The journey toward a successful servitisation transformation for the Danish industrial SMEs

An abductive investigation

PhD Dissertation

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Til min elskede familie Tina, Oliver og Isabella

i Acknowledgements

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Best Regards,
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ii Abstract

Purpose – Studies in the servitisation literature have found evidence suggesting that the servitisation transformation process is problematic, leading to a lack of profitability or expected outcomes. The purpose of this PhD dissertation is to establish how Danish manufacturing SMEs can increase the likelihood of a successful servitisation transformation through configurations. This is done by developing a servitisation maturity model (SeMM) that handles the coexisting dimensions of servitisation in a multidimensional perspective.

Method and design – In its focus on solving the practical problem for managers, this dissertation employs pragmatism as its philosophical stance. The abductive approach has been applied by shifting between conceptualisation and validation, guided by the acknowledgment of new lessons from the present investigations and peer feedback. The conceptualisation of key elements of the SeMM is based on two systematic literature reviews, while the validation of the theoretical SeMM is computed through partial least squares structural equation modelling (PLS-SEM). The data collection for validation is based on an online self-completion survey that was distributed using publicly available email addresses.

Findings – The research presented in this dissertation proves the existence of coexisting dimensions while establishing the relational importance among the dimensions. The research develops and validates a new servitisation maturity model with the incorporation of multidimensionality. Through the established relational weights, the research provides practitioners with a tool for assessing which dimension (and underlying theories) improve their likelihood of a successful servitisation transformation. The final SeMM provides practitioners with the weighted importance of each dimension and its underlying theories, allowing them to evaluate the effect of a simulated configuration on the estimated level of success; this to identify which operators have the largest impact on increasing the likelihood of a successful servitisation transformation.

Novelty – This PhD dissertation contributes five novel findings for academia and industrial managers. (1) This is the first study to consolidate and conceptualise key dimensions of the servitisation transformation based on the entirety of the existing literature. It therefore addresses the gaps identified by Ulaga and Reinartz (2011), Schaarschmidt *et al.,* (2018) and Andersen *et al.,* (2020). (2) This is the first study to deliberately investigate the definitions of servitisation success and what it means to be successful in a servitisation context. Furthermore, this is the first study to provide specific suggestions as to composing indicators for measuring servitisation success. (3) This is the first statistical investigation into maturity modelling in the context of servitisation that takes the multidimensionality into account, thus adding to the statistical validation of existing theory as called for by Kowalkowski *et al.,* (2017a). (4) This is the first study to truly embrace and investigate these key dimensions in a multidimensional perspective by taking the coexisting influences among dimensions into account. Doing so closes the gaps introduced by Baines *et al.,* (2017), Lexutt (2020) and Kohtamäki *et al.,* (2019a). (5) This is the first statistical validation of prior theoretical and conceptualised maturity indicators within servitisation. It has led to the validation of 33 existing theories, prioritised their importance for a successful servitisation transformation, and it addresses the gaps emphasised by Rabetino *et al.,* (2018) and Kohtamäki *et al.,* (2019a, p. 233).

iii Dansk Resumé

Formål - Undersøgelser inden for litteraturen omkring servitisation har indikeret en problematisk transformation til servitisation, der fører til udeblivelsen af rentabilitet eller forventede resultater. Formålet med denne PhD er, at fastslå, hvordan danske fremstillings SMV'er kan øge deres sandsynlighed for en vellykket servitisation transformation gennem konfigurationer. Dette ved at udvikle en servitisation modenhedsmodel (SeMM), der håndterer sameksisterende dimensioner af servitisation i et multi-dimensionelt perspektiv.

Metode & Design - Gennem et særligt fokus på at løse det praktiske problem, følger denne PhD pragmatisme som filosofisk holdning. Den abduktive tilgang er blevet anvendt ved at skifte mellem konceptualiseringer og validering, styret af en anerkendelse af, at ny viden skal inddrages løbende. Konceptualiseringen af nøgleelementerne i SeMM er baseret på to systematiske litteraturgennemgange, mens valideringen af den teoretiske SeMM beregnes gennem teknikken: partiel least squares structural equation modeling (PLS-SEM).

Resultater - PhD-forskningen beviser eksistensen af sameksisterende dimensioner, samtidig med at den etablerer den relationelle betydning mellem dimensionerne. Forskningen udvikler og validerer en ny servitisation modenhedsmodel med inkorporering af multi-dimensionalitet. Gennem de etablerede relationelle vægte giver forskningen virksomhederne et værktøj til at vurdere, hvilke(n) dimension(er) (og underliggende teorier) der forbedrer deres sandsynlighed for at opnå en vellykket servitisation transformation. Den endelige SeMM giver praktikere den vægtede betydning af hver dimension samt underliggende teorier, hvilket giver mulighed for at evaluere effekten af simuleret konfiguration, via det estimerede succesniveau. Dette for at identificere, hvilke operatører der har den største indflydelse på at øge sandsynligheden for en vellykket servitisation transformation.

Nyhed - Denne PhD bidrager med fem nye resultater for akademiske og industrielle ledere; (1) Dette er den første undersøgelse, der konsoliderer og begrebsliggør nøgle-dimensioner af servitisation transformationen sammenfattet af den eksisterende litteratur. Dette bidrager til tidligere identificerede mangler af Ulaga and Reinartz (2011), Schaarschmidt *et al.,* (2018), Andersen *et al.,* (2020); (2) Dette er den første undersøgelse, der bevidst undersøger definitionerne af servitisation succes, og hvad det vil sige at have succes i en servitisation sammenhæng. Desuden er dette den første undersøgelse, der leverer specifikke forslag til sammensætning af indikatorer til måling af servitisation succes; (3) Dette er den første statistiske undersøgelse af modenhedsmodellering i forbindelse med servitisation, som tager multi-dimensionaliteten i betragtning. Dermed bidrager forskningen med den statistiske validering af eksisterende teori, hvilket efterlyses af Kowalkowski *et al.,* (2017a); (4) Dette er den første undersøgelse, der omfavner og undersøger disse dimensioner, i et multi-dimensionelt perspektiv, ved at tage de sameksisterende relationer mellem dimensioner i betragtning. Hvilket tidligere har været efterspurgt af Baines *et al.,* (2017), Lexutt (2020) og Kohtamäki *et al.,* (2019a). (5) Dette er den første statistiske validering af tidligere teoretiske og konceptualiserede modenheds-indikatorer inden for servitisation. Dette har ført til validering af 33 eksisterende teorier, og prioriteret deres betydning for en succesfuld servitisation transformation, samt tilføjer til de videns huller der er understreget af Rabetino *et al.,* (2018) og Kohtamäki *et al.,* (2019a, p. 233)

iv List of appended publications

Contribution papers (Included in this dissertation)

Publication 1:

Madsen, M. E. E. (2021). The multi-dimensional hierarchical structure of the servitisation transformation. Spring Servitisation Conference, 2021 (Conference proceeding).

- The publication was presented during the Spring Servitisation Conference in 2021, and published as a conference proceeding in May, 2021.

Publication 2:

Madsen, M. E. E., & Goduscheit, R. C. (2023). The untold story of the inherent tensions in the assessment of servitisation success: A conceptual approach. *International Journal of Technology Management* (**Accepted** for publication), 10.1504/IJTM.2023.10057925.

- The publication was accepted for publication November 2022, and expected fully published in fall, 2023 in the International Journal of Technology Management.
- Impact factor 2022: 1.526

Publication 3:

Madsen, M. E. E., Martínez, V. H., Goduscheit, R. C., Bigdeli, A. Z., Kapoor, K., & Olesen, J. V. 2023. Developing a substantiate servitisation maturity model in a multidimensional reality: A statistical investigation of the key dimensions. *International Journal of Operation and Production Management* (**In review** – submitted February 2023).

- The paper has been submitted in February 2023 at the International Journal of Operation and Production Management, and have been accepted for peer review.
- Impact factor 2021: 9.360

Supporting papers (not included in this dissertation)

Publication a:

Andersen, T. A., Madsen M. E. E., & Goduscheit R. C. (2020). Key dimensions of assessing servitisation towards a conceptual maturity model. 21st CINet Conference 2020.

Publication b:

Madsen, M. E. E., & Goduscheit, R. C. (2021). Tensions in the assessment of servitisation success: A conceptual approach. 22nd CINet Conference 2021.

- Invited for the special issue at IJTM resulting in Publication 2

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PART ONE
The Foundation of the PhD

"I checked it very thoroughly," said the computer, "and that quite definitely is the answer. I think the problem, to be quite honest with you, is that you've never actually known what the question is."
– Douglas Adams, *The Hitchhiker's Guide to the Galaxy*

1. Introduction

Theodore Levitt (1983) argued that market conditions are changing rapidly as globalisation pushes companies to innovate and do business differently. And the exponential growth in technology and digitalisation since then has further escalated the pace of change (OECD, 2018). For manufacturers, strategic logics such as standardisation and scalability through, for instance, LEAN (Nassereddine & Wehbe, 2018), have demonstrated an ability to cope with such changing market conditions. More recently, however, interest in service integration as a safeguard against increased global competitive pressures, among other things, is growing among manufacturers (Vandermerwe & Rada, 1988;Baines & Lightfoot, 2014). In fact, the number of servitised manufacturers in Denmark was found to have increased from 20% in 2007 to 59% in 2017 (Hsuan *et al.,*, 2017), which reflects the increased interest in this strategic concept. The Danish Technological Institute (Christiansen, 2019) has likewise placed further emphasis on the importance of servitisation for the international competitiveness of Danish manufacturers, which highlights the importance and relevance of further strategic dissemination of servitisation. Nonetheless, despite this increased focus on servitisation, a considerable number of studies call attention to a problematic transformation whereby manufacturers fail to transform into profitable product/service providers (Baveja *et al.,*, 2004;Benedettini *et al.,*, 2015). But while the servitisation community agrees on some of the antecedents for the failed attempts; for example, intensified investments (Visnjic & Van Looy, 2013) lack of organisational capabilities, (Tenucci & Supino, 2019) and managerial execution, (Neely *et al.,*, 2011)), less is known about how to make the likelihood of a successful transformation more likely.

For the past 150 years, manufacturers have been approaching customers through vertical integration and by bundling services in an attempt to control their supply chain (Schmenner, 2009). This integration of services in manufacturing firms was first termed 'servitisation' in 1988 (Vandermerwe & Rada, 1988). Back in the 1800s, only the minority of companies was involved in these strategic changes (Schmenner, 2009), whereas servitisation is now a global trend across industries, driven by forces of deregulation, technology, globalisation and severe competitive pressure (Vandermerwe & Rada, 1988). Servitisation is found to present both competitive and economic opportunities that motivate manufacturers to begin the journey towards becoming a product/service provider (Oliva & Kallenberg, 2003). This is believed to be a means for sustaining market shares (Ulaga & Reinartz, 2011) while simultaneously acquiring new, profitable business areas and revenue streams (Publication 2). Servitisation has commonly been considered a transition or transformation in a linear and gradual move from less to more advanced services (Baines *et al.,*, 2020). However, there has been a growing perception that this transformation is emergent, intuitive (Martinez *et al.,*, 2010), as well as illogical and unstructured (Baines *et al.,*, 2020). This is consistent with the notion from process research in organisation theory that 'firms cannot simply reproduce processes that work in other companies' (Visnjic *et al.,*, 2022), which emphasises how such a transition process is unlikely to be smooth and linear. Nevertheless, scholars agree that the servitisation transformation involves the entire organisation (Baines *et al.,*, 2017), with particular focus on, for example, operating processes, capabilities and platforms (Baines *et al.,*, 2020). Transforming the organisation into a product/service provider (Wikström *et al.,*, 2009) has proven cost-intensive and often means that firms suffer negative financial returns when expanding their service offerings (Gebauer *et al.*, 2005). Benedettini *et al.* (2015) found that the presence of a service business leads to an increased bankruptcy risk due to greater internal

risks, while Baveja *et al.,* (2004) revealed that only 21% of firms succeeded in their service strategies in 2004. As for the latter, a more recent study highlights this phenomenon, as only 5% out of 345 manufacturers managed to complete their servitisation transformation (Nebuloni *et al.,*, 2019). In 2008, Neely (2008) emphasised that it appeared more difficult for manufacturers to make incremental profit by adding services than might be expected. Although manufacturers involved in servitisation were found to achieve higher revenue, they still exhibited lower profitability than pure manufacturing firms (Brax, 2005;Neely, 2008), which was substantiated by Sawhney *et al.,* (2004), Eggert *et al.,* (2011) and Eggert *et al.,* (2015).

The existing literature has emphasised that this lack of profitability is influenced by intensified investments (Visnjic Kastalli & Van Looy, 2013), the volume of the service ratio (Nezami et al., 2016), the capabilities within the organisation (Eggert et al., 2011, 2015), the development of proper organisational capabilities and culture and, importantly, the execution (Neely et al., 2011; Tenucci & Supino, 2019). In general, a significant challenge is how to efficiently and effectively transform a manufacturing organisation into a 'service organisation' (Tenucci & Supino, 2019) to exploit the servitisation opportunities (Baines *et al.,*, 2017). Such challenge is further complicated by servitisation being a cross-organisational transformation (Baines *et al.,*, 2017) involving multiple operations of the transformation simultaneously (Kindström & Kowalkowski, 2014), which emphasises the need for a strategic understanding. However, important studies also point out how the ambiguous definition of servitisation causes several problems. The lack of clarity of the concept, typology and framing has prompted investigations from various angles and led to divergent theoretical and managerial implications (Kohtamäki *et al.*, 2019). Furthermore, the ambiguous use of conceptual definitions has resulted in a lack of conceptual clarification and increased the complexity of servitisation (Brax & Visintin, 2017) which complicates the dissemination of the concept to practitioners (Andersen *et al.,*, 2020) and scholars (Publication 2). This lack of a conceptual overview is believed to lie behind the failure of transforming the organisations as a whole due to managerial misinterpretation (Andersen *et al.,*, 2020), leading to the expected value from servitisation not transpiring (Sawhney *et al.,*, 2004). This has also been addressed by previous calls for an evolutionary perspective on the operationalisation of servitisation (Kowalkowski *et al.,*, 2017b) and a more coherent definition and operationalisation of the concept (Kohtamäki *et al.,*, 2019a). Overall, many manufacturers fail to successfully transform (Baveja *et al.,*, 2004) as they fail to be profitable (Neely, 2008), are in danger of bankruptcy (Benedettini *et al.,*, 2015), or abandon the strategy due to the absence of the expected value (Sawhney *et al.,*, 2004). This is believed to be due to conceptual misinterpretations (Andersen *et al.,*, 2020) and an ambiguous operationalisation of the concept (Kohtamäki *et al.,*, 2019a).

Over the past decade, Denmark has increased its focus on strengthening the competitive advantage of the industrial small and medium-sized enterprises (SMEs) through the implementation of service offerings (Hsuan *et al.,*, 2017). In this period, the percentage of servitised manufacturers increased from 20% in 2007 to 59% in 2017 (Hsuan *et al.,*, 2017). More recently, Denmark was ranked in the top three of the most servitised countries in Europe, with more than 70% of all Danish SMEs being servitised in 2018 (European Commission, 2018). In 2019, the Confederation of Danish Industry (DI) invested €3.9 million in the industrial project Servitize.DK (The Danish Industry Foundation, 2019), which was tasked with further disseminating servitisation among Danish SMEs with an additional focus on research and practical implications (The Danish Industry Foundation, 2019). These numbers indicate the interest and dissemination of servitisation within the Danish industry and highlight Denmark as a particularly interesting case country for studying the servitisation transformation. From here onwards, following the recommendations by the European Commission, an SME is

classified as such based on the number of employees (maximum of 250 employees) (European Commission, 2003). Following this, the general aim of the dissertation is to investigate how small- and medium-sized Danish practitioners increase the likelihood of a successful servitisation transformation by understanding and elucidating the operationalisation of it.

The premise of this study, to increase the likelihood of success, is based on our understanding of the definition of 'servitisation success' and our ability to comprehend the elements or dimensions making up the servitisation transformation. Dimensions have been used to conceptualise transformational, prescriptive models within servitisation (Wikström *et al.,*, 2009;Rapaccini *et al.,*, 2013), and several dimensions have been introduced and rendered important for servitisation to succeed as a strategy (e.g. 'market'; (Alvarez *et al.,*, 2015)) (Publication 3). A dimension is defined as '*representing the context in which certain measures are analysed*', with the '*context specified by theory and concepts*' (Ahmed & Miquel, 2005, p. 29). The majority of servitisation literature has previously investigated such transformational dimensions through a unidimensional perspective (Publication 3). While this has deepened the understanding of the associated dimensions and improved the operationalisation of each dimension (e.g. Wikström *et al.,* (2009)), unidimensional investigations imply that such dimensions progress in isolation from external influences (Kindström & Kowalkowski, 2014). This contradicts the emerging emphasis on how the cross-organisational implications of servitisation entail a transformation of the entire organisation (Baines *et al.,*, 2017). This leads to the progression of multiple simultaneous contextual dimensions (Kindström & Kowalkowski, 2014;Kohtamäki *et al.,*, 2019a), which cannot be accounted for through a unidimensional perspective. A growing emphasis on such a multidimensional perspective has emerged within the literature (Kindström & Kowalkowski, 2014;Kohtamäki *et al.,*, 2019a), leading to calls for further attention ((Baines *et al.,*, 2017;Lexutt, 2020). In this study, the multidimensional perspective posits a set of contextual dimensions that individually represent part of the progressive transformation of servitisation, which theoretically evolves in coexistence (Publication 3). The coexistence is constituted as a nomological network with laws of interrelationships among the identified dimensions and with associations to the observable indicators (Cronbach & Meehl, 1955). A progression in one dimension might therefore lead to a progression in several dimensions. While few studies have adopted the multidimensional perspective, they are believed to have overlooked important dimensions of the transformation, such as 'management' and 'strategy' (e.g. Coreynen *et al.,* (2018); Adrodegari and Saccani (2020)) (Publication 2), which excludes the potential impact of dimensions acknowledged in the investigation and impeding the comprehension of the total effect in a multidimensional coexistence. Calls have also been made to study the consequential effects among coexisting dimensions, as the development of one dimension might not lead to progression in another (Kindström & Kowalkowski, 2014;Baines *et al.,*, 2017;Kohtamäki *et al.,*, 2019a). Lexutt (2020) further emphasises the need for research into the causal effects to understand this coexistence and the consequences of leveraging each dimension. For this reason, it is necessary to shed light on the existence of multiple dimensions within the servitisation transformation and to establish a more profound and coherent operationalisation of the concept. The central terms and concepts of this research are the six key dimensions and their nomological network. These were identified through a systematic literature review of the servitisation transformation literature followed by a fine-grained textual analysis and a typology-based conceptualisation (Andersen *et al.,*, 2020;Lindgreen *et al.,*, 2021). This led to the identification of six key dimensions for comprehending the manufacturers' transformation towards servitisation (Andersen *et al.,*, 2020): strategic management, organisational governance, market reach, service integration, digital integration and value function (introduced in more detail in section 2.3).

The term success is defined as ‘a progression or development of the focal firm’ performance toward a preferred situation’ (Bustinza *et al.,*, 2019) (Publication 1), which is found to be highly influenced by the managerial perception of the preferred concept (Publication 2). Accordingly, the ambiguous definition of servitisation (Brax & Visintin, 2017) has led to a great variety of definitions of success within the literature (Publication 2). In general, most servitisation studies lack a clear definition and hardly touch on what characterises success or how to quantify it (Publication 2). This might be why prior studies merely rely on generic financial performance measures (e.g. profitability), instead of including non-financial indicators (e.g. Raddats *et al.,* (2015), (Parida *et al.,*, 2014)). Recent studies have emphasised the importance of evaluating both financial and non-financial indicators of success, as servitisation is found to advance more than just economic outcomes (Cestino & Berndt, 2017;Lexutt, 2020). None of these studies, however, specify how to quantify and achieve such success (e.g. Cestino and Berndt (2017); Lexutt (2020)) (Publication 2). Coupled with the understanding of servitisation as a continuum (Baines *et al.,*, 2020), this assessment of success should be seen as a continuous assessment and not the achievement of an end state (Publication 2). For this reason, to enable the further dissemination of ‘being successful’, a better understanding of what constitutes servitisation success needs to be established.

Adrodegari and Saccani (2020) describe the maturity model as a tool to assess and position firms in the midst of a transition, adding to the notion by Röglinger *et al.,* (2012), who defined it as a theoretical tool to specify the stage-by-stage evolvement along an anticipated, desired or logical path (Publication 3). Although the servitisation process is found to be unstructured and illogical (Baines *et al.,*, 2020), a desired path still navigates companies in comprehending and seizing opportunities within the transition as they emerge (Spring & Araujo, 2013). Again, Visnjic *et al.,* (2022) emphasise that companies cannot simply reproduce the transition of others, as the success of others reveals little about how to transform in a given context. Hence, individual and specialised recommendations are needed to guide managers through the transition. Maturity modelling has therefore been applied and highlighted as important for improving the operationalisation of servitisation by including the manufacturers’ current state (Adrodegari & Saccani, 2020). Several well-defined servitisation maturity models (SeMM) have been developed (e.g. Adrodegari and Saccani (2020); (Coreynen *et al.,*, 2018)), but they have lacked important elements (Publication 2). For instance, these have been developed as unidimensional models with only one incorporated dimension (e.g. Alvarez *et al.,* (2015)) or have evaluated multiple dimensions in isolation from one another, not taking the coexistence of the multidimensionality into account (e.g. Adrodegari and Saccani (2020)) (Publication 3), thereby omitting the relational effects among dimensions. Consequently, no existing SeMM incorporates the multidimensional coexistence, nor the potential consequential relational effects among such dimensions (Publication 3). In continuation, none of the existing SeMMs have been statistically validated or emerge from empirical learning (Publication 3). For this reason, there is potential for increasing the operationalisation of servitisation by developing a well-founded, properly validated multidimensional servitisation maturity model (MdSeMM) to structure and emphasise the relevance of each dimension.

Although addressed by several calls (e.g. Rabetino *et al.,* (2017); Baines *et al.,* (2017)), several studies have emphasised the difficulty of achieving a successful servitisation transformation (Benedettini *et al.,*, 2015). This study taps into the main calls for ‘elaborating the operationalisation of servitisation’ (Kohtamäki *et al.,*, 2019a) and ‘understanding the multidimensionality of servitisation’ (Kindström & Kowalkowski, 2014). These are calls that, to our knowledge, remain unmet within the literature. From an academic perspective, this research strives to contribute to the literature by tapping into several of these calls in five ways:

- First, by **identifying and unifying key dimensions** within existing literature through a systematic literature review to respond to the gaps identified by Ulaga and Reinartz (2011) and Schaarschmidt *et al.,* (2018). A consolidation of key dimensions is further believed to enable a better dissemination of the complexity by establishing a common understanding of the concept (Szasz & Seer, 2018;Andersen *et al.,*, 2020).
- Second, by **investigating the nomological structure** of the potentially coexisting key dimensions. This study responds to the calls for understanding the multidimensionality (Kindström & Kowalkowski, 2014), the inherent relational structure(s) (Kindström & Kowalkowski, 2014;Lexutt, 2020) and the potential consequential effects among the key dimensions (Baines *et al.,*, 2017). This furthermore provides insight into the relational effects among key dimensions, helping managers understand the total effect of their investments in these dimensions, which allows for a better allocation of future investments and resources.
- Third, by establishing a literature-based **criterion for servitisation success**, which adds to the conceptual clarity within the field.
- Fourth, by theoretically developing and statistically **validating a multidimensional servitisation maturity model** to improve the dissemination and operationalisation of the concept through explanatory and predictive measures, allowing managers to identify the current state of the transformation while also predicting future investments.
- Last, by **statistically validating** (Kowalkowski *et al.,*, 2017a) and **consolidating** (Szasz & Seer, 2018) existing knowledge within servitisation.

While knowledge exists of 'why' the transformation is troublesome, the gaps above indicate the need for further research in terms of the application of 'how'. Hence, this research is guided by the practical problem of 'how' to overcome the problematic transformation and strives to develop a solution to advance future servitisation practices. This approach is the essence of pragmatism, which seeks to investigate an identified problem to obtain an achievable solution for future practices (Kaushik & Walsh, 2019). The pragmatists also place greater emphasis on directing such problems with 'what' and 'how' instead of 'why', for instance (Creswell, 2013, p. 11). This was because the pragmatists' reality is based on whether a practical consequence has impact and its relevance for the 'real world' (Saunders *et al.,*, 2012;Kaushik & Walsh, 2019). Although such reality is socially constructed from habits and beliefs (Yefimov, 2004), pragmatists believe that an objective reality exists apart from human experience (Kaushik & Walsh, 2019). However, reality can never be determined once and for all in as much as it is a social construction (Pansiri, 2005). Moreover, pragmatism seeks to establish new knowledge to be used as a tool for improving future practices (Kaushik & Walsh, 2019) by tapping into parts (inquiries) of the reality and seeking to establish knowledge that can change that particular part. This study therefore adopts pragmatism by focusing on the managerial implications of the researched problem (reality) to establish new understandings of how to improve future transformations of SMEs (knowledge). Although an absolute reality cannot be determined, this study seeks to use the context of Danish servitised SMEs to identify the truth for that particular inquiry. For pragmatists, however, a practical solution relevant to the 'real world' is needed to establish the 'truth'. An empirical investigation is therefore needed to establish the relevance and impact of the new 'knowledge'. Hence, following pragmatism, researchers must first establish the 'knowledge', then estimate its relevance for conducting proper research (Kaushik & Walsh, 2019). This follows the idea of an abductive approach by switching back and forth between conceptualisation and validation in a process called dialectical shuttling (Atkinson *et al.,*, 2003). Accordingly, this research adopts the abductive approach by shifting between conceptualisations of theories and quantitatively estimating these theories (Atkinson *et al.,*, 2003). In the initial phase of the PhD, it became evident that additional knowledge gaps existed;

gaps requiring exploration before the theoretical model could be developed. The formulation of four sub-questions led to two conceptual studies and two quantitative estimations of the model (see Figure 1). The four studies led to the adjusted final model, which was then estimated to evaluate the 'truth' of the model and the new knowledge.

The research has been further guided by the theoretical lens of configurational theory, as suggested by Kohtamäki *et al.,* (2019a, p. 215). The configuration logic believes that there are different equifinal ways in which certain dimensions can lead to servitisation success (Forkmann *et al.,*, 2017b), which is in line with the servitisation continuum (Baines *et al.,*, 2020). The main assumption is that the coalignment of strategy and its context results in performance variance, which permits the existence of more than one perfect combination of dimensions for becoming successful (Kohtamäki *et al.,*, 2019a, p. 215). In other words, a configuration of key servitisation dimensions is likely to result in consequences for the performance variance, which is in line with the research objective as well as the pragmatist view of reality and truth, as the practicality is manifested in the performance variance. The theoretical lens taps perfectly into the research of multidimensionality, as it assumes that dimensions should fit together (Kohtamäki *et al.,*, 2019a, p. 215). Furthermore, the combination of pragmaticism and reconfiguration encourages the use of maturity modelling by following the previously presented definitions by Adrodegari and Saccani (2020, p. 775 & p. 777) and Röglinger *et al.,* (2012): '[a tool] assessing and positioning companies undergoing the transformation' and 'a theoretical tool to specify the stage-by-stage evolvement along an anticipated, desired or logical path'. This is in line with the findings produced by Visnjic *et al.,* (2022) that successful transitions into dual business models (e.g. servitisation) include incremental progressions. This is consistent with incremental improvements through organisational configurations structured as maturity. The configurational logic is used to steer the theoretical reasoning of servitisation and maturity, while the logic is not to steer the methodology, hence used to identify *combinations* within servitisation through fuzzy-set Qualitative Comparative Analysis (fsQCA) (Pappas & Woodside, 2021). The theoretical underpinning of configurational theory is influenced by the theories of **dynamic capabilities**, **organisational identity**, **resource-based view** as well as **organisational change**, as these are theories embedded in the configured dimensions; for example, dynamic capabilities embedded in the indicators of the digital integration dimension or the theory of organisational identity, tensions and paradoxes, which was adopted in the success study (cf. Publication 2) (Kohtamäki *et al.,*, 2019b).

To shed light on the problematic transformation and literature gaps presented, this dissertation seeks to elaborate on the following research question, with respect to the author's scientific philosophy as presented in the methodology section (3.1):

How do Danish industrial SMEs increase the likelihood of a successful servitisation transformation through the reconfiguration of key dimensions in a multidimensional perspective?

Since additional preliminary knowledge is needed to establish the foundation necessary to answer the research question, the following four sub-questions have been formulated:

SQ_1: *What are the key dimensions explaining the servitisation transformation existing within the servitisation literature?*

SQ_2: *How is servitisation success defined and quantified in the literature?*

SQ$_3$: *If dimensions indeed coexist, what are the theoretical structures of such multidimensionality, and what kind of relational influence exists among them?*

SQ$_4$: *What impact do the key dimensions have on servitisation success, and how are the relational effects influencing this success?*

This research sets out to investigate the six dimensions' prediction of success by taking their relational interrelationships into account. The multidimensionality assumes a path model to be present, and structural equation modelling (SEM) is the most suitable (Hair *et al.,*, 2010). However, to conduct the SEM analysis, a structural as well as a measurement model must be developed. The structural model (inner model) consists of theoretical constructs (dimensions) and the theorised interaction terms among these constructs. The measurement model (outer model) consists of the indicators approximating each of the theorised constructs. From here, the abductive approach is applied by establishing the structural and measurement models through conceptualisations (Figure 1), while estimating and adjusting the model through statistical computations and evaluations. The abductive approach and the methodological structure behind SEM have been used to structure this PhD research.

The main findings of this dissertation can be summarised in five novel academic contributions. First, this is the first study to consolidate and conceptualise key dimensions of the servitisation transformation based on the entirety of the existing literature, thus addressing the gaps identified by Ulaga and Reinartz (2011), Schaarschmidt *et al.,* (2018) and (Andersen *et al.,*, 2020). Second, this is the first study to deliberately investigate the definitions of servitisation success and what it means to be successful in a servitisation context. Furthermore, this is the first study to provide specific propositions for composing indicators measuring servitisation success. This contributes to the consolidation and unification of servitisation as a concept, hence closing the gaps presented by Szasz and Seer (2018). Third, this is the first statistical investigation into maturity modelling in the context of servitisation that takes multidimensionality into account. It investigates and identifies the dimensional influence on the achievement of servitisation to extend our understanding of the servitisation journey. This adds to the statistical validation of existing theory as presented by Kowalkowski *et al.,* (2017a). Fourth, this is the first statistical investigation into the relational effects among contextual servitisation

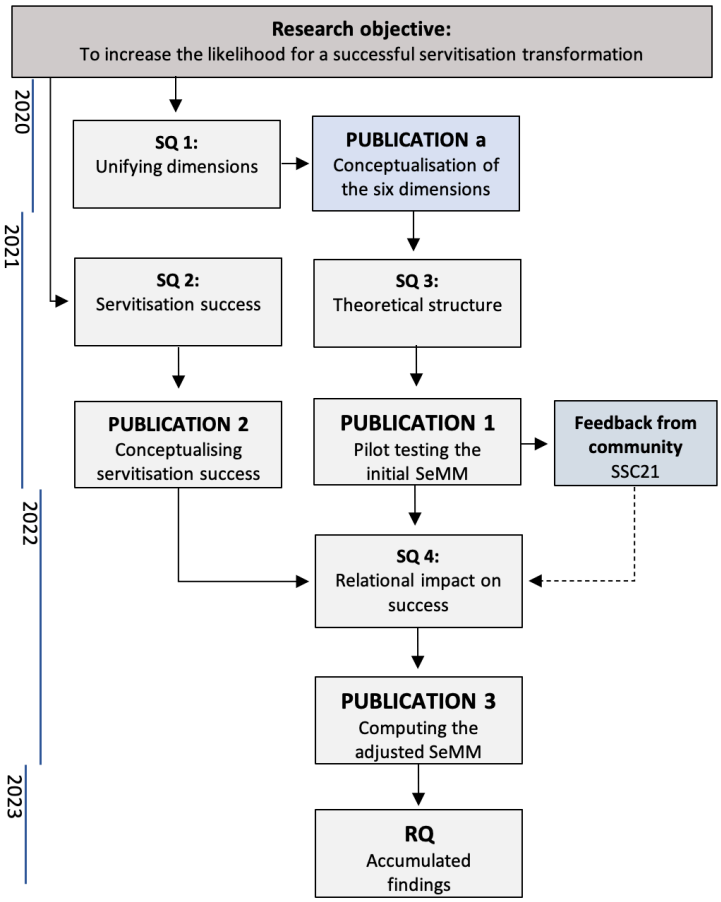

Figure 1: Appended papers and their relation to the research objective and the sub-questions (SQs).

dimensions in a multidimensional perspective. While previous studies have investigated the dimensions of servitisation in isolation and in unidimensional perspectives, this is the first study to truly embrace and investigate these dimensions in a multidimensional perspective, taking the coexisting influences among dimensions into account. By doing so, this dissertation fills the gaps identified by Baines *et al.,* (2017);Lexutt (2020) and Kohtamäki *et al.,* (2019a). Fifth, this is the first statistical validation of prior theoretical and conceptualised maturity indicators within servitisation. This has led to the validation of 33 existing theories and prioritised their importance in terms of a successful servitisation transformation, and it closes the gaps identified by Rabetino *et al.,* (2018) and Kohtamäki *et al.,* (2019a, p. 233).

The following three sections present the journey of developing the adjusted maturity model. Part 1 establishes the foundation for the PhD in its entirety. Chapter 1 frames the research problem and research question. Chapter 2 constitutes the theoretical foundation by elaborating on key theoretical aspects of this research, namely servitisation as a concept, the six dimensions, the literature of maturity modelling and servitisation success. This theoretical foundation is established through two systematic literature reviews (see section 3.6). Chapter 3 unfolds the methodological reasoning of the study as well as the scientific positioning and considerations.
Part 2 presents the three appended papers, including discussions of the key lessons that have led to the next step of the research (see Figure 1) through Chapter 4. And finally, Part 3 further discusses the accumulated findings and their importance for academia and practitioners to estimate the truth of the findings. This through the discussion in Chapter 5, and the conclusion of the PhD in Chapter 6.

