability investments based on the defined actions and characteristics at each servitization stage. The inclusion of digital elements

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within each dimension ensures the model is relevant for guiding digital transformation in service-oriented manufacturing contexts.

1. Introduction

Businesses continually strive to enhance their profitability, productivity, and customer satisfaction. One strategy that manufacturing companies can adopt is servitization, or Product-Service System (PSS). This model involves integrating a suite of services with their product offering (Vandermerwe and Rada, 1988). Servitization denotes the transition of manufacturing enterprises from a product-centric to a service-oriented business model (Baines et al., 2009) and is designed to tap into new revenue streams. This transformation is frequently delineated into three service tiers: basic services, encompassing maintenance and spare parts; intermediate services, facilitating product utilisation through offerings such as operator training or remote monitoring; and advanced services, wherein the provider ensures performance or outcomes via models like pay-per-use or outcome-based contracts (Lightfoot et al., 2013). Simultaneously, Product-Service Systems (PSS) categorise offerings according to the nature of value provided. (Tukker, 2004)Identifies three categories: product-oriented PSS, which facilitate the sale of a product; use-oriented PSS, which grant access to the product (e.g., leasing); and result-oriented PSS, which yield a predetermined consequence. The most comprehensive service level, known as Advanced or Result-Oriented Servitization, offers the greatest benefits. Notable examples include Rolls-Royce's "Power by the Hour" for aircraft engines (Harrison, 2017) and Xerox's "pay per page" model for photocopiers (Harris and Wonglimpiyarat, 2020).

However, to transition into each of these three different service levels requires different configurations and capabilities within a business (Michalik et al., 2019). Especially Small-Medium Enterprises (SMEs) face a bigger hurdle compared to their larger counterparts, specifically with the lack of financial and knowledge resources (Chirumalla et al., 2024). Previous research has demonstrated that small and medium-sized enterprises (SMEs) and large companies differ substantially in terms of firm characteristics, including their sizes, organizational structures, and finances. These differences significantly influence their organizational processes and overall performance (Ghobadian and Gallear, 1996, Ates et al., 2013, o'dwyer and Ledwith, 2010, Bos-Brouwers, 2009). A framework/model which allows a holistic and granular approach to transition into each of these service levels is required due to the various configurations required for each service type.

Maturity Models (MM) are seen to be a very important and useful tool to guide a business on a step-by-step basis towards its desired maturity level. MM can be used for different purposes, either *descriptive, prescriptive,* or *comparative* in nature. Descriptive MM are applied for "as-is" assessments where a business can identify where it currently sits in relation to a specific maturity element, e.g. Strategy. It is used as a diagnostic tool (Poeppelbuss and Roeglinger, 2011, de Bruin et al., 2005). Prescriptive MM are used to identify desirable maturity levels and provide specific guidelines for improvement (Poeppelbuss and Roeglinger, 2011). There are already MM developed within the field of servitization, as seen Section 4. However, many of these models are descriptive and either conceptual in nature, not tested with a range of industry and academic practitioners or do not comprehensively consider the "digital" aspect of digital servitization.

In addition, existing models fail to identify the required resources and capabilities for each service level (Basic, Intermediate, Advanced) and there are differences on which elements/constructs constitute servitization. Since the existing literature does not offer a complete Descriptive Maturity Model, with detailed input from both industry and academic experts, this raises the following research questions: *"What are the essential elements for an SME to determine it reediness level in order to transition into a digital servitization business model?"*

To address these gaps, a "*Descriptive"* MM is developed and is evaluated with industrial and academic experts as well as applying in 2 SME businesses for further validation. The proposed model not only

provides a comprehensive framework to identify the required capabilities in each servitization level but provides a building block to developing a "*Prescriptive" MM* in the future. The remainder of this paper is organized as follows. In Section 2, the theoretical background and development of the initial maturity model are proposed by discussing and summarizing relevant literature on servitization, MM's and servitization specific MM's. The outline of the research methodology used to develop and apply the maturity model is shown in Section 3. In Section 4, the results of the maturity model development and testing are presented. Finally, the discussion and conclusion of the results, followed by theoretical, managerial implications and limitations as seen in Section 5.

2. Theoretical Background

2.1. Digital Servitization Transition State of Art

Digital servitization signifies a comprehensive change for manufacturing enterprises, necessitating a fundamental reorganisation of resources, organisational frameworks, and procedures to amalgamate digital technologies with service provisions (Chirumalla et al., 2023). A dynamic capabilities perspective emphasises the necessity for ongoing adaptation and reconfiguration of resources and competencies as organisations identify and capitalise on digital opportunities in their service sectors (Chirumalla et al., 2023). Concurrently, institutional theory highlights the influence of external constraints and norms in moulding and legitimising this transition, with recent studies using institutional frameworks to elucidate the intricate dynamics propelling digital servitization (Lee et al., 2024).

As technologies like IoT, AI, and remote connectivity have advanced, servitization has transformed into digital servitization, wherein digital capabilities are pivotal in service delivery and value co-creation (Kohtamäki et al., 2020; Lenka et al., 2017). This transformation allows companies to provide predictive maintenance, performance-based contracts, and data-informed customer insights (Ardolino et al., 2018). Nevertheless, SMEs encounter unique obstacles in digital servitization, such as restricted access to resources, insufficient digital competencies, and lack of strategy alignment (Le-Dain et al., 2023). Studies indicate that digital servitization is non-linear and differs according to company size, industry, and digital maturity (Bagni and Filho, 2024, Harrmann et al.).To achieve a digital servitization business model there are barriers that are needed to be overcome in relation to specific aspects as seen in Table I.

Table I-Key themes addressed for digital servitization related literature

Aspects	**Barriers**		
	Digitization	**Organization Transition**	**Personnel**
Service Strategy/ Capabilities	(Gebauer et al., 2020, Paschou et al., 2018b, Romero et al., 2019)	(Raddats et al., 2019, Jovanovic et al., 2016, Valtakoski and Witell, 2018, Suppatvech et al., 2019, Walters and Teso, 2019, Le-Dain et al., 2023, Harrmann et al., Bagni and Filho, 2024)	
Knowledge/Expertise	(Moeuf et al., 2020, Mittal et al., 2018, Jovanovski et al., 2019, Paschou et al., 2018a)	(Luco et al., 2019, Kohtamäki et al., 2020a, Sala et al., 2019, Paschou et al., 2018b)	(Luco et al., 2019, Rapaccini et al., 2020a)
Organization Structure and Culture	(Kohtamäki et al., 2019)	(Boucher et al., 2020, Tronvoll et al., 2020, West and Gaiardelli, 2016, Baines et al., 2019, Kohtamäki et al., 2020b)	(Queiroz et al., 2020)

Finances and Resources/ Return on Investment	(Luco et al., 2019, Kohtamäki et al., 2020a, Sala et al., 2019)	(Martín-Peña et al., 2019, Queiroz et al., 2020, Lexutt, 2020, Tenucci and Supino, 2020, Crozet and Milet, 2017)	(Rapaccini et al., 2020a)
Customers	(Luco et al., 2019, Jovanovski et al., 2019, Teslya, 2019, Rapaccini et al., 2020b)	(Jovanovic et al., 2016)	(Jovanovic et al., 2016)
Competitors, Suppliers and Value Chain	(Kohtamäki et al., 2019)	(Valtakoski and Witell, 2018, Tronvoll et al., 2020, Kohtamäki et al., 2019)	

Source: Author's own work

These challenges underscore the necessity for developing a robust model to aid SMEs and MNEs towards a servitized business model. There is a clear need for a maturity model that can underpin this framework.