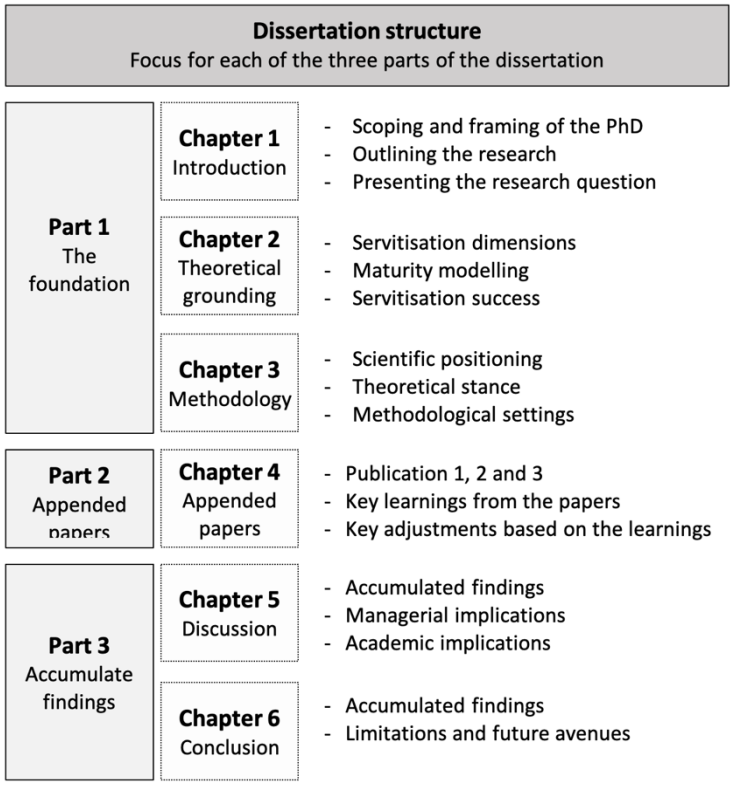

Figure 2: Structure of the dissertation.

2. Theoretical grounding

To answer the research question, a theoretical choice of developing a multidimensional servitisation maturity model has been made. This because the maturity modelling suits the configurational approach, as will be presented in sections 2.4 and 3.1.3, but also to comply with the need for developing more profound maturity models within the literature (as stressed by, e.g., Adrodegari and Saccani (2020)). Nonetheless, to develop a profound maturity model that addresses the most important aspects of servitisation and reflects a multidimensional structure, a better understanding of the theoretical grounding of such model is needed. This is particularly true for four central elements, as illustrated in Figure 3, and they will be presented in this chapter, accordingly.

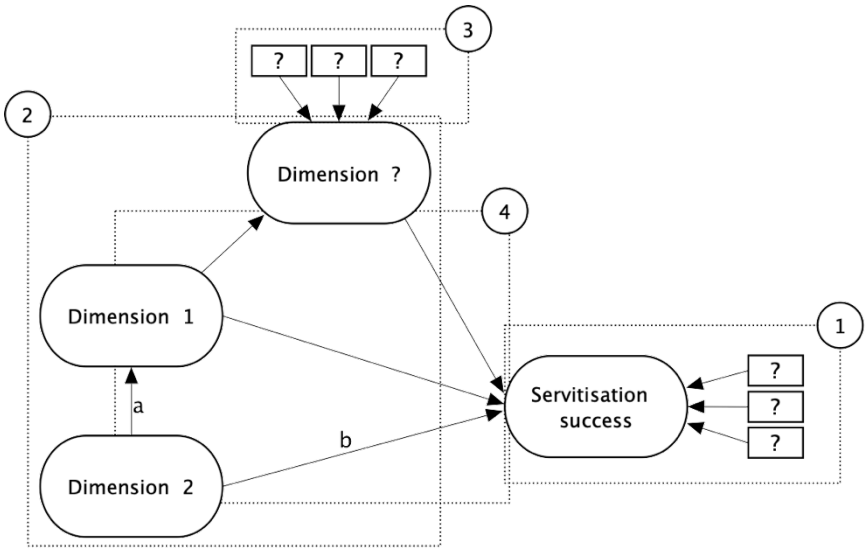

Figure 3: Simplified example of a multidimensional maturity model.

The principal purpose of the study is to 'increase the likelihood of a successful servitisation transformation'. This essentially requires an understanding of what defines success within servitisation and/or when servitisation is achieved (area 1 in Figure 3). To anticipate how the dimensions influence this success, an approximation of the success is needed to estimate the dimensional importance. The definition of success and how success is quantified are discussed in the following (section 2.5) and in Publication 2, and they are based on the second systematic literature review (section 3.6.1).

A premise for developing a multidimensional maturity model is to identify which dimensions must be incorporated (area 2 in Figure 3). The dimensions represent important aspects of the servitisation transformation and should be identified carefully. The existing literature has presented some of these dimensions, but with aspects of the transformation missing. The identification of the key dimensions is discussed in the following (section 2.3) and in Publication a and is based on the first systematic literature review presented in section 3.6.1. The approximation of each dimension to estimate the dimensional maturity level is an important element in the development of the model as well.

To estimate the influence of the dimensions, each must be approximated through associated theory and with quantifiable indicators (area 3 in Figure 3); in other words, the dimension is

estimated on indicators that represent essential theories of the associated dimension. The identification of associated indicators followed the principles of Cronbach and Meehl (1955) as well as the motivation of empirical meaning by Bagozzi (2011). Only a limited number of validated indicators can be adopted directly, as the majority of previous servitisation maturity models have omitted the validation process of their indicators (see Publication 3, Table 20). Hence, a necessary step for this research is the identification and validation of indicators. The identification is based on the literature review (LR1) and will be briefly discussed in the following (section 2.4). This was first presented in Publication 1 and adjusted in Publication 3.

The multidimensionality of the maturity model implies that the dimensions are coexisting and that changes in one dimension might affect the outcome of another. This is illustrated in Figure 3, with dimension 2 influencing dimension 1 (path a), while also having a direct effect on success (path b). To compute such relational effects among the independent variables (the six dimensions) and their total effect towards a dependent variable (e.g. servitisation success), a multivariate path analysis is preferred (Hair *et al.,*, 2017b) (see discussion in section 3.7.3). The proposed structure is constituted as a nomological network with each construct (dimension) and the interrelationships (Cronbach & Meehl, 1955) to conceptualise the multidimensionality and to ensure the theoretical meaning of the model (Bagozzi, 2011). The path analysis is grounded in the theorised measurement model (indicators of success and the six dimensions individually: areas 1 and 3) and the structural model. The structural model identifies the theoretical relations within each dimension and whether the dimensions have positive or negative consequences for success (area 4 in Figure 3). The identification and theorising of the relations and the direction of the relations are based on the first systematic literature review and presented in Publications 1 and 3.

This Chapter presents the theoretical grounding that enabled the development of the maturity model illustrated in Figure 3. Sections 2.1 and 2.2 address that perspective on servitisation and the reasoning behind servitisation as a multidimensional concept. Section 2.3 presents the identification of the six key dimensions and the importance of the underlying indicators in approximating each dimension. Section 2.4 outlines and discusses the present state of maturity modelling within servitisation. Section 2.5 describes and discusses the present state of servitisation success and its limitations, while section 2.6 introduces the main calls to which this research is responding. Theoretical reasonings and discussions that are central parts of Publications 1, 2 and 3 are briefly discussed in the following and in greater depth in the publications in Chapter 4. The three literature reviews are presented in more detail in section 3.6.1.

2.1 Establishing the conceptual baseline of servitisation

Integrating services into manufacturers' offerings is not a new concept. There is evidence of a minority of manufacturers having approached customers through vertical integrations since the 1800s in an attempt to control their supply chain (Schmenner, 2009). However, it was first in 1988 that Vandermerwe and Rada (1988) defined servitisation as a gradational process of integrating services into a manufacturing firm with the objective of gaining a competitive edge. Back then, it was (and still is) believed to be driven by technological developments, increased globalisation and deregulations (Vandermerwe & Rada, 1988).
Although the community has unanimously acknowledged and emphasised the importance of service integration (e.g. Bowen *et al.,* (1989); Baines *et al.,* (2009b)), scholars have theorised the phenomenon differently, leading to such diverse conceptualisations as servitisation

(Vandermerwe & Rada, 1988), product–service systems (PSS) (Mont, 2002; Tukker & Tischner, 2006), service infusion (Brax, 2005) and integrated solutions (Davies, 2004; Davies et al., 2007). As these theories differ in their definitions; for example, PSS as a specific type of value proposition to fulfil a specific need (Tukker & Tischner, 2006) and service infusion as bundling services with the core product (Forkmann *et al.,*, 2017a), distinguishing between the recommended practices has proven difficult, which has led to interchangeable uses of the concepts within the literature (Raddats *et al.*, 2019) as well as diverging academic and managerial implications (Kohtamäki *et al.*, 2019a; Rabetino *et al.*, 2015). These conceptually differing approaches towards a similar means (service integration) have added to the complexity of the phenomenon. This diversity, combined with the lack of conceptual clarity of 'servitisation', has been addressed as problematic for the field (Brax & Visintin, 2017;Kohtamäki *et al.,*, 2019b).
In recent years, servitisation has been approached and defined differently. Some studies have focused on understanding the product/service solutions (Dimache & Roche, 2013), while others have focused on the service delivery (Alvarez *et al.,*, 2015) or the activation of the ecosystem (Liu *et al.,*, 2014); all of which possessed differing perceptions of servitisation. Through the study of Publication a and the first systematic literature review (SLR1; see section 3.6.1), a variety of conceptual definitions were identified. This led to the suggested distinction of four focus areas of servitisation to help identify the conceptual level of servitisation for practitioners and scholars (from Publication 2).

***Offering-focused* servitisation perspectives**	Emphasise the inclusion of solutions or delivered value to the customers (Dimache & Roche, 2013).
***Process-focused* servitisation perspectives**	Focus on the optimisation of processes and delivery ability within the focal firm (Alvarez *et al.,*, 2015).
***Firm-focused* servitisation perspectives**	Focus on the organisational and focal firm specifications with the transition in mind (Altmann & Linder, 2019)
***Business model-focused* servitisation perspectives**	Stress the value creation within the focal firm and the interlinked ecosystem (Liu *et al.,*, 2014).

Table 1: Four definitional types of servitisation adopted from Publication a

This study adopts a firm-focused servitisation perspective by tapping into the configuration of the manufacturing firm as a whole. In particular, this research adopts the definition of servitisation presented by Baines *et al.,* (2017), stating that servitisation constitutes a transformation of the company as a whole with the integration of value creation through product/service solutions.

2.2 The multidimensionality of servitisation

Previous studies have assumed that the servitisation transformation follows a redefined and structured path (Alvarez et al., 2015; Oliva & Kallenberg, 2003), specified as end-state models, gradual transition models and step-wise progression models (Brax & Visintin, 2017). However, servitisation is believed to exist on a continuum; instead of being an achievable end state, it is a progression from basic to more advanced service offerings (Kowalkowski *et al.,*, 2015). Such a continuum in the advancement of services calls for modifications and adjustments made to the entire organisation (e.g. capabilities, managerial mindset and allocation of resources) on a continuous scale (Baines *et al.,*, 2017). Lexutt (2020, p. 110) further argues that the servitisation transformation should be understood in multiple dimensions that are 'tightly interrelated and mutually reinforcing'. Such multidimensionality is defined as a

‘multidimensional structure based on the concept of facts or measures, and dimensions representing the context in which these measures are analyzed’ (Ahmed & Miquel, 2005, p. 29) and has been called for in the literature (Baines *et al.,*, 2017;Lexutt, 2020). This multidimensionality implies the coexistence of multiple dimensions that change simultaneously (Kindström & Kowalkowski, 2014;Lexutt, 2020), where each dimension represents a specific area of the transformation (e.g. digitalisation). To understand the total effect of the transformation in a multidimensional perspective, however, such dimensions and their coexisting influences must be identified and understood. In other words, we must identify how a change in dimension A potentially leads to a change in the effect of dimension B.
In the context of servitisation, such multidimensionality represents the conceptual ‘levers’ that the extant literature has emphasised as important for the transformation. For instance, several studies have proclaimed the importance of specific practices that fit into the focus areas of the transformation; for example, ‘management’ by Wikström *et al.,* (2009) through the emphasis of ‘goal’, ‘key process’ and ‘digitalisation’ by Neff *et al.,* (2014) through the emphasis of ‘[digital] appliance and ‘data integration’. These focus areas are termed ‘dimensions’, as they represent a specific conceptual and contextual area of the transformation. While several servitisation dimensions have been proposed, none have been validated or tested (see Publication 3, Table 20). Section 2.3 presents the six key dimensions of the servitisation transformation that were identified based on the extant knowledge of the current literature.

With some 34 years of research, servitisation is a relatively young field. Much is known, but much remains to be learned. Previous studies have focused on a unidimensional conceptualisation of the transformation (Kohtamäki *et al.,*, 2019a). In fact, the majority of studies within servitisation have been found to focus on a single organisational level or function-specific area of the transformation (identified through SLR1). This has deepened the knowledge of specific areas and established the foundation for future research (e.g. the well-used ‘organisational concept’ by Wikström *et al.,* (2009)). As noted by Kohtamäki *et al.,* (2019a, p. 214), however, there is a need for a ‘multidimensional, richer, and more realistic conceptualization regarding servitization’ that takes the relative importance of each dimension into account. While a few studies have managed to establish such multidimensionality through maturity modelling, the models have lacked important aspects (e.g. Coreynen *et al.,* (2018) Adrodegari and Saccani (2020)). For instance, neither Coreynen *et al.,* (2018) nor Adrodegari and Saccani (2020) included the important dimensions of ‘management’ and ‘strategy’, nor have they quantified the weighted importance among the coexisting dimensions, which leaves the interaction terms out of the model. Only by understanding the relational effects among the dimensions do we understand the multidimensionality of the transformation. This PhD dissertation therefore strives to comprehend the full effect of the multidimensional coexistence by investigating the relational impact of the full transformation. These relations are further discussed in section 2.4, which introduces maturity modelling within servitisation.

2.3 The key dimensions of servitisation

A dimension ‘represents the context in which certain measures are analysed’, while the context is specified by the theory and concepts (Ahmed & Miquel, 2005, p. 29). In this study, the dimensions are represented by thematic aspects of the theoretical transformation of servitisation. In other words, each dimension represents specific contextual and thematic aspects of the transformation based on established knowledge. For instance, Coreynen *et al.,* (2018) suggest ‘digitalisation’ as a thematic aspect (i.e. dimension) of servitisation. However,

these thematic contexts are not always explicitly used, which is the case for the study by Klein *et al.,* (2018b). Here, they investigate the barriers for smart services, which they base on service development through digitalisation. From here, the thematic context is equivalent to the study by Coreynen *et al.,* (2018). In contrast to antecedents, dimensions are single, thematic aspects of the transformation that do not necessarily lead to any successors. Dimensions can also have both positive and negative consequences for the transformation. Following the notion of multidimensionality (presented in section 2.2), such dimensions are meant to be understood in interrelationship with each other. However, a necessary starting point for fully understanding such coexistence is a profound understanding of which dimensions exist and relate to one another. Following the idea put forward by Peterson and Zimmerman (2004), a nomological network provides the theoretical framework to grasp the constructs of a theory, their observable manifestations and the interrelationships among the constructs (i.e. dimensions). Further along these lines, Cronbach and Meehl (1955, p. 291) proclaims that nomological networks is about elaborating the insight of the network by proposing new constructs and 'laws' sufficiently clear enough for others to accept or reject them. When sufficiently clear, the proposed laws (relational connection between construct and observable variables, and interrelationships between constructs) are tested to claim the truth of the propositions (Cronbach & Meehl, 1955, p. 291). Cronbach and Meehl (1955) describe a construct as 'an abstract idea for which the interrelationships among relevant, observable variables have been specified', which is highlighted by Peterson and Zimmerman (2004, p. 139). This is further in line with Bagozzi (2011, p. 265), who motivated the establishment of the theoretical meaning by specifying the conceptualisation of the focal construct and the (potential) theoretical relationships together with the empirical meaning by 'the observational content associated with theoretical constructs'. In the following, these constructs of servitisation are defined, their substantiation is evaluated, and their reasoning is presented to establish the theoretical meaning of the model (section 2.3.1) (Cronbach & Meehl, 1955, p. 297;Bagozzi, 2011). The proposed laws of the nomological network are then presented as the relation from theoretical constructs to observables indicators (empirical meaning) (section 2.3.2) and the interrelationships between specific constructs (theoretical meaning) (section 2.3.3), as emphasised in the first and second principles by Cronbach and Meehl (1955, p. 290); hence, striving to propose a convincing nomological network with both theoretical and empirical meaning. The endogenous variable of servitisation success is treated separately in section 2.5.

To accumulate the existing knowledge within the field, an adoption of existing dimensions was preferred. The six key dimensions were identified through SLR1 followed by a fine-grained text analysis and a typology-based conceptualisation of 249 scientific papers (Andersen *et al.,*, 2020;Lindgreen *et al.,*, 2021). Papers with similar contextual interests were clustered and confined to an existing (e.g. 'digitalisation') or new category (e.g. 'organisational governance'), allowing for the inclusion of previously investigated dimensions as well as the addition of new ones, including 'strategic management', as identified in Sousa and da Silveira (2019), who examined the relationship between product customisation and the servitisation strategy, or the study by Demeter and Szasz (2013), who investigated how servitisation is positioning Hungarian manufacturers. This led to the identification of six key dimensions for comprehending the manufacturers' transformation towards servitisation based on the existing literature. These were further compared to earlier proposed dimensions from previous servitisation maturity models, which resulted in small adjustments to their scope (see Publication 3, Table 20). Taking into account the prior maturity models and the formalised dimensions through SLR2, each dimension was labelled and defined accordingly, as seen in Table 18 (Publication 3). Each dimension has been monitored and challenged to verify their viability by the following top servitisation scholars: Associate Professor Ali Bigdeli (Aston University), Associate Professor Kawal Kapoor (Aston University) and Associate Professor

Veronica Martínez (University of Cambridge). They failed to invalidate the dimensions' presence and magnitude and were unable to propose additional dimensions. The six dimensions were identified through Publication a and presented in Publications 1 and 3.

2.3.1 Defining the constructs

The nomological network act as theoretical frame for proposing a new network of constructs allowing for developing the multidimensional maturity model of servitisation. To elaborate on existing SeMMs, the servitisation maturity stream of literature has been given particular emphasis in structuring these constructs through their components, but with respect to the more established base of servitisation knowledge. With respect to the theoretical and empirical meaning proposed by Bagozzi (2011), the theoretical meaning is established in the following through a definition of each construct, while the theoretical relationships are presented in section 2.3.3 and in publications 1 and 3. A definition of these constructs is presented in the following together with their reasoning and an evaluation of their substantiation (Cronbach & Meehl, 1955, p. 297). The underlying reasoning of the given constructs stems from Publication a, while the definitions, exemplifications and components have received particular emphasis in the following.

2.3.1.1 Digital Integration

> *Researchers have examined the role of digital technologies, especially those related to information and communication technologies within manufacturing, examining how new digital technologies drive and act as the facilitators of servitisation (Jin et al.,, 2014;Vendrell-Herrero et al.,, 2017;Pistoni, 2018). As such, incorporating digital services into physical products aims to develop the capturing and processing of data and information, allowing manufacturing companies to develop new business models by exploiting the potential of their products (Neff et al.,, 2014;Vendrell-Herrero et al.,, 2017). By facilitating the development of economic operations, the digitalisation enables the better allocation of resources and more accurate information sharing within and outside the boundaries of the company (Kindström & Kowalkowski, 2014).*
>
> ***Paragraph from section 4.1 in Publication a.***

The digital integration construct addresses the ability of manufacturers to integrate new technologies, increase external accessibility (e.g. customer sites and network partners ICT systems) and apply data as a resource for new service offerings. This consists of two components adopted from the existing SeMM literature identified through SLR2: digital appliance (Jin *et al.,*, 2014;Coreynen *et al.,*, 2018;Neff *et al.,*, 2014), and accessibility (Neff *et al.,*, 2014).

- **Digital appliance** is about the degree of implemented digitalised technologies within the manufacturing company and how well they are employed. Jin *et al.,* (2014) quantified the appliance as the degree of complexity of the IT system implemented, while Neff *et al.,* (2014) add to this notion through the degree of automatisation in collecting data.
- **Accessibility** is about the manufacturer's integrated access to data, which has been addressed by Coreynen et al. (2018) as the variety of integrated data points; for instance, the integration of customer- and/or value-chain-related data.

Hence, this construct is about how digitalised the individual manufacturer is, a positive development indicating 'more digitalised'. Manufacturers excelling in digital integration have

implemented digitised technologies, which enables new business models and/or extends the existing ones through the integration of addition data points. BM silo, a case from the Servitize.DK project, used to sell 'dumb' silos (in their words) and wanted to extend their reach to the German market.[1] The logistical costs were extensive, however, and success required the addition of value into the silos. Consequently, they installed a variety of sensors to make them smart and digital. For instance, they installed humidity and temperature sensors into the silos to trace the conditions of the stock while also installing a weight-sensor that allowed the monitoring of the amount of (e.g.) cattle feed. This allowed BM Silo to develop a new value proposition, offering the customers a solution where the cattle feed was automatically ordered at the supplier, at a given threshold, before they ran out. Additionally, BM Silo has started to integrate robotics into their production line, with a fully automated setup expected in 2025 (Servitize.DK, 2020). This is an example of a manufacturer who has excelled in the digital integration construct by adding data points and utilising the technological opportunities.
Digital servitisation is developing rapidly with new insights into how digitalisation and technologies can help to foster new product-service solutions; for example, the studies by Sjödin *et al.,* (2020) about co-creation through digital servitisation and Klein *et al.,* (2018a) about the barriers for smart-service businesses. Based on the results of SLR1 and SLR2 together with the discussions with the servitisation scholars (as presented on **page 25**), it is our belief that accessibility and appliance is appropriate at the current state, but I recognise that the digital integration construct must be refined in the coming years to keep up with new insights.

2.3.1.2 Strategic Management

> *Prior research investigating the consequences of servitisation suggests that it can be a beneficial strategy (Oliva & Kallenberg, 2003;Fang et al.,, 2008;Baines et al.,, 2009b;Suarez et al.,, 2013;Neff et al.,, 2014;Jin et al.,, 2014;Baines & Lightfoot, 2014). However, this requires a fundamental change in the product mindset from the pure industrial context to more customer-centric approach (Kindström & Kowalkowski, 2014). Otherwise, manufacturers are at risk of losing their strategic focus if they do not manage the transition properly (Fang et al.,, 2008).*

Paragraph from section 4.1 in Publication a.

The strategic management construct is much about the managerial focus and behaviour when facilitating servitisation, and the anchoring of servitisation as a strategic reasoning into the company setting. It is not about the planned strategic moves, but merely about how well managers facilitate it and how the culture copes with it. This stands in contrast to how Jin *et al.,* (2014) interpret strategic management, as their conceptualisation is based on the degree of planning in five stages. However, as several of these stages involve formalised processes or capabilities, these are conceptually more aligned with the organisational governance of this study (see elaboration in 2.3.1.4). Additionally, the service orientation among managers is found to have a positive influence on the development and maintenance of service businesses (Gebauer & Friedli, 2005). The strategic management construct addresses the ability of manufacturers to build and maintain strategies to implement servitisation successfully. This consists of three components adopted from the existing SeMM literature identified through SLR2: managerial behaviour (Coreynen *et al.,*, 2018), management commitment (Neff *et al.,*, 2014;Coreynen *et al.,*, 2018;Lexutt, 2020) and culture (Jin *et al.,*, 2014;Wikström *et al.,*, 2009;Lexutt, 2020).

[1] Case presentation by BM Silo CEO Dorthe Zacho Martinsen at a knowledge-sharing meeting in the Servitize.DK project group (7 February, 2020).

- **Managerial behaviour** is about how managers behave in a product-service-oriented manner. Manufacturers enrolled in a servitisation transition are coming from a pure goods-oriented organisation with focus on product-related issues, such as durability, style, conformance quality etc. (Gebauer *et al.,*, 2010). To break with such an orientation, the managerial behaviour is crucial for the transformation to be successful (Gebauer *et al.,*, 2010). Coreynen *et al.,* (2018) argues that such managerial behaviour plays an important role in initiating the service orientation among employees and to embed it into the culture (Gebauer *et al.,*, 2010). An important part of the strategic management is therefore how the managers behave in a service-oriented manner; for instance, by emphasising the importance of solving customer's problems, by stressing the importance of services for the business or by rewarding service-oriented behaviours among employees.
- **Management commitment** reflects how the management priorities the servitisation transition. Following the findings by Gebauer *et al.,* (2010), managers must spend sufficient time and resources to put normative pressure on employees to understand the value of services. While the resource allocation will be treated by the Organizational Governance construct, the amount of time and effort invested by the managers has been reflecting the commitment of the managers in prior SeMMs (e.g. Neff *et al.,* (2014) Lexutt (2020)).
- **The culture** component is about the organisational culture and reflects the set of shared beliefs about servitisation within the focal firm. Following the notion by Schein (1996, p. 236) culture is '*the set of shared, taken-for-granted implicit assumptions that a group holds and that determines how it perceives, thinks about and reacts to its various environments*'. These shared, taken-for-granted assumptions have previously been addressed as how the organisation as a whole interprets the servitisation concept. For example, Lexutt (2020) presented the service orientations by the culture, and Wikström *et al.,* (2009) presented the strategic orientation by organisation. Additionally, Coreynen *et al.,* (2018, p. 29) emphasised how, '*in order to servitize successfully, manufacturers are advised to move toward a new corporate culture*' with a service focus; a corporate culture normalised by the managerial behaviour and commitment (Gebauer *et al.,*, 2010).

Hence, strategic management is about how the organisation and managers approach and comply with the servitisation concept. It is about how managers engage and interact when facilitating the transformation, and how the orientation of the organisation as a whole is present. Improved strategic management means that the managers have refined their behaviour towards services, and commit themselves to the servitisation transformation. It also means that the managers motivate and encourage employees to engage in the transformation through a customer-centric service-orientation, where the managers seek to embed this behaviour as a normative among employees (Gebauer *et al.,*, 2010). The notion that management involvement and commitment is important has been exemplified (Alghisi & Saccani, 2015;Lexutt, 2020) and emphasised several times in the literature (Oliva *et al.,*, 2012;Raddats *et al.,*, 2015). As Alghisi and Saccani (2015) state, for example, '*an increased awareness and commitment of the top management is needed to boost the service awareness and attitude of employees and to adequately invest in the service business*'. Following the notion by Gebauer *et al.,* (2010) (that behaviour and commitment affects the organisational culture) and the delimitation of strategic management (as being about neither strategic planning nor strategising), I believe that managerial behaviour, management commitment and the culture are appropriate components for measuring the strategic management construct.

2.3.1.3 Market Reach

> *Among the most critical elements of servitisation maturity literature is the value co-creation, in which the literature emphasises the important role of customers and network partners play in the success of servitisation (Alvarez et al.,, 2015;Rapaccini et al.,, 2013;Tukker & Tischner, 2006). This includes for instance, educations on product and service features, co-creating services with external partner, build and enhance customer experience, and knowing customer needs (Bitner & Brown, 2008). The servitisation literature places huge importance on the value proposition, which must be focused on solving customers' actual problems and must be built on actual measurable outcomes and capabilities (Gebauer et al.,, 2005;Neely, 2008;Neu & Brown, 2016).*

Paragraph from section 4.1 in Publication a.

The market reach construct embraces this emphasis and addresses the ability of manufacturers to scan the business environment to identify and apply external capabilities and resources in supporting the servitisation journey through new and optimised service solutions (Bitner & Brown, 2008). This consists of three components adopted from the existing SeMM literature identified through SLR2: network stage (Jin *et al.,*, 2014;Cui *et al.,*, 2019;Coreynen *et al.,*, 2018), network role (Coreynen *et al.,*, 2018;Jin *et al.,*, 2014;Wikström *et al.,*, 2009), and network involvement (Coreynen *et al.,*, 2018;Jin *et al.,*, 2014;Rapaccini *et al.,*, 2013). The reasoning of the three components has been adopted from Coreynen *et al.,* (2018), while the exact typology has been based on the authors' interpretation of the categories among similar SeMMs (e.g. involvement of customers by Rapaccini *et al.,* (2013) and roles by Jin *et al.,* (2014). Coreynen *et al.,* (2018) focused specifically on partners in general as the market, while the comparable study by Rapaccini *et al.,* (2013) divided the market into customers, suppliers and other stakeholders. For this study, I decided to focus on the customers and suppliers only, since 'other stakeholders' were not used as broadly in the SeMM literature; in fact, only Rapaccini *et al.,* (2013) introduced this group.

- **Network stage** is about how well-informed the manufacturers are about external partners (i.e. customer and/or supplier). As noticed by Coreynen *et al.,* (2018), network management includes the coordination of a network of partners, which emphasises the importance of remaining informed about the external partners' strategies and goals (Kohtamäki *et al.,*, 2013b); this both in terms of initiating collaboration on co-creation (Kowalkowski *et al.,*, 2012;Ruiz-Alba *et al.,*, 2019) and enabling the manufacturer to identify potential partnerships (Bitner & Brown, 2008). The network stage is an expression of how developed the internal network management is, with particular emphasis on remaining informed.
- **Network role** is about the role of the external partner (i.e. customer and/or supplier) in relation to the manufacturer. Jin *et al.,* (2014) identified the roles (of the customers) as a) pure buyer, b) object of study, c) source of information, d) co-designer and e) partner. Additionally, Jin *et al.,* (2014) have argued that customers are evolving from passive to proactive participants in collaborations due to their degree of involvement. This aspect is also taken up by Coreynen *et al.,* (2018), who focused on how Jin *et al.,* (2014) worked with how to define roles (i.e., partners) optimally, namely, that the external partners possess a role with the manufacturer, where they both seek to support each other's success in a win–win situation. This reflection of network roles has been adopted in this study as the optimum of the roles being fully achieved (partnership) (Jin *et al.,*, 2014).
- **Network involvement** is about the degree of involvement that the manufacturer seeks to obtain with the external partner (i.e. customer and/or supplier). This definition overlaps conceptually with the network role, as both components relate to the proximity of the partner–manufacturer collaboration. However, the focus in this study on network involvement has been on the awareness among manufacturers as to whether to involve an

external partner (due to the manufacturer's own objective), while network roles refer to the role filled by the external partner (common objectives). The degree of involvement has been assessed differently, but a common denominator is the goal to optimise the outcome of the relationship. Jin *et al.,* (2014) established five stages, the optimum being 'a long-term relationship'; Rapaccini *et al.,* (2013) defined their optimum as 'optimised' cooperation, while Coreynen *et al.,* (2018) focused on the degree to which the manufacturer had a planned outcome for each collaboration. While both Jin *et al.,* (2014) and Rapaccini *et al.,* (2013) focused on the type of role emphasised by Network Role, Coreynen *et al.,* (2018) focused on the manufacturers' ability to assess the relevance of cooperation. This study has adopted the latter, as it anticipates whether the manufacturer is indeed aware of its objectives for the potential collaboration.

Hence, the market reach construct is about how well the manufacturer identifies, operationalises and utilises the opportunities through suppliers and customers. Improving market reach means that the manufacturer has refined their ability to remain informed and to collaborate with suppliers and/or customers when relevant. Here, the important part is to measure how well the manufacturer taps into the market and their awareness of the opportunities within it. This involves both the development of remaining informed (e.g. knowing the needs of the customers), establishing valuable roles (e.g. encouraging customers to engage in a relationship with the manufacturer), and involving key partners when relevant (e.g. establishing specific objectives for each collaboration). Frederiksen Scientific (cFS), a case from Servitize.DK, sold physics and chemistry teaching equipment to the Danish public school (folkeskolen).[2] cFS strived to be more than an equipment provider and wanted to develop services that extended their solutions into the classrooms by providing teaching activities, sessions/workshops and online assignments based on cFS' own equipment to ease the teachers' work and to encourage the children's learning. To develop such solutions, key collaborators were identified (Network Involvement), and co-created content was developed through collaboration with national schools (Network role). Today, cFS has developed a community platform where teachers share, obtain and comment on content developed by cFS in collaboration with co-creators, or content developed by the user themselves (network stage). The ability of manufacturers to actually seize the opportunities identified (sensed) among the external partners is addressed in the service integration construct (see 2.3.1.6). This, as the service integration construct relates specifically to the ability of manufacturers to sense, seize and reconfigure their offering in general. The three components of market reach are believed to comprise the knowledge about partners, customers and markets within the SeMM literature. The fourth component presented in Table 20, Publication 3, is a combined component about network management with elements from both network stages, network roles and network involvement. As the three components were present within the combined component, these inputs have been segregated into the remaining three, as they did not provide additional insights. After discussions with the servitisation scholars, these three components were found sufficient to conceptualise the market reach construct.

[2] Case presentation by Frederiksen Scientific' CEO Torben Lynge Overgaard at a knowledge-sharing meeting in the Servitize.DK project group (25 November, 2021).

2.3.1.4 Organisational Governance

The construct of organisational governance is about how the manufacturers manage key internal assets, such as processes, policies, capabilities and resources. In this construct, servitisation presents manufacturers with new experiences and realities (Oliva & Kallenberg, 2003) such as:

> *the need to re-engineer new organisational structures to facilitate service design and delivery (new internal and external processes to fit service delivery routines), the accumulated organisational approach in managing servitisation processes and projects (Jin et al.,, 2014;Rapaccini et al.,, 2013), and the awareness on managing strategic choices by developing clear, implementable service management policies, process and resources (Tukker & Tischner, 2006).*

Paragraph from section 4.1 in Publication a.

The Organisational governance construct addresses the ability of manufacturers to build, integrate and align the organisation with the transformational properties from embarking on the servitisation journey. This consists of four components adopted from the existing SeMM literature identified through SLR2: process formalisation (Rapaccini *et al.,*, 2013;Wikström *et al.,*, 2009;Jin *et al.,*, 2014;Coreynen *et al.,*, 2018;Adrodegari & Saccani, 2020;Alvarez *et al.,*, 2015), policy formalisation (Wikström *et al.,*, 2009;Jin *et al.,*, 2014), capabilities (Lexutt, 2020;Coreynen *et al.,*, 2018;Adrodegari & Saccani, 2020) and resources (Rapaccini *et al.,*, 2013;Wikström *et al.,*, 2009;Adrodegari & Saccani, 2020).

- **Process formalisation** is about how specifically the organisational processes have been formalised. The degree of formalised processes has been well-established within the SeMM literature, and despite small differences have they all been assessed from informal processes to optimised or specialised processes (Alvarez *et al.,*, 2015;Jin *et al.,*, 2014;Rapaccini *et al.,*, 2013). For instance, Alvarez *et al.,* (2015, p. 1090) presented examples of informal processes as 'processes undocumented; tend to be driven in an ad hoc; uncontrolled and reactive manner', while the optimised processes are presented as 'all engaged in continuous improvement and refinement of processes'. Coreynen *et al.,* (2018) adopt this approach but frame the process formalisation as the ability to reconfigure the processes.
- **Policy formalisation** is about how specifically the organisational policies have been formalised. Similar to the process formalisation is the degree of policy formalisation depending on the level of optimised rules (Wikström *et al.,*, 2009). Jin *et al.,* (2014) presented the formal policies of the manufacturer as the 'standardised and formal rules' to govern processes, while Rapaccini *et al.,* (2013) refer to product policy, price policy, place policy and promotion policy. As a definition, this study adopts the understanding of policies to act as guidelines that dictates how processes and procedures should be carried out and could be seen as generic decisions (Eddy, 1990). The concept policy does not obtain much attention in the SeMM literature, whereby only a single indicator is incorporated to measure the formalisation of policies (og1).
- **The capability** component is about how developed the manufacturer's service-oriented capabilities are. As a concept, capabilities have been defined as a *'firm' capacity to deploy resources'* (Makadok, 2001). The capabilities have been treated differently in the SeMM literature and have been assessed as the degree of decentralisation of decision-making (Lexutt, 2020), employees' service-capabilities (Coreynen *et al.,*, 2018), formalisation of roles (Adrodegari & Saccani, 2020) and the awareness of skill requirement (Adrodegari & Saccani, 2020). While Coreynen *et al.,* (2018) present four employee capabilities, they relate to the kind of role that the employee undertakes to deploy a service (e.g. '*our*

employees serve customers as a trusted advisor'). Similarly, Adrodegari and Saccani (2020) have conceptualised ten specific employee capabilities. These were related to themes addressed within other constructs, such as digital integration with the 'capability to manage customer production process data', which are incorporated as the manufacturer's ability to integrate customer-related data (di3). Hence, to assess the development of capabilities in this construct, a more generic manner was preferred. To measure the capabilities in a more general manner, an indication of the standardised roles therefore seemed more accurate for this study. Instead, the degree of decentralised decision-making was included to assess employee participation and involvement. Hence, capabilities are measured as the degree of formalised roles and the degree of decisional freedom within these roles.

- '**Resources'** is about how prioritied and developed the service-oriented resources are within the manufacturer. Following the definition of firm resources by Barney (1991, p. 101), these include *'all assets, capabilities, organisational processes, firm attributes, information, knowledge, etc. controlled by a firm'*. This emphasises the broadness of resources. As such, many of the resources enabling servitisation have been incorporated in other constructs; for instance, digital integration with 'the integrated access to external data' (di2–di4), strategic management with 'empower employees' (sm6), or market reach with 'stay informed about partners' (mr3–mr4). This will be discussed further in section 2.3.2. Instead, this component focuses on the allocation of resources necessary to develop the service-oriented assets; hence, indicating the priority of resources by the manufacturer.

The organisational governance construct is about how well the manufacturer has organised and formalised the process, policies, capabilities and resources to strengthen the transformation. An improvement in organisational governance means that the manufacturer has refined how they organise service development and delivery. Process, policy and capabilities should be optimised and formalised, while the resources allow for better optimisation. The case study by Huikkola and Kohtamäki (2017) is a good example of this. In their analysis of nine leading industrial solution providers, they found that while single resources are rarely the source of competitive advantages, their exploitation leads to strategic capabilities through business processes like management systems, structures and organisational culture. Hence, associating the aspects of resources, capabilities, processes and policies of the firm, while also indicating an interrelationship between strategic management and organisational governance (will be discussed in 2.3.3). Keeping in mind that organisational governance is not about specific activities (e.g. capabilities and resources, as they are conceptualised in the other constructs), we believe that the four components represent the construct well. Despite the segregation of certain resources making it harder to interpret the true value of resources, we believe that the segregation of resources to the related constructs provides the best explanation of the nomological network.

2.3.1.5 Value Function Activities

> *One of the key aspects of value activities is placed in the value chain regarding the responsibility to support and service products throughout the product life cycle, along with finding an innovative way to make service more tradable with a functional cost structure (Spring & Araujo, 2013). Managing the value chain activities can therefore be challenging in the context of servitisation, which requires skills to be formed (OG), new partnerships to be created (MR), and wider sets of suppliers in both upstream and downstream directions, who must be managed effectively to leverage capabilities (Adrodegari et al.,, 2020;Cui et al.,, 2019). Our literature review on servitisation maturity uncovered a wide agreement regarding the assessment of business model components to support servitisation – particularly in terms of managing the value chain activities (Adrodegari et al.,, 2020).*

Paragraph from section 4.1 in Publication a.

The value function construct addresses the ability of manufacturers to embrace servitisation by developing new business model(s) capable of creating and capturing value (Baines & Lightfoot, 2014). This consists of three components adopted from the existing SeMM literature identified through SLR2: value creation (Cui *et al.,*, 2019), pricing (Cui *et al.,*, 2019), and cost structure (Lexutt, 2020); hence, being about providing and capturing value within the business model.

- **Value creation** is about how well the manufacturer meets customer requirements. This was established by Cui *et al.,* (2019), who conceptualised a four-stage assessment from 'meet basic customer requirements' to 'provide a performance-based solution'. The latter seeks to improve the operational performance of the physical product in relation to customer needs; hence, allowing the manufacturer to sell the performance of the solution instead of being limited to the physical good.
- **Pricing** or revenue modelling is about the degree to which the pricing scheme is customised for the individual customer. Pricing has been a specific topic in servitisation, and the introduction of novel pricing schemes has innovated the business models; for instance, power-by-the-hour by Rolls Royce (Smith, 2013) or the more generic pay-per-use (Gebauer *et al.,*, 2017). A range of diverse pricing schemes have been developed in recent years, which reflects a change in the transition of the product ownership but also a stream of customised pricing (Kindström & Kowalkowski, 2014). For the same reason, Cui *et al.,* (2019) argue that the degree of customised pricing schemes should be related to the maturity of servitisation.
- **Cost structure** is about how well the manufacturer manages the financial risks and uncertainties. Changing the cost structure means that the manufacturer undertakes some of the risks and uncertainties previously held by the customer (Leoni, 2019). Furthermore, Kindström and Kowalkowski (2014) argue that the more the manufacturer offers customised solutions, the greater the complexity and risk. It is therefore crucial for the financial success of servitisation that manufacturers are aware of potential risks and uncertainties.

Hence, the value function construct is about how the manufacturer and customer capture the value of servitisation, and how well the manufacturer manages the potential risks associated with the transformation. Improving the value function means that the manufacturer has refined the value capturing of their solutions, ultimately providing the opportunities for their customers to only buy the performance of a good instead of the physical good itself. This allows the manufacturer to develop more customised revenue models but also means that they must monitor their risks and uncertainty related to this progress. Stenhøj Hydraulik (cSH), a case

from Servitize.DK, is a very good example of this transformation. cSH produced and sold hydraulic presses and gates for business-to-business and wished to increase their captured value per sold unit. To do so, they acquired a service specialist to develop entirely new business models with a specific focus on value capturing and customised value propositions through service solutions.[3] Here, cSH improved their value function by developing customised offerings, accommodating the needs of the individual customer with individual pricing schemes. We believe that value creation, pricing and cost structure are suitable components for the value function construct.

2.3.1.6 Service Integration

The service integration construct is seen as the accumulation of the role of service among the other constructs in the nomological network.

> *Here, we understand the combination of data appliance, service infrastructure and process- and policy formalisation as means for the use of digital technology to provide new value creation and revenue-generating opportunities (Vendrell-Herrero et al.,, 2017), which echoes the notion that the capture of strategic customer data is a necessary but not sufficient condition for servitisation when considered by itself (Ulaga & Reinartz, 2011).*

Paragraph from section 4.1 in Publication a.

The service integration construct addresses the ability of manufacturers to utilise internal assets (e.g. data, service infrastructure, processes) to develop new, optimised service solutions. This consists of three components adopted from the existing SeMM literature identified through SLR2: sensing (Coreynen *et al.,*, 2018), seizing (Coreynen *et al.,*, 2018), and service infrastructure (Coreynen *et al.,*, 2018;Alvarez *et al.,*, 2015;Li *et al.,*, 2013). These three components are highly inspired by dynamic capability theory (Fischer *et al.,*, 2010) and reflect the capability of sensing service opportunities, seizing service opportunities and maintaining service competitiveness through enhancing, combining, protecting and reconfiguring (Coreynen *et al.,*, 2018). Although these are all capabilities, they have been conceptualised as a separate construct, the common theme being how well the manufacturers are coping with the service opportunities.

- **Sensing** is about seeing or noticing the service opportunities. The terms sensing and seizing are introduced in SeMMs by Coreynen *et al.,* (2018), who adopt the notion from the theory of dynamic capabilities. The ability to sense service opportunities is, then, about seeing the potential and threats in the service-oriented business (Fischer *et al.,*, 2010).
- **Seizing** is about utilising service opportunities and refers to the formulation of a strategic response when an opportunity presents itself (Fischer *et al.,*, 2010); hence, the manufacturer being able to transform a service opportunity into a commercialised new service (Coreynen *et al.,*, 2018).
- **Service infrastructure** is about the flexibility or ability to reconfigure the infrastructure to deliver the service opportunity while maintaining high quality. Coreynen *et al.,* (2018) suggested this component as the mass service customisation that reflected the ability of manufacturers to configure the service offerings due to new opportunities. Li *et al.,* (2013) provided a somewhat similar notion but focused more on the development of an optimised, fixed infrastructure able to deliver a variety of services and not necessarily being

[3] Servitize.DK workshop at Stenhøj Hydraulik with Service Manager Philip Toftegaard Christensen, case presentation by BM Silo CEO Dorthe Zacho Martinsen at a knowledge-sharing meeting in the Servitize.DK project group (7 February, 2020).

reconfigured. This component addresses the ability to reconfigure the infrastructure to respond to the service opportunities.

Hence, the service integration construct is about how well the manufacturer can sense, seize and reconfigure their infrastructure to be able to deliver a new service without hampering performance. Adopting the thinking of dynamic capabilities to represent the ability of manufacturers to realise and harness service opportunities is believed to comply with the scope of this construct. In continuation of the Frederiksen Scientific case (cFS) presented in 2.3.1.3, the introduction of digitalisation permits the company to *sense* the needs of their customers through the commentary function in the digital platform. These needs were further *seized* through community engagement and/or by the co-creation of new content together with the customers.[4] This construct could have been an integrated part of the organisational governance but was separated, as the ability to integrate services into the business model is perceived as a crucial element in servitisation success (Fischer *et al.,*, 2010).

Common for all six dimensions is that additional indicators would shed light on other important aspects of the constructs and their underlying components. As discussed in Publications 1 and 3, however, increasing the number of items would have a negative impact on the response rate (Sahlqvist *et al.,*, 2011). Therefore, the focus in both Publications 1 and 3 has only been to adopt key aspects of each construct, which have previously been introduced in the SeMM literature. This, as the PhD seeks to consolidate the existence of prior SeMMs in a multidimensional perspective. Hence, potentially excluding relevant theoretical areas of (e.g.) the degree of smart solutions implemented in the digital integration construct.

2.3.2 Specifying the law of observable relations

To establish the interrelationships between the six dimensions and towards servitisation success, each dimension must be approximated on associated indicators or observable variables, as defined by Cronbach and Meehl (1955). The composition of corresponding indicators must cover the most important aspects of the associated dimension, as they define the dimensions assessed in the model (Hair *et al.,*, 2017b). In other words, uncovered aspects of a dimension lead to an insufficient approximation. As Figure 3 illustrates, the identification of the measurement model is highly necessary to develop a proper SeMM. However, following the fourth principle of the nomological networks (Cronbach & Meehl, 1955); a nomological network is extended as the field learns more about a theoretical concept (i.e. servitisation), which has been enriched continuously in this PhD by extending the net through the lessons in Publications 1 and 2 (principle five). As discussed in section 2.4, very few SeMM indicators have previously been statistically validated (see Publication 3, Table 20). For this reason, the identification and formulation of proper indicators for each of the six dimensions have had a particular focus in Publications 1 and 3. The lessons from Publication 1 and feedback from the servitisation community led to adjustments of the incorporated indicators for Publication 3. These lessons are presented in section 4.1.1, while the identification of the indicators is presented in Publications 1 and 3. However, the law of observable relations will be elaborated in the following on the basis of the final model from Publication 3. With respect to the empirical meaning of the nomological network, as emphasised by Bagozzi (2011), the association of the observable variables to the constructs has been described in this section. To specify the law of

[4] Case presentation by Frederiksen Scientific' CEO Torben Lynge Overgaard at a knowledge-sharing meeting in the Servitize.DK project group (25 November, 2021).

association between the observable variables and the constructs, two fundamental elements must be established: Firstly, the conceptual definitions of the underlying constructs (which have been elaborated in 2.3.1); and secondly, the measurement mode of the model, as it reflects how the indicators should be related to the constructs and to each other. As will be discussed further in section 3.7.3 and in Publications 1 and 3, the measurement model follows a reflective mode requiring reflective indicators.

The reflective indicators must be theoretically related, as they are represented by the construct (Hoyle, 2012, p. 119;Becker *et al.,*, 2012, p. 362), meaning that the causality runs from the construct to the observable variable (Hair *et al.,*, 2017b, p. 47); that is, they are interchangeable. The components presented in section 2.3 are inspired by the existing indicators and constructs found in the SeMM literature. Thus, these components place emphasis on representing the maturity of servitisation, as we have adopted the underlying conceptualisation of maturity from these constructs; for instance, the reasoning that increased performance constitute a higher maturity of the manufacturer (Coreynen *et al.,*, 2018). Translated into the PLS-SEM context, this means that an increase in a construct (i.e. improved maturity of SI) affects the outcome of the indicators, as they are represented by the construct. In other words, an increased maturity of digital integration would result in improved appliance and accessibility. Contrary to the formative indicators, which constitute a unique aspect of a construct, the reflective indicators must represent the effect of the related theoretical aspects of the associated construct (Hoyle, 2012, p. 119). This means that the indicators must be theoretically related or, as stated by (Peterson & Zimmerman, 2004, p. 139), relevant observable variables that represent the basic features of the construct.
Keeping this in mind, the indicators have been associated with their relevant constructs, which also includes determining the relatability of the indicators. The indicators identified during SLR2 were all categorised according to the 18 components of the six constructs to establish their individual associations to the constructs (see Publication 3, Table 20). Due to the adoption of existing components and indicators, some of these associations were formed intuitively by following the original association suggested by the related study; for instance, the indicator adopted from Neff *et al.,* (2014) for the digital integration construct about automated and optimised technologies, which is related to the technology appliance (di1), or the indicator adopted from Alvarez *et al.,* (2015) for the organisational governance construct regarding the degree of formalised and optimised processes (og3), which is directly about the process formalisation. Other indicator associations required more theoretical considerations, such as whether the indicator (Coreynen *et al.,*, 2018) regarding the ability to identify customer needs is related to sensing in the service integration construct or the network stage in the market reach construct, which relates to the identification of external partners' needs. The latter was associated to sensing, as it is about recognising customer needs (sometimes intangible needs), whereas the network stage is more about staying informed about the customers' (tangible) objectives. These further considerations typically emerged when indicators had been rephrased or reformatted, or if the literature disagreed regarding their conceptual affiliation. For the latter, the theoretical reasoning of the indicator's association to the construct has been outlined in Table 2. For the former, the research team developed a typology for indicating the degree of adoption; 'adopted' means using the exact same item as proposed; 'adapted' refers to using the exact same item, but with slightly different phrasing or reformatting adjustments; and 'inspired' means developing a new item based on the same theoretical reasoning as proposed. This typology has been used in Table 2 and in Publication 3, Table 21.
The association procedure was continued with a linguistic pilot test together with backward and forward translations, which reformulated some items. This is elaborated in section 4.1 of Publication 3.

Digital Integration (DI)			**Association** (and reasoning)	**Implications** (and limitations)
Appliance	di1	*Our technology allows fully automated and optimised real-time data*	appliance was represented by two SeMMs, which interpreted the appliance of technologies from different angles. While Jin *et al.,* (2014) assessed the presence of technology related to knowledge management, Neff *et al.,* (2014) undertook a more general approach, assessing the degree of automated and optimised data collection. The degree of automation interprets the degree of technological advancement. It was adopted to assess the appliance of technology. No other association was considered.	The items measure the degree of automated and optimised real-time data in the organisation. Hence, an improvement in this indicator means that the manufacturer has refined their data-collecting technology in general (without specific technologies or settings in mind).
Accessibility	di2	[Our IT systems] give us integrated access to value-chain-related data.	Accessibility was adopted directly from Coreynen *et al.,* (2018), who prescribed it in terms of digitalisation and assessed it according to four items. Three items were adopted related to the external data points (customer-, market- and order-related data). No other construct association was considered, as they are originally theorised as being about the degree of digitalisation.	The items measure the degree of access to data related to specific areas of the business. Hence, an improvement in di2, di3 and di4 means that the manufacturer has refined their accessibility to data.
	di3	… give us integrated access to customer-related data		
	di4	… give us integrated access to market-related data		
Strategic Management (SM)				
Managerial behaviour	sm5	Our management coaches employees to behave in a service-oriented manner and sets rewards for service-oriented employee behaviours	Indicators sm5, sm6 and sm7 are directly adopted from Coreynen *et al.,* (2018), who specify three items measuring the 'the service orientation of management behaviour' (hence, these are theoretically associated to the managerial behaviour in strategic management). For this reason, no other construct associations are considered, as they are originally theorised to measure this specific construct (Coreynen *et al.*,, 2018).	The item measures the degree to which managers teach and reward their employees to behave in a service-oriented manner.
	sm6	Our management empowers employees to respond to a broad range of customer problems		The item measures the degree to which employees are allowed to tackle customer problems as they find best suited. This implies a focus on the flexibility of service-solutions, while the similar item (decentralisation) in organisational governance is about who makes decisions in general. An improvement in sm6 means that the employees are allowed to evolve suitable solutions to customer needs.
	sm7	Our management supports employees in solving customer problems		The item measures the degree to which the managers support the employees in the problem-solving process.
Management commitment	sm2	Our organisation pays close attention to service implementation	Lexutt (2020) emphasised the importance of management commitment in terms of i.a. committing resources and attention for service implementation. As previously discussed, the allocation of resources has been treated in the component of resources in organisational governance, whereas the allocation of managerial attention has been adopted as an indication of management commitment. No other associations were considered.	The item assesses the degree of attention that the managers place on service implementation. An improvement in this indicator means increased attention (i.e. commitment) towards services. Limitation: the item has been formulated incorrectly in Publication 3, as it should have been formulated as 'our management'.
	sm4	Our management sees services as a way to compensate for fluctuating product sales		The item assesses the degree of management service valuation in terms of stabilising market fluctuations. An improvement in this

			The service orientation of management is conceptualised by Coreynen *et al.,* (2018) as specifying how management values services. Three of these have been adopted directly to assess the values of the management. Following the idea developed by Adrodegari and Saccani (2020), management commitment is derived by driving change and establishing a service culture, which is led i.a. by the management orientation and values (Gebauer & Friedli, 2005). For this reason, the items suggested by Coreynen *et al.,* (2018) have been adopted as items (sm4, sm8, sm10) for assessing management commitment. No other associations were considered.	indicator means that the management has refined their appreciation of services.
	sm8	Our management aims to exploit the financial potential of services		The item assesses the degree to which management is willing to change the orientation towards services through execution. An improvement in this indicator means that management has refined their willingness to execute on services.
	sm10	Our management considers the service potential to be highly profitable		The item assesses the degree of management valuation of services in terms of profitability. An improvement in this indicator means that management has refined their appreciation of services.
	sm9	Our organisation is able to formulate clear service-related strategies and objectives	Lexutt (2020) stresses the importance of managerial commitment as crucial to servitisation success, with emphasis on the ability of management to set clear service-related strategies and objectives – to reflect the managerial priorities as well as to establish the normative pressures on employees (Gebauer *et al.,*, 2010). Hence, this item was adopted from Lexutt (2020), with no other construct associations considered.	The item assesses the ability of the organisation to formulate clear strategies and objectives. An improvement in this indicator means that the organisation has refined their formulation and consistency in stating service-related goals. Limitation: the item has been formulated incorrectly, as it should have been stated as 'our management'.
Culture	sm1	The strategic development of our organisation has mainly been led by a… [goods-centric – business-oriented]	The strategic orientation of a company is proven to change the organisational mindset and culture (Kindström & Kowalkowski, 2014) and is emphasised as an important aspect of the servitisation transformation (Fang *et al.,*, 2008). Wikström *et al.,* (2009) conceptualised items for this aspect and derived it from the change in orientation from a good-oriented towards a business-dominant orientation. Inspired by Wikström *et al.,* (2009), sm1 was developed to assess the organisational mindset. Based on the arguments from Kindström and Kowalkowski (2014) and Fang *et al.,* (2008); no other associations were considered.	The item assesses the orientation of the organisation, with the 'good-oriented' as the worst orientation, and 'business-dominant' as the best in the context of servitisation. An improvement in this indicator means that the organisational mindset has changed towards a more service-minded orientation. The scale follows the 7-point Likert scale and was developed in collaboration with experts from the University of Cambridge (see Publication 3)
	sm3	Our organisation recognises services as a lasting differentiation strategy	This item is an adapted and rephrased version of a management value item from the study by Coreynen *et al.,* (2018). In line with the sm1 reasoning, this item frames the organisational mindset to identify the cultural value of services. No other associations were considered.	The item assesses the degree to which the organisation (i.e. employees) recognises services as valuable. An improvement in this indicator means that the organisational opinion of services is optimistic and relevant.
Market Reach (MR)				
Network Stage	mr3	Our organisation remains informed about the goals, potentials and strategies of our customers	Items mr3 and mr4 have been adapted from Coreynen *et al.,* (2018) and segmented into customer and supplier perspectives, respectively, as discussed in section 2.3.1.3. No other associations were considered.	This item measures how well the organisation stays informed about its customers and suppliers. An improvement in this indicator means that the organisation has refined their information level regarding the customers and suppliers.
	mr4	Our organisation remains informed about the goals, potentials and strategies of our suppliers		

Network Role	mr5	Our organisation regularly discusses with our customers how we can support one another in our success	Items mr5 and mr6 have been adapted from Coreynen *et al.,* (2018) and segmented into customer and supplier perspectives, respectively, as discussed in section 2.3.1.3. No other associations were considered.	This item measures the degree to which the organisation sustains a dialogue of potential collaboration with customers and suppliers. An improvement in this indicator means that the organisation has refined its ability to develop and maintain a continuous dialogue with its customers and suppliers.
	mr6	Our organisation determines in advance possible suppliers with whom to discuss the building of relationships		
Network Involvement	mr1	Our organisation analyses what we would like to achieve with each customer	Items mr1 and mr2 have been adapted from Coreynen *et al.,* (2018) and segmented into customer and supplier perspectives, respectively, as discussed in section 2.3.1.3. No other associations were considered.	This item measures the degree to which the organisation is able to identify potential objectives with each customer and supplier. An improvement in this indicator means that the organisation has refined its ability to scan for and choose among opportunities.
	mr2	Our organisation analyses what we would like to achieve with each supplier		
Organisational Governance (OG)				
Process formalisation	og3	Our organisation has ensured a formal, optimised process for service delivery	The degree of optimised processes was proposed by Alvarez *et al.,* (2015) as a continuous improved and formalised process. This was in line with the concept by Rapaccini *et al.,* (2013), who emphasised the optimisation of service processes as crucial. Both studies proposed similar items for assessing the process formalisation, but this study has adopted it from Rapaccini *et al.,* (2013). No other association was considered, as the emphasis in the literature is perceived as convincing.	This item measures to what degree the organisation has implemented formal and optimised service processes. An improvement in this indicator means that the organisation has refined their formalised processes.
	og6	Our organisation is able to turn service activities into a professional business	Items og6, og7, og9 and og10 have been adopted from Coreynen *et al.,* (2018), who originally proposed them to assess the ability of manufacturers to reconfigure processes. In this study, however, these items are used to assess the degree to which the organisation has incorporated processes to configure their settings. This overlaps with the reconfiguration, which has been conceptualised in service integration as component service infrastructure. However, the aim of service infrastructure is to establish whether the organisation can reconfigure without compromising on quality, whereas the aim here is to establish the degree to which such processes are established (i.e. formalised). The degree of professional services (og6), the degree of profitable services (og7) and minimising costs all tap into this perspective on whether necessary processes are established. The degree of resistance (og10) is about whether the organisation can overcome employee resistance to change, which is affected by how employees value services. Then pointing at strategic management as the proper construct. However, Lenka *et al.,* (2018) emphasise how organisational resistance emanates from i.a. ambiguous processes, a lack of capabilities and ineffective incentives. For this reason, the ability of the organisation to overcome resistance has been associated with the organisational governance.	This item measures the degree to which the organisation is able to turn services into professional businesses. An improvement in this indicator means that this ability has been refined.
	og7	Our organisation is able to turn service activities into a profitable business (whereby services are either embedded in product prices or charged separately)		This item measures the degree to which the organisation is able to turn services into profitable businesses. An improvement in this indicator means that this ability has been refined.
	og9	Our organisation has procedures and routines to minimise costs related to new service activities		This item measures the degree to which the organisation has established processes that ensure the cost-efficiency of new services. An improvement in this indicator means that their process of identifying cost reductions has been refined.
	og10	Our organisation can overcome internal resistance and conflicts		This item measures the degree to which the organisation is able to overcome resistance. An improvement in this indicator means that the organisation is refining its ability to overcome such resistance. Limitation: while this only measures the degree of managing the resistance, no information on what kind of resistance, what triggered the resistance, nor what reduced the resistance is specified. However, this has been established to be sufficient for the scope of this work.

Policy	og1	Our organisation is currently following service-specific policies that are…	This item has been inspired by Jin *et al.,* (2014), who proposed the assessment of systematic behaviour identified as competency to use standardised and formal rules. Hence, the ability of organisations to establish and enforce policies. The scale anchor is developed on seven prescriptive levels of formalisation adopted from Rapaccini *et al.,* (2013). No other associations were considered.	This item measures the level of formalised policies specified towards services. An improvement in this indicator means that the organisation has refined the level of standardisation and detail of their rules stemming from policies ranging from the informal to the optimised.
Resources	og2	The allocation of monetary resources to the development of service-oriented skills, tools and/or methods are…	This item has been inspired by Rapaccini *et al.,* (2013) and Jin *et al.,* (2014), both of whom emphasised the allocation of monetary resources towards developing new service-related assets, competences and capabilities as being a crucial element of resource. No other associations were considered.	This item measures how optimised the allocation of monetary resources is within the organisation. An improvement in this indicator means that the organisation has refined their ability to allocate monetary resources.
	og5	Our organisation encourages employees to prioritise business development over product development	This item has been adopted from Wikström *et al.,* (2009), who stated that the focus that the employees are encouraged to take by management influences the allocation of time to specific areas. Wikström *et al.,* (2009) assess this emphasis on the level of orientation that the employees were encouraged to take; i.e. from product development, to customer knowledge and finally to business development. Business development is considered the optimal outcome, as it emphasises being more organised around natural flows with co-creation activities embedded (Wikström *et al.,*, 2009). This optimum has been used as the frame for this item. No other associations were considered.	This item measures the degree to which the employees are encouraged to allocate their time to business development. An improvement in this indicator means that the organisation has refined their emphasis on business development rather than product development.
Capabilities	og4	Our organisation is currently following organisational roles that are…	This item has been adapted from Adrodegari and Saccani (2020), who specified the degree of formalised roles as an organisational capability. This reasoning was adopted from Rapaccini *et al.,* (2013), who also assessed capabilities in terms of 'no formal roles' towards 'optimised roles'. These anchors have been adopted for this item as well. No other construct associations were considered for this item, although a discussion of whether it is a resource (as it can be seen as human resources within specific areas) or a capability (as it relates to the definition and specification of activities). The latter was chosen, however, as Adrodegari and Saccani (2020) emphasise that these roles (when optimal) are 'responsible for specific service categories'; hence, highlighting a capability	This item measures the degree of formalised roles by presenting seven prescriptive levels of formalisation. An improvement in this indicator means that the formality and prescriptions of the roles have been refined.
	og8	Our management encourages employees to take decisions on their own	The degree of decentralisation was adopted from Lexutt (2020), who specified it as the degree to which the employees were allowed to take decisions. This item was included to assess employee participation and involvement in continuation of their roles. No other associations were considered.	This item measures the degree to which the employees are allowed to participate in the decision-making. An improvement in this indicator means that the decision-making has been more decentralised (moving from top management towards the employee).

Value Function (VF)				
Value	vf1	Our organisation is able to provide a performance-based solution that guarantees the operational performance of the product	This item has been inspired by Cui *et al.,* (2019), who specified the maturity modelling from a business model perspective. Here, the value proposition was estimated as four stages with the performance-based solutions as the optimal setting. Due to the alignment of the business model perspective, this item has been associated with value function. No other associations were considered.	This item measures the ability of organisations to deliver the optimum of value proposition (performance-based solutions according to Cui *et al.,* (2019)) An improvement in this indicator means that the organisation has refined the advancement of their offerings.
Pricing	vf2	Our organisation is able to provide customised cost structures for our customers	This item has been inspired by Cui *et al.,* (2019), who specified the revenue and profit modelling as the degree of customised pricing, which is also emphasised by Gebauer *et al.,* (2017). Due to the alignment of the business model perspective, this item has been associated with value function. No other associations were considered.	This item measures the degree of customisable pricing schemes. An improvement in this indicator means that the organisation has refined their ability to customise the prices for each customer based on their needs.
Cost structure	vf3	Our organisation evaluates the operating and financial risks while continuously managing uncertainty	Uncertainty and financial risks arise as the customised pricing schemes are developed (Leoni, 2019). Due to this effect, the item has been associated with value function. Furthermore, Cui *et al.,* (2019) emphasised that such operating and financial risks and uncertainties must be managed continuously to ensure a proper transformation. This further strengthens the inclusion of vf3, as inspired by the maturity discussion in Cui *et al.,* (2019). No other associations were considered.	This item measures the degree to which the organisation is able to manage uncertainty and potential risks. An improvement in this indicator means that the organisation has refined its ability to do so.
Service Integration (SI)				
Sensing	si1	Our organisation can easily observe and identify customers' needs	This item is inspired by Coreynen *et al.,* (2018), who introduced four items for assessing sensing service opportunities and threats with emphasis on identifying, observing and reacting. While reacting is more related to seizing, this study combined identifying and observing into a single item in. Moreover, only the customer perspective was integrated. No other associations were considered.	This item measures to what degree the organisation can identify potential customer needs. An improvement in this indicator means that the organisation has refined their ability to sense new opportunities among their customers. Limitation: as this item only possess the perspective of customers, potential opportunities within the suppliers or competitors are not incorporated.
Seizing	si2	Our organisation has the capacity to commercialise new services and communicate changes to the customer	This item has been adopted directly from Coreynen *et al.,* (2018), as they are related to the ability of the organisation to seize service opportunities. No other associations were considered	This item measures the organisations' ability to seize service opportunities when identified. An improvement in this indicator means that the organisation has refined its ability to commercialise new service opportunities.
Service infrastructure	si3	Our organisation can adjust our process design according to customer demand without significantly increasing costs	Items si3, si4, si5 and si6 have been adopted directly from Coreynen *et al.,* (2018), as they are related to the ability of the organisation to reconfigure the service infrastructure without compromising on quality in terms of increasing costs (si3 and si5) or sacrificing quality (si4) while maintaining high volume (si6). No other associations were considered.	This item measures the ability of the organisations to adjust existing processes without increasing the cost significantly. An improvement in this indicator means that the organisation has refined their processes to be flexible and adaptable.
	si4	Our organisation can add product-service variety without sacrificing quality		This item measures the ability of the organisations to add a variety of solutions to the customer without reducing the experienced quality. An improvement in this indicator means that the organisation has refined their offerings to become customisable.

	si5 Our organisation can easily add significant product-service variety without increasing costs		This item measures the ability of the organisations to add a variety of solutions to the customer without increasing the cost. An improvement in this indicator means that the organisation has refined their offerings to stay flexible.
	si6 Our organisation can customise product services while maintaining high volume		This item measures the ability of the organisations to customise their solutions for the customer while maintaining high volume. An improvement in this indicator means that the organisation has refined their offerings to become customisable.

Table 2: The laws of indicator association with constructs

2.3.3 Specifying the law of interrelationships among dimensions

The law of the interrelationships between the six constructs is based on theoretical reasoning and will be presented in the following as interrelationships A to G.

The structural consideration of which constructs antecede each other is discussed briefly here. Each construct is believed to comprise a separate concept within servitisation. They exist individually but are influencing and influenced by other constructs within the theory. SLR1 was used to map the order of the constructs by identifying arguments or theoretical discussions that insinuated or directly investigated the link between two constructs (e.g. digitalisation). Digitalisation is widely seen within the servitisation literature as an enabler for implementation (Ntanos *et al.,*, 2018;Lenka *et al.,*, 2017). As such, one can argue that digital integration is an antecedent for core elements of market reach, service integration and organisational governance. For instance, sensing in service integration as digitalisation directly influences the ability to collect, analyse and forecast potential possibilities; network stage in market reach as digitalisation is directly influencing the ability of a company to stay informed about key partners; and resource in organisational governance, as IT systems help companies to forecast and manage their resources through, for example, ERP systems. For this reason, it is hardly surprising that digital integration obtains several interrelationships among other constructs. For an interrelationship to be considered for the mapping, several theoretical arguments had to be in place. These were judged according to the amount of literature emphasising a relation, or (if recently published) the reputation of the author and/or journal within servitisation. Hence, following the structural practice of SEM (reading the model from left to right; (Hair *et al.,*, 2017b, p. 14)), the lower constructs (to the left) were not sufficiently influenced by others (independent), but did sufficiently influence the higher constructs (to the right); hence, being the lowest constructs. The highest (farthest to the right) were not influencing other constructs sufficiently (other than servitisation success), but were sufficiently influenced by lower constructs (dependent). The middle constructs were both sufficiently influenced and influencing the model (intermediary). While these interrelationships will be presented in Publications 1 and 3 as the hypothesis of each model, a short exemplification with key theoretical arguments is presented below.