A maturity model is a framework which allows an assessment and development of a business capability in a specific domain e.g. technology development, work processes, etc. The development of a particular domain can be divided into different maturity phases or levels, where the higher the maturity level, the more complete or higher the achieved capability. Maturity Models originated from the IT industry and was used as more as a management tool (Paulk, 2009). The Capability Maturity Model Integration (CMMI) originated from the Software Engineering Institute of Carnegie Mellon University, which is an offshoot from the Capability Maturity Model (CMM) and aims to provide a framework to guide process improvement across either a project, division or entire organization (ScienceDirect, 2016). There are two types of CMMI models that can be used, staged or continuous. The staged maturity model assesses process maturity through discrete, sequential stages, ensuring structured progression. In contrast, the continuous maturity model evaluates specific process areas independently, allowing organizations to prioritize improvements without a linear sequence. While the staged model offers a structured roadmap, the continuous model provides flexibility for tailored advancements.

The next section will review the existing descriptive maturity models currently in servitization and analyse the limitations.

2.2. Existing Descriptive Maturity Models in Servitization

A maturity model is required for SME's to understand their current and future state and this area of research has been lacking recently (Tronvoll et al., 2020), (West and Gaiardelli, 2016),(Kohtamäki et al., 2020b) as most of the digital servitization/ Product-Service-System literature has focused on large Multi-National Enterprises (MNE). However as SME's lack the financial capability to hire external consultants to assess their current capabilities (Jovanovski et al., 2019), (Luco et al., 2019) a maturity model needs to be developed so an SME can use it to assess its current state and find improvement opportunities needed to transition to its desired service strategy business model. Previous researchers have created a maturity model for SME. (Adrodegari and Saccani, 2020b) looks at addressing the issue of no models or guidelines for transition and built a Servitization Maturity Model (SeMM) from the literature review and applied it to 2 Spanish SME firms. The maturity dimensions focus on management, tools, capabilities, approaches etc against business components e.g. value proposition, key resources etc. However, the study is only applied to 2 SME firms and would be improved by extending to multiple sectors with multiple firms. (Coreynen et al., 2018) uses a similar approach, however different dimensions are used such as service deployment, service development and service orientation. The tool allows companies to assess Servitization capacity and areas for improvement. However other factors e.g. personnel recruitment, training etc are not considered. (Walters and Teso, 2019) applies the same method of creating a framework for maturity assessment using SME case studies. While (Kimita et al., 2022c)propose a comprehensive capability-based maturity model, the model focuses on a single large

business and not multiple SMEs and lacks empirical validation with expert consensus before testing the model. (Beducci et al., 2024) provides a state of art literature review on servitization and PSS maturity models.

Only one author (Paschou et al., 2019) had a focus on digital servitization however the model was only theoretical and had not been tested for evaluation. There have been a few authors (Andersen et al., 2020), (Dmitrijeva et al., 2020), (Elezović, 2019), (Neff et al., 2013) who have included a digital dimension, However, digital servitization is characterized by the use of digital technologies to facilitate the transition from a product-oriented model to a service-oriented business model. This therefore posits that an element of digital technology usage should be included in each transformational aspect of the transition to a service business model, which is an area that is not investigated before. The maturity of a firm during digital servitization transition can be seen through the lens of the Data-Information-Knowledge- Wisdom (DIKW) model (Ardolino et al., 2018) outlining that the more mature a company is, the better data can be converted into information then into knowledge and finally wisdom. This approach significantly enhances the effectiveness of decision-making within the company (West et al., 2018). While (Paschou et al., 2019) incorporate digital dimensions within their model, the maturity levels do not evolve in alignment with the (DIKW) model, which is instrumental in illustrating how digital technologies facilitate decision-making during the servitization transition. (Häckel et al., 2021) focus on creating a maturity model for each service level (product, use, result); however, their model is descriptive and primarily evaluated by researchers in the servitization field, lacking empirical testing in real-world settings. Several maturity models have been proposed in the field of servitization, but only (Häckel et al., 2021) has attempted to develop a descriptive MM that addresses the three levels of servitization: product, use, and result (or basic, intermediate, and advanced). However, this model was not developed in collaboration with both industry and academic experts and not tested in real-world settings. As a result, existing MMs do not comprehensively capture the various domain areas of servitization, such as strategy, structure, and culture, or adequately explain how capabilities for each domain are developed at each servitization level (basic, intermediate, advanced). The following section outlines the research design, including the multi-stage Delphi process and validation methods

3. Methodology

Developing a maturity model (MM) requires establishing a conceptual theoretical framework before proceeding to empirical testing. Several methodologies exist for developing a MM.(Becker et al., 2009) detail the stages for MM development within the IT industry. The methodology outlined by (de Bruin