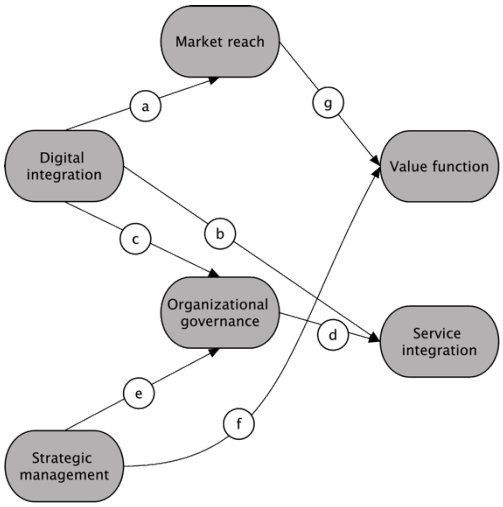

Figure 4: Nomological network

A) Digital integration towards market reach

The interrelationship between digital integration and market reach has been well established in the literature, as technology is seen as an effective approach to integrating customers and external partners (Pal, 2016). Frederiksen Scientific (presented in 2.3.1.3) achieved customer integration by establishing an online digital platform, which ultimately became a community platform for their subscribers.[5]

Key theoretical arguments for this interrelationship are that:

[5] Case presentation by Frederiksen Scientific CEO Torben Lynge Overgaard at a knowledge-sharing meeting in the Servitize.DK project group (25 November, 2021).

- Digitalisation increases the network involvement and value co-creation (Lenka *et al.,*, 2017), enabling a deeper integration of customer processes (Coreynen *et al.,*, 2017;Hullova *et al.,*, 2019;Grieger & Ludwig, 2019;Finne *et al.,*, 2013).
- Digitalisation influences how the firms interact with external partners and customers (Gebauer *et al.,*, 2017;Lenka *et al.,*, 2017;Baines *et al.,*, 2009a).
- Digitalisation enables more accurate information sharing within and outside the organisation (Kindström & Kowalkowski, 2014).

B) Digital integration towards service integration

In line with interrelationship A, the interrelationship between digital integration and service integration is well established in the literature, as technology is seen as an effective approach to sensing and seizing the opportunities (Gebauer *et al.,*, 2017). In our case, the digital platform allowed Frederiksen Scientific to *sense* the needs of their customers through the feedback system; these needs were then *seized* through community engagement and/or by co-creating new content together with the customers.[6]

Additional key theoretical arguments for this interrelationship are that:

- Digital technologies and appliance create new opportunities and are understood as core enablers and drivers for servitisation (Sjödin *et al.,*, 2020;Simonsson *et al.,*, 2020).
- Digitalisation is seen as essential for effective delivery by optimising the service infrastructure and processes (Reim *et al.,*, 2019).
- Digital advancement can play an important role in enabling service provision (Jagstedt, 2019).

C) Digital integration towards organisational governance

In line with A and B, the interrelationship between digital integration and organisational governance is well established through the literature, as technology is seen as an effective approach to developing new capabilities and resources (Sjödin *et al.,*, 2020), to incorporate external capabilities (Story *et al.,*, 2017), and to optimise internal procedures and processes (Robinson *et al.,*, 2016). The integrated robotics in the BM Silo production line (presented in 2.3.1.1) offers a good example of how the integration of digital equipment has a positive impact on organisational governance;[7] particularly in terms of formalised processes and capabilities within the firm.

Key theoretical arguments for this interrelationship are that:

- Digitalisation enables the better allocation of resources and more accurate information-sharing within the firm (Kindström & Kowalkowski, 2014;Eloranta & Turunen, 2016).
- Digitalisation enables new optimised procedures and processes within the organisation (Pal, 2016;Robinson *et al.,*, 2016;Valtakoski & Witell, 2018;Reim *et al.,*, 2019).

D) Organisational governance towards service integration

The case study by Kanninen *et al.,* (2017) investigated dynamic capabilities related to servitisation with emphasis on the challenges occurring in the transformation. Through the 14 companies, they i.a. identified how the reliance on the flexible allocation of qualified resources for service provision was important for sensing, seizing, and especially

[6] Case presentation by Frederiksen Scientific CEO Torben Lynge Overgaard at a knowledge-sharing meeting in the Servitize.DK project group (25 November, 2021).

[7] Case presentation by BM Silo CEO Dorthe Zacho Martinsen at a knowledge-sharing meeting in the Servitize.DK project group (7 February, 2020).

reconfiguring the infrastructure. Hence, the formalisation of allocation procedures has a positive influence on the service integration.

This is in line with other key theoretical arguments for this interrelationship:

- The degree of formalised procedures and processes have been seen as progressions of servitisation, as they ensure consistency and quality (Jin *et al.,*, 2014;Beltagui, 2018).
- Service integration consists of the ability of the firm to seize service opportunity (Coreynen *et al.,*, 2018), as well-developed processes, capabilities and available resources directly influence the service infrastructure.
- Accordingly, the ability of the firm to build, integrate and align organisational processes and policies is crucial for the efficient transformation of the service infrastructure (Baines *et al.,*, 2009b;Sakyi-Gyinae & Holmlund, 2018;Adrodegari & Saccani, 2020).

E) Strategic management towards organisational governance

The case study by Huikkola and Kohtamäki (2017) is a good example of this interrelationship between strategic management and organisational governance. In their study, they argue that while single resources are rarely the source of competitive advantages, their exploitation leads to strategic capabilities through management systems, structures and organisational culture. They argue further that this is influenced by 'how disciplined the solution provider applies them [business processes] in their daily business operation' (Huikkola & Kohtamäki, 2017, p. 759). Thus, pointing at both the organisational culture and the managerial encouragement, commitment and in general behaviour towards services in their daily work, which are key parts of strategic management. Additionally, Gebauer and Fleisch (2007) emphasise how 'higher managerial commitment to services will lead to higher investments', as stated by Lexutt (2020); hence an increase in resource allocation.

Additional key theoretical arguments for this interrelationship are that:

- The organisational resistance can hinder the transition to services, whereas the strategic management of the organisational culture and leadership from an early state is important (Lenka *et al.,*, 2018).
- The managerial mindset and commitment influence the long-term resource focus (Crowley *et al.,*, 2018) and resource investment in the service business (Gebauer & Fleisch, 2007).

F) Strategic management towards value function

As emphasised by Gebauer and Friedli (2005), the service orientation of managers has a positive influence on the development and maintenance of service businesses (i.e. value function). Furthermore, Antioco *et al.,* (2008) identify that management commitment to services has a direct effect on the creation of service volume, as also emphasised by Lexutt (2020). Hence, a managerial behaviour that fosters service orientation has a positive influence on the volume/development of services and the maintenance of existing ones.

Further key theoretical arguments for this interrelationship are that:

- The managerial commitment poses a fundamental role in maintaining and building transition strategies (Baines *et al.,*, 2009a;Neff *et al.,*, 2014).
- The managerial mindset (customer-centric) facilitates better value propositions through customer integration, hence leading to new value creation and optimised cost structures (Huikkola *et al.,*, 2016;Liu *et al.,*, 2014).
- The fundamental shift in the organisational culture acts accommodates the service provision (Baines *et al.,*, 2009a;Lütjen *et al.,*, 2019).

G) Market reach towards value function

Market reach was an important part of the transformation for Frederiksen Scientific: The focus on developing the role of the customer by integrating them into the co-creation of their platform content is influencing the cFS value proposition positively. Furthermore, the platform allows cFS to stay informed about customers, which enables performance-based solutions to further enhance the value proposition. The CEO also described how the customers are able to subscribe to various schemes based on the degree of available content.[8] This phenomenon is also presented by Heinis *et al.,* (2018), who investigated how case firms assembled pricing schemes in collaboration with their customers increased the integration of collaboration.

Additional key theoretical arguments for this interrelationship are that:

- Co-creation and solution development are enabled by integrating customer needs (Lenka *et al.,*, 2017) and utilising the network capabilities (Coreynen *et al.,*, 2017).
- The respective roles of customers and network partners play an important role in the value co-creation (Rapaccini *et al.,*, 2013;Oliveira & Azevedo, 2018).

2.4 The servitisation maturity modelling

Maturity models were first defined by the Project Management Institute (Fahrenkrog *et al.,*, 2003) as a reference that guides firms towards a reliable and sustainable outcome. More recently, Adrodegari and Saccani (2020, p. 775) have described maturity models as a tool to assess and position firms during a transition, adding to the notion by Röglinger *et al.,* (2012), who defined it as a theoretical tool to specify the stage-by-stage evolution along an anticipated, desired or logical path.

Adrodegari and Saccani (2020) emphasised the importance of investigating servitisation maturity modelling with a particular focus on reconfiguring the entire business model. This dissertation commends such emphasis and adds to it in two important ways. First, by embracing comprehensive servitisation dimensions to embed the diversity of the existing servitisation knowledge (key dimensions from section 2.3). Second, the multidimensional perspectives are necessary in SeMM to understand the transitional complexity arising when multiple dimensions are transformed simultaneously (Kindström & Kowalkowski, 2014;Kohtamäki *et al.,*, 2019a). This study taps into this reasoning, as the inclusion of relational influences provides new insights into the coexistence. Reviewing prior SeMMs through LR1 revealed a diversity in the contextual setting that has induced variety in both the degree of maturity (assessment/measurement of the maturing level) and the inclusion of dimensions in the models (the context in which the measures are analysed; (Ahmed & Miquel, 2005, p. 29)) (Adrodegari & Saccani, 2020). For instance, Wikström *et al.,* (2009) assessed the degree of maturity on the background of a theory-based description of each level (e.g. from goods-dominant to business-dominant), while Coreynen *et al.,* (2018) evaluated the maturity through management self-assessment on a 7-point Likert scale with mean interpretation. While managers easily understand such examples, none of them take the weighted importance of the relational effect into account. As it is reasonable to believe that not all dimensions are equally important for the transformation, such techniques risk producing inaccurate results. Furthermore, they assume that each dimension has a positive impact, whereas in reality, the potential of both positive and/or negative relational effects exists within such models (Kindström & Kowalkowski,

[8] Case presentation by Frederiksen Scientific CEO Torben Lynge Overgaard at a knowledge-sharing meeting in the Servitize.DK project group (25 November, 2021).

2014). Prior SeMM studies have primarily focused on a unidimensional setting by concentrating on separate contextual dimensions of servitisation (e.g. Cui *et al.,* (2019) Alvarez *et al.,* (2015)), which has had a positive impact on the understanding of these dimensions individually. However, while some studies are managing to incorporate contextual diversity by including several dimensions, they still investigate them as separate, isolated dimensions (Coreynen *et al.,*, 2018;Adrodegari & Saccani, 2020). Importantly, no SeMM that verifies the coexistence of the included dimensions was identified (nor were the weighted relational effects among such coexisting dimensions). In fact, only one SeMM has been statistically verified (Lexutt, 2020), and none of them quantified a weighted maturity level (see Publication 3, Table 20). For this reason, it is necessary to establish a structural model for the maturity model by theorising the relations between the dimensions and their direction (as illustrated in Figure 3, area 4). This theorisation of the relations has been presented, tested and adjusted in Publications 1 and 3, and specific lessons from Publication 1 are discussed further in section 4.1.1.
In conclusion, to our knowledge, no maturity models dealing with servitisation have been found to be truly multidimensional. Following the reasoning of Adrodegari and Saccani (2020) and Röglinger *et al.,* (2012), maturity models are a suitable theoretical frame for operationalising such multidimensionality and enable a proper dissemination and application of the findings. Therefore, this dissertation adopts the maturity model as theoretical frame to establish such a multidimensional servitisation maturity model (MsSeMM).

2.5 Servitisation success

'Success' is defined as a progression or development of the focal firm' performance toward a preferred situation (Bustinza *et al.,*, 2019) (Publication 2). Some scholars even argue for a comparison of progressions to take the industrial development into account, as progression merely proves successful in comparison with others (Fliess & Lexutt, 2019). As noted by Cooper and Kleinschmidt (1987), success depends on the type of success desired by the company, whereas the definition and/or estimation plays an important role when assessing the success. The managerial perception of what terms a success and when a concept is achieved is therefore important (Smith-Doerr *et al.,*, 2004). As the definition of servitisation varies and remains ambiguous in the field (Brax & Visintin, 2017), so does the interpretation of servitisation success (Publication 2). This has led to variation in how to measure and perceive success in the field (Publication 2). Such variation and lack of clarity complicate the approximation of servitisation success, as a clear definition of the achievement remains lacking. However, a relatively recent line of research embraces an understanding of servitisation that comprises both financial and non-financial success indicators (Raddats *et al.,*, 2015;Lexutt, 2020). While financial indicators rely on economic metrics, the non-financial indicators are a combination of, for instance, customer, internal process and people perspectives that emerge from the strategic interest (Dossi & Patelli, 2010). The achievement of a successful servitisation transformation then relies on the dependent indicators of success, ultimately identified by how the managers perceive the concept (Smith-Doerr *et al.,*, 2004). Then, to approximate a reliable measure of success, a combination of financial and non-financial indicators contained in the extant servitisation literature is compounded in Publication 3. Further investigation of the term servitisation success is presented in Publication 2 and incorporated into Publication 3.

2.6 Overview of the identified main literature gaps

In the investigation and in answering the PhD research question, the dissertation strives to address multiple knowledge gaps and calls for research. In particular, this research hopes to answer two central calls from the field: Elaborating the **operationalisation of servitisation** (Kohtamäki *et al.,*, 2019a) and understanding the **multidimensionality of servitisation** (Kindström & Kowalkowski, 2014), both of which are relevant for the problematic servitisation transformation that manufacturers experience (Baveja *et al.,*, 2004;Benedettini *et al.,*, 2015) due to the conceptual misinterpretations (Andersen *et al.,*, 2020) and ambiguous operationalisation of the concept (Kohtamäki *et al.,*, 2019a).

Kohtamäki *et al.,* (2019a) emphasised how a lack of unification in conceptualising servitisation has resulted in very different types of definitions and operationalisations, leading to deviations in the recommendations for practitioners. It is also believed to overcomplicate the dissemination of the concept (Brax & Visintin, 2017). Moreover, Kohtamäki *et al.,* (2019a, p. 231) emphasised that 'the field evolves through the creation of a consistent body of knowledge, and this would require a very clear and precise way of developing theory in servitization'. Despite the risk of oversimplifying the concept, this is consistent with the call made by Szasz and Seer (2018) to consolidate the existing knowledge of servitisation to make more the field more consistent. Adding to Baines *et al.,* (2017), Szasz and Seer (2018) conclude that the servitisation field has reached a maturity for consolidation and validation. In continuation, Schaarschmidt *et al.,* (2018) suggest to identify and unify key dimensions of servitisation to drive future research. In line with Szasz and Seer (2018), Kowalkowski *et al.,* (2017b) call for more quantitative validations of the existing concepts, theories and models within servitisation, as most of the previous findings have been based on qualitative studies.

Kindström and Kowalkowski (2014) and Lexutt (2020) call for a better understanding of the multidimensionality of servitisation with special attention to the relational structure among coexisting dimensions. In continuation, Baines *et al.,* (2017) call for a better understanding of the potential consequential effects within servitisation; this to establish a more balanced view of both the positive and negative consequences of the concept and thus a better understanding of whether a dimension exerts a positive or negative relational influence in the context of multidimensionality.

2.7 Summary of definitions

Servitisation	'Manufacturers adopting a strategy of bundling products and services into integrated solutions' (Vandermerwe & Rada, 1988) (Baines *et al.,*, 2007).
Servitisation transformation	The reconfiguration of the entire organisation (Baines *et al.,*, 2017) in a transformative process from a solely goods-centric manufacturer towards a product-service provider (Wikström *et al.,*, 2009), with the increased implementation of sophisticated services (Oliva & Kallenberg, 2003).
Success	Success is the progression or development from one state to another in the focal firm's performance (Bustinza *et al.,*, 2019), while such 'progression only prove[s] successful in comparison with others' (Fliess & Lexutt, 2019).
Dimension	Dimension is defined as 'representing the context in which certain measures are analysed' with the context specified by theory and concepts (Ahmed & Miquel, 2005, p. 29).
Multidimensionality	'Multidimensional structure are based on the concept of facts or measures, and dimensions representing the context in which these measures are analysed' (Ahmed & Miquel, 2005, p. 29).
Maturity modelling (MM)	'Maturity model as a tool to assess and position firms under a transition' (Adrodegari & Saccani, 2020, p. 777), adding to the notion by Röglinger *et al.,* (2012) and (2020, p. 775): 'a theoretical tool to specify the stage-by-stage evolvement along an anticipated, desired or logical path'.
Servitisation maturity model (SeMM)	Maturity models operating in the context of servitisation.
Multidimensional servitisation maturity model (MdSeMM)	A maturity model based on dimensions of servitisation, with the integration of coexisting interconnections among the dimensions, thus including the coexistence among the dimensions.
Configurational theory	Meyer *et al.,* (1993, p. 1175) define organisational configuration as 'any multidimensional constellation of conceptually distinct characteristics that commonly occur together'. Fiss (2007, p. 1179) further emphasises the capacity of the configurational approach to take 'a systematic and holistic view of organisations, where patterns or profiles rather than individual independent variables are related to an outcome such as performance' (see section 3.1.3).
Abductive approach	Bryman (2016, p. 22) states that the abductive approach 'starts with an observation' (problem or puzzle) 'and tries to explain it using the most likely explanation'. From here, the researcher strives to understand or solve the problem or puzzle by going back and forth between the puzzle, the social world and the literature (Atkinson *et al.,*, 2003;Bryman, 2016) (see section 3.3).

Table 3: Overview of definitions.

3. Research methodology

The clarification of the theoretical stance in the previous chapter forms the foundation for the next step in the research. Following Wilson (2014), methodology classifies the research design by presenting the rationale behind the chosen research strategy, methods and analysis. In the next chapter, the fundamental principles of the PhD research are presented together with the associated reasonings and clarifications of the fit between paradigm, approach, design, strategy and methods. While the reasonings and the more consistent choices are presented in this section, the more specific and detailed methods and analytical techniques adopted for each study are presented individually within the respective publications (see Chapter 4 for appended publications). However, to ease the understanding of the applied methods and techniques, outputs from related publications will be presented briefly. Figure 5 illustrates the 'research onion' proposed by Saunders *et al.,* (2015) with the methodology adopted for this PhD research incorporated into the model. The following chapter will present the methodological choices for each layer by peeling off one methodological layer at a time.

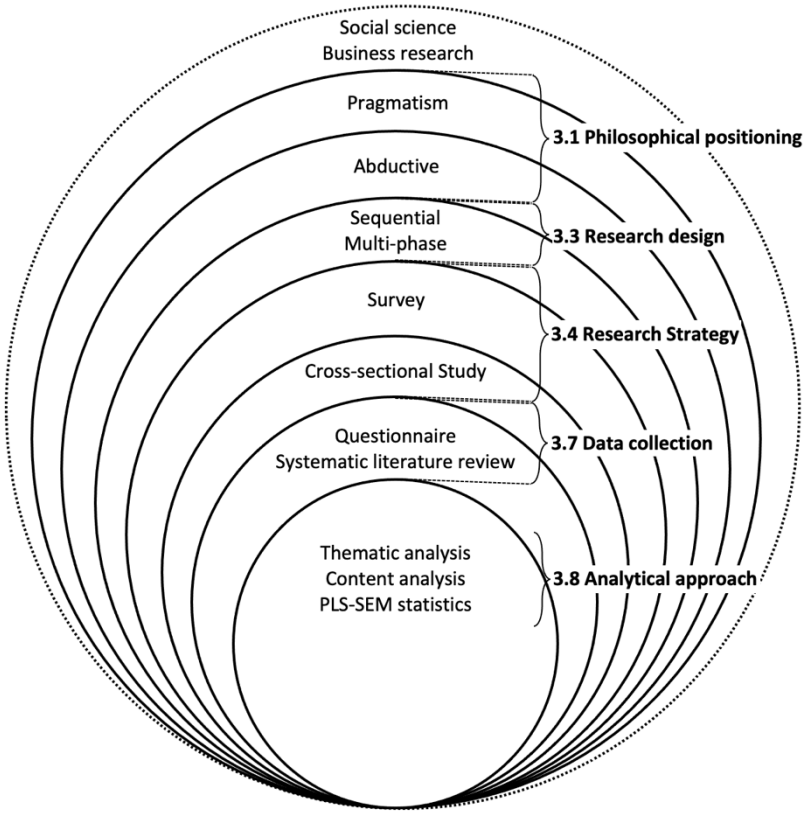

Figure 5: Research onion of the PhD research adopted from Saunders et al., (2015)

The nature of this research is driven by an attempt at understanding how to improve the operationalisation of Danish manufacturers, thereby contributing to social science by tapping into 'how society works', but with a particular focus on business research as it strives to solve the managerial problem of the failed transformation (Wilson, 2014). Following the notion of pragmatism, this research develops 'true' knowledge in terms of the relevance and applicability of its findings (Kaushik & Walsh, 2019, p. 4). Furthermore, the abductive approach is adopted as it switches back and forth between conceptualisation and validation to incorporate new knowledge and, in this study, to ensure its managerial value (Atkinson *et al.,*, 2003). This fits the definition of business research presented by Wilson (2014, p. 3) as 'the systematic and objective process of collecting, recording, analysing and interpreting data for aid in solving managerial problems'. On a similar note, Easterby-Smith *et al.,* (2012) emphasised how business research is expected to have some practical consequences and that managerial implications are most important. With this in mind, the methodology is presented in the following.

3.1 Philosophical positioning of this research

The paradigm refers to the researcher's philosophical assumptions and the basic beliefs guiding and defining their worldview (Lincoln, 2011). This allows the researcher to tap into the shared beliefs and values of the particular community and allows for a better interpretation of the positioning of the research by others (Kaushik & Walsh, 2019). From here, the paradigm is believed to be a practical yet conceptual tool for answering an associated research question (Abbott, 2004, p. 42). The choice of paradigm follows the belief of the researcher and guides the differing perspectives of axiology, ontology, epistemology and methodology (Saunders *et al.,*, 2012). This research taps into the community of pragmatism, as it seeks to investigate an identified problem to arrive at an achievable solution for future practices (Kaushik & Walsh, 2019). The pragmatic paradigm views the value of research to be found in the production of practical solutions and is steered by a problem. From here, pragmatism sees the research problem as the central element and applies multiple approaches to understand the it (Creswell, 2013, p. 11). Pragmatics typically also place greater emphasis on directing such problems with 'what' and 'how' questions (Creswell, 2013, p. 11).
Critics point towards the socially and contextually situated research problems that the problem-centred pragmatics strive to solve, which are said to limit their ability in identifying and analysing structural social problems (Thompson, 1996;Kaushik & Walsh, 2019). For this study to reduce the risk of biasing the perception of the research problem, prior calls have been emphasised to frame and define the problematic transformation. Further, critics point out the pragmatist independence of methods as a concern, as researchers are said to address their research question with the methods available, and with the conviction of 'whatever works' (Kaushik & Walsh, 2019). To comply with this concern, Kaushik and Walsh (2019) emphasise the importance of a thorough research design for bridging the potential gap between research methods and the research question. For this reason, the methodology of the entire PhD has been elaborated further in this chapter (Chapter 2). As this PhD strives to solve a practical problem, pragmatism is still believed to be the best suited philosophical stance for this study. Furthermore, although pragmatism is not steered by the ontological and epistemological considerations (Savin-Baden & Major, 2013, p. 60), an elaboration of them is presented.

3.1.1 Ontology

The pragmatic view of 'truth' and 'reality' originates in whether a practical consequence impacts and is relevant to the real world, which should be understood in relation to the specific context (Saunders *et al.,*, 2012;Kaushik & Walsh, 2019). According to Kaushik and Walsh (2019, p. 4), reality is true 'as far as it helps us to get into satisfactory relations with other parts of our experience', while truth is 'whatever proves itself good or what has stood the scrutiny of individual use over time'. As far as pragmatism is concerned, an objective reality is believed to exist apart from human experience, although such reality is grounded in the environment, which can only be encountered through human experience (Kaushik & Walsh, 2019). Hence, reality and knowledge are believed to be socially constructed through habits and beliefs (Yefimov, 2004), implying that reality can never be determined once and for all (Pansiri, 2005). For this reason, it is not possible to discern knowledge claims from contingent beliefs, habits and experiences (Howe, 1988). Reality will therefore change with new experiences and knowledge. Accordingly, objectivity is something to strive for, and this study will strive for an objective reality through the ontological perspective of realism, while acknowledging that perfect objectivity is unachievable, as the 'meaning' is steered by human experience, which is

context-dependent (Kaushik & Walsh, 2019). Objectivity is sought after through methodological rigorousness, as suggested by Kaushik and Walsh (2019), and the researcher's effort to be objective and value-free (axiology). Manufacturers could follow a variety of strategic propositions, which then represent alternative realities for obtaining a successful business. However, this study focuses on the reality of the problematic servitisation transformation, as prior research has already shed light on the 'why it occurs' and because the gaps identified emphasise the 'how to overcome it' (see Chapter 2). This study examines the latter, thus following the nature of pragmatism by striving to solve a practical problem of relevance to the real world (Kaushik & Walsh, 2019).

3.1.2 Epistemology

Pragmatic epistemology understands knowledge as being socially constructed; that is, formed by a shared pool of experience (Kaushik & Walsh, 2019). Knowledge is not seen as reality, but merely as a tool for better managing the existence of the firm and taking part in the world (Goldkuhl, 2012). Hence, pragmatism seeks to establish such new knowledge to be used as a tool for improving future practices (Kaushik & Walsh, 2019). According to the theory of inquiry by Dewey (1938), inquiry is understood as investigating a part of this reality, and it seeks to create knowledge to bring about changes for that particular part (Kaushik & Walsh, 2019). The conceptualisation of servitisation is believed to be a result of such socially constructed reality based on the experience of the community. From here, the 'how to overcome it' becomes the inquiry of investigation and represents that part of the reality that must be improved. The approach of the inquiry is guided by the researcher's curiosity and theoretical logic (see section 3.1.3). Pragmatism seeks to reconcile a variety of perspectives (objectivism and subjectivism, facts and values, accurate and rigorous knowledge, and differing contextualised experiences) to consider differing concepts, theories, ideas and findings as instruments for thoughts and practical consequences in a specific context (Saunders *et al.,*, 2012). This idea of joining theoretical perspectives on the basis of the problem to answer the research question is equivalent to the inductive approach of establishing new knowledge (Bryman, 2016). Following the reasoning of pragmatism, however, reality only becomes the truth when it has practical consequences (Kaushik & Walsh, 2019). Hence, to establish whether new knowledge holds true, it must be empirically tested, which calls for a deductive approach (Bryman, 2016). Consequently, this study adopts an abductive approach to enable both processes by switching back and forth between conceptualisation and validation in a process called dialectical shuttling (Atkinson *et al.,*, 2003). Criticism of abduction as allowing for all sort of hypotheses and its inability to be a logic of discovery (Paavola, 2004) has been emphasised. This study develops its hypothesis on established literature, theories and concepts to ensure thorough support for the hypothesis. Moreover, I acknowledge that the logic of discovery is not plausible, as the hypothesis and premise of the SeMM is present within the literature, hence following the notion by Paavola (2004) as presented above; this also, since the objective of this study is to consolidate the existing knowledge to solve the problem at hand. From an epistemological perspective, this study seeks to establish new knowledge in two ways: by matching theories with the observed phenomenon (problematic transformation) to establish a new theory upon transitioning (instrumentalism) and through sensory perception by quantitatively testing the new knowledge (empiricism). Both approaches establish new knowledge usable for improving the specific part of the problematic transformation. Critics point at the limited focus of the pragmatists on generalisable findings, as pragmatism merely focuses on the transferability of the solution to other contexts (Morgan, 2007). Thus, this study

obtains a focus on the transferability with limited focus on generalisability. The adoption of multiple epistemological perspectives is in accordance with how the literature rejects accessing reality through a single-scientific method (Maxcy, 2003;Kaushik & Walsh, 2019).

3.1.3 Theoretical logic

Furthermore, to tap into the inquiry of the reality under investigation, this study adopts the theoretical lens of configuration logic while also emphasising the theory of organisational identity (Kohtamäki *et al.,*, 2019b). The configuration logic was suggested by Kohtamäki *et al.,* (2019a) to allow for various recipes of success. Accordingly, it believes that different equifinal ways exist in which certain dimensions can lead to successful servitisation (Forkmann *et al.,*, 2017b), which is in accordance with the continuum of servitisation (Baines *et al.,*, 2020). Meyer *et al.,* (1993, p. 1175) define the organisational configuration as 'any multidimensional constellation of conceptually distinct characteristics that commonly occur together'. Fiss (2007, p. 1179) further emphasises the ability of the configurational approach to take 'a systematic and holistic view of organisations, where patterns or profiles rather than individual independent variables are related to an outcome such as performance'. To establish such an approach, scholars must rely on a variety of clustering algorithms, interaction effects and deviation score approaches to identify the configurations and their effects (Fiss, 2007). The methodological reasoning of this logic points at the fuzzy-sets qualitative comparative analysis (fsQCA), which identifies combinations of configurations to obtain a given performance measure (Pappas & Woodside, 2021). However, this research does not seek to identify combinations of configurations, but rather to understand the nomological network and how the proposed laws of constructs can be configured to predict paths that increase the possibility for servitisation success. Thus, the theoretical lens of configurational logic is used to steer the theoretical reasoning of maturity modelling and the configuration of predicted paths. This is in line with prior servitisation maturity research such as Lexutt (2020), who uses the configuration terminology in theorising their maturity model, or the study by Mettler and Rohner (2009), who adopted the reasoning of configuring specific indicators to predict potential outcomes. This is in keeping with the pragmatic belief that reality cannot be accessed through a single-scientific method (Maxcy, 2003;Kaushik & Walsh, 2019), while following the multidimensional perspective of servitisation (see section 2.2) and the adoption of theorising through maturity modelling as a measurement tool. Nonetheless, very few studies (e.g. the studies by (Ringle *et al.,*, 2020;Moreno & Casillas, 2008)) have combined the usage of structural equation modelling (SEM) and configurational logic, hence making room for methodological confusion. As will be discussed in section 3.3, however, the pragmatic approach is determined by the research question, the context and the research consequences at hand – and not by the normative approaches within academia (Nastasi *et al.,*, 2010;Tashakkori & Teddlie, 2010). Therefore, although the combination of theoretical lens and methodological approach does not follow the normative approach within academia, it follows the faith in research in pragmatism. Further, while prior studies have criticised this theoretical logic due to limited evidence of true causality (Barney & Hoskisson, 1990), the main reason has been found to be the lack of statistical power behind such research (Ferguson & Ketchen, 1999;Fiss, 2007). The need for statistical power stems from the assumption in the configurational approach of complex causality in a structured relationship, where the causal relations depend on the configuration (Fiss, 2007). However, due to the growing emphasis on path modelling and the development of computational power (Hair *et al.,*, 2011), such statistical power is now available for comprehending the configuration of multidimensional constellations, as

emphasised by Meyer *et al.,* (1993, p. 1175) (for more, see section 3.7.3). This is not a consideration for nomological networks, as it seeks to prove interrelationships that are not necessarily causal.

Ontology	Epistemology	View of reality	Paradigm	Unit of analysis	View on the solution
Realism	Abduction Instrumentalism and empiricism	Objectivism	Pragmatism	The practical consequences of the organisational reconfiguration	The pursued truth is the proven configurational consequences emerging from the six dimensions

Table 4: Coherence between ontological and epistemological assumptions

3.2 Research aim

This study seeks to answer the research question by consolidating the existing knowledge within servitisation to develop a new maturity model that assesses how to increase the likelihood of a successful transformation through the reconfiguration of coexisting dimensions. From an academic perspective, this research addresses two literature gaps relating to the problematic transformation presented in section 2.6: to consolidate the existing literature to elaborate the operationalisation of servitisation (Brax & Visintin, 2017;Szasz & Seer, 2018;Kohtamäki *et al.,*, 2019a) and to establish a better understanding of the servitisation transformation through a multidimensional perspective (Kindström & Kowalkowski, 2014;Lexutt, 2020).

3.3 Research design

The research design establishes a focus and guides the research in order to answer the formalised research question (Wilson, 2014). Following the definition by Bryman (2016, p. 22), the abductive approach 'starts with an observation' (problem or puzzle) 'and tries to explain it using the most likely explanation'. From here, the researcher strives to understand or solve the problem or puzzle by moving back and forth between the puzzle, the social world and the literature (Atkinson *et al.,*, 2003;Bryman, 2016). The foundation of this research is the problematic servitisation transformation observed in the literature (Baveja *et al.,*, 2004;Benedettini *et al.,*, 2015). The puzzle of the study has been 'how to increase the likelihood of a successful servitisation transformation' (see research question on page 18), while the approach to solving the puzzle has been influenced by the adoption of pragmatism and the configurational theory. Pragmatic researchers are not guided by any one philosophical stance (Tashakkori & Teddlie, 2010), nor are they limited to a single methodological approach, as the approach is determined by the research question, context and research consequences at hand (Nastasi *et al.,*, 2010). This is in line with the nature of the abductive approach 'going back and forth' to solve the problem (Atkinson *et al.,*, 2003). For this reason, the PhD research has adopted a sequential, multi-phase design, meaning that the researcher conducts sequential research projects linked together by a common purpose but with varying methods (Creswell *et al.,*, 2011). The methodological approach was then chosen based on the research consequences at the time of the individual study (Nastasi *et al.,*, 2010). For instance, the peer feedback of adjusting the measures from the servitisation community led to revisiting LR1 (see section 3.6 for more details). Following this reasoning, the study started from an inductive curiosity of the

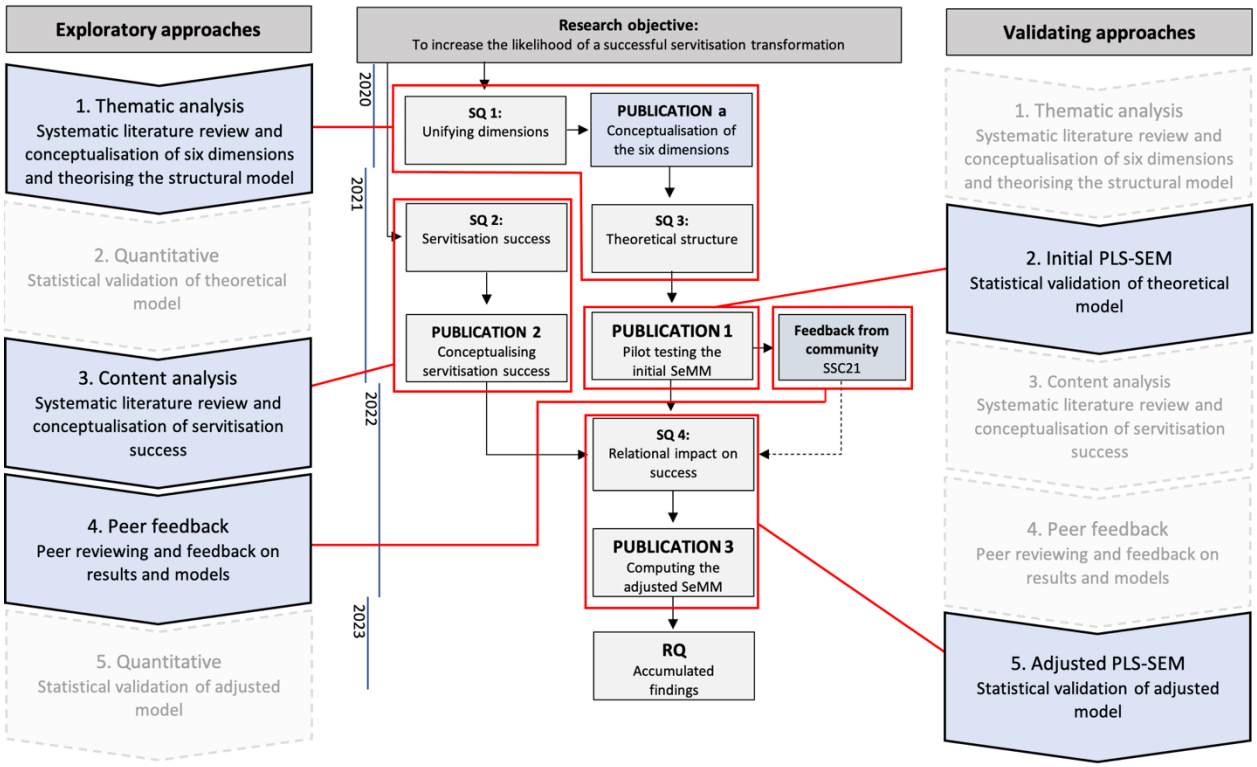

Figure 6: The abductive flow of the investigation.

problematic transformation and led to the examination of the current limitations of the literature in explaining 'how' to overcome it, as described in Chapter 2. This was followed with a deductive approach by developing an initial SeMM based on the existing literature and knowledge to solve the 'puzzle' (flow 1, Figure 6). This development included the formation of the six dimensions through a systematic literature review (see section 3.6.1), laying the foundation for theorising the coexisting structure of the MdSeMM as well as the measurement of the dimensions. The emergence of new conceptualisations and theoretical structures was led by the qualitative reasoning of the literature reviews (Bryman, 2016). The first validation of the model was computed through the quantitative technique of partial least squares structural equation modelling (PLS-SEM). This is intended to validate the presence of the coexisting dimensions and to estimate the weighted importance of each dimension (flow 2, Figure 6) (Publication 1). These tests confirmed the model's limited ability to approximate the success of servitisation, which led to a new systematic literature review (see section 4.2.1) and the study on servitisation success (flow 3, Figure 56) (Publication 2), thus reverting to the inductive and qualitative methods. Furthermore, the findings of the first validation were presented during the Spring Servitization Conference 2021 and led to important peer feedback from the servitisation community. Additional feedback was given after the conference as well as community members such as Professor Tim Baines, Associate Professor Bart Kamp and Associate Professor Ali Bigdeli were interested in developing the model further (flow 4, Figure 6). Ali Bigdeli and Kawal Kapoor was invited to contribute to developing the final model, which is presented in Publication 3. The combination of the lessons learned from flows 2, 3 and 4 led to the development of the adjusted model, which was computed using PLS-SEM, as presented in section 3.7.3 (flow 5, Figure 6) (Publication 3).

3.4 Research strategy

In the search for a properly developed SeMM, this PhD focused on conceptualising a proper SeMM from the existent literature and validating its value. Here, the research strategy followed the research objective of validating the true value of the SeMM through statistical outputs. This strategy was chosen, as the incorporation of the multidimensionality requires numerous observations collected on multiple variables. This is in line with the cross-sectional design incorporated into this research and is defined as the collection of multiple cases within a single point in time (Wilson, 2014). This design improves the research in two ways (Bryman, 2016): It enables the inclusion of the variation of groups, allowing for transferability, and it facilities rectangle data in a single time series. The setting of this research focuses on Danish industrial SMEs, which constitute a highly varied group (see section 3.5 for more info). The validation of the results, as prescribed by pragmatism and abduction, requires variation among cases to enable the profound testing of the data (Bryman, 2016). This is accomplished through the collection of multiple observations that represent the variation among Danish industrial SMEs. This allows for representative findings to answer the research question. Furthermore, the 'reconfiguration of key dimensions' requires a research strategy allowing for the collection of multiple variables simultaneously to represent multiple dimensions. Each of the six dimensions must be represented in the data collection to validate the coexistence and relational effects among them. The cross-sectional design allows for this incorporation of multiple variables with sufficient variation to validate their relational importance (Wilson, 2014). The quality of the cross-sectional design is assessed on its reliability, replicability and validity, which is evaluated for the PhD project in its entirety in section 3.8 (Bryman, 2016).

3.5 Research context

Before describing the data collection methods associated with the research strategy above, this chapter briefly introduces the context of this research and does so in relation to three particular terms: manufacturers, SMEs and Denmark. The servitisation concept is about the integration of service offerings into manufacturing firms (Vandermerwe & Rada, 1988), implying that manufacturers are the prime focus of the study. This study additionally adopts the understanding of a manufacturer as a company or legal person that produces physical goods from raw materials in large quantities (European Commission, 2021, p. 5) and follows the NACE European industrial codes (European Commission, 2012). In the past decade, Denmark has increased its focus on strengthening the competitive advantage of manufacturing SMEs through the implementation of service offerings (Hsuan *et al.,*, 2017) and has been ranked as one of the most servitised countries in Europe, with >70% of all SMEs servitised in 2018 (European Commission, 2018). Furthermore, in 2019, the Confederation of the Danish Industry (DI) invested €3.9 million in Servitize.DK, an industrial project, to further communicate the concept to SMEs (The Danish Industry Foundation, 2019). The Servitize.DK project took place between 2019 to 2022 with the purpose of enhancing the competitiveness, growth and value creation among Danish industrial SMEs through an increased dissemination of product/service business concepts (servitisation) (Servitize.DK, 2019). Servitize.DK had three branches: *transform*, focusing on transforming individual SMEs through consultancy, workshops and inspiration; *forum*, focusing on disseminating the servitisation concept as a network, presentation and knowledge platform; and *research*, focusing on translating the lessons learned and experiences from the transform branch into new knowledge through research activities. I

have been involved in Servitize.DK in the dissemination of the initial research results and knowledge exchange at the quarterly project meetings, and I have gained practical experience from participating in *transform* workshops with focal SMEs. This collaboration provided hands-on experience and a forum for testing ideas and to receive feedback from servitisation experts and researchers from Aarhus University, Copenhagen Business School, Alexandra Institute, Force Technology, and the Danish Technological Institute. The European Union defines SMEs in terms of size of revenue (< €50 million) and number of employees (10–250) (European Commission, 2003), while the manufacturing industry in Denmark is categorised in 45 industrial groups (European Commission, 2012). Interestingly, the current servitisation literature has been found mainly to be based on the empirical knowledge of large manufacturing firms (Baines & Lightfoot, 2014). Moreover, Kowalkowski *et al.,* (2013) emphasise that the versatility of SMEs increases the likelihood of their success through various value constellations in a multifarious progression. The more fluctuating nature of the transformation of the SMEs and the increased awareness of servitisation among Danish SMEs make this segment a particular interesting case to investigate. The segment of Danish industrial SMEs totals 52,725 companies distributed across the 45 industrial sub-groups of C10–C32.[9]

NACE	Industry name	No. of SMEs	Proportion (%)
C10	Manufacture of food products	7,821	14.8%
C11	Manufacture of beverages	1,281	2.4%
C12	Manufacture of tobacco products	46	0.1%
C13	Manufacture of textiles	1,485	2.8%
C14	Manufacture of wearing apparel	3,397	6.4%
C15	Manufacture of leather and related products	428	0.8%
C16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	1,893	3.6%
C17	Manufacture of paper and paper products	455	0.9%
C18	Printing and reproduction of recorded media	2,780	5.3%
C19	Manufacture of coke and refined petroleum products	62	0.1%
C20	Manufacture of chemicals and chemical products	1,098	2.1%
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	561	1.1%
C22	Manufacture of rubber and plastic products	1,450	2.8%
C23	Manufacture of other non-metallic mineral products	2,411	4.6%
C24	Manufacture of basic metals	548	1.0%
C25	Manufacture of fabricated metal products, except machinery and equipment	7,774	14.7%
C26	Manufacture of computer, electronic and optical products	2,138	4.1%
C27	Manufacture of electrical equipment	1,621	3.1%
C28	Manufacture of machinery and equipment n.e.c.	5,369	10.2%
C29	Manufacture of motor vehicles, trailers and semi-trailers	463	0.9%
C30	Manufacture of other transport equipment	662	1.3%
C31	Manufacture of furniture	2,624	5.0%
C32	Other manufacturing	6,358	12.1%
	Total number of industrial SMEs =	52,725	100.0%

Table 5: Composition of the Danish industry SMEs in May 2021.

[9] The Central Business Register (CVR), May 2021.

3.6 The literature reviews and data collection methods

The following chapter presents the data collection method employed in this research. Here, a clarification of the methodological considerations underlying the specific methods is presented, with an emphasis on the coherence between the methods used, the epistemology of the project and the individual publication. The detailed methodology of each publication can be found in the methods section of the individual publication. Following the reasoning of the research design, prior knowledge has been extracted from literature reviews to develop the initial MdSeMM. During the PhD research project, two systematic literature reviews (SLR1 and SLR2) were conducted, while a third literature review was conducted in continuation of the first systematic literature review, with a particular focus on servitisation maturity modelling (LR1). To validate the initial MdSeMM and the adjusted MdSeMM, data were collected for both studies through the distribution of questionnaires (see section 3.6.2) and with two additional data collections for pilot testing. These four questionnaire surveys are presented in greater detail in section 3.6.2. Table 6 illustrates the full collection of data and the association with each publication.

	SLR1	LR1	SLR2	Pilot 1	Survey 1	Pilot 2	Survey 2
Publication a	X	X					
Publication 1	X	X		X	X		
Publication 2			X				
Publication 3		X				X	X

Table 6: The data collection method used for each publication.

3.6.1 Systematic literature review

Wilson (2014) defines the 'literature' as all sources of published materials and a 'review' as a critical evaluation of its content. A 'literature review' is then about identifying, evaluating and critically assessing the content within the chosen topic (Wilson, 2014). To delimit the review topic, parameters formulated as keywords and criteria are developed to specify the relevant areas of the literature. These are used to refine the search for articles for review. Specific parameters were identified for each review, but with the following common denominators:

- English is the preferred academic language. Therefore, a criterion for American and British English was required.
- The type of publication was set to 'academic articles' and 'review articles' without any peer-review specification.
- The time period of publication was set to 1988–present year (2020 for SLR1), as the conceptualisation of servitisation was first established by Vandermerwe and Rada (1988) in 1988.
- The journal category was set to business journals and management journals, as they are the journal types that this research is targeting.

The adopted parameters (i.e., keywords and criteria for each literature review) are illustrated in Table 7. To evaluate and critically assess the literature coherently, a formalised and systematic evaluation procedure is recommended (Tranfield *et al.,*, 2003) to ensure that the articles are evaluated in an identical manner and that the researcher can make consistent decisions in the filtration process. According to Tranfield *et al.,* (2003), literature reviews

possess a lack of thoroughness and often reflect the biases of the reviewer. This, he argues, is reduced by adopting a more systematic approach in the selection of articles, filtering them for relevance, and assessing the articles consistently (Tranfield *et al.,*, 2003;Bryman, 2016). In particular, Bryman (2016, p. 92) suggests a five-step procedure for conducting a systematic literature review:

1. Define the purpose and scope of the review.
2. Seek out studies relevant to the scope and purpose of the review.
3. Assess the relevance of each study for the research question(s).
4. Assess the studies from step 3.
5. Analyse each study and synthesise the results.

This procedure has been applied, albeit with some adjustments. While the purpose and scope were defined (step one) and used to establish prescribed parameters (step two) (see Table 7), steps two and three were adjusted through the adoption of the screening process suggested by Brax and Visintin (2017). In general, steps two and three involve the screening and selection of articles for further review and should be executed carefully. The Brax and Visintin (2017) screening process suggests that parameters are defined as suggested by Tranfield *et al.,* (2003), but with a search process that gradually narrows the search results for each added parameter. For instance, Figure 7 illustrates this literature-screening process by starting with the raw search string, resulting in 880 articles. In this example, one search string was applied as illustrated in Table 7: 'SLR1'. The type of article, language and journal category were then selected, reducing the search result by 588 articles. The remaining 292 articles were then extracted and the abstracts reviewed with respect to step three of the Tranfield *et al.,* (2003) procedure; that is, with a particular focus on the purpose and scope of the review. In this example, the articles only had to include 'servitisation', as the purpose was to understand the servitisation concept. A final full-text inspection of the extracted articles was conducted to ensure their quality. This is equivalent to step four in the Tranfield *et al.,* (2003)procedure, in which predefined criteria for quality measures are assessed. In the SLR1 example, no limitations were defined according to used methods, theoretical stance or research design; instead, articles had to concern themselves with the prescribed

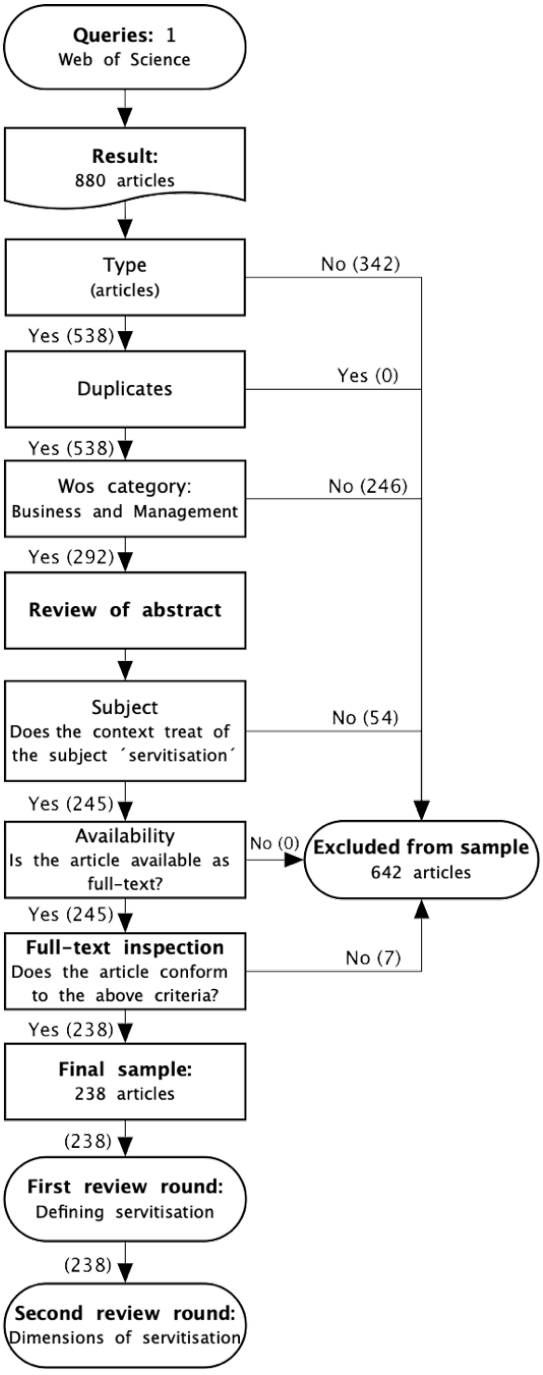

Figure 7: Screening process of SLR from Publication a.

parameters and servitisation (Bryman, 2016). In other words, the articles should discuss servitisation or simply mention the concept. This gradual filtration of articles ensured the replicability of the review by presenting each step and the search results in a transparent manner. This procedure was applied for the two SLRs with some adjustments according to the purpose and scope of the review.

Step five involves recording important information and analysing the content of the extracted articles (Bryman, 2016). The analysis and interpretations are discussed in greater detail in the respective publications. Important information, such as author(s), year of publication, methods, findings and suggested future research, was extracted from each article, along with predefined focus areas (see Figure 7). These focus areas were defined according to the purpose and scope of the review, but also on the basis of discussions with academic colleagues. From the SLR1 example, these focus areas could be information about 'servitisation definition', 'adopted or own definition', 'definitional type' and 'the existence of dimensions'. Step five restarted a couple of times during SLR1, as learning evolved and patterns were identified; for instance, after reviewing more than 40 articles, a pattern emerged that the type of definition scholars used for servitisation was related to organisational levels, which established the idea of the four definitional types (offering-, process-, firm- and business model-focused). Similarly, the identification of dimensions was established as patterns started to evolve and a fine-grained content analysis of the articles was conducted (Elo *et al.,*, 2014). In addition, a backward citation search was made for each article by examining the reference lists to ensure that all important contributions were included and that, for instance, no dimensions were overlooked (Hu *et al.,*, 2011).

Figure 8: Screenshot of the recordings from SLR1.

The first review was conducted during the first six months of the PhD research in April 2020, which laid the foundation for the conceptual understanding of servitisation. This includes the identification of the six key dimensions as well as the relational understanding of them. The maturity review (LR1) was conducted in May 2020, and it was a spin-off of sorts of SLR1 for the purpose of further understanding SQ3. The last systematic literature review focused on the servitisation success and was conducted in February 2021 to answer SQ2.

	SLR used in publication	Purpose and scope of the review	Search strategy	Database	Date for extraction	Parameter (keywords)	Criteria				Search terms	Search string	Identified articles (excluded)
							Language	Type of publication	Time period	Category			
SLR1	Publication 1 Publication a	To identify definitions of servitisation, to specify the definitional types, and thematic interest of servitisation within the servitisation literature.	Systematic literature review	Clarivate's Web of science	April 2020	Servitisation	English	Review articles & academic articles	1988 – 2020	Business journals and management journals	Serviti*ation Serviti*	Serviti*ation (All fields in article)	880 (642)
LR1	Publication a Publication 1 Publication 3	To comprehend the level of current servitisation maturity levels, and identify common denominators of servitisation dimensions.	Based on SLR1 review with citation search		May 2020	Maturity modeling Servitisation			1988 – 2020		Maturity Serviti*ation	References mentioning maturity in the context of servitisation	11
SLR2	Publication 2	To identify a definition of servitisation success, and to identify common denominators of it within the servitisation literature.	Systematic literature review		February 2021	Servitisation Success Achievement			1988 - 2021		Serviti*ation Serviti*ed Succes* Achiev*	Serviti*ation AND success* (All fields) Serviti*ation AND achieve* (All fields) Serviti*ed (All fields)	342 (276)

Table 7: Purpose, parameters and identified articles of the systematic literature reviews

3.6.2 Questionnaires

The newly acquired knowledge and conceptualisations from the SLRs have been validated as suggested by the abductive approach (Atkinson *et al.,*, 2003). The cross-sectional design allows for the collection of multiple cases of a single time period to establish the variation of several variables (Wilson, 2014). For the validation of the conceptualised dimensions and the theorised MdSeMM, a large set of observations is needed to establish the necessary variation for each variable (Bryman, 2016). To collect multiple observations across groups for two or more variables (rectangle data), a questionnaire is preferable. As illustrated in Figure 6, two validation studies have been conducted during the PhD research (in Publications 1 and 3, respectively). Each of the publications distributed a questionnaire for a pilot study as well as an adjusted questionnaire for the validation. The data collection process has been summarised in Table 8, while the detailed analysis can be found in the methodology sections of Publications 1 and 3 as well as in section 3.7.3. The questionnaires were designed as online self-completion surveys to make the participation easer for the respondents (Rowley, 2014). The surveys were distributed through email to all respondents with a publicly available email and had built-in mechanisms to ensure the identity of the respondents to avoid repeated entries. This enabled the monitoring of the distribution and interpretation of the response rates. However, the observations were all anonymised after the completion of the data collection by deleting sensitive personal data (email solely). The recommended sample size for pilot tests of scale development studies, as is the case in these studies, is set to n = 25–30 observations (Hertzog, 2008, p. 184;Johanson & Brooks, 2009). For the adjusted survey distribution, the sample size depends on the complexity of the structural equation model (PLS) following the ten-times rule (Hair *et al.,*, 2017a). Hence, the sample size should be ten times larger than the largest number of indicators per construct or the largest number of relations with a construct. For sampling two in Table 8, an additional effort to collect observations was made by encouraging potential non-responders to provide information about the research and its potential. The relatively small sample sizes summarised in Table 8 would normally impose statistical limitations on the research. However, the PLS technique adopted for the validation provides robust estimators despite small sample sizes or non-normality in data sets (Hair *et al.,*, 2011). As appears from the 'sample size' column, the data set exceeds the recommended minimum criteria (Hertzog, 2008, p. 184;Johanson & Brooks, 2009;Hair *et al.,*, 2017a).

	Collection used in:	Aim	Target group	Collection strategy	Data collection	Response rate	Sample size (required)
Pilot 1	Pub. 1	Preliminary pilot test of questionnaire	Danish industrial SMEs 1–250 employees NACE C10-C32	Distributing a unique survey link to randomised firms from the target group	Online self-completion survey – SurveyXact	5.5%	11 (25–30)
Sampling 1	Pub. 1	Validation of the initial MdSeMM		Distributing a unique survey link to publicly available emails within the target group		8.7%	104 (80)
Pilot 2	Pub. 2	Preliminary pilot test of questionnaire		Distribute to previous attendee who accepted reassessing		25.4%	28 (25–30)
Sampling 2	Pub. 2	Validation of the adjusted MdSeMM		Distributing a unique survey link to publicly available emails within the target group	Online self-completion survey + phone calls	3.1%	159 (150)

Table 8: Data collection

3.7 Analytical procedures

The analytical techniques adopted in the PhD research have focused on analytical techniques for SLR-based conceptualisations and for the validation of the theorised models through the PLS-SEM computations. For the conceptualisations, analytical approaches such as content analysis (in Publications a and 2) and typology-based conceptualisations have been adopted. The latter are used and explained in detail in the method section of Publication 2. The three analytical procedures are presented briefly in the following.

3.7.1 Content analysis

The content analysis followed the recording of important information, as described in section 3.6.1 and suggested by Bryman (2016). This information involved typologies, definitions, findings and predefined focus areas from the articles and was extracted to a raw data repository, as suggested by Miller *et al.,* (2018), with a column for each category of information and a row for each article (see Figure 8). The focus areas were defined before the review started and were based on the purpose and scope of the research at hand. However, as new thoughts and ideas developed in the beginning of the reviews, new focus areas were developed and added, and the reviewing process restarted. Importantly, before adding new categories to the review process, thorough discussions of a possible new category were organised with academic colleagues. The repository allowed for examining patterns across numerous articles through the matrix layout and provided a good visual understanding of the literature through the colour coding of related outcomes. This further enhanced the discussions with the academic colleagues and my own understanding of the topic. This approach was adopted for SLR1 and SLR2 and used in Publications a and 2.

3.7.2 Typology-based conceptualisation

The typology-based conceptualisation seeks to develop a new conceptual understanding by combining two or more existing typologies to create new perspectives and thoughts on a phenomenon (Lindgreen *et al.,*, 2021). These new perspectives allow researchers to change the perspective to create a new understanding of the investigated phenomenon, thus adding to the theory synthesis used to combine the typologies (Lindgreen *et al.,*, 2021). This conceptualisation technique was adopted in Publication 2 and established new categories for success by combining the four definitional types of servitisation and the extracted definitions of success from SLR2.

3.7.3 Partial least squares structural equation modelling

The primary objective of multivariate techniques is to expand the researcher's explanatory ability and statistical efficiency, and while powerful techniques have been developed, none of them can examine more than a single relationship at a time (e.g. multiple-regressions, factor analysis, etc.) (Hair *et al.,*, 2010). Structural equation modelling (SEM) is a regression-based statistical multivariate technique computing iterative equations to incorporate several paths

defined by the measurement and structural model (Hair *et al.,*, 2011). To explore the validation of coexisting dimensions, SEM is believed to be the best suited methodological technique (Hair *et al.,*, 2011). There are four reasons for choosing SEM as a technique for this research.

- First, it is the best-suited approach for predicting target constructs (e.g. servitisation success) and identifying driver constructs (dimensions with relational effects on e.g. success) in a nonlinear structure (as seen in Figure 9) (Rigdon, 2012;Hair *et al.,*, 2017b).
- Second, the technique is suitable for empirically testing the laws of the nomological network to justify the nets (Cronbach & Meehl, 1955) by statistically testing the interrelationships between latent constructs and the observable indicators (Cronbach & Meehl, 1955), which is computed as the strength and significance of the path coefficients for the prior and outer-loadings for the latter (Hair *et al.,*, 2017b).
- Third, the SEM outputs allow for the interpretation of how an improvement to one construct will affect the endogenous (dependent) variables through its direct (relational), indirect (mediating) and total effects, which is consistent with the idea of the configurational theory (Hair *et al.,*, 2017b).
- Fourth, the PLS technique is chosen, as it provides more robust estimators; it can comprehend the complexity of the proposed nomological network; and it allows for more exploratory investigations compared to CB-SEM (Hair *et al.,*, 2011).

By understanding the effect sizes between dimensions, practitioners are able to predict the potential outcome of improving one dimension (Jöreskog & Wold, 1982). The direct effects estimate the immediate effect from dimension A to B, while the indirect effects estimate a mediating effect from dimension A on B through C (as is the case for, e.g., digital integration towards servitisation success through the service integration dimension in Figure 9) (Matthews *et al.,*, 2018). In this case, it is relevant for practitioners to understand how digital integration does not possess any direct effect on servitisation success, but rather a relatively strong indirect (mediating) effect by improving several other dimensions simultaneously (see Publication 3, Table 23). This research adapts the PLS-SEM technique, as it is preferred for theory exploration studies (Hair *et al.,*, 2019b). PLS-SEM aims at maximising the explained variance of the endogenous (dependent) variable to increase the causal explanation of the model (Hair *et al.,*, 2011). An endogenous variable is explained by an antecedent construct and is a dependent variable per se (Hair *et al.,*, 2017b;Matthews *et al.,*, 2018). Due to the relational complexity of the adjusted MdSeMM, several endogenous variables are computed simultaneously. From the example of the adjusted MdSeMM in Figure 9, 'market reach', 'organisational governance, 'value function', 'service integration' and 'servitisation success' are all endogenous (dependent) variables. Each iteration of the SEM is a set of regression computations computing each of the endogenous variables with respect to the relational effects among them (Hair *et al.,*, 2010, p.

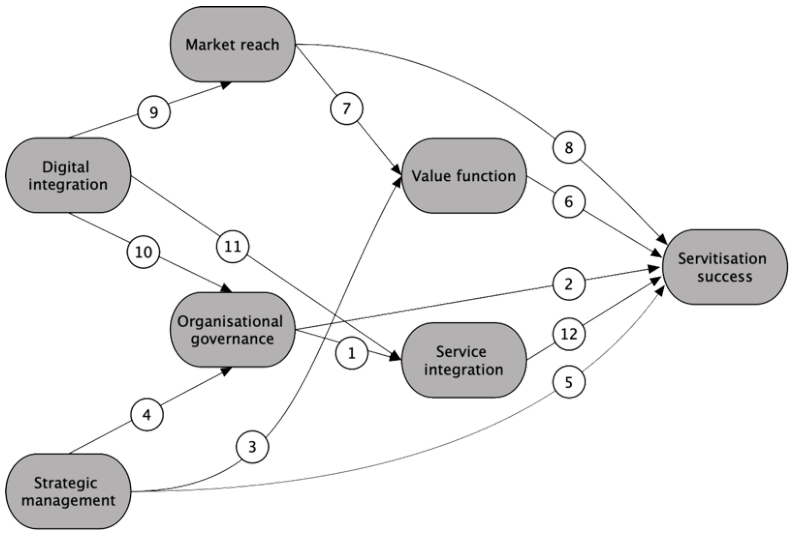

Figure 9: The adjusted MdSeMM model from Publication 3.

547). PLS-SEM is considered to be a composite-based SEM method, as it assumes that the concepts of investigation can be measured as composites (Jöreskog & Wold, 1982); that is, a weighted, accumulated composition of the associated indicators for each construct.
The measurement model allows us to set the relations among the observed indicators and their associated latent constructs by defining a specific structural model (Bollen, 1989). Hence, the observable indicators, the latent constructs, and the indicators' associations with the constructs are formed before the structural model (Martínez-López *et al.,*, 2013), whereof the measurement mode occupies a crucial part in the structural modelling, as it amplifies the meaning of the constructs (Martínez-López *et al.,*, 2013, p. 124). In this PhD, the observable indicators are seen as functions of the latent construct resulting in the indicators being manifested by the associated latent construct (Diamantopoulos & Siguaw, 2006). As discussed in section 2.3, the latent constructs represent the maturity of the associated construct, which is a concept that exists independently of the indicator's presence (i.e. reflective), contrary to a formative construct, which is combined by its indicators (Coltman *et al.,*, 2008). While these indicators do possess a broad theoretical theme, they are believed to be interchangeable and aligned through the theory of maturity. However, the results from Publication 3 indicate that the item is indeed inter-correlated through the assessment of the internal consistency, reliability and AVE, while the item relationship with the constructs was also obtained by assessing the convergent and discriminant validity, as evaluated in section 5.1 (Coltman *et al.,*, 2008). The measurement mode then follows a reflective perspective for both models in Publications 1 and 3. For reflective measurement models, the indicator composite is based on a set of correlation weights (i.e. outer loadings), which accounts for the correlational interference in its explanation of the latent construct (Hair *et al.,*, 2011). Hence, the outer loadings possess the ability to reflect the approximated influence of the associated construct to interpret the maturity of the outer model (Hair *et al.,*, 2011), which leads to the third reason for selecting PLS-SEM as a technique for this study: The discussed outputs of PLS-SEM validate the theorised measurement and structural model while also facilitating a new assessment tool for practitioners to make more qualified decisions. Further, the validation of the models confirms and adjusts the proposed nomological network, permitting others to extend the nets further, which extends our knowledge of servitisation, as emphasised by Cronbach and Meehl (1955) as the fourth and fifth principles. This is in accordance with the objective of the abductive approach and the pragmatic perspective on truth. Following the best practices proposed by Hair *et al.,* (2017a);Hair *et al.,* (2019b);Hair *et al.,* (2020), the exploratory approach follows a reduction of the theoretical model by estimating and evaluating the measurement model and the structural model. This has been conducted for both the initial MdSeMM in Publication 1 and the adjusted MdSeMM in Publication 3, both of which present the computations, outputs and interpretations of the models.

3.8 Evaluation of the research methodology

Following pragmatism, 'truth' is believed to exist when new knowledge is applicable and relevant for the real world. This study seeks to obtain a high degree of applicability and coherence with existing knowledge by inviting the servitisation community to evaluate the theory before the final validation. Crucial feedback on applicability and suggestions for indicator adjustments led to an improved model for answering the research question. More importantly, recognised servitisation scholars Ali Bigdeli and Kawal Kapoor from Aston University accepted my invitation to theoretically disprove the existence of the six dimensions and the theorised relations between them, which resulted in them confirming them as being

satisfactory for the servitisation transformation. Likewise, the highly cited Associate Professor Veronica Martinez-Hernandez from the University of Cambridge agreed to collaborate on developing and testing the measurement model for the final paper (Publication 3) to answer SQ4. The objective of this involvement with the servitisation community has been to achieve literary coherence, managerial applicability and high-quality research. Through the application of systematic literature reviews and by adopting the best practices within PLS-SEM, I aspired to remain as objective as possible to avoid biasing the results and interpretations. By disseminating new thoughts and conceptualisations for the servitisation community, academic colleagues and members of the Servitize.DK project, I strived to include existing knowledge and experience within my field. In the following, the research quality is examined and evaluated for both the qualitative and quantitative approaches.

3.8.1 The research quality

The evaluation of the research quality of the PhD research in its entirety is discussed and presented in the following. The evaluation focuses on the systematic literature review part with emphasis on the qualitative assessment of the conceptualisation (Bryman, 2016)) and the quantitative part (validation of the models through PLS-SEM).

3.8.1.1 For the systematic literature review

The assessment of the systematic literature review (SLR) in this PhD relies on three levels of assessment: a) the structure of the search and selection of papers for the review (Hiebl, 2023b), b) the qualitative analysis of the reviewed papers due to their qualitative nature (Lincoln & Guba, 1985;Hiebl, 2023a), and c) the systematicity of the entire review (Simsek *et al.,*, 2023). Kunisch *et al.,* (2023) argue that SLRs can be assessed in various ways depending on their combination of methodologies, including an assessment as both quantitatively and/or qualitatively oriented. While the high degree of systematicity of SLR might lead the reader to a quantitatively oriented analysis of, for example, the frequency of terms (as expressed as the original thought of SLRs (Kunisch *et al.,*, 2023, p. 6)). This study uses the systematicity to improve the 'complete census of relevant literature' (Webster & Watson, 2002, p. 16) and to 'minimizing bias, to produce more reliable findings to inform decision making' (Kunisch *et al.,*, 2023, p. 6). However, as the majority of the servitisation literature is based empirically on qualitative findings (Kowalkowski *et al.,*, 2017b), this research seeks to conceptualise the categories of dimensions in a qualitative manner. This, as the reviewer according to Hiebl (2023a) must interpret the findings and their meaning in the conceptualisation, which is often reinterpreting the qualitative findings from the reviewer's own context; something that is not possible when reviewing quantitative papers (Hiebl, 2023a). It is therefore important to assess the quality of such qualitative analysis, which is accomplished using the four criteria established by Lincoln and Guba (1985), but also the systematicity of the review as a whole.

a) Assessing the quality of the search and selection procedure

Following Hiebl (2023b), an important part of the SLR is a high degree of transparency in the selection of prior academic work, and he emphasises three objectives of SLRs: That they be 1) structured, 2) comprehensive and 3) transparent.