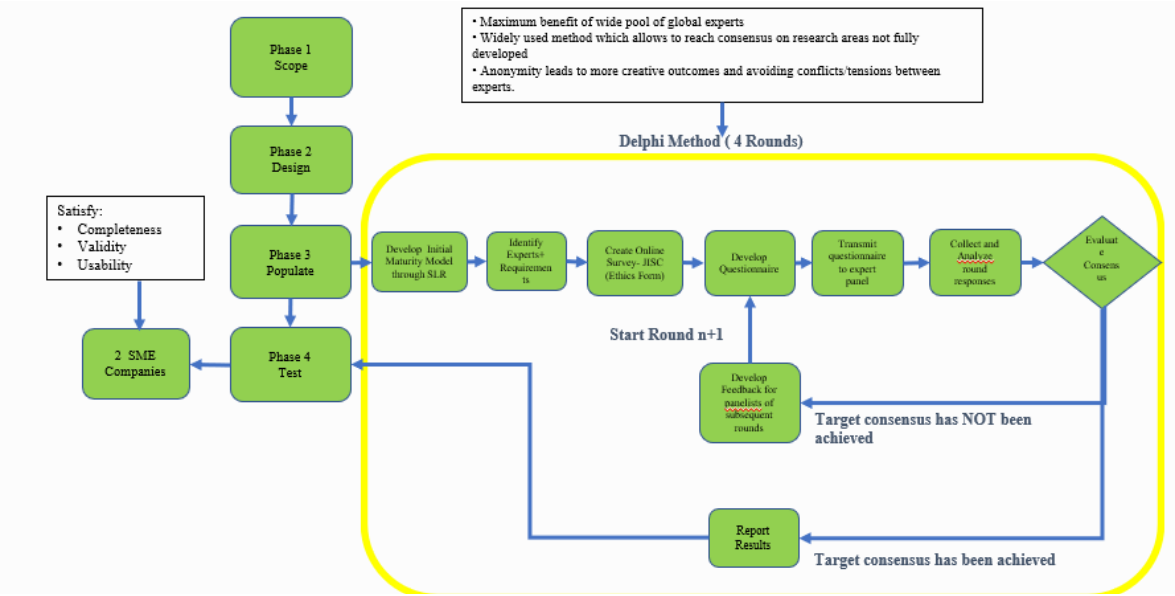


Figure 1-Descriptive Maturity Model Development Method Flowchart (Source: Adapted from (De Bruin et al, 2005))

et al., 2005) for the "Descriptive Maturity Model" is utilized in this research. The methodology encompasses 4 phases, each of which will be briefly explained below and visualized in Figure 1:

3.1. Phase 1: Scope

Two key aspects that need to be addressed are outlined in Figure 2. The first involves the focus of the model, which is the domain the MM is targeted at e.g. domain specific or general. As this MM aims in assessing capabilities (Capability MM) at each maturity level the focus of the model is domain specific. The second aspect of scoping involves identifying which stakeholders will be involved. Both industry and academic perspectives are considered in this research.

Criterion	**Characteristic**			
Focus of Model	Domain Specific		General	
Development Stakeholders	Academia	Practitioners	Government	Combination

Figure 2- Decisions when scoping a Maturity Model (de Bruin et al., 2005)

3.2. Phase 2: Design

The design of the model allows the requirements of the audience to be met. The model design needs to balance out the simplicity of the model and complex reality (de Bruin et al., 2005). Hence, each maturity level must be distinct and well defined with clear logical progression. During model design the number of maturity dimensions must be kept to a minimum to reduce complexity but also capture as much information as possible.

3.3. Phase 3: Populate

The objective of this phase is to populate the model with relevant maturity dimensions, sub-dimensions, and corresponding maturity levels or stages. It is advised to first complete a literature review to identify the common maturity dimensions and sub-dimensions. In addition, an exploratory method (Delphi) is used to further validate the initial MM developed based on the findings from the literature review.

3.3.1. Phase 3.1. Systematic Literature Review

A Systematic Literature Review (SLR) was conducted to identify relevant papers on transitional and maturity modelling. Given the limited research available on SMEs, the scope was expanded to include Multinational Enterprises (MNEs) in the search. To ensure comprehensive coverage on digital servitization transition, five databases—Engineering Village, SCOPUS, Web of Science, Google Scholar, and IEEE Explore are utilized. This research aimed to pinpoint business characteristics essential for transitioning to a digital servitization model. Search terms covered both "Servitization" and "transition" aspects (as detailed in Table II), combined using the AND operand. The "I4" aspect, including "digital," is omitted to broaden results. Executing these search terms yielded numerous articles. Post-duplication removal, 1,059 articles entered the screening phase. The first screen excluded 949 articles lacking relevance to transitioning from product to service-based models, leaving 110. The second screening dismissed 59 articles that, despite discussing servitization transition, did not address challenges or key factors. This left 42 articles for full-text review in the "*Eligibility*" phase. Ultimately, 15 articles focusing on maturity modelling and dimensions are selected in the "Included" phase. The remaining 27 research papers which discuss factors like competencies, barriers, and challenges, are also analysed to bolster the identified maturity dimensions.

Table II-Maturity Model Servitization Key Search Terms

Term 1	**Term 2**
"servitization" OR "product-service-system" OR "Product-Service-Systems" OR "servicification" OR "service infusion" OR "product-service-offering"	"maturity*" OR "Transition*" OR "readiness" OR "transformation" OR "Assessment"

Source: Author's own work

3.3.2. Initial Validation

To validate the model, this research incorporated the Delphi survey method. Digital Servitization and MM research is still in its infancy and no unanimous consensus has been reached on the capabilities required for each maturity level (basic, intermediate, advanced).

3.3. Delphi Method Development

There is no unanimous method for developing a Delphi study (Hallowell and Gambatese, 2010), however nearly all articles published in this domain state common characteristics that must be satisfied:

1. *Number of Experts*: There is no unanimous consensus in the number of experts to select (Jivraj Shariff, 2015). However according to (Clayton, 1997), between 5 to 10 can be used for a heterogenous population (people with expertise on topic but coming from different social/professional groups e.g. teachers, university academics, school principals) or between 15 to 20 for a homogenous population (experts coming from same disciplines). 10 participants were selected, which balances heterogeneity (experts from different professional groups) and mitigates potential dropout issues.

2. *Expert Panel Criteria:* Both industrial and academic experts globally were included, with at least 5 years of experience in servitization, whether through publishing or assisting businesses in transitioning to a servitization model.

3. *Number of Rounds:* Based on (Erffmeyer et al., 1986) and (Young and Hogben, 1978), 5 rounds is deemed optimal, covering both maturity dimensions and levels:

Stage 1: Maturity Dimensions

- Round 1 (Online Survey): open and closed ended questions in relation to identified maturity dimensions and sub-dimensions from the Systematic Literature Review.
- Round 2 (Online Survey): Round 1 questions were submitted to experts again but this time they are also be able to see the reply of the other panellists and will be asked to adjust answers from the first round.
- Round 3 (Video Interviews): Results from Round 2 was shared back to all panellists which allows final refinements to dimensions and gaining consensus. Round 3 was in the form of a video interview with the remaining 5 participant who gave scores on the likert scales and were allowed to expand their comments on how they perceived a particular sub-dimension and why they agreed or disagreed.
- Round 4 (Video Interviews): Some experts in Round 3 being uncertain about specific maturity sub-dimensions, such as 'Attitude,' and consequently giving a '3/Neither' rating, the results of Round 3 were shared back with them. This approach enabled these experts to review the perspectives of other participants on these sub-dimensions, enhancing their understanding and allowing them to revise their initial scores accordingly

Stage 2: Maturity Levels

- Round 5: Open and closed ended questions in relation to identified maturity levels for each maturity dimension.