Structured relies on an outlined order that must be well explained, founded and not arbitrary (Hiebl, 2023b, p. 231). This has been strived for and accommodated through the

adaptation of existing, well-defined procedures for sorting and filtering papers for review (Bryman, 2016, p. 92;Brax & Visintin, 2017) (see section 3.6.1). **Comprehensive** refers to whether the review covers all of the relevant research items (Hiebl, 2023b, p. 231), which has been attempted via the structured inclusion and exclusion criteria formalised by the adapted procedure (Brax & Visintin, 2017), thus with adjustments to meet the research question (e.g. SLR1 with Servitisation as context). **Transparent** reviews allow other researchers to trace the sample selection within a study by illuminating the sample and methodological steps conducted to arrive at the specific sample (Hiebl, 2023b, p. 231). While the transparency in Publications 1 and 3 had a high priority for the researchers, these steps were outlined in a concise manner due to the limited space of the papers. As suggested by Hiebl (2023b, p. 231), the optimal scenario is to publish a separate SLR paper to obtain this transparency. To obtain such transparency in the project in hand, however, these steps have tentatively been elaborated in the methodology chapter, section 3.6. It is felt that the dissertation has achieved all three objectives.

b) Assessing the quality of the qualitative analysis

Lincoln and Guba (1985) suggest four criteria for evaluating the trustworthiness of research: credibility, transferability, dependability and confirmability. These four criteria are used to evaluate the quality of the conceptual work of the research and are examined individually. The quality of the research process is proposed to be evaluated on the basis of criticality, reflexivity, honesty and integrity (Major & Savin-Baden, 2010, pp. 79-84) and is evaluated briefly. Criticality has been applied by inviting two external researchers (Ali Bigdeli and Kawal Kapoor from Aston University, UK) to disprove the conceptualised six dimensions and another to criticise the theorised hypothetical relations between dimensions (Veronica Martínez from University of Cambridge, UK). Reflexivity has been applied by involving academic colleagues and recording and documenting interpretations and decisions. The intention here has been to mitigate my own convictions and prejudices as to the research problem while simultaneously limiting the framing of the most relevant findings and the angle of investigation (Malterud, 2001, pp. 483-484). This has likewise been approached through universalism within the discussion of systematicity in the latter part of this chapter. Honesty and integrity have been pursued in terms of being true to the knowledge extracted from the SLRs and by being aware of own prejudices when interpreting this knowledge, as highlighted by Hiebl (2023a).

Credibility – The confidence in the truth of the findings is what constitutes credibility (Lincoln & Guba, 1985). To establish confidence in the conceptualisations and theorisations within the research, additional analysts were involved to establish ***analyst triangulation*** (Patton, 1999). In the identification of the six dimensions, for instance, two researchers (Postdoc Troels Andersen and I) evaluated in parallel the presence of the dimensions. Later, during the preparation of the adjusted MdSeMM, Ali Bigdeli and Kawal Kapoor were then invited to disprove the existence of the dimensions and to clarify whether other dimensions were excluded; this to improve the confidence in the conceptualisation of the dimensions. In addition, the two researchers provided the research with ***peer debriefing***, as the external researchers critically assessed the research design, emergent hypotheses and incorporated indicators (Lincoln & Guba, 1985), all of which provided ground for more explicit considerations. Further to this, the items and scales were critically assessed by an English linguistic expert (from the University of Cambridge) and a service industry expert to improve the clarity and interpretations. These initiatives are believed to bring the findings of the PhD closer to the reality of the practitioners, which is believed to have improved the credibility of the findings (Lincoln & Guba, 1985).

Transferability – The conceptualisation is based on the general knowledge of servitisation and does not take any cultural aspects into account (despite the translation of the questionnaire). Although the study is conducted in a Danish context, the model is believed to be applicable in other countries with respect to the transferability of the incorporated theories. This research has focused on establishing a thorough understanding of the research setting (i.e. a ***thick description***; (Lincoln & Guba, 1985)) for each publication to allow the practitioners to assess the transferability to their situation and context.

Dependability – Particular effort was made to account for and record all of the research activities and decisions to explicate all of the changes occurring in the course of the PhD project (Savin-Baden & Major, 2013). Recording these decisions, rationales and recommendations helped to establish consistency throughout my studies. This was partly achieved by making note of new lessons learned and perspectives, partly to ensure transparency in publications by noting the research design and method decisions to enable replicability of the studies. Furthermore, the researcher strived to follow logical, traceable and clearly documented processes (Nowell *et al.,*, 2017) with respect to the recommendations made in the existing literature. To improve the learning process and to ensure the dependability of the research, the involvement of external peers has been a general priority of the project, including the involvement of the servitisation community through email correspondence and virtual meetings to discuss my research results and how they should be interpreted, including correspondence with Associate Professor Bart Kamp about the methodological approach for improving and developing the initial MdSeMM model further in May–June 2021. The consistency and applicability of the findings were also examined by presenting the findings of the initial MdSeMM for the board of researchers within the Servitize.DK project in October 2021.

Confirmability – According to Lincoln and Guba (1985), confirmability is achieved when credibility, transferability and dependability are all established. Confirmability is established when clarity is achieved in terms of how the researcher has arrived at their interpretations and conclusions (Nowell *et al.,*, 2017). This has led to an increased focus on adopting established, acknowledged and recommended methods and procedures to obtain transparency. For the same reason, the researcher aspired to present the underlying reasons for the chosen theoretical, methodological and analytical approaches to allow readers to understand 'how' and 'why' they were adopted (Nowell *et al.,*, 2017).

c) Assessing the quality of the systematicity of the entire review procedure

The model for systematicity has been adopted from Simsek *et al.,* (2023) to evaluate the ability of the dissertation to select, review and analyse the relevant literature systematically and in an explicit manner by assessing the principles of systematicity: transparency, coverage, saturation, connectedness, universalism and coherence. Kunisch *et al.,* (2023, p. 33) also emphasise systematicity as a central estimator of the SLR execution, with principles such as transparency and completeness. The six principles of systematicity are used to evaluate the quality of the SLRs in the dissertation and are presented and evaluated briefly in the following.

According to Simsek *et al.,* (2023, p. 295), the principle of **transparency** follows three requirements: a) 'reviewers must be open and explicit about processes and methods used', b) 'demarcate the linkages between the observations collected from the literature and the findings or conclusions of the review', and c) 'should make clear the assumptions underpinning the review'. The first requirement has been accommodated by being explicit

about the review procedure and the methods used (e.g., the qualitative techniques used for conceptualisation presented in sections 3.7.1 and 3.7.2), and it has been discussed in *structured* and *transparent* in the above (pp. 69–70). As regards the second requirement, the demarcation of observations during the review and the findings have been incorporated as arguments from the literature to support the findings (e.g. section 2.3.3 with the presentation of the laws of construct association based on observations from the review). These observations have also been used as arguments in the presentation of the key dimension in section 2.3.1. c) in the presentation of the procedure, all assumptions and definitions of, for example, the subjects of servitisation success, have been outlined to enable a transparent review and a common understanding of the underlying assumptions (see section 3.6.1).

Completeness relates to the degree of coverage in the literature regarding the scope of the research subject (Simsek *et al.,*, 2023, p. 295). This involves all available sources of literature, including grey literature (Adams *et al.,*, 2017, p. 432). This project has focused on peer-reviewed academic papers, because one of the aims of the study is to consolidate the existing knowledge base. As the grey literature most likely includes important and relevant aspects that have yet to be published, these aspects have potentially been overseen in the review, whereas this study most likely does not obtain a high degree of completeness. Within peer-reviewed publications, however, this study did strive to incorporate all of the relevant items within the scope. This was completed by following the predefined selection and filtration procedure, which started broadly (to include all potential studies) and excluded the irrelevant papers based on a close valuation of relevance for the subjects (see section 3.6.1). In continuation of the completeness, the third principle of systematicity is **saturation**, which assesses whether 'no additional data are being found' if extending the number of reviewed papers (Simsek *et al.,*, 2023, p. 295). To test the saturation of the reviews and to overcome personal biases (as will be discussed later in universalism), external scholars were invited to challenge the findings of constructs, the laws of associations, and the assessment of servitisation success (as discussed in the section on credibility above and in the introduction to this chapter). Furthermore, the saturation was believed to be obtained due to the broadness of the inclusion of the relevant literature mentioning the subject of servitisation (during SLR1) and servitisation success (SLR2), although I acknowledge and subscribe to the view espoused by Hiebl (2023a, p. 323), that comprehension (i.e. completeness) can be hard to obtain. Further along these lines, the invitation of external scholars was seen as an important step to ensure saturation, as I easily could (and might) have overseen important aspects of the literature. This is in line with what Hiebl (2023a, p. 322) has written about trust; that if the missing aspects are indeed important, peers and journal reviewers will identify and criticise such absence.

Connectedness relates to whether the reviewer acknowledges the potential linkages and connections among various facets of the literature (Simsek *et al.,*, 2023, p. 295). The objective of identifying key dimensions of servitisation might have steered the research to the degree where the reviewers might have lost sight of the potential alternatives. However, the dimensions were used as key facets of the field, and a particular emphasis on the relations between these facets was established in SLR1. In SLR2, dissimilarities were also established (various understandings of success) although the focus was on establishing a common denominator for success within servitisation, which underpins the ability of the reviewer to obtain multiple perspectives simultaneously (Publication 2). Moreover, the external scholars' evaluation of the SLR1 and SLR2 results would appear to imply that (to their knowledge) no further relations or implications were overseen. This would appear to indicate saturation.

Universalism relates to the principle of overcoming biases and remaining impartial when reviewing papers (Simsek *et al.,*, 2023, p. 295). In the review process, the researcher strived to obtain a high degree of objectivity by; following the detailed, predefined procedures when selecting papers (3.6.1 p. 62), developing a profound note system in Excel with all of the related questions or information to be extracted based on theory and new learning (section 3.6.1 p. 63), and finally following predefined analysis techniques adopted from similar studies (sections 3.7.1 and 3.7.2). Further, all changes to the review were discussed with colleagues (e.g. R. Goduscheit and T. Andersen) to determine the relevance, importance and consequence of such changes while challenging the arguments for doing so.

Coherence relates to whether the reviewer has applied the explicit methods and processes throughout the entire research project (Simsek *et al.,*, 2023, p. 295). The systematic – and in particular transparent – principle has been used in both reviews (SLR1 and SLR2) and throughout the research. This has been evident in the detailed notetaking system to document the observations, decisions, consequences and convictions. This has been used to learn from the process (as discussed regarding dependability above), but also to continuously test the argumentation for the decisions being made, thereby improving the coherence of the systematicity.

3.8.1.2 Quality of the quantitative research

The cross-sectional design specifies three measures of quality that must be achieved for a quality research (Bryman, 2016): validity, replicability and reliability. The replicability of the study is steered by whether other researchers are able to replicate the exact same study. The procedures for selecting respondents, designing measures of concepts (maturity and success), administering research instruments (online surveys) and analysing the data through PLS-SEM have therefore been explicitly described in the papers (Bryman, 2016). Additionally, established and acknowledged procedures for PLS-SEM research (e.g. Hair *et al.,* (2021)) have been applied to ease the replication of others (e.g. Hair *et al.,* (2021)). The assessment of reliability and validity follows the recommended techniques, thresholds and relatable academic standards of PLS-SEM (Hair *et al.,*, 2020).
To evaluate the validity of the measurement model, the content validity, convergence validity (average variance extracted > .50) and discriminant validity (HTMT < .85) have been applied to both the initial MdSeMM and the adjusted MdSeMM in Publications 1 and Publication 3 (Hair *et al.,*, 2019b;Hair *et al.,*, 2020). **Content validity** relates to whether the vital theoretical aspects of a construct are approximated through the incorporated indicators (Hair *et al.,*, 2017b). Hence, content validity is highly theoretical and related to the theorisation of the measurement model. Profound conceptualisation and theorisation are then crucial (as evaluated in section 3.8.1.1), while the reduction of the model should carefully remove any theoretically important indicators. The removal of indicators (due to unreliability) has therefore been critically examined following the Hair *et al.,* (2019b) guidelines for careful step-wise removals (see description in Publications 1 and 3). However, reflective measurement models (which is the case for both MdSeMMs) are less sensitive for the removal of indicators than is the case for formative models (Hair *et al.,*, 2021). This is due to the nature of reflective indicators, as they are caused by the same construct and should therefore be highly correlated and interchangeable (convergent validity) (Hair *et al.,*, 2017b, p. 47). Thus, individual items can generally be removed as long as the construct is reliable (construct reliability) (Hair *et al.,*, 2017b, p. 47). This ensures the achievement of the content validity in the studies.

Convergent validity refers to whether indicators relate to other indicators of an associated construct (Hair *et al.,*, 2020); in other words, whether associated indicators are measuring the same phenomenon. This was obtained for the adjusted model, which illustrates how the incorporated indicators measure the same phenomenon of the associated construct with individual theoretical deviations, thereby also obtaining the reflective requirement of correlated indicators (Hair *et al.,*, 2017b, p. 47). **Discriminant validity** refers to whether constructs truly differ from other constructs within the same model or if they represent the same phenomenon (Henseler *et al.,*, 2015). This is obtained with an HTMT <.70, implying that each construct represents a unique aspect of the transformation. Concluding on the validity evaluation, the indicators are clearly good representations of the theory behind each construct, while each construct represents a unique part of the transformation, thereby ensuring the validity of the items, indictors and constructs. Additionally, the **external validity** has been accommodated and evaluated using two approaches. Firstly, the data collection was designed to achieve replicability through the stratification of the sampling to represent all manufacturing SMEs in Denmark to enable representative and generalisable results (Kim & Toya, 2019). As illustrated in appendix V, however, the stratification was not fully obtained for the sample, as some sub-industries did not follow the exact industry proposition. Further along these lines, the sampled proposition of firm size and firm age are believed to be consistent with the industry proposition (see Table 19). The second approach evaluated the external validity statistically using the PLSpredict technique to compute the out-of-sample prediction of the model (Hair & Alamer, 2022). This accounts for the ability of the model to predict the outcome of observations outside the sample, hence stressing the extent to which the studies attain external validity.

To evaluate the reliability of the measurement model, the internal consistency reliability (Cronbach's alpha), indicator reliability (> .50) and construct (composite) reliability (Jöreskog's rho_c > .70) have been applied for both the initial MdSeMM and the adjusted MdSeMM in Publications 1 and 3 (Hair *et al.,*, 2019b;Hair *et al.,*, 2020). The **internal consistency reliability** relates to whether the indicators that are measuring the same phenomenon are associated with each other (i.e. the presence of intercorrelation) (Hair *et al.,*, 2021). This is a requirement for the reflective measurement formatting and indicates the consistency among indicators. This has been obtained for the reduced adjusted MdSeMM (see Publication 3). The **indicator reliability** relates to the amount of variance explained by the associated construct in the reflective measurement model. This is computed by squaring the indicator loadings to measure the amount of variance shared between the indicator and its associated construct (Hair *et al.,*, 2019a). A low indicator reliability indicates that the construct fails to explain the outcome of that indicator. Unreliable indicators have been removed from the initial and adjusted models, as the procedure prescribes (Hair *et al.,*, 2019b). This ensured that the included indicators were relevant for the model. **Construct (composite) reliability** relates to the quality of items measuring the construct, indicating that all items are consistently measuring the associated construct (Hair *et al.,*, 2021). In conclusion, the indicators and items are formalised correctly and measured consistently with the associated indicators, while these indicators are explained by their associated construct.

The overall validity and reliability of the measurement model for both MdSeMMs were deemed acceptable, albeit with considerably improved results in the adjusted MdSeMM. This indicates that the adjustments from the initial MdSeMM have had a positive influence on the performance of the model. To evaluate the structural model, the **explained variance** for each endogenous variable (R^2) and the path coefficients' **effect size** (f^2) were examined for both models. Only in the case of the adjusted model was the **out-of-sample prediction** calculated to evaluate the predictive power of the model (Shmueli *et al.,*, 2019). Again, the adjusted model

produced improved results, indicating a better-structured model. A detailed evaluation of each model is presented in the analysis section of Publications 1 and 3. These evaluation criteria follow the best practice in the literature (Hair *et al.,*, 2019b), and the results are indeed acceptable compared to related studies (e.g. Zhu *et al.,* (2018); Sousa and da Silveira (2017)).

The researcher strived for a high level of objectivity by adopting and applying predefined and well-articulated procedures for analysis, which were valid for both the systematic literature review (the procedure by Brax and Visintin (2017) as discussed in section 3.6.1, the conceptualisation of the nomological network, and statistical techniques, which, via standardised procedures and neutral rules, minimise the number of external influencers (Bryman, 2016, pp. 271-272)). Additionally, I worked to overcome the biases of my own beliefs, values and opinions by inviting scholars from various parts of the servitisation field and statisticians to challenge my results and interpretations (as discussed in section 3.8.1). This was mainly for the theorisation of the nomological network (Kapoor, Goduscheit, Martínez, Bigdeli, and Vestergaard) but also for the development of the questionnaire (Kapoor and Cambridge linguistic experts), the selection of computational techniques and thresholds (Vestergaard and Thøgersen), and interpretation of the results from the final model in Publication 3 (Martinez, Goduscheit and Vestergaard).

3.9 Summary

This chapter has described the philosophical stance and research approach as means for the research strategy covering the three-year PhD research project. The research philosophy has been described in terms of pragmatism with a particular focus on an exploratory approach to develop a practical solution to the problem. In an abductive approach, this is achieved by shifting between conceptualisation based on the existing literature and expert interventions and quantitative investigations by statistically testing the theorised MdSeMM through PLS-SEM. The research quality was ensured by applying best practice methodological techniques and approaches together with the author's involvement in the servitisation community to triangulate the conceptualisations. The objective was a high degree of systematicity to ensure a coherent and transparent study. In the next chapter, the appended publications are presented together with the learning presented in each publication, which led to the next.

PART TWO
The Appended Papers

"Sometimes the fastest way to get there, is by going slow"
John Vestergaard Olesen, PhD, Co-Supervisor
Inspired by Tina Dickow

4. Appended publications

The methodology chapter unfolded the design and strategy of the PhD research in its entirety. The research involved in developing a profound SeMM led to four studies submitted as two journal papers and three conference proceedings (one of which was invited for a special issue at the international journal of technology management (IJTM). In this chapter, three of the main studies are presented as Publications 1, 2 and 3, while the main lessons learned from Publication a are presented briefly. As stated in section 3.3, Publication a laid the theoretical and conceptual foundation for the initial SeMM. From here, the lessons learned included the identification of the six dimensions, maturity indicators for approximating the dimensions and the gathering of knowledge to allow for theorising the nomological structure of the initial SeMM through SLR1 and LR2 (see section 3.6.1). The six identified dimensions were digital integration (DI), strategic management (SM), market reach (MR), organisational governance (OG), value function (VF) and service integration (SI). Based on the reviews, several theory-based relational hypotheses suggesting a relation between two dimensions as well as the direction of the relation were proposed for validation. This knowledge was used to establish the first nomological structure of the initial SeMM.

Publication 1 is the initial SeMM study, which presented the idea and conceptualisation of a multidimensional servitisation maturity model for the first time at the Spring Servitization Conference in 2021. Following the abductive reasoning, this was the 'most likely solution' to the managerial problem based on the existing knowledge (Bryman, 2016) (see related discussion in section 3.3)

Title of paper	The multi-dimensional hierarchical structure of the servitisation transformation
Publication status	Published in conference proceeding at the SSC21.
The research question	Hypothesised nine theoretic relational effects among the six dimensions to establish the coexistence of these.
Methodology | data sources	Conceptualisation based on SLR1 and LR2 and survey data for statistical validation.
Methodology | sampling strategy	Online self-completion survey distributed to publicly available emails to randomly selected companies within the target group; that is, Danish Industrial SMEs.
Methodology | analysis technique	Partial least squares structural equation modelling. Software: SmartPLS 2.0.
Main findings	Seven (out of nine) significant relations were identified, emphasising the coexistence of servitisation dimensions despite weak statistical outputs.

Table 9: Overview of Publication 1 (initial SeMM study)

Publication 2 identifies and defines servitisation success, and it describes how the literature is concerned with the achievement of servitisation. This study was first presented at the 22nd Continuous Innovation Network Conference (CINet) in 2021. It was subsequently invited for submission to a special issue of the International Journal of Technology Management (IJTM) and accepted for publication in November 2022.

Title of paper	Tension in the assessment of servitisation success: A conceptual approach
Publication status	Accepted for publication (November 2022).
The research question	What are the inherent tensions and paradoxes in the measurement of servitisation success?
Methodology | data sources	Academic articles and review articles.
Methodology | search strategy	Systematic literature review of existing publicly available scientific articles. Search terms: serviti*ation, succes*, achieve*. Parameters: English, academic articles and review articles. Database: Web of Science.
Methodology | analysis technique	Typology-based conceptualisation through a combination of servitisation definitional types and the servitisation success definitions.
Main findings	Revising the methodological view of servitisation success emerging from identified definitions. Conceptualises new approaches to understanding servitisation success.

Table 10: Overview of Publication 2 (servitisation success study)

Publication 3 is an adjusted SeMM study. It presents the final conceptualisation and validation of the model. This paper is submitted to the *International Journal of Operation and Production Management* (IJOPM) in February 2023. This paper has been a great international collaboration with scholars from Aston University, University of Cambridge and Aarhus University.

Title of paper	Developing a substantiated servitisation maturity model in a multidimensional reality: A statistical investigation of the key dimensions
Publication status	In peer review (submitted February 2023)
The research question	How do the relations between dimensions influence the success of the SME servitisation transformation, and to what extent do they impact the operational importance of the dimensions?
Methodology | data sources	Conceptualisation based on SLR1 and LR2 and survey data for statistical validation.
Methodology | sampling strategy	Online self-completion survey distributed to publicly available emails to randomly selected companies within the target group. Additional phone calls to inform potential respondents about the research.
Methodology | analysis technique	Partial least squares structural equation modelling. Software: RStudio – SEMinR package.
Main findings	Confirms the presence of eight relations between the key dimensions of servitisation. Confirms the multidimensional reality through the identification of additional mediating effects. First evidential maturity model within servitisation. First to validate and weigh the relations between key dimensions and their maturity indicators.

Table 11: Overview of Publication 3 (the adjusted SeMM study)

In line with the abductive approach, the PhD project was continuously adjusted and guided back and forth between conceptualisation and validation. These adjustments were guided by the lessons learned from each study presented after each of the three papers below (sections 4.1.1, 4.2.1 and 4.3.1). The key findings of the three publications and how they address previous calls and literature gaps are presented and summarised in section 4.4.

4.1 Publication 1

The Multi-Dimensional Hierarchical Structure of The Servitisation Transformation

Michael Engkær Engsig Madsen

ABSTRACT

Purpose: This paper is studying the hierarchical structure of the six servitization dimensions, in order to help the reader understand the potential relational maturity effects emerged among these.

Design/Methodology/Approach: This study is framed upon a theoretical reasoning of nine hypothetical relations among servitization dimensions. These postulated relations are investigated by a statistical partial least square analysis, based on 101 observations of Danish SME manufacturers.

Findings: Seven significant relations were identified which emphasise the coexistence of a multi-dimensional transformation. None of these relations were found to add a negative effect.

Originality/Value: As one of the first quantitative studies to investigate the coexistence of multiple servitization dimensions, this study leads to valuable insight and a set of new research avenues.

KEYWORDS: servitization, maturity, multi-dimensional, consequential effects, partial Least Square

1. Introduction

Servitization is an organisational transformation embracing the entire organisation (Baines *et al.,*, 2009b). Previous literature has assumed that this transformation is following a redefined and structured path (Oliva & Kallenberg, 2003), and while the structured progression models are mainly based on large manufacturing firms (Brax & Visintin, 2017), it seems that the versatility of SMEs, facilitate them to succeed through various value constellation in a multifarious progression (Kowalkowski *et al.,*, 2013). This indicates that the servitization transformation, in reality, is unstructured and following a continuum.

Hence, the maturity of servitization should be understood in a similar manner. Additionally, it is believed that the servitization transformation should be viewed in a multi-dimensional perspective (Baines *et al.,*, 2017). While servitization is following a continuum, such multiple dimensions follow a simultaneous progression, which potentially entail a relational influence among each other. Thus, a superior understanding of such relations is crucial to understand the total effects toward a successfully progression of servitization. Furthermore, such understanding includes the relational consequential effects among the dimensions (Kindström & Kowalkowski, 2014). For this reason, it is the researcher' vision to identify the pathway towards a successful servitization transformation, through unique maturing combinations of the servitization dimensions and underlying components. Firm maturity is defined as the increased capability to manage specific domains (Rapaccini *et al.,*, 2013, p. 302). By adopting the view of positive and negative consequential effects, it is believed that a successful

transformation consists of the right proportion of several dimension' maturity level. To consider the maturing proportion a profound understanding of the dimensional relations is necessary. Yet, although recent servitization research have successfully presented a comprehensive, or even holistic, framework for understanding the servitization maturity in a multi-dimensional perspective (Adrodegari & Saccani, 2020). It have been emphasised that a profound maturity model embracing the transformation as a whole are still missing, as important components like management and strategic dimensions are absent in current models (Andersen *et al.,*, 2020). Extending the thoughts of Adrodegari and Saccani (2020), Andersen *et al.,* (2020) identified six generic dimensions (organisational governance; strategic management; value function activities; market reach; digital integration; and service integration) consolidated by existing literature of servitization and conceptualised upon prior servitization maturity models (e.g. Jin *et al.,* (2014)). For this reason, these extended dimensions are employed in the further investigation. However, prior research overlooked the importance of understanding the relation among co-existing dimensions, hence failing in taking the fluctuating progression into account. As It is reasonable to believe that such relations are not equivalent among each dimension, a certain hierarchical order may occur. For this reason, the research is studying the hierarchical structure of the six servitization dimensions, in order to help the reader understand the relational effects emerged among these.

2. Theory and hypothesis

2.1 The Relation of Servitization Maturity Components

As stated by Adrodegari and Saccani (2020), only few studies have constructed a servitization maturity model (MM) of the transition toward service businesses. The degree of maturity has been assessed upon multifaceted levels, and consist in the literature of pre-defined levels of maturity (Rapaccini *et al.,*, 2013), theoretical defined prescriptions (Wikström *et al.,*, 2009), and evaluating own performance scores (Coreynen *et al.,*, 2018). A similarity for the prior MM is it, that each of the presented MM' evaluate the maturity level of each component individually, and not in relation to each other. Neither do they consider the outcome of other components. An exception is the study by Coreynen *et al.,* (2018), who evaluate the maturity level of each component on multiple observable variables, but who did not consider the relations among the components. For this reason, it leaves a potential to further develop our understanding of MM' by incorporating such balanced view of the relational connections among each dimension, which to our best knowledge has not been achieved within servitization.

2.2 The Hypothetical Relations of Servitization Maturity Dimensions

2.2.1 Organisational Governance

The organisational governance (OG) refers to a firms' ability to build, integrate and align the organisation with the transformational properties from embarking on the servitization journey (Andersen *et al.,*, 2020), from which new experiences and realities emerges for the manufacturer (Oliva & Kallenberg, 2003). These new realities comprise of the need for re-engineer new organisational structures to facilitate service design and delivery (Rapaccini *et al.,*, 2013;Jin *et al.,*, 2014), and the awareness on managing strategic choices by developing clear, implementable service management policies, process and resources (Tukker & Tischner, 2006). The degree of formalised procedures and processes have been seen as a progression of servitization, as these ensures consistency and quality (Jin *et al.,*, 2014). While such formalisation of the organisation follows the organisational concept (Wikström *et al.,*, 2009),

it is reasonable to believe that such elements have a positive influence on service infrastructure, thus relating to integration of services. Service integration comprise among other things of the firm's ability to seize service opportunities (Coreynen *et al.,*, 2018), whereas elements as processes, capabilities and available resources influences the outcome of this dimension. For this reason, are the following hypotheses stated: **H[1]**: *A manufacturing firms' degree of organisational governance have an impact on the degree of service integration.* In similar constellations, are the value function activities positively influenced by the allocation of resources, and the organisational structure to facilitate co-created value (Huikkola *et al.,*, 2016), this in term of procedure and processes (Coreynen *et al.,*, 2018), organisational concept, and personnel approach (Wikström *et al.,*, 2009). This in particular by establishing dedicated teams and roles for new service development, and developing specific sales tools, methods and procedures for cost of ownership models (Adrodegari & Saccani, 2020): **H[2]**: *A manufacturing firms' degree of organisational governance have an impact on the degree of value function.* Further, the availability of resources, formalisation of procedures and processes, and the organisational concept all are seen as instruments for the management to implement new strategic directions. Hence: **H[3]**: *A manufacturing firms' degree of organisational governance have an impact on the degree of strategic management.*

2.2.2 Strategic Management

Strategic management (SM) refers to firms' ability to build and maintain strategies in order to successfully implement servitization (Baines *et al.,*, 2017;Andersen *et al.,*, 2020). Prior research investigating the consequences of servitization have emphasised that servitization is a beneficial strategy if managed properly and with strategic focus (Baines *et al.,*, 2009b;Neff *et al.,*, 2014). The managerial commitment poses a fundamental role in maintaining and building strategies of the transition (Neff *et al.,*, 2014;Lexutt, 2020), and is seen as an important element for the value function activities. As the managerial mindset changes toward customer-centric logic, it will facilitate better value propositions through customer integration, hence leading to new value creation and optimised cost structures (Huikkola *et al.,*, 2016;Liu *et al.,*, 2019). As well as the fundamental change of the organisational culture as accommodative to service provision (Baines *et al.,*, 2009b). Hence, **H[4]**: *A manufacturing firms' degree of strategic management have an impact on the degree of value function.*

2.2.3 Value Function Activities

The value function activities (VF) refer to firms' ability to embrace servitization by developing new business models that can create and capture value that servitization promises (Baines & Lightfoot, 2014;Andersen *et al.,*, 2020). Particular emphasis are placed on the value chain activities, regarding the responsibility to support service-products throughout the product life-cycle, along with finding an innovative way to make service more tradable, with a functional cost structure (Spring & Araujo, 2013). Managing the value chain activities within servitization can be challenging, and required skills have to be acquired through organisational governance (H^2) (Adrodegari & Saccani, 2020), as well as new up- and downstream partnerships. The latter, need to be managed effectively in order to leverage the needed capabilities in a strategic management perspective (H^4) (Cui *et al.,*, 2019;Adrodegari & Saccani, 2020). For this reason, market reach is an important component for the VF as the co-creation and solution development are enabled through the integration of customer needs (Lenka *et al.,*, 2017) and utilising network capabilities (Coreynen *et al.,*, 2017). Hence, **H[5]**: A manufacturing firms' degree of market reach have an impact on the degree of value function activities.

2.2.4 Market Reach

The market reach (MR) refers to firms' ability to scan the business environment to identify and apply external capabilities and resources in supporting the servitization journey through new and optimised service solutions (Andersen *et al.,*, 2020). Prior literature agrees on the importance of value co-creation of whom a particular emphasis is put on the role of customers and network partners (H5) (Rapaccini *et al.,*, 2013). Accordingly, digitalisation enables a deeper integration into customers processes, to reach new levels of servitization through increased network involvement and value creation (Coreynen *et al.,*, 2017), which potentially influences both the MR and VF of the firm. Hence, **H^{6}***: A manufacturing firms' degree of digital integration have an impact on the degree of market reach.*

2.2.5 Digital Integration

Digital integration (DI) refers to firms' ability to integrate new technologies, increase external accessibility and apply data as a resource for new service offerings (Andersen *et al.,*, 2020). Digitalisation is breaking barriers between industry segments and changing traditional value chains into the provision of services (Kuula *et al.,*, 2018). As such, incorporating digital services aims to develop the capturing and processing of data and information, allowing manufacturers to develop new business models by exploiting the potential of their products (Neff *et al.,*, 2014;Vendrell-Herrero *et al.,*, 2017). Hence, **H^{7}***: A manufacturing firms' degree of digital integration have an impact on the degree of value function.* Digitalisation enables better allocation of resources and more accurate information sharing within and outside the boundaries of the firm (Kindström & Kowalkowski, 2014). Both of which positively influences the market reach (H^{6}) and management governance. Hence, **H^{8}**: *A manufacturing firms' degree of digital integration have an impact on the degree of management governance.* Further, digital technologies and appliance create new opportunities and is understood as a core enabler and driver for servitization (Sjödin *et al.,*, 2020). Digitalisation is seen as essential for effective delivery by optimising the service infrastructure and processes (Reim *et al.,*, 2019), which potentially influence the service integration positively as the maturity of service integration increases: **H^{9}**: *A manufacturing firms' degree of digital integration have an impact on the degree of service integration.*

2.2.6 Service Integration

The service integration refers to firms' ability to integrate data appliance from service and product data, service infrastructure, and process and policy formalization into the development of new optimised service solutions (Andersen *et al.,*, 2020).

2.3 The multi-dimensional servitization maturity framework

The dimensions compose an essential role in the progression of servitization toward the achievement of it. Success is seen as a progression or development of the focal firm' performance toward a preferred situation (Bustinza *et al.,*, 2019), and should be assessed upon financial and non-financial measures. As such, the model is estimated to predict the servitization success (SS), and hence each dimension' prediction toward the endogenous variable (SS). The improvement of each dimension is believed to contribute to a successful achievement of servitization. Figure 10 illuminate the hypothetical relation among each dimension, and illustrates the complexity within the servitization field in a simplified manner. Further assessment of the dimensional impact of servitization success, are outside the scope of this study.

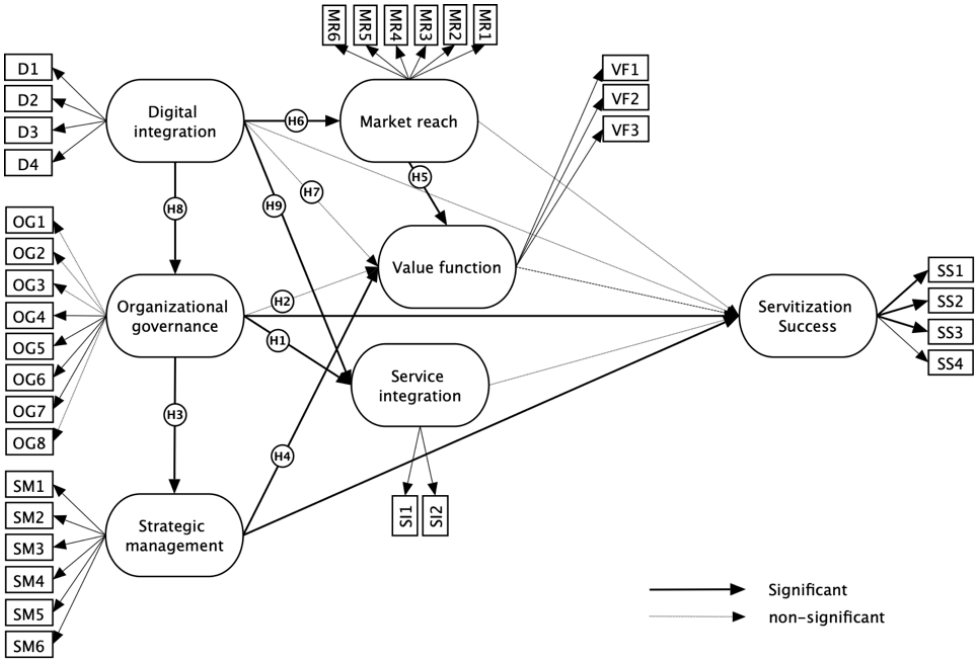

Figure 10: The servitization progression model

3. Methodology

Inspired by the study of Kohtamäki *et al.,* (2013a), the postulated relations are tested upon a partial least square (PLS), by computing the significance of the relations' path-coefficients. PLS is a suitable statistical tool for predicting the relationships rather than explaining them, in the latter covariance-based methods are preferred (Jöreskog & Sörbom, 1982). Generally, PLS is seen as more robust than other SEM techniques in violation of statistical assumptions, and are referred to as a distribution-free method (Vilares *et al.,*, 2010). The statistical tool SmartPLS 3.0 are used for this study.