Expert Recruitment

A total of 41 participants were contacted via LinkedIn and email, with 10 responding—yielding a 24.3% response rate (see Table III). The Delphi panel comprised a balanced mix of academic and industry experts from sectors including SMEs, manufacturing, consultancy, software, and chemicals.

Participants were selected for their direct involvement in servitization or digital transformation projects, with most having over 10 years of experience. Including both practitioners and academics enriched the process by incorporating both theoretical and practical perspectives on servitization maturity.

Table III-Delphi Survey Expert Participants

No	Category	Industry	Region	Years of Experience
1	Industry	SME	UK	10
2	Academic	University	Italy	10-15
3	Academic	University	UK	>15
4	Academic	University	Switzerland	>15
5	Industry	Consultancy	UK	5-10
6	Industry	Machinery	UK/USA	>15
7	Industry	Consultant	USA	10-15
8	Academic	University	UK	10-15
9	Industry	Chemical	USA	5-10
10	Industry	Software	USA	5-10

Source: Author's own work

Questionnaire Survey Delivery Method

The questionnaire, developed using JISC online survey software, included both quantitative (Likert scales from Strongly Disagree to Strongly Agree) and qualitative (open-ended) questions. Starting from Round 3, video interviews were conducted to gain a deeper understanding of expert responses, prompted by variations observed in Round 2 descriptions. Each participant was scheduled for a two-hour interview, allowing for a more detailed exploration of their views.

Measuring Consensus

There are different ways of measuring consensus within Delphi studies for likert scales and no unanimous threshold level is agreed upon within academic literature (von der Gracht, 2012). However, a more appropriate and objective method is the Average Percentage Majority of Opinions (APMO). This method was defined by (Kapoor et al.) and is shown in Equation 1.

$$APMO = (Majority\ Agreements + Majority\ Disagreements)/(Total\ Opinions\ Expressed) \times 100\%$$

Equation 1-Average Percentage Majority Opinions (APMO) Consensus(Kapoor et al.)

3.4. Phase 4 Test

This phase involves testing the developed MM constructs and the validity, reliability and generalizability (de Bruin et al., 2005).

3.4.1. Validation

Construct Validation is a combination of both content validity and face validity (de Bruin et al., 2005) . Content validity ensures the domain is fully represented, which in this study was achieved through a comprehensive SLR on "servitization" and "maturity modelling" and selecting a diverse group of experts from both industry and academia across different regions. To ensure face validity, the survey was pre-tested with four participants who provided feedback on its flow, length, coverage, usefulness, and comprehensibility.

3.4.2 Case Study Methodology

To test the maturity model, executives from two SMEs were solicited to complete a survey evaluating their present maturity level, in addition to the model's clarity, readability, and comprehensibility. Despite the restricted sample size of two organisations, this methodology adheres to recognised standards of case study research. Yin (2018) contends that a two-case approach provides significant analytical advantages via replication, hence strengthening the reliability of emerging patterns. Eisenhardt (1989) also observes that smaller samples might offer significant insights when each instance presents substantial contextual data. This methodology aligns with previous research on servitization maturity models. (Adrodegari and Saccani, 2020a) implemented their model in two SMEs to illustrate its practical significance, whereas (Kimita et al., 2022b) applied the maturity model through a single comprehensive case study.

3.4.3. Research Timeline

The initial literature review began in October 2020 and continued through February 2022, during which key maturity dimensions and sub-dimensions were identified from academic and practitioner sources. The Delphi validation phase, involving five iterative rounds with industry and academic experts, was conducted between February 2022 and May 2024. Subsequently, the model was evaluated in practice through application in two SME companies—from May 2024 to July 2024.

Ethical Approval

This is to confirm that this research study has adhered to all applicable ethical standards and guidelines throughout the research process. This research was approved by Cranfield University on 30/01/2023 with the reference number: CURES/17681/2023.

Informed.Consent

Prior to commencing data collection, the participants were provided with detailed information about the study's procedures and fully informed about the purpose of the research and the study's aims, their rights as respondents, and the measures taken to ensure their confidentiality and anonymity. The subsequent section presents the findings from each stage of the model generation process.

4. Results

4.1 Initial Maturity Model

A SLR was conducted as seen in Section 3.3.1 and from this an initial maturity model was developed with the most common maturity "dimensions" and "sub-dimensions" used by various authors who also developed a maturity model. The initial maturity model, seen in Table IV is used as an input into the Delphi Survey Method. The next sub-section will focus on the maturity levels used in current literature.

Table IV-Initial Servitization Maturity Model

Dimensions	Sub-Dimensions	Author(s)
Strategy	Digital Resource Allocation	(Gudergan et al., 2015, Babaei and Aghdassi, 2020)
	Digital Service Offering	(Paschou et al., 2019)
	Business Model	(Paschou et al., 2019, Neff et al., 2013, Andersen et al., 2020, Cui et al., 2019)
	Feedback System/KPI	(Rapaccini et al., 2013, Neff et al., 2013)
Culture	Employee Commitment towards digital servitization	(Häckel et al., 2021, Gudergan et al., 2015, Teso and Walters, 2017)
	Top-Down Leadership for digital servitization	(Paschou et al., 2019, Gudergan et al., 2015, Dmitrijeva et al., 2020)
	Employee skills and internal development training of digital	(Häckel et al., 2021, Paschou et al., 2019, Teso and Walters, 2017)

	technology	
Customer	Customer Feedback	(Alvarez et al., 2015, Paschou et al., 2019)
	Customer Integration/Intimacy	(Babaei and Aghdassi, 2020, Exner et al., 2017, Cui et al., 2019, Alvarez et al., 2015)
	Customer Real Time Data Integration	(Alvarez et al., 2015, Babaei and Aghdassi, 2020)
	Knowledge of Customer Installed Base	(Alvarez et al., 2015)
	Customer Training	(Alvarez et al., 2015)
Process/Practice	Internal Communication	(Teso and Walters, 2017)
	Performance Management	(Adrodegari and Saccani, 2020b, Rapaccini et al., 2013)
	Standards/ Procedures	(Babaei and Aghdassi, 2020, Paschou et al., 2019, Andersen et al., 2020, Adrodegari and Saccani, 2020b, Rapaccini et al., 2013)
	Roles	(Babaei and Aghdassi, 2020, Rapaccini et al., 2013)
Market	Competition Identification	(Babaei and Aghdassi, 2020, Alvarez et al., 2015)
	Market Trends Analysis	(Paschou et al., 2019)
Network	Digital Service Ecosystem	(Paschou et al., 2019)
Structure	Separation of internal service and product departments	(Alvarez et al., 2015)
	Internal and External Collaboration mechanism	(Häckel et al., 2021)
	Capital Management	(Häckel et al., 2021)

Source: Author's own work

4.2.2 Maturity Levels

The different maturity levels used by various authors is seen in Table V. At the basic level servitization is divided into 3 different levels (Product, Use, Result) which has been used by (Frederiksen et al., 2021). However there have been several variations of these levels such as (Häckel et al., 2021) who includes "Pure Product" and "Product-Oriented PSS" in its maturity level. Other authors (Frederiksen et al., 2021), (Cui et al., 2019) and (Paschou et al., 2019) have similar labels and levels whereas (Exner et al., 2017) has seven levels ranging from "Purely Product" to "Purely Service". There are also a number of authors (Alvarez et al., 2015), (Gudergan et al., 2015), (Rapaccini et al., 2013) who based their maturity levels off the capability maturity model integration (CMMI). The next section will focus on the Delphi Survey results and how each dimension gained consensus or not.

Table V -Overview on Existing research on servitization maturity levels

Author	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7	Level 8
(Kimita et al., 2022a)	Initial	Managed	Defined	Quantitatively Managed	Optimizing			
(Häckel et al., 2021)	Pure Product	Product-Oriented PSS	Use-Oriented PSS	Result-Oriented PSS				
(Frederiksen et al., 2021)	Product	Use	Result					
(Babaei and Aghdassi, 2020)	Incapable	Struggling	Truncated	Exhaustive				
(Andersen et al., 2020)	Low (0 to 10)	Medium	Hight					
(Adrodegari and Saccani, 2020b)	1=No Service Orientation	2	3	4	5=highest servitization maturity			

(Dmitrijeva et al., 2020)	Exploration	Engagement	Expansion	Exploitation				
(Cui et al., 2019)	Products plus basic after sales	Products plus extended service	Integrated Solutions	Performance Based Solutions				
(Paschou et al., 2019)	Beginner-Basic	Experienced - Intermediate	Leader-Advanced					
(Elezović, 2019)	0	1	2	3	4	5	6	7
(Teso and Walters, 2017)	Very Poor=0	1	2	3	4	Very Good=5		
(Exner et al., 2017)	Purely Product							Purely Service
(Alvarez et al., 2015)	Initial	Repeatable	Defined	Managed	Optimizing			
(Gudergan et al., 2015)	Incomplete	Performed	Managed	Defined	Quantitatively Managed	Optimized		
(Neff et al., 2013)	Level 1	Level 2	Level 3	Level 4	Level 5			
(Rapaccini et al., 2013)	Initial	Repeatable	Defined	Managed	Optimized			

Source: Author's own work

4.3. Delphi Survey Results

An overview of the Delphi survey through each Rounds 1 to 4 which focuses on gaining consensus on the initial maturity model developed in Section 4.2 and suggested (sub) dimensions by the experts is seen Table VI.

Table VI-Delphi Survey Rounds Results

Maturity Dimensions	**Sub-Dimensions**	**Agreement Consensus (>4)**			
		Round 1 (No=10) APMO=70%	**Round 2 (No=8) APMO=68%**	**Round 3 (No=5) APMO=79%**	**Round 4 (No=5) APMO=80%**
Strategy	Digital Resource Allocation	80%		80%	100%
	Digital Service Offering	90%		60%	80%
	Business Model	90%		60%	60%
	Feedback System/KPI	90%		100%	100%
	Customer Buy In		87.5%	60%	100%
	Definition of Business Processes		77.5%	60%	80%
	Price Offering		75%	80%	80%
	Service Delivery		100%	40%	60%
	Service Design		100%	60%	80%
	Change Management		100%	40%	40%
	Innovation Capability		63%		
Culture	Employee Commitment towards digital servitization	100%		80%	100%
	Top-Down Leadership for digital servitization	100%		100%	100%
	Employee skills and internal development training of digital technology	100%		100%	100%
	Inclusion of best management practices and leadership training		50%	40%	
	Attitude		100%	40%	40%
	Risk-taking culture/comfort with high-levels of ambiguity		87.5%		40%
	Efficient use of vendors/3rd party service providers		75%	100%	100%
	Customer-centricity / Service focus		100%	60%	60%
Customer	Customer Feedback	100%		20%	40%
	Customer Integration/Intimacy	90%		100%	100%
	Customer Real Time Data Integration	70%		100%	100%
	Knowledge of Customer Installed Base	100%		60%	80%
	Customer Training	70%		0%	0%
	Division of responsibilities in a services model		50%		

	Focus on customer outcomes		87.5%	60%	60%
	VOC - Voice of Customer		75%	20%	20%
	Customer Co-Creation		87.5%	40%	40%
	Customer Co-Development		87.5%	60%	60%
Process/Practice	Internal Communication	50%			
	Performance Management	80%		40%	20%
	Standards/ Procedures	0%			
	Roles	90%		40%	40%
	Adopting an agile approach in how you deliver services to customers.		62.5%		
	sales / business development		62.5%		
Market	Competition Identification	70%		20%	
	Market Trends Analysis	90%		20%	
	Buying patterns and customer behaviors		62.5%		
	"Future Proofing"; Forecasting		62.5%		
	Market segmentation (e.g. early adopters)		75%	20%	60%
Network	Digital Service Ecosystem	100%		60%	100%
	Partnership policy and approach		75%		
	Alignment of offerings, at all levels of a vertically integrated XAAS business model		62.5%		
	Service Level Agreements;		75%	80%	80%
	Contracting and Differentiating		50%		
	Collaborative relationships with suppliers/partners		100%	60%	80%
Structure	Separation of internal service and product departments	30%			
	Internal and External Collaboration mechanism	100%		100%	100%
	Capital Management	60%			
	sales organization		75%	60%	80%
	Change management capability - the ability to recognise and respond to a need for change.		87.5%	40%	20%
	Incentives/Quotas		50%		
	Business Systems		50%		
Additional Dimensions	Digital		75%	0%	
	Costing		75%	60%	20%
	Pricing		75%	40%	40%
	Risk Management		87.5%	100%	75%
	Financing		75%	100%	25%
	Innovation		63%		
	Change Management		87.5%	0%	0%

Source: Author's own work

The final dimensions of the maturity model as shown in Table VII were established through the first four rounds of the Delphi process. This model progressed to Round 5, which aimed to delineate specific capabilities and requirements for each maturity sub-dimension from the remaining 4 experts.