3.1 Data Collection, Response Pattern and Respondents

The data collection was distributed through a web-based questionnaire sent to manufacturing firms registered under the Danish industry code ´C28. producers of machinery and tools´ within the Danish firm register (CVR.dk). This provided the study with 1.597 potential SMEs of which 1.194 had approved sharing contact information. Additional mails were sent to 358 SMEs enrolled in the Servitize.dk project, to ensure participants with varying degree of service implementation. The first notification comes with a brief description of the research purpose and the potential managerial contribution to encourage the respondents. A second notification were sent to all non-responders six days later. Following the ten times rule, a minimum of observations is estimated by the highest denominator of eighter the largest number of observable variables for a single latent variable (in this case 8), or the largest number of loadings toward a single latent variable (6) in the model (Hair *et al.,*, 2011). Thus, a required number of observations are set to 80 respondents. In total, 163 observations were gathered resulting in a response rate of 22,9% (82) for servitize.dk and 6,7% (81) for the industry. Three control variables were included to ensure the relevance of the observations. The degree of servitization established whether firms are involved in a servitization process assessed upon their service advancement (none, initial, repeatable, defined, managed or optimised) inspired by Rapaccini *et al.,* (2013). The number of employees states whether they are considered a SME (5 removed).

3.2 Measurement of Constructs

The measures and items used in this investigation are adopted from prior research in servitization maturity modelling. By adopting the item formulations by Coreynen *et al.,* (2018), each item are rephrased to statement-related whereas respondents evaluate recent performance upon each item. This evaluation was scaled on a 7-point Likert scale from 1 (strongly disagree) to 7 (strongly agree). As such, being positively related to the progression of servitization with respect for the adopted item' measures. Each item adopted this framing to ease the reading and interpretation by the respondent. As the study have rephrased and structured new items, a particular focus were made on testing the validity and reliability prior to distribution. To assess the internal validity of measures, items and the survey structure, three academic colleagues were invited to evaluate these aspects leading to smaller phrasing adjustments. Further, by inviting one respondent to conduct the survey while observed, additional linguistic adjustments were made. The survey was distributed in Danish, which potentially creates a misinterpretation due to linguistics. To protect the content validity of the translated items, a back-translation were made by letting an unbiased person translate the Danish version into English and compare the English versions. Finally, a pilot test was conducted for test of the measure' reliability and internal consistency. 200 respondents were invited to participate, providing 11 responses. From here, a Cronbach' Alpha (α = .976) proved the reliability and consistency of the measures (Hertzog, 2008, p. 185). The final distribution gathered 104 completed observations and 59 partially completed. All observations exceeding an 85% completion rate were merged into the dataset (n=125), and a further missing value analysis proved the values as Missing Completely at Random (P = .483). To avoid biased results from imputations, a pair-wise deletion was chosen during the investigation. This, however results in an uncertain effective sample size.

3.3 Common Variance

A preliminary analysis of the model and the dataset were made by evaluating the significance of both outer loadings and weights, controlling for variance inflation factors (VIF) and for outliers. This led to a sequential extraction of two items both insignificant in loadings and weights (SS4 and OG3), while no VIF' were identified at this stage. Additionally, an assessment of the factor scores led to a list-wise removal of 24 outliers, with an absolute value above 1.96 (α=.05) (Weston & Gore, 2006). To evaluate the reliability and validity of the estimated model, a further emphasis is put on the internal reliability, convergent validity and discriminant validity in the following. To test for internal consistency a composite reliability of the models' constructs were applied, which fulfilled the criterion for a confirmatory model (>= .70) with adequate reliability as the scores ranged from .781 to .883 (Hair *et al.,*, 2011). Further, all outer loadings obtain significant, although several items attained a weak outer loading beneath the criterion of .70 for good indicators. Following Hair *et al.,* (2011), OG8 were removed as it did not surpass the critical .40 cut-off (.384). The remaining weak outer loadings were obtained as the removal of these might harm the content validity. This indicate that the combination of items is insufficient as they do converge poorly. To ensure the convergent validity on the construct level an assessment of the Average Variance Extracted (AVE) were performed. From here, it was evident that the constructs are capable of explaining more than half of the variance of its indicators by exceeding the .50 limit, hence establishing the convergent validity of the constructs (Hair *et al.,*, 2011). Further, the discriminant validity was established, as no cross-loadings exceeded the indented loadings of the associated constructs. Additionally, while the disattenuated correlation establishes the discriminant validity for the majority of the constructs, this is not true for OG (Heterotrait-Monotrait ratio = .962), which emphasises the necessity for remodelling the construct. While OG2 (.512) and

OG1 (.557) showed weak loadings, these were previously kept for the sake of content validity. However, as the analysis illuminate how each discriminates the validity, these are removed sequentially. Finally, a bootstrapping procedure were performed with 2000 re-samples with the same number of cases as the original sample (n = 101), to establish the significance of the postulated relations.

Constructs and Items (all measured in 7-point Likert scale)	**Loading**
Organizational Governance (1 strongly disagree – 7 strongly agree)	
OG1: We have incorporated a focus on natural work flows within the entire organization – Wikström et al., 2009	-
OG2: We have prioritized business development – Wikström et al., 2009	-
OG3: We encourage employees to manage decision on their own - Coreynen et al., 2018	-
OG4: We have ensured a formal, optimized process for the service delivery - Coreynen et al., 2018	.744***
OG5: We are able to turn service activities into a profitable business - Coreynen et al., 2018	.914***
OG6: We are able to turn service activities into a professional business - Coreynen et al., 2018	.886***
OG7: We have procedures and routines to minimize costs related to new service activities - Coreynen et al., 2018	.848***
OG8: We can overcome internal resistance and conflicts - Coreynen et al., 2018	-
Strategic management (1 strongly disagree – 7 strongly agree)	
SM1: [Our management] consider services as a lasting differentiation strategy – Coreynen et al., 2018	.686***
SM2: … consider the combination of products and services as a potential way to improve profitability –Coreynen et al., 2018	.782***
SM3: … aims to exploit the financial potential of services – Coreynen et al., 2018	.836***
SM4: … considers services to compensate fluctuating product sales – Coreynen et al., 2018	.715***
SM5: … considers services as highly profitable – Coreynen et al., 2018	.771***
SM6: We are able to formulate clear service-related strategies and objectives – Coreynen et al., 2018	.676***
Value function activities (1 strongly disagree – 7 strongly agree)	
VF1: Are able to provide a performance-based solution that guarantees product's operational performance – Cui et al., 2013	.741***
VF2: We are able to provide customized cost structures for our customers – Cui et al., 2013	.672***
VF3: We evaluate the operating and financial risks and manage uncertainty continuously – Lexutt, 2020	.777***
Market reach (1 strongly disagree – 7 strongly agree)	
MR1: We analyse what we would like to achieve with each customer – Coreynen et al., 2018; Jin et al., 2014	.680***
MR2: We regularly discuss with our customers how we can support one another in our success – Cui et al., 2014	.789***
MR3: We remain informed about the goals, potential and strategies of our customers – Coreynen et al., 2018	.764***
MR4: We analyse what we would like to achieve with each supplier – Coreynen et al., 2018	.787***
MR5: We determine in advance possible suppliers with whom to discuss the building of relationships – Coreynen et al., 2018	.703***
MR6: We remain informed about the goals, potential and strategies of our suppliers – Coreynen et al., 2018	.752***
Digital Integration (1 strongly disagree – 7 strongly agree)	
D1: Our technology allows fully automated and optimized real-time data – Neff et al., 2014	.717***
D2: Our IT systems allows us integrated access to customer-related data – Coreynen et al., 2018	.857***
D3: Our IT systems allows us integrated access to value chain-related data – Coreynen et al., 2018	.830***
D4: Our IT systems allows us integrated access to market-related data – Coreynen et al., 2018	.801***
Service integration (1 strongly disagree – 7 strongly agree)	
SI1: We can easily add significant product-service variety without increasing costs – Coreynen et al., 2018	.915***
SI2: We can add product-service variety without sacrificing quality – Coreynen et al., 2018	.770***
Servitization Success (1 strongly disagree – 7 strongly agree)	
SS1: We were able to increase the service-specific revenue in the previous 24 months (only services)	.851***
SS2: We were able to increase the company-specific profit margin in the previous 24 months (entire firm)	.673***
SS3: Degree of service implementation (service advancement) – Jovanovic et al., 2016	.675***
SS4: Our sales are primarily to established customers with recurring buying patterns (Customer's loyalty) -	-

*** $p \leq 0.001$ ** $p \leq 0.01$ * $p \leq 0.05$

Table 12: Adopted and rephrased Items and constructs

4. Results

The reconfigured model obtains a SRMR of .098 (<.10) indicating an acceptable fit (Weston & Gore, 2006). The inner model obtained no critical collinearities with a max VIF of 2,23. Overall, the validity and reliability of the items and constructs are assessed as acceptable for a preliminary study with reasoning in statistical and theoretical emphasis. Further, the model were capable of explaining 44,2% of servitization success, with an adjusted R^2 of .442, which emphasis weak strength of the model (Hair *et al.,*, 2011). The relations emerged from OG, counts the connections toward SI (H1), VF (H2) and SM (H3), of which the relation between OG to SI (β=.40; p≤.05) and OG to SM (β=.68; p≤.05) were significant. In the meantime, the relation from OG to VF (β=-.03; n.s.) were statistically insignificant. Hypothesis 4 identified a significant relation from SM to VF (β=.31; p≤.05), similar to the relation from MR to VF (β=.47; p≤.05). Further, the DI obtained the most postulated relations, and hence the potential strongest emphasis for increasing the servitization effort. The relations emerged from DI included DI to MR (H6; β=.41; p≤.05), DI to OG (H8; β=.40; p≤.05) and DI to SI (H9; β=.37; p≤.05) which all returned significant, while DI to VF (H7) were insignificant. The majority of relations toward servitization success were found to be insignificant except SM to SS (β=.21; p≤.05) and OG to SS (β=.44; p≤.05). This, however, can be explained by a poorly estimation of SS, which the outer loadings did imply and due to the removal of SS4. The evaluation of these relations is illustrated in figure 10.

5. Discussion

The study identified seven statistically significant relations among the servitization dimensions, hence retaining the majority of the postulated hypothesis. The findings demonstrate several relations, impacting several dimensions simultaneously, which strengthen the idea of servitization as a continuous transformation of multiple coexisting dimensions. As interestingly, none of the significant relations articulated a negative consequential effect, although OG to VF possessed a small insignificant negative effect (β=-.033). This indicates that the dimensions are positively influenced by each other, and it is reasonable to conclude, that an increase in one dimension, leads to an increase in another related dimension. Such findings, allows practitioners to evaluate future plans accordingly to the potential impact of each dimension. This, by acknowledging the relational effect among each other, but in particular by estimating an accurate influence. The composite value calculated through linear weighting process based on the models outer loadings and the respective response of each item (Song *et al.,*, 2013), potentially provides the practitioners with such preliminary evaluation tool of own servitization maturity score of each dimension. The standardised outer loadings interpret the impact of each predictors toward the intended construct, while the path coefficients reveal the impact of each relation. As such, these findings potentially can be used to assess the importance of each theoretical element, hence ease the decision-making process, by allocating resources to the elements with the highest impact toward a given goal. For instance, an increase of the manufacturer's organisational governance eventually led to an increase of .683 in the performance of strategic management, which e.g stems from the allocated resources. Furthermore, this weighted importance of each dimension' role in servitization, emphasising important streams for future research. However, as the PLS are most suitable for predicting relations, additional investigations are needed to obtain the explanation of these predictions. Despite the delimitation of the model, due to the remodelling in section 3.3, it is reasonable to believe that these relations provide important insights in the search of fully understanding the field of servitization as a whole.

6. Conclusion

This research illuminated new insight into the hierarchical structure of the six servitization dimensions, by theorising and statistically identifying seven significant (DI>OG, DI>MR, DI>Si, OG>SI, OG>SM, SM>VF, MR>VF) and two insignificant (DI>VF, OG>VF) relations. These findings add to the stream of a multi-dimensional perspective of servitization maturity, by establishing the coexistence of the six dimensions. Further, these findings provide practitioners with a preliminary foundation for decision-making through weighted importance of each dimension, their relations and underlying parameters. Importantly, none of the relations had a significant negative consequential effect. Due to the limitations of the model, additional studies into statistical predictors of the dimensions are needed. In particular, this study calls for further investigation into predictors of organisational governance and servitization success to enable a better prediction of the dimensions impact. Finally, additional research into usability of the weights, and the identified relations are welcome. Overall, it is believed that these findings are an important first step toward a unique maturing combination approach.

7. Limitations

The study is lacking under the need for a clear definition of servitization success, which hindered the ability to construct or adopt predictors of this dimension.

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4.1.1 The lessons learned from Publications 1

Publication 1 was conducted as an initial pilot investigation to test the validity and reliability of the structural model and associated indicators. A full PLS-SEM computation was conducted (n=105), and the initial findings were presented at the SSC21[10] to receive additional feedback to enhance the content validity of the model. This led to important insights and feedback from experts within the servitisation community. As a result, two items were removed because of their insignificance and irrelevance for the dimensions of servitisation success (SS) and organisational governance (OG), while the approximation of SS was found, theoretically, to be too weak for statistical estimations. This was consistent with the feedback received from the community, although no specific inclusions were suggested. This emphasised the necessity to elaborate on the understanding of servitisation success through a systematic literature review (SLR2, Publication 2). Additionally, the statistical outputs from the initial SeMM combined with the community recommendations identified several areas for improvement of the model. For instance, service integration (SI) was strengthened by four additional indicators (si1, si2, si3 and si6 in Publication 3), while retaining two significant indicators of the construct (si4 and si5). These improvements were made to obtain a better explanation of SI based on recommendations from the community. For OG, five significant items were retained (og3, og6, og7, og9 and og10), while one item was rephrased (og5), and five others were added to strengthen the approximation of resource allocation, capability and policy formalisation as recommended at the SSC21. No changes were necessary for market reach (MR) (all significant) and value function (VF) (all significant). Digital integration (DI) was found to have an insignificant direct effect on SS, and while this could be a result of the weak approximation of SS, further investigations found that there was a mediating effect through both OG>SS (full), MR>VF (full) and OG>SI (partial) (Hair *et al.,*, 2017b). This finding is consistent with the academic understanding of digitalisation as an enabler for servitisation (Sjödin *et al.,*, 2020). Therefore, the mediating relation was adopted for the adjusted SeMM in Publication 3.

The statistical outputs from the initial SeMM were deemed acceptable for a preliminary study with scale development and an exploratory focus (Chin, 1998;Hair *et al.,*, 2019b). Hence, Publication 1 demonstrated the potential of the SeMM and established an understanding of the limitations in the knowledge. The next paper, Publication 2, seeks to develop a better understanding and approximation of servitisation success.

[10] Spring Servitization Conference 2021, Aston University, Birmingham, UK.

4.2 Publication 2

The Untold Story of the Inherent Tensions in the Assessment of Servitisation Success – a Conceptual Approach

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Abstract

This study discusses the paradoxes that arise from differing perceptions of servitisation success and spotlights potential external and internal tensions. We seek to establish a more profound understanding of the servitisation concept, and by conducting a typology-based conceptualisation on the basis of a systematic literature review, we include prior studies on servitisation success in relation to the definitional differences within servitisation. Employing the theory of organisational identity, this study presents a range of paradoxes that lead to internal and external tensions potentially hindering the servitisation transformation. It presents a series of theoretical contributions, including a revised methodological view of servitisation success that can be employed in future studies.

Keywords: Servitisation, servitisation success, operationalisation, internal tensions, external tensions, paradox, typology-based conceptualisation, systematic literature review.

1. Introduction

Servitisation is an organisational transformation that involves the entire business (Baines *et al.,*, 2009a) and originates in the firm's manufactured products (Brax & Visintin, 2017). Servitisation is a global trend across industries, driven by forces of deregulation, technology, globalisation and severe competitive pressure (Gomes *et al.,*, 2018). If successful, servitisation brings opportunities for inimitable competitive advantages (Ulaga & Reinartz, 2011) and acts as a defence against commoditisation of existing products (Oliva & Kallenberg, 2003), generating additional sources of revenue (Raddats & Kowalkowski, 2014) while achieving increased sales performance of existing products (Oliva & Kallenberg, 2003). In other words, servitisation can be a means for defending market shares on the one hand while acquiring new profitable business areas and revenue streams on the other.

Despite an increase in academic and managerial focus, the definitional understanding of servitisation is still ambiguous (Brax & Visintin, 2017), hence the equivocal operationalisation of the concept. Furthermore, while a considerable number of prior studies have addressed success within servitisation, most of these merely hint at the meaning of such success. Some studies discuss 'successful servitisation transformation' without even explicating the definition of success or the criteria for being considered successful (e.g. Adrodegari and Saccani (2020)). For instance, studies on success factors of servitisation lack a clear definition or clarification of servitisation success, as is the case in the study by Polova and Thomas (2020). This lack of

definitional clarity can lead to subjectivity and implicit assumptions in the servitisation phenomenon and consequently in the findings presented in previous studies. This can lead to a diverse operationalisation of servitisation within the individual organisation due to heterogeneity in the conceptual understanding of its managers and collaborators (Brax & Visintin, 2017). This heterogeneity highlights how relevant it is for managers to establish a better understanding of the organisational identity in order to refine the organisational collaboration when it comes to the application of servitisation (Kohtamäki *et al.,*, 2019b). To our knowledge, no prior studies have investigated the influence of the definitional ambiguity, on the managerial challenges of accomplishing servitization. Hence, this study seeks to establish such a theoretical understanding to ease the operationalisation of servitisation through conceptualisation.

A relatively recent line of research embraces an understanding of servitisation that comprises both financial and non-financial success indicators (Raddats *et al.,*, 2015;Lexutt, 2020). While financial indicators rely on economic metrics, the non-financial indicators are a combination of customer, internal process and people perspectives that emerge from the strategic desire (Dossi & Patelli, 2010). However, the strategic desire is governed by the conceptual understanding of servitisation. As a consequence, non-financial indicators are more subjective and entail different interpretations of servitisation success. For instance, while Cestino and Berndt (2017) define servitisation success in a customer-centric view as the 'value created for customers', Jovanovic et al. (2016) define it as a stepwise progression that is assessed on the basis of 'the development and implementation of service solutions'. Once again, the potential influence of varying conceptual perceptions among employees stresses how important it is that practitioners understand these variations in the organisational identity. Furthermore, to our knowledge, a profound review of the definition of servitisation success has not been conducted as of yet. Therefore, this study will identify prior knowledge of such a distinction through a systematic literature review. Recently, four types of servitisation have been proposed to simplify the definitional diversity within the concept (offering-focused, process-focused, firm-focused and business model-focused) (Andersen *et al.,*, 2020). This study has adopted these four definitional types to help exemplify the diversity.

Definitional ambiguity is, however, not the only immanent challenge in the voluminous and constantly growing body of literature on servitisation. Existing studies have suggested that some of the measures of success have built-in tensions that cause good performing measures to exert a negative influence on other objectives within the firm, emphasising the presence of a paradox (Dodd & Favaro, 2006). Similarly, the ambiguity of servitisation brings with it diverse perceptions, which may lead to a paradoxical situation. For instance, Qvist-Sorensen (2020) regards the servitisation strategy as an 'advancement of service solutions', while Adrodegari and Saccani (2017) considers it an 'organizational adaptation to the market environment'. These are equally relevant approaches; however, striving for diverse strategies may potentially foster paradoxical situations. According to Bengtsson et al. (2016), a paradox is defined as related yet contradictory elements that hinder the full development of each element. For instance, the majority of financial measures are based on revenue and profitability, which are commonly known to foster a firm paradox (Dodd & Favaro, 2006). In this regard, manufacturing firms are unable to increase overall profitability and service revenue simultaneously, as a growth orientation and increased service investments slow profitability growth (Dodd & Favaro, 2006;Neely, 2008), thus facilitating a paradoxical situation (Bengtsson *et al.,*, 2016). Paradoxes engender manifold tensions, as the contradictory elements of the paradox can lead to diverse perceptions of the related objectives (Lewis, 2000). In other words, tensions – both internal and external – are the result of a paradox in a cause-effect relationship that creates frictions (Bengtsson *et al.,*, 2016). External tensions occur among top management in the external environment, as they set different strategies and objectives due to

differing perceptions of servitisation. Internal tensions occur among lower-level managers with different definitional understandings of servitisation that result in differing objectives. From here, unintentional opposition can arise as departments seek to achieve their goals. Thus, progress in one aspect might lead to failure in another, depending on the firm's orientation and collaboration (external) and the floor managers' perceptions (internal). In keeping with the theory of organisational identity (Kohtamäki *et al.,*, 2019b), this study seeks to shed light on the potential paradoxes and tensions stemming from varying definitional perceptions of when servitisation can be said to have been achieved. This to help practitioners avoid such paradoxical situations during their journey towards a successful transformation. For this reason, the study investigates the following research question: *'What are the inherent tensions and paradoxes in the measurement of servitisation success?'*

2. Theoretical and conceptual foundation

2.1 The servitisation concept

Vandermerwe and Rada (1988) define servitisation as the integration of services into manufacturers' portfolio as product-service solutions. Since then, a lack of definitional clarity has marked the studies on the phenomenon (Kohtamäki *et al.,*, 2019a). As stated by Raddats *et al.,* (2019), despite differences in the definitions of the various concepts of manufacturers' service implementation (e.g. servitisation, service infusion and product-service systems), these concepts are usually used interchangeably, increasing ambiguity and confusion within the literature.

2.2 The unit of analysis in servitisation research

The missing conceptualisation and operationalisation of servitisation hamper the consistency of the servitisation strategy concepts (Kohtamäki *et al.,*, 2019a). Thus, the servitisation concept needs to be more coherent to strengthen future research streams and enable a better dissemination of future findings. It is widely agreed that servitisation constitutes a transformation of the company as a whole (Baines *et al.,*, 2017), in the sense that it is as a multi-dimensional transition impacting several levels simultaneously (Kindström & Kowalkowski, 2014;Kohtamäki *et al.,*, 2019a). Nevertheless, scholars tend to study servitisation through diverse conceptual lenses.

Dimache and Roche (2013) emphasise that 'servitization essentially describes the move on the PSS continuum from "product plus services as an add-on" to complete service delivered through the product', which solely relies on the development and implementation of the product-service systems offered. Similarly, Alvarez et al. (2015) agree with the assumption that servitisation is centred on the service implementation, and they focus on the importance of the ability to deliver such services to customers. This approach to servitisation zooms in on the delivery of the services rather than the service per se. Similar approaches are presented by Altmann and Linder (2019) who frame servitisation as a strategy or paradigm to follow, and Liu *et al.,* (2014, p. 81) describe it as a business model transformation: 'construct a new business model that offers firms a package of integrated solutions to increase customer-created value by lifetime and life-end services bundled with products'. Recent literature (Andersen *et al.,*, 2020) has identified four overall definitional types to establish a better coherence of the phenomenon:

- *Offering-focused* servitisation perspectives emphasise the inclusion of solutions or delivered value to the customers (Dimache & Roche, 2013).

- *Process-focused* servitisation perspectives focus on the optimisation of processes and delivery ability within the focal firm (Alvarez *et al.,*, 2015).
- *Firm-focused* servitisation perspectives focus on the organisational and focal firm specifications with the transition in mind (Altmann & Linder, 2019)
- *Business model-focused* servitisation perspectives stress the value creation within the focal firm and the interlinked ecosystem (Liu *et al.,*, 2014).

Each type leads to different focus areas and perceptions of the servitisation concept. As illustrated in Table 13, the differing perspectives are present in the definitions used in the studies, leading to disparate perceptions of success. While some scholars call for standardising the concept (Kohtamäki *et al.,*, 2019a), this study seeks to embrace the differences and highlight the potential paradoxes and tensions that arise from the diversity of these perceptions.

Offering-focused perspective	**Process-focused perspective**	**Firm-focused perspective**	**Business model-focused perspective**
'Servitization *refers to the transformation in which manufacturers are increasingly offering services that are directly coupled to their products'*	*'The innovation of a manufacturer's capabilities and processes to move from selling products, to selling integrated products-service offerings that deliver value in use.'*	*'Servitization can be understood as a strategy adopted by industrial firms in a process of organizational adaptation to the market environment'*	*'How the supplier can develop its organization to increase the service layer of the offering to convert the manufacturing-based business model into a service-oriented business model.'*
Coreynen et al., (2017)	Baines *et al.,* (2009a)	*Adrodegari and Saccani (2017)*	*Makkonen et al., (2019)*
Industrial Marketing Management	*International Journal of Operations and Production Management*	*Service Industries Journal*	*Industrial Marketing Management*

Table 13: Servitisation definition types.

2.3 The measurement of servitisation success

Previous literature has demonstrated that servitisation leads to competitive advantages through inimitable hybrid solutions (Ulaga & Reinartz, 2011), along with a potential increase in customer loyalty (Cusumano *et al.,*, 2014) and creation of lock-in effects. Certain benefits (e.g. inimitable services, stable revenue, competitive advantage, customer satisfaction and increased financial performance) are widely acknowledged within the literature (Jovanovic *et al.,*, 2016;Lexutt, 2020), but obtaining those is no guarantee for success. For instance, satisfied customers are of little avail if they do not generate additional revenue or profit. Jovanovic *et al.,* (2016) describe how the benefits of servitisation can be unlocked by differentiating offerings by creating customer-specific product-service bundles. However, they restrict their assessment of servitization success to the degree of servitization (advancement of services), which is only indirectly linked to the increased stable revenue or closer customer relationships (Jovanovic *et al.,*, 2016). Hence, only estimating part of the success. Noticeably, studies by both Jovanovic *et al.,* (2016) and Lexutt (2020) use a financial parameter to express the benefits of servitisation, although only Lexutt (2020) uses it as a direct indicator of success. For this reason, the attainment of such benefits does not necessarily equal overall success of the

servitisation project. As mentioned, certain objectives – by having consequential effects on coexisting objectives – might render it difficult to make the most of the overall success (Dodd & Favaro, 2006). Furthermore, it is unclear by which standard success is measured. However, transforming the organisation into a servitised one is cost-intensive and often leads to short-term negative financial returns (Gebauer *et al.,*, 2005). Several case studies illustrate this; the service division of Siemens was overall unprofitable (Gebauer *et al.,*, 2009), and Intel's €150 million web-based service unit shut down after five years due to unprofitability (Sawhney *et al.,*, 2004). Neely et al. (2008) establish that manufacturers find it more difficult to achieve a profit by adding services than might be expected. Although servitised firms have a higher revenue, they still have a lower profitability than pure manufacturing firms (Neely, 2008). This lack of (immediate) success could potentially be explained by the challenges of developing the 'service organisation' and, in particular, the taxing process of implementation (Tenucci & Supino, 2019).

While these studies equate failure with lack of profitability (Neely, 2008;Tenucci & Supino, 2019) (and ultimately bankruptcy (Benedettini *et al.,*, 2015)), few studies on servitisation success manage to be as explicit when it comes to estimating success (e.g. Fliess and Lexutt (2019) and Raddats *et al.,* (2015)). Some scholars argue that success is the progression or development from one state to another in the focal firm's performance (Bustinza *et al.,*, 2019), while others argue that progressions should be compared for the purpose of taking the industrial development into account, as progressions only prove successful in comparison with others (Fliess & Lexutt, 2019). This underlines the importance of well-established and widely applied and generalisable estimators of success. Such an example are financial performance indicators (e.g. profit and revenue growth), which are widely used within the servitisation literature (Baines & Lightfoot, 2013;Huikkola *et al.,*, 2016;Weigel & Hadwich, 2018) to assess failure and success. However, servitisation successes have recently been analysed beyond the financial performance measures. For instance, Cestino and Berndt (2017) assess servitisation success based on whether it creates customer value. This requires a well-developed understanding of the diversity in the perceived success among managers within the intra-organisational setting. As the definition of servitisation varies and remains ambiguous (Brax & Visintin, 2017), so does the interpretation of servitisation success.

2.4 Potential tensions between the perceptions of success

Having various perspectives and conceptualisations of a phenomenon is not necessarily problematic: If they all tell their separate story about the phenomenon, they each contribute to a more complete understanding. However, the different perspectives could represent innate paradoxes and tensions. For instance, a keen emphasis on the offering-focused perspective could potentially jeopardise profitability at firm level (Benedettini *et al.,*, 2015). The paradox is defined as 'contradictory yet interrelated elements (dualities) that exist simultaneously and persist over time' (Smith & Lewis, 2011, p. 387), and as such, the well-developed 'servitisation paradox' is itself paradoxical as it involves the contradictory logic of having an increased service offering without a corresponding increased profit (Gebauer *et al.,*, 2005). Additionally, this very nature of paradoxes means that countless tensions emerge as internal and external tensions, as noted by Bengtsson *et al.,* (2016). Internal tensions are felt when managers pursue two coexisting and contradictory indicators with conflicting goals (Fang *et al.,*, 2011, p. 774).

Inimitable competitive advantages are a well-established outcome of servitisation (Ulaga & Reinartz, 2011), and they are a potential source of a paradox that could lead to internal tensions. It is reasonable to believe that the uniqueness of offerings tempts the sales force to pursue

increased sales performance to obtain a higher revenue for the firm, since winning new customers can lead to sales commission. Simultaneously, it is reasonable to believe that the service department uses such uniqueness to pursue an increase in customer satisfaction and, accordingly, an increase in the profitability of existing customers. Having two coexisting contradictory forces (customer satisfaction versus sales growth) with conflicting goals that arise from differing perceptions of firm success frames a potential paradox within servitisation. As noted by Bengtsson *et al.,* (2016), frustrations and tensions occur as the lower levels of the organisation misunderstand the strategic decisions made by the top management. A strategic move towards services could potentially lead to the previously discussed internal tensions of the sales and the service department, but as noted by Bengtsson *et al.,* (2016), a duality of tension emerges. External tensions refer to the level of difficulty that the top management experience when they, for instance, strive for both customer satisfaction and sales growth (Bengtsson *et al.,*, 2016). For example, managers may find it difficult to maintain existing customer satisfaction to achieve higher profitability while simultaneously picking up new customers to increase sales growth. This example highlights two coexisting and contradictory perceptions of servitisation that oppose each other and reduce the efficiency of such a transformation. As a consequence, the varied perceptions of servitisation success lead to paradoxes that foster both internal and external tensions. These tensions most likely hinder the full potential of the servitisation transformation and destroy value for all parties involved (Burton *et al.,*, 2016).

To further develop our understanding of servitisation success, a conceptualisation of the phenomenon is included in the study. The conceptualisation, based on existing theory, seeks to add to the general theories in an effort to bring forward new thoughts and perspectives on the concept of servitisation success as well as the tensions emerging within it (Lindgreen *et al.,*, 2021). To embrace these differences, a typology-based conceptualisation of the identified four definitional typologies and the servitisation success is necessary.

3. Methodology

Using the theory of organisational identity, this study seeks to identify the potential paradoxes and tensions arising from differences in the conceptual understanding of servitisation success within and across organisations. The typology-based conceptualisation seeks to recombine existing typologies to identify new perspectives or thoughts on a phenomenon (Lindgreen *et al.,*, 2021). This technique is in line with the objective of the study, as it categorises the predefined success definitions into the four types presented in Section 2.2. The categorisations are based on a conceptual match between the descriptions of the definitional types from Andersen *et al.,* (2020) and the definitions of success from the review. However, to enable such a conceptualisation, more knowledge is needed on the typologies of servitisation success and the interpretation of success. Such a clarification is believed to add to the consolidation of the servitisation concept (Kohtamäki *et al.,*, 2019a), and – as it incorporates the whole body of knowledge within servitisation (Denyer & Tranfield, 2006;Brax & Visintin, 2017) – the systematic literature review is useful for that purpose. It also adds to the theory synthesis used to combine the typologies (Lindgreen *et al.,*, 2021). The systematic literature review provides structure to the process (Tranfield *et al.,*, 2003), and to ensure rigor, this study has adopted the five-step process suggested by Miller *et al.,* (2018).

Stage one involved the identification of proper keywords. They were identified through discussions within the research team and with academic colleagues working within the field of servitisation. Initially, this led to three keywords: ‘serviti*ation + succes*’, ‘achieve* +

serviti*ation' and 'serviti*ed'. Both 'achieved' and 'servitised' are related to the end state of servitisation and therefore associated with the achievement of servitisation.

Stage two involved the journal search. Here, it was specified that only peer-reviewed articles from the last 32 years were reviewed (1988-2020), starting with the revolutionary paper by Vandermerwe and Rada (1988) that sparked the field of servitisation research. Only English-language business and marketing journals were included; journal ranking was not a selection criterion. The keywords were formed into three search strings to enable an individual search for articles for each keyword. The search was conducted in all parts of the articles (e.g. title, topic, text, etc.) to capture all articles that to some degree addressed success within servitisation. The inclusion of an asterisk took linguistic differences into account. Similarly, an asterisk in 'success' allowed for variations of the term (e.g. successful). As a result, 129 papers were identified (63 papers for success*, 36 papers for achieve* and 30 papers for serviti*ed).

Stage three involved scanning and selecting articles for the review. This stage adopted the data screening process by Brax and Visintin (2017), which ensured transparency of the scanning (see Figure 11). From here, the abstract of each identified article was examined through the lens of three questions: Is it a duplicate? Does it address servitisation (subject one)? Does it address some degree of success, achievement or outcome (subject two)? This led to the selection of 63 papers. During the review of subject one and two, it became evident that the degree of success varied, as some articles investigated the definition of servitisation success, while others investigated the phenomenon 'to be successful' in the context of servitisation. To prevent confirmation biases, none of these articles were selected at this particular stage.