Table VII- Final Maturity Dimensions Consensus

Dimension	***Sub-Dimension***
Strategy	*Digital Resource Allocation*
	Digital Service Offering
	Feedback System/KPI
	Customer Buy In
	Definition of Business Processes
	Price Offering
	Service Design
Culture	*Employee Commitment towards digital servitization*
	Top-Down Leadership for digital servitization
	Employee skills and internal development training of digital technology
	Efficient use of vendors/3rd party service providers
Customer	*Customer Integration/Intimacy*
	Customer Real Time Data Integration
	Knowledge of Customer Installed Base
Network	*Service Ecosystem*
	Service Level Agreements
	Collaborative relationships with suppliers/partners
Structure	*Internal and External Collaboration mechanism*
	Sales organization
Risk Management	*Risk Management*

Source: Author's own work

The final servitization maturity model developed as a result of the iterative Delphi Survey Rounds is seen in Table VIII.

Table VIII-Final Servitization Maturity Model

Dimension	Sub-Dimension	Maturity Level			
		Pure Product (Level 0)	**Basic (Level 1)**	**Intermediate (Level 2)**	**Advanced (Level 3)**
Strategy	**Digital Resource Allocation**	No digital resources in place for service delivery	Litte investment in creating digital services for basic services	Increasing investment and effort in digital technologies to deliver services	Substantial and continuous investment in utilising digital technologies to deliver outcome-based services
	Digital Service Offering	No digital service provided	Digital technologies used for service delivery is limited	A few Digital technologies used for enabling service delivery	Digital technologies are an enabler for value creation and enhanced product performance
	Feedback System/KPI	No feedback system to customer in place OR no metrics to measure performance	Very little need to measure product performance and customer feedback as only basic services/purchase order provided	Product performance and customer feedback measured frequently to optimize product availability	Product performance and customer feedback measures and feedback systems integrated systematically during service deployment e.g. payments, maintenance.
	Customer Buy In	• Customer has not been convinced of the value of servitization • No appetite/desire for as-a-service	• Discussions with customer to understand benefits products and service e.g. Have access to data • Committed to pilot or limit service scope	• Service level agreement for a pilot • Retention / renewable, increased scope or term and active engagement in features	• Outcome based contract in place with customer(s) • Co-development / collaboration, rapidly scaling adoption, longer term (>5 years) commitment
	Definition of Business Processes	• No evidence of a guarantee in place. Not committed to guaranteeing the outcome • Very low business processes in place to deliver services • No formal documentation, measurement, tracking and refinement	Core process and methodology defined	Established iterative development in place, able to enhance core process and establish new features	Business Processes are guaranteed to deliver advanced services and/ or all services flows are documented, instrumented, tracked, measured and continuously refined.
	Price Offering	We do not know how to effectively price our services	• Evidence of single transaction for product. Customer only Buying the asset • We understand cost-to-serve a small number of customers and can	• Evidence of longer-term contract (3-5 years). Paid based on units being produced or amount of time product is in use • Continuous payment • We have a measurable	• We have a clear understanding of scale Vs profit Vs cost to service. We understand freemium Vs premium and how to sell • Outcome-based as-a-service/guarantee pricing with financial incentives for missed SLAs • Result based payment

			create value • One-time payment for product and basic service fe*e*	value proposition and scalable pricing model	
	Service Design	No/adhoc creation of services	• Asset is easily serviced on site or remotely. Shorter recovery time at lower cost. • Any servicing done in the same way as before e.g. warranty.	• Team embedded in customers operations so product operates as effectively as possible e.g. on site	• Product is being monitored remotely, including predictive maintenance and predicting failure. Service engineer sent before failure occurs. Utilising advanced technologies. • Repeat and mature model for envisioning, ideating, testing, refining and launching service offerings
Culture	**Employee Commitment towards digital servitization**	Product way of thinking; working for developing and selling physical products	Offering basic services mindset	Thinking in terms of customer usage and higher level of service integration	Thinking in terms of customer results. Mindset to deliver advanced service
	Top-Down Leadership for digital servitization	• Leadership very hardly involved Top down talking points, no commitment	• Leaders/ Managers are more involved • A vision and interest to understand opportunities	• Service champions build a coalition/team to bring experts internally and externally • Internal / External promotion and thought leadership • Understanding of financial impacts	• Leaders are involved day to day in delivering advanced services including customer interaction, providing support to employees • Salespeople remunerated/rewarded
	Employee skills and internal development training of digital technology	No training in relation to digital technology or services	Employees have basic training required to carry out product consultation	A few Employees trained selectively in using digital technologies for delivering specific services	Most/all employees trained extensively in utilizing digital technologies for delivering outcome based services
	Efficient use of vendors/3rd party service providers	No use of 3rd party vendors	Little use of 3rd party vendors to support services	Increasing use of 3rd party vendors to support services	We can identify and incorporate 3rd party experts to deliver service capabilities
Customer	**Customer Integration/Intimacy**	Very little customer interaction	Interactions are minimal	Increasing levels of cooperation and integration with customer by service provider	Very proactive and autonomous service integration with customer initiated constantly by service provider
	Customer Real Time Data Integration	Non existent data being received as only product being provided	Very little data/information being received including	Partly automated Data collection from product in	Data/information constantly being received from product automatically for

			manual and reactive collection of data	use is received frequently for condition monitoring	condition monitoring, predictive maintenance
	Knowledge of Customer Installed Base	We know number of units sold but have not traceability of asset/product once it has been used	Map of assets currently being used by customers.	Ability to connect to asset and obtain data feed.	Ability to interact with the product to optimize the running of asset in use e.g. over the air
Market	**Market Segmentation**	• We have market segmentation, but only for products.	• Done some market analysis, pains and gains	Demonstrate a business model blueprint. Looking at service aspect. Created a new customer value proposition	Offer evidence of piloting with customers including contracts with customers.
Network	**Service Ecosystem**	• No ecosystem of 3rd parties/everything in-house	• No third party or in house service capability. • Distributors in place to distribute products	• In house service team Contract with 3rd party service agents	• We have alternative 3rd party service provider capabilities in place if we cannot service asset for any reason to honour advanced service contract • Service team Integrated with the customers operations.
	Service Level Agreements	• No performance guarantee including uptime, recovery time etc.	• No performance guarantee including uptime, recovery time etc. Traditional product/warranty sale	• Basic agreement which includes service schedules/agreements • Consistently delivering within SLAs, outcomes delivered on time, cost reduction opportunities can be defined	• A full Description of asset and its expected performance to achieve an agreed outcome including risk management strategies in place. • Able to flex SLA compliance with cost to serve, redundancy at every level of operating model, clear technology improvement initiatives and activities
	Collaborative relationships with suppliers/partners	• Very little to non-existent collaboration with key suppliers/partners • Low consequence / arms-length terms	• Little collaboration with key suppliers/partners • Clear roles and deliverables, scalable terms	• Increasing levels of Collaboration with key suppliers/partners	• High Collaboration with key suppliers to deliver services • Incentives and business models aligned, growth based on success of outcomes, long term commitments
Structure	**Internal and External Collaboration mechanism**	• Non existent communication between product and service departments	• Little communication and interaction between product and service departments (siloed)	• Increasing Levels of communication and interaction between product and service departments	• Integrated service and product department to deliver outcome based services
	Sales organization	• No sales function in place to sell services	• Little sales function as only selling basic services e.g. warranty, spare parts	• Sales department focused on providing intermediate services e.g. condition monitoring, leasing	• Highly integrated Sales department focusing on selling outcome based solutions

Risk Management	**Risk Management**	Very little risk management practises in place to support service	• Little risk management processes in place as only basic services provided	• Risk assessment matrix-Considered likelihood and severity matrix of product failing in service. • Moderate level of risk management to cover extreme under/over performance and/or obvious liabilities and failure points	• Very well defined and managed risk management strategies in place due to providing outcome-based service as risk is transferred to service provider

Source: Author's own work

4.4. Testing

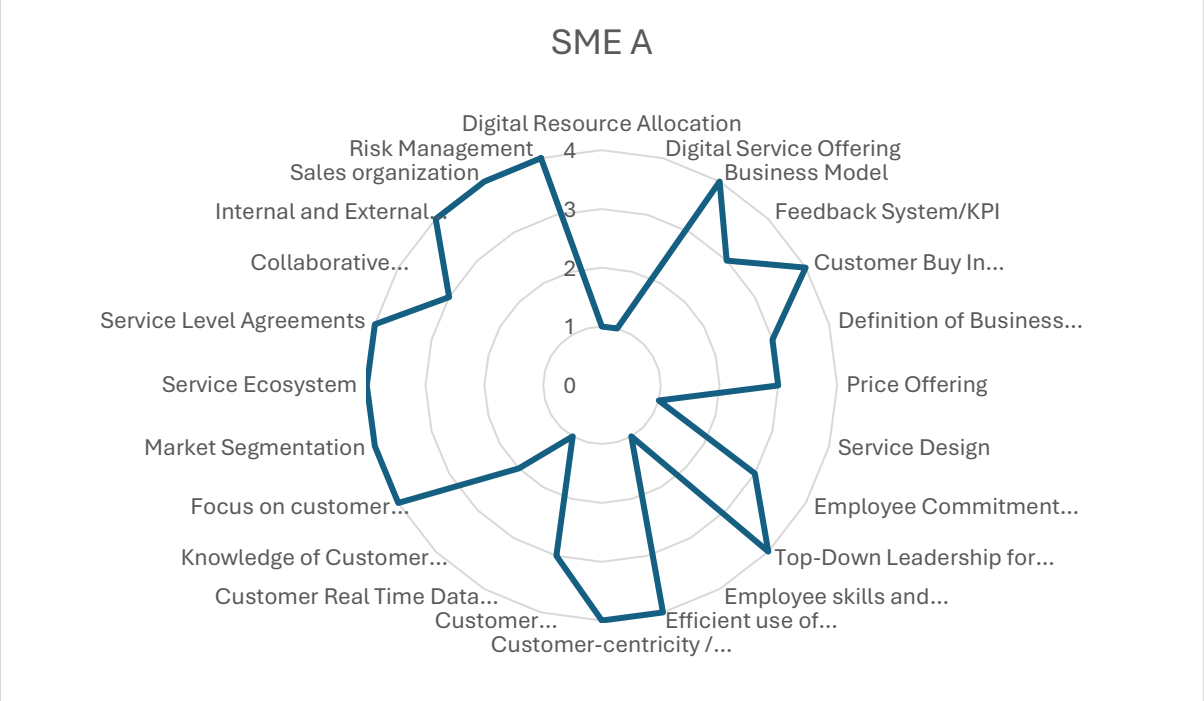
The maturity model was tested with 2 SMEs both working in the Lighting and Milling industry. SME A operates in the Lighting industry which has 10 employees and provides “Lighting as a service”. Their servitization journey began with the installation and remote management of lighting systems under fixed contracts SME B, a precision milling SME with 5 employees, serves a global customer base with both physical product manufacturing and tailored milling services. They are both directors of the company and have significant oversight and knowledge about the current state of the company in key areas.

A self-assessment survey was developed using JISC Online Survey Software, containing targeted questions for each maturity model sub-dimension. SME directors were asked to evaluate the current (“as-is”) maturity level of their organization for each sub-dimension. To ensure consistency and clarity, a supporting document was provided that defined and explained each sub-dimension in detail. The next sub-sections will outline their suggestion comments.

4.4.1. SME A

SME A provided valuable insights into the servitization maturity model, assessing the current state of his company as depicted in Figure 3. The expert found the survey user-friendly and easy to use, enabling easy identification of the current state for each sub-dimension. The expert confirmed the clarity of the descriptions, however suggested changes to the wording as seen below and expressed that having access to this model earlier would have significantly eased his company’s transformation process. The expert remarked, *“Had I had this model at the time, it would have helped to avoid the mistakes made earlier in my journey. It's a complete story from beginning to end, which I related to this model.”*

SME A recommended several revisions for clarity. Risk management, for example, could be integrated into the strategy dimension, aligning with many Delphi experts’ views. The expert also proposed redefining “Network” as “Structure” to better capture organizational elements and suggested merging market segmentation into customer-related categories to reduce complexity. Other refinements included renaming “Definition of Business Processes” for clarity, relocating “Customer Buy-In” to the Customer dimension, and replacing “Service Design” with “Serviceability.” To avoid a narrow digital focus, it was suggested removing “Digital” from sub-dimensions like “Employee Commitment” and “Top-Down Leadership,” with the latter simplified to “Leadership”.

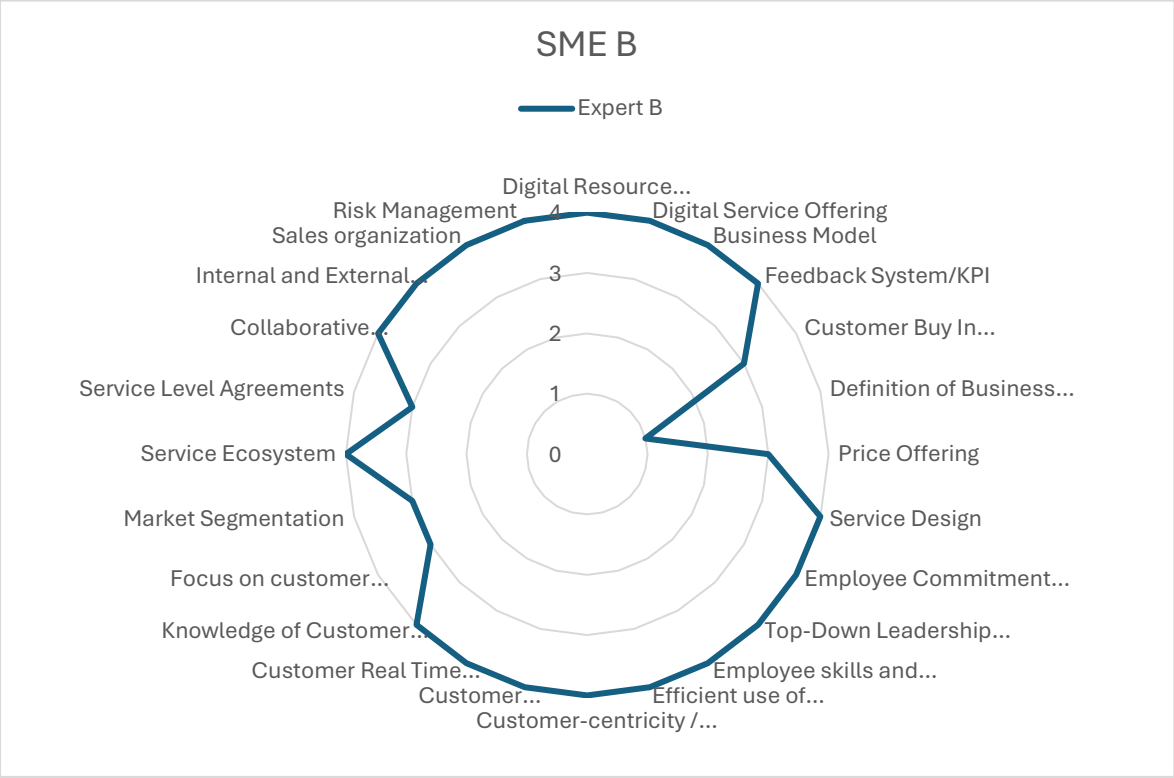


Source: Authors' own work

Figure 3- SME A Maturity Radar- Current State

4.4.2. SME B

SME B was satisfied with the flow, structure, and wording of the maturity descriptions as seen in Figure 4 and stated that "*This process of understanding my current state for different components, e.g. Strategy, Culture was very interesting and allows me to see my current weaknesses and where to improve them*".



Source: Authors' own work

Figure 4-SME B Maturity Radar- Current State Source

The next section discusses how the model aligns with existing literature, its theoretical contributions, and implications for practitioners and researchers.

5. Discussion and Conclusion

The descriptive maturity model developed in this study significantly advances theoretical understanding in servitization and digital transformation, particularly within the context of SMEs. Unlike earlier maturity models (Adrodegari and Saccani, 2020a, Paschou et al., 2019, Häckel et al., 2021), this model was explicitly shaped by rigorous consensus-building through the Delphi method. Previous models have largely focused either on conceptual frameworks or specific industrial contexts, often overlooking the nuanced capabilities SMEs require at different maturity levels—basic, intermediate, and advanced. By clearly delineating specific capabilities necessary for progression at each stage, this study addresses a significant theoretical gap identified in the literature review, particularly the work of (Häckel et al., 2021, Paschou et al., 2019).

The Delphi survey method was particularly instrumental in ensuring the robustness of the model. By systematically incorporating perspectives from both industry and academic experts, the study effectively bridged the gap between theoretical constructs and practical realities, capturing diverse views that typically differ significantly, especially in dimensions such as "Culture." Industry practitioners emphasized pragmatic and operational considerations, whereas academic experts often highlighted theoretical completeness and conceptual clarity. This methodological rigor ensured that the resulting dimensions and sub-dimensions of the maturity model were comprehensive, balanced, and practically relevant. The iterative Delphi rounds facilitated consensus on maturity dimensions that were previously undeveloped or inadequately explored, such as "Employee Commitment" and "Leadership."

Novel sub-dimensions introduced, such as "Price Offering" and "Risk Management," alongside redefined constructs like "Serviceability" and "Employee Commitment," represent additional theoretical contributions. The following sections discuss theoretical and practical implications, as well as limitations.

5.1. Theoretical Implications

The descriptive maturity model developed in this research offers theoretical implications for the field of servitization and Product-Service Systems (PSS). Firstly, it advances existing literature by providing a comprehensive review of the capabilities required at each servitization level—basic, intermediate, and advanced—crafted through collaboration between industrial and academic practitioners and empirically tested with SMEs. This facet of the model addresses a noted gap in prior research, which typically lacks detailed differentiation of capabilities across servitization levels, thereby enriching the strategic guidance available for firms at different stages of their servitization journey. Secondly, utilizing the Delphi Method—marks a departure from existing approaches by fostering a consensus among a diverse group of experts. This methodological innovation is crucial, as it resolves the ambiguity surrounding the foundational components of servitization, such as strategy and culture, which previous studies have often left undefined. By having a “digital” element for nearly all the maturity dimensions represents an improvement upon previous maturity models which have limited focus or neglected an important facet of servitization(Andersen et al., 2020, Dmitrijeva et al., 2020). By integrating a structured consensus-building approach, this study not only enriches the theoretical foundation of servitization models but also enhances their practical applicability and validity.

5.2. Managerial Implications

For practice, the model guides SMEs and MNEs in advancing to their desired level of servitization, especially the advanced level. This strategic transition is facilitated by explicitly delineating the capabilities necessary at each phase of servitization maturity, allowing organisations to devise and execute organised development trajectories. For example, management can use the maturity model to

evaluate their status quo and desired target state. This makes it easier for managers to assess the necessary efforts for developing needed capabilities.

5.3. Limitations

The descriptive maturity model developed has limitations. Firstly, the sample size for the Delphi Method is within the guidelines, however a larger sample size can further validate the model and may result in further "dimensions" to be found. There may be dimensions that other researchers have discovered which is not in this model. Response bias is a concern, as SME managers' views may differ from other employees. However, this is mitigated by selecting company directors, who have the most comprehensive understanding of overall operations and strategy. Future research could incorporate perspectives from middle management and operational staff to gain a more holistic understanding of servitization maturity. Additionally, the testing of the descriptive maturity model has been limited to a small sample size, which may affect the generalizability of the findings. Future research could address this by testing the model across a broader array of companies and different sectors. Finally, this model is only a "descriptive" model, and the next phase of the research is planned to address these limitations by evolving the model into a more prescriptive tool.

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