The fourth stage involved the data extraction. The reviewing procedure started by downloading and carefully reading, reviewing and sorting all articles. A standardised set was adopted pro forma to capture important typologies, definitions and findings to be extracted to a raw data repository which later enabled a deeper discussion

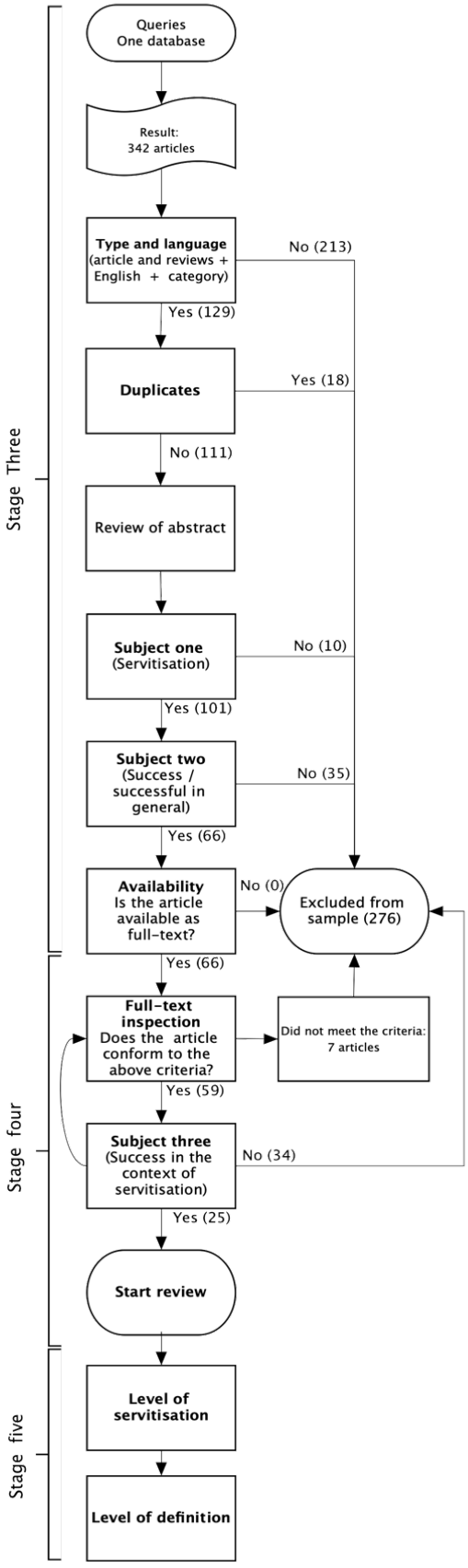


Figure 11: Screening process of the systematic literature review.

in stage five (Tranfield *et al.,*, 2003). Furthermore, seven papers were removed from the full-text inspection as they did not meet the conditions.

Based on the findings of subject one and two, it became clear that the success mentioned was not necessarily anchored to servitisation. To obtain this knowledge, a full-text inspection was conducted on the 66 papers from stage three. Eventually, it became clear that, although some scholars referred to success (or 'to be successful') in the context of servitisation, this success had little to do with servitisation as such. For instance, Frishammar and Parida (2019) investigated the successful transformation into a circular economy in a servitisation context, but without discussing how the latter was influenced. As a result, 34 articles were excluded.

These findings highlighted the need to add two additional specifications to the standardised pro forma set: papers only focusing directly on servitisation success and papers only focusing on success in the context of servitisation. Appendix 1 provides the full pro forma template.

Stage five involved analysing extracted data from the selected articles to identify definitions of servitisation success within the literature to facilitate the typology-based conceptualisation. From here, a content analysis was conducted deductively as two separate rounds of reviews. The deductive approach was directed by the search for a definition of servitisation success and resulted in an in-depth discussion of the phenomenon.

3.1 Literature review

3.1.1 Level of servitisation

As a starting point, the investigation focused on the level of servitisation presence within the literature in relation to two perspectives – whether articles investigated servitisation success as a phenomenon or in the context of servitisation. While most articles investigated success in the context of servitisation (22 articles), few investigated the phenomenon directly (3 articles).

3.1.2 Success definitions

Next, we focused on identifying the definition of success. While some studies did not explicate what constituted success (7), others constructed (10) or borrowed (5) a definition from the literature. Nevertheless, a great variety of success definitions was found in the literature, highlighting the definitional ambiguity within servitisation (Brax & Visintin, 2017). A fine-grained textural analysis of the articles' definitions was conducted on the basis of the pro forma set, and the studies were categorised according to four levels: whether the studies 1) investigated a definition, 2) constructed a predefined definition, 3) borrowed a predefined definition or 4) none of the above. This showed the investigation depth of each definition and contributed to a better understanding of the preliminary work put into the

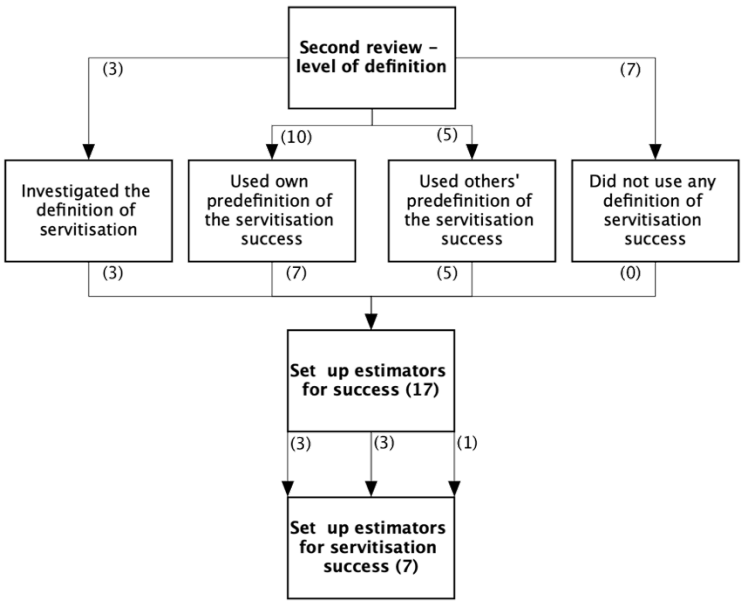


Figure 12: Second round of the review process.

construction of these definitions. Furthermore, additional studies had identified estimators that capture (and in some cases quantified part of) servitisation success with a focus on assessing the servitisation success in a multi-dimensional manner (Lexutt, 2020).
A reasonable number of success factors have been identified in previous servitisation studies (Weigel & Hadwich, 2018;Hwang & Hsu, 2019), which contributes positively to the operationalisation of servitisation. However, some studies investigate these success factors without using a clear definition of success (Tronvoll *et al.,*, 2020), which makes it more difficult to determine what type of success these factors are bringing about. As noted by Cooper and Kleinschmidt (1987), such success factors are dependent on the type of success desired by the company, and as a consequence, the definition or estimation of the success is important. In this sense, a success factor does not result in success per se, as the success factors differ according to the perceptions of success. For this reason, no additional investigation was made into these factors.

	First category	Second category	Third category	Fourth category
1	Increased revenue	Increased total revenue		Company-based financial measures
2	Additional sales			
3	Total sales			
4	Profitability		Improved profitability	
5	Profit level	Expand profit		
6	Profit level change			
7	Service revenue			Service-based financial measures
8	Service profit			
9	Ratio of service sales			
10	Increased advanced services		Degree of advanced services	Offering-based
11	Degree of servitisation (service advancement)			
12	Innovative performance			
13	Increased customer value		Increased customer value	
14	Creating value through services			
15	Competitive comparison (performance-wise)			Firm-based
16	Increased market share			
17	Competitive advantage			
18	Level of objectives achieved			
19	Customer satisfaction		Customer satisfaction	Business model–based
20	Retain existing customers		Customer loyalty	
21	Customer loyalty			
22	Partner retention			
23	Market position		Brand positioning	
24	Brand recognition			

1. Qvist-Sorensen (2020) **2.** Lexutt (2020) **3.** Martin-Pena *et al.,* (2019); Parida *et al.,* (2014) **4.** Colen and Lambrecht (2013); Parida *et al.,* (2014); Huikkola *et al.,* (2016); Chiarini and Vagnoni (2017); Weigel and Hadwich (2018); Hwang and Hsu (2019); Bustinza *et al.,* (2019); Lexutt (2020) **5.** Bustinza *et al.,* (2019) **6.** Bustinza *et al.,* (2019) **7**. Parida *et al.,* (2014); García-Magro and Soriano-Pinar (2019) **8.** García-Magro and Soriano-Pinar (2019) **9**. Lexutt (2020) **10.** Qvist-Sorensen (2020) **11.** Jovanovic *et al.,* (2016) **12.** Weigel and Hadwich (2018) **13.** Cestino and Berndt (2017) **14.** Bustinza *et al.,* (2015) **15.** Fliess and Lexutt (2019), Bustinza *et al.,* (2019) **16.** Cestino and Berndt (2017); Lexutt (2020) **17.** Bustinza *et al.,* (2019); Bustinza *et al.,* (2015) **18.** Weigel and Hadwich (2018) **19.** Parida *et al.,* (2014); de Oliveira *et al.,* (2018); Weigel and Hadwich (2018); Bustinza *et al.,* (2019); García-Magro and Soriano-Pinar (2019) **20.** Bustinza *et al.,* (2019) **21.** de Oliveira *et al.,* (2018) **22.** Weigel and Hadwich (2018) **23.** Huikkola *et al.,* (2016) **24.** de Oliveira *et al.,* (2018)

Table 14: The typology-based categorised success indicators.

The indicators of success found within the literature encompass overlapping elements, which necessitated a formalised categorisation into umbrella indicators. As the number of indicators is limited to 33 estimators, a formalised categorisation is possible based on each indicator's theoretical foundation and description. For instance, the indicators 'increased revenue', measured as the increased amount of revenue (Qvist-Sorensen, 2020), 'additional sales', measured as the increased amount of sales (Lexutt, 2020), and 'total sales', measured as the entire revenue of the firm (Martin-Pena *et al.,*, 2019), were categorised into 'increased total revenue' as an overall indicator. A simultaneous comparison was conducted among the research team, and additional overlapping estimators were identified and categorised into umbrella indicators, as illustrated in Figure 12. These second- and third-step categorisations were broken into subgroups of definitional proportions. Yet, while such categorisations remove the precision of each indicator, they are used to strengthen the conceptualisation of servitisation success. At the end, 25 articles had a particular, direct focus on success or success in the context of servitisation, and they were selected for the final review and discussion.

4. Findings

While definitions of success are essential for most studies investigating the impact of servitisation, the definitions used were mostly only implicitly understood within the studies (Hwang & Hsu, 2019). The literature review illustrated a great variety in scholars' definitions and perceptions of success. Thus, it remains unclear whether unspecified definitions of success lead to accurate decoding, or whether the interpretations of such findings differ (Shannon, 1948). However, differences within the perceptions of success signify that scholars within the servitisation literature do not all interpret success in the same manner. Thus, the operational findings could be perceived differently (Kohtamäki *et al.,*, 2019a), which is why a more incisive definition or measurement of success is preferred.

An extensively used success measure, which has been framed differently within the servitisation literature, is performance (Bustinza *et al.,*, 2019;Martin-Pena *et al.,*, 2019). Performance has been used as a measurable and comparable indicator of success that integrates relevant parameters which, in combination, assess the progression towards success (Raddats *et al.,*, 2015;Bustinza *et al.,*, 2019). As such, it is reasonable to assess additional performance parameters for success in a simultaneous manner. Thus, performance acts as a flexible measure that is comparable across intra- and interorganisational settings. However, a greater understanding of the built-in tensions between the measures is necessary for optimising the operationalisation of such performance measures (Dodd & Favaro, 2006) and conceptualising the right combination.

Prior studies have relied on a great variety of performance measures. For instance, Martin-Pena et al. (2019) relied on firm performance defined as 'total sales', while others, like Bustinza *et al.,* (2019), relied on a combination of both organisational performance defined as 'competitive advantage' and business performance defined as 'profitability'. However, their work suggest that such typologies curb further conceptualisations. To avoid such a limitation, this study adopts the dual performance measure by Gebauer et al. (2009), who divided performance into financial and non-financial measures. These represent the differences known within the literature and suit the conceptualisation progress by Lindgreen et al. (2021, p. 3).

4.1 Financial success

Financial measures within servitisation are widely used to estimate success (Visnjic *et al.,*, 2018); in particular, measures such as 'profitability' (Colen & Lambrecht, 2013) and 'increased overall revenue' are broadly used (Cestino & Berndt, 2017). Due to the fact that revenue-based

measures rely on relatively homogeneous data, and therefore are high in accessibility and availability, make them a highly comparable and applicable measure for most manufacturers (Schwartz *et al.,*, 2017). Such measures are the result of company activities and seen as capturing the health of the company. Recently, well-founded service-specific measures have gained momentum, including 'service profit' (Parida *et al.,*, 2014) and 'service revenue' (García-Magro & Soriano-Pinar, 2019). In line with the prior discussion, performance should be assessed on several parameters. Thus, this study adopts the two financial performance levels of Raddats *et al.,* (2015): the company-specific level and the service-specific level.

	Indicators / measures of success	**References**
Service-specific level	Increased service revenue	Parida et al. (2014), Garcia-Magro & Soriano-Pinar (2019)
	Improved service profit	Garcia-Magro and Soriano-Pinar (2019)
	Ratio of service sales	Lexutt (2020)
Company-specific level	Increased total revenue	Raddats et al. (2015), Colen et al. (2013), Cestino et al. (2017), Lexutt (2020), Martin-Pena et al. (2019), Parida et al. (2014)
	Improved profitability	Lexutt (2020), Huikkola et al. (2016), Colen et al. (2013), Hwang and Hsu (2019), Bustinza et al. (2019), Parida et al. (2014), Chiarini and Vagnoni (2017), Weigel and Hadwich (2018)

Table 15: Financial performance typologies.

4.2 Non-financial success

Unlike financial measures, non-financial measures cannot be seen as heterogeneous in nature. The definitional types represent diverse perspectives – and thus theoretical lenses – on servitisation. It is therefore reasonable to argue that these are affecting the perception of successful servitisation. In the review, it became evident that these definitional types do correspond to the view of success. For instance, De Oliveira et al. (2018) state that modern firms' success is more than can be expressed by financial measures, as servitisation is more about value capturing. This resonates with the business model-focused definition presented in the same paper, which states that '[servitisation is] a strategy in which companies seek innovative capabilities and processes to create value through integrated solutions' (de Oliveira *et al.,*, 2018). Likewise, Jovanovic et al. (2016) describe servitisation success as a measure of implemented solution advancement, corresponding to an offering-focused definition.

As these examples illustrate, the non-financial measures are too scattered to act as indicators for the servitisation success as a whole. Hence, the definitional types of servitisation seem suitable for delineating how variants of the success entities differ (Lindgreen *et al.,*, 2021).

During the review, we searched for additional indicators and measures to inform the thoughts and perspectives of servitisation success. The identified indicators were aligned in accordance with the established definitions to broaden the typology-based conceptualisation. This serves to highlight and clarify the possible usage of each definitional performance.

	Non-financial indicators of success	**References**
Offering performance	Degree of advanced services	Qvist-Sorensen (2020), Jovanovic et al. (2016)
	Innovativeness	Weigel and Hadwich (2018)
	Increased customer value	Cestino and Berndt (2017), Martin-Pena et al. (2019)
Process performance	[None found]	

Firm performance	Competitive comparison	Fliess and Lexutt (2019), Bustinza et al. (2019)
	Increased market share	Lexutt (2020), Cestino and Berndt (2017)
	Competitive advantage	Bustinza et al. (2015, 2019)
	Level of objectives achieved	Weigel and Hadwick (2018)
Business model performance	Customer satisfaction	Parida et al. (2014), Garcia-Magro and Soriano-Pinar (2019), Weigel and Hadwich (2018), Bustinza et al. (2019), Lexutt (2020), De Oliveira et al. (2018)
	Customer loyalty	De Oliveira et al. (2018)
	Partner retention	Weigel and Hadwich (2018)
	Brand positioning	Huikkola et al. (2016), De Oliveira et al. (2018)

Table 16: Non-financial performance measures.

Offering performance entails developing and implementing solutions from an innovative and customer-centric approach as well as the delivery of customer value. Process performance involves efficient and effective delivery of service solutions through the optimisation of processes and delivery capabilities with a certain focus on both internal and external procedures, processes and abilities. Noticeably, no existing process estimators were identified during the review, which calls for additional attention. Firm performance represents the external strategic achievements, with a particular focus on competition and market durability. Business model performance entails value capturing and creation internally and in the interlinked ecosystem, with a particular focus on enabling value through organisational and network abilities.

4.3 Financial and non-financial performance measures

Table 17 shows the adopted categories for the typology-based conceptualisation with the four definition types displayed horizontally and the financial performance categories displayed vertically.

	Offering-focused	**Process-focused**	**Firm-focused**	**Business model-focused**
Non-financial performance measures	Offering performance	Process performance	Firm performance	Business model performance
Financial performance measures	Service-specific financial performance		Company-specific financial performance	

Table 17: Typologies of financial and non-financial performance

5. Discussion

5.1 Paradoxes stemming from definitions, and their insidious tensions

The definitional diversity of servitisation has been shown to lead to shortcomings in the operationalisation of the transformation (Kohtamäki *et al.,*, 2019a).

The review revealed that scholars are vague when it comes to their definitional standpoint, implying that using the findings could lead to misleading guidance. For instance, the process-defined study by Baines *et al.,* (2009a) focuses on the ability to deliver value for customers. Another study by Ntanos *et al.,* (2018) asserts the optimisation of processes within the organisational distribution rather than the implementation of services, as is the case in studies by Coreynen *et al.,* (2017) and Ferreira *et al.,* (2016), among others. The latter study

emphasises the advancement of service development and implementation and thus induces a very different view of servitisation and its achievement. Paradoxes emerge as related yet contradictory elements occur (Lewis, 2000). The related definitions outline diverse strategic directions, which could hinder the full potential of servitisation and produce a paradoxical situation. To overcome these shortcomings and obstacles, it is important for practitioners to understand such paradoxes. This to avoid unnecessary challenges and to impose a formalised organisational identity that creates an intentional servitisation transformation at all organisational levels.

Diverse perspectives of servitisation set off multifarious investigations and increase our knowledge of a complex phenomenon. However, external and internal tensions arise when such diverse perspectives of the core concepts remain implicit or even ignored.

5.1.1 External tensions in the definitions of servitisation

Tensions arise from a definitional paradox when differing perceptions of servitisation occur. As such, to neglect such differences could lead to misinterpretations by the receiver (scholars and practitioners) or attempts to dismiss previous findings, leading to imperfect research. Thus, tensions among scholars with diverse definitional understandings of the concept could potentially hinder the development of the field or lead to false-negative findings steered by diverse definitional perspectives (e.g. the investigations of servitisation success factors (Tronvoll *et al.,*, 2020)). Likewise, diverse interpretations by top management could potentially lead to failed cooperation with external partners, as they seek different goals. This would increase the difficulty of managing such cooperation and lead to external tensions. Consequently, the incorporation of ecosystem processes or customer co-creation might be hindered by unintentional opposing operationalisations of servitisation. This, combined with academia's general disinclination for explicating the definitional stance, increases the complexity of understanding the operationalisation and reasoning of the usage, thus inhibiting the dissemination of servitisation to practitioners.

5.1.2 Internal tensions in the definitions of servitisation

The measure of success can be perceived differently depending on the perception of the firm (Smith-Doerr *et al.,*, 2004), and as such, it is complex in nature. Success definitions can coexist within the same organisation or even within groups, as success is a social construction, and for this reason, the perception of servitisation has a large impact on the construction of such success (Smith-Doerr *et al.,*, 2004). This internal tension caused by the definitional paradox may foster division in the transformation and the derived success objectives. Thus, definitional ambiguity among scholars makes room for diverse definitional understandings within the focal firm and leads to diversity in the operationalisation of the transformation. This can lead to unintentional cooperative tensions, as the lack of a common understanding means that the parties involved work towards different objectives.

The tensions between various types of servitisation can be diminished by acknowledging the diversity within the organisation and highlighting the differences in expected outcomes and estimators. By identifying these according to the types of definitions, it is possible to advance the intra-organisational cooperation.

5.2 Paradoxes stemming from measurements, and their insidious tensions

The definitional types lead to a variety of preferred success indicators for the achievement of servitisation. Each of these has the potential to foster the manufacturers' overall objective of servitisation. However, as with the definitional ambiguity, these variations of measures are the source of potential paradoxes and hence external and internal tensions. While the external tensions refer to the level of difficulty top managers encounter when engaging with two contradictory measures (e.g. revenue and profitability), the internal tensions refer to the frustration and tension experienced by the lower levels of the organisation when facilitating such contradictory measures (Bengtsson *et al.,*, 2016, p. 21). Understanding these paradoxes is essential for practitioners to enable a successful transformation by combining a proper set of objectives for their organisation and to foster a coherent organisational identity.

5.2.1 The paradox of product versus service revenue

Within servitisation, Parida *et al.,* (2014) argue that the product is becoming the starting point of the sales instead of the core of it. Previous studies have emphasised the importance of pay-per-use as an alternative source of income during servitisation (Gebauer *et al.,*, 2017), and while this creates new sources of revenue (increased service-specific financial performance), a natural decrease in product sales occurs as the customer do not own the product (decreased company-specific financial performance).

This leads to the paradox of whether to sell products (increase product revenue) or sell the right to use the product as a service (increase service revenue). Hence, tension between the two financial performances emerges. Whether services cannibalise the product revenue is a concern within strategy and marketing literature (Kohtamäki *et al.,*, 2020). Furthermore, increasing the lifespan of the product through maintenance services may reduce the opportunities for product sales. It is reasonable to assume that concomitant internal tensions may arise from a paradox of, for example, the sales department seeking to increase the product sales, while the R&D department seeks to increase the life expectancy of the products. This is described by Visnjic *et al.,* (2013) as 'tensions between those responsible for product revenue, and those responsible for service revenues'. An additional example of this is the one-off sales nature of products and the continuous sales-/fee-based nature of services that might lead to similar tensions during the transition.

As emphasised by Vaittinen *et al.,* (2018), customer readiness for new services is essential for the success of servitisation. External tensions might arise as new cost structures are incorporated and ownership switches, which are influenced by the customers' willingness to adapt. One might wonder whether such continuous costs are more difficult to accept than a single initial cost, which represents another external tension.

5.2.2 The paradox of service-specific profit versus company-specific profit

It is worth expanding on the thoughts of the profit/revenue paradox by Dodd and Favaro (2006). A paradox of service-specific profit versus company-specific profit can lead to the contradictory opportunities of either increasing the development of services and raising prices accordingly (due to competitive advantages and added value) (service-specific) or reducing or retaining the investments to achieve a higher overall profit (company-specific) – *to servitise or not to servitise*. As noted by Parida *et al.,* (2014), to increase the revenue from servitisation, a high level of investment is necessary. But while servitised firms generate higher revenues, they tend to generate a lower net profit than pure manufacturing firms (Neely, 2008). In turn, this reduces the overall profit. This paradox is essential in the preliminary application of servitisation, as managers coming from a good-centric orientation favour the company-specific

revenue because it relates to their origin. Hence, it highlights the necessity for managers to comprehend the importance of embedding proper indicators into the organisational identity early on.

The external tensions both occur as strategic decisions about the degree of servitisation, measured as the investment in services, and in terms of whether to pursue relational or transactional selling of products and services (Neely, 2008). Both examples entail a significant increase in investments. Internal tensions can result from differing attitudes towards the degree of customer relationship management and the degree of service implementation. Similarly, as an extension of Visnjic *et al.,* (2013) notion, differing preferences might occur among those who are responsible for service profit (the service department) and those responsible of the company's overall profitability (the shareholders).

5.2.3 The paradox of customer satisfaction versus market share

Even though Cestino and Berndt (2017) stress the importance of customer satisfaction, they consider the increase of market share (increase in subscribers) to be the objective of servitisation, whereas Weigel and Hadwich (2018) emphasise customer satisfaction as the main objective. The market share measure (offering performance) and the customer satisfaction measure (business model performance) stem from differing definitional points, potentially involving a variety of external tensions, for example the preference of relational versus transactional connections. Customer satisfaction is characterised as the customer's overall evaluation of the purchase (Weigel & Hadwich, 2018), and it implies a continuous improvement of the delivered value (Zairi, 2000). As emphasised by Bastl *et al.,* (2012), buyer-supplier relationships play an important role in the development of integrated solutions, and the provision of such integrated solutions is dependent on relational and not transactional interaction with customers (Jagstedt, 2019). Despite the importance of customer satisfaction, an external tension arises, as such relations and continuous improvements are a long-term objective (relational) and not necessarily consistent with the focal firm's short-term objective of increased market share (transactional interaction). Concurrently, top management will have to deal with the built-in risk of specifying the customer portfolio if the external markets are stagnant (Winton, 1999), as is the case in high-relational interactions. Again, focal firms might lose the upper hand if they reduce the external risk by diversifying the customer portfolio through transactional interactions by allocating resources to a variety of activities whose preferences are not closely related (Winton, 1999). Hence, top management will choose between transactional or relational interaction with the customer, as the customer's willingness to cooperate with the focal manufacturer will vary, and this can lead to external tensions.

5.2.4 The paradox of market share versus customer loyalty

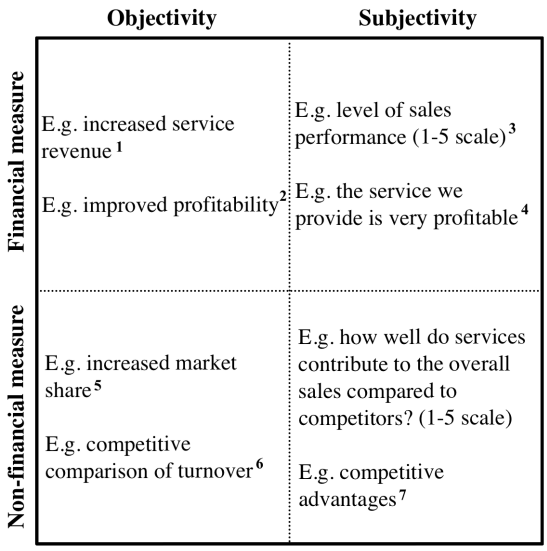
Customer loyalty consists of customer satisfaction, retention and repeated purchases, need for dialogic feedback, assessment of future needs and issue management (Zairi, 2000). Each of these is time-consuming, which might make it tempting to focus on more transactional interactions to enable a higher volume of sales. External tensions occur as a result of managers' difficulty of balancing the strategic focus on entering new markets and retaining existing customers. This would, for instance, have differing priorities for shareholders (increased shareholder value – new markets) and managers of the service department (increased value – existing customers). Meanwhile, the definitional ambiguity creates room for internal tensions within the organisation, as self-assessments of an achieved success are individual; for example, the preferred objectives of sales personnel varying between increased market share and customer satisfaction. For this reason, it is necessary to clarify the organisation's definition of servitisation success and accentuate the underlying indicators. Only by addressing the internal

and external tensions can the manufacturers overcome such barriers to a successful transformation.

5.3 Development of a framework for measuring servitisation success

The achievement of a successful servitisation transformation relies on the dependent parameter of success. Thus, it is necessary to emphasise the importance of the managerial perception of the success indicators in the operationalisation of servitisation. Additionally, the theory of organisational identity is necessary for determining how actors at different levels perceive the transformation (Kohtamäki *et al.,*, 2019b). For this reason, the operationalisation should begin by identifying the managerial perception of servitisation success in order to specify the success indicators. Hence, a better dissemination of servitization have to emerge from a comprehensible definitional understanding of the concept. This prevents misinterpretation of important findings by elaborating on previous implicit definitions. Our research thus urges scholars within the servitisation field to embrace definitional clarification by identifying the definitional stance of their research.

To specify servitisation success, incorporating both financial and non-financial indicators is an important step to embrace the varied perceptions among practitioners. The very nature of financial indicators relies on an objective view of computed economic achievements, while non-financial indicators are governed by more subjective views of the objectives at hand. Nevertheless, while some non-financial indicators have financial implications, these are less targeted than financial indicators like 'revenue' or 'profitability' (Lexutt, 2020). Similarly, some financial indicators possess a degree of subjectivity. For instance, the financial indicators by Lexutt (2020, p. 121) are subjectively assessed – 'the services we provide are very profitable.' Following such a notion, this study suggests that the distinction of non-financial and financial performances relies on the objectivity and subjectivity of the indicator, as illustrated in the propositional framework of assessing servitisation success (Figure 13).



1. Parida et al. (2014) **2.** Huikkola et al. (2016) **3.** Lexutt, (2020) **4.** Lexut, (2020) **5.** Cestino and Berndt (2017) **6.** Bustinza et al. (2019) **7.** Bustinza et al. (2019)

Figure 13: The framework of assessing servitisation success and the firm performance.

Accordingly, the assessment of servitisation success should comprise objective, subjective, financial and non-financial performance indicators categorised according to their definitional type. From a managerial perspective, such clarification facilitates superior perspectives of the relevant theories at hand, which visualise the immersive tensions that emerge from the differing perceptions of success. However, this only holds true as long as the managers' self-assessments are correct. Additional knowledge on such assessments is therefore needed, as is identification of accommodating measures of each quadrant with a particular focus on potential paradoxes.

6. Conclusion

This study finds that servitisation success should be interpreted according to the following definitional types: offering-focused, process-focused, firm-focused or business model-focused. Theoretically, it shows that the definitional ambiguity has complicated the interpretation of servitisation success, as the objectives follow such perceived definitional understandings. As such, the study presents a typology of servitisation success to illuminate and embrace the diversity and to unify future research on operationalisation of servitisation to increase its usability. However, the precision of the identified success indicators and the management of potential tensions and paradoxes are crucial and call for additional attention. To embrace such gaps, this paper presents a modified assessment methodology of servitisation success (Section 5.3), identified by assessing servitisation success according to the differing definitional types. By developing a new method for interpreting servitisation success, this paper suggests a more precise way for managers to assess their transition. From an organisational identity perspective, practitioners should interpret the success according to the definitional types to gain a better understanding of the indicators suitable for their progression.

During the review, it became evident that the use of the term 'servitisation success' varies widely within the servitisation field of research. This has led to inconsistencies and questionable findings by previous studies, as the basis of the investigation is uncertain. Inconsistencies and ambiguous definitions led our attention to the presence of potential tensions arising from related paradoxes. This paper presents the definitional and measurement paradoxes. The definitional paradox arises when scholars unintentionally convey diverse definitional types of servitisation, leading to misinterpretations of their findings. Likewise, implicit definitions of success within servitisation success investigations induce further tensions through misinterpretation. Misinterpretation of such findings without clear definitions of type of success is easily adopted by practitioners, resulting in failure to disseminate the servitisation operationalisation. The measurement paradoxes arise when contradictory objectives based on differing definitional understandings are pursued. Such paradoxical indicators of success lead to both external and internal tensions. When acknowledging the potential tensions, managers are more likely to avoid such barriers, which highlights the importance of these findings. As tensions likely hinder the full potential of the servitisation transformation and destroy value for all participants, such tensions are critically important for the achievement of servitisation (Burton *et al.,*, 2016).

Essentially, the study answers the presented research question 'what are the inherent tensions and paradoxes in the measurement of servitisation success?' by identifying five paradoxes and their underlying internal and external tensions emerging from the perception of servitisation success. It shows that a particular focus on the identification of success indicators suitable for each definitional type should be pursued, and manufacturers should take an intentional stand as to the path they seek.

The study provides a series of novel theoretical contributions for the literature that, to the best of our knowledge, are presented for the first time:

- A comprehensive review of the term 'servitisation success' led to an insightful discussion of the use of the term within academia. The theoretical implication relies on future studies' emphasis on explicating the use of the term to enable a common distinction and highlights a shortcoming in the current literature due to the implicit use of the term.
- An overview of the definitional confusion within servitisation with a related discussion on the potential consequences. This theoretically illuminates the problematic definitional

diversity in assessing success and underlines the importance for managers to understand these diversities to better identify proper success indicators.

- An insight into the paradoxes and underlying tensions that servitisation are likely to (unintentionally) cause. This to theoretically demonstrate the consequences of definitional ambiguity, guide managers in the preliminary stage of the transformation to reduce or eliminate potential organisational paradoxes and to highlight the importance of establishing an identical identity for the entire organisation.
- A cohesive typology of important success indicators categorised according to the definitional perception of servitisation to allow for a common distinction among managers and academia.
- A new methodological framework for assessing the success indicators to guide managers in identifying proper success indicators for their identity.

Furthermore, a profound focus on success indicators for process performance is necessary to enable a coherent combination of relevant indicators. Regardless of future investigations into the built-in tensions and paradoxes, such paradoxes are inexhaustible and not limited to the ones listed. However, it is important to ensure a more profound dissemination of the servitisation concept and to specify the achievement of such transformation. To facilitate the interpretation and dissemination of future findings, we encourage future studies to adopt the definitional types of this paper to clarify and position potential findings.

6.1 Limitations

The identification of the original indicators is based on reviewer-based intuition, as most literature did not explicate the measure of success. Hence, important implicit indicators of success might by missing. However, as paradoxes arise mainly from the diversity of definitions and interpretations of prior studies, we believe that these are consistent and provide academia with an important insight.

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Appendix 1 - Standardised pro forma set

	Standardised pro forma set for coding	*Sample 1*
Baseline information	Article	Resource realignment in servitization
	Year	2016
	No. of citations – November 2020	29
	Journal	*Research-Technology Management*
	Paper type	Journal paper
	Authors	Huikkola, T; Kohtamäki, M; Rabetino, R
	Source	10.1080/08956308.2016.1185341
Exclusion criteria (stage three)	Availability (access)	Yes – access to full text
	Published scientific paper	Yes – published journal paper
	Investigating servitisation success directly (subject two)	No
	Talks about servitisation success (subject two)	Yes – success in service strategies for manufacturers
	About servitisation (subject one)	Yes
Method	Main method	Qualitative case study
	Sample size	115 successful, servitised manufacturers
	Test/analysis/techniques	-
Content analysis (success definition)	Definition of success	They identified successful, servitised manufacturers based on: - Service sales as a percentage of total revenue - The proportion of services invoiced related to produced customer value versus all services invoiced - Long-term profitability - Market position
	Investigated/own predefined/none	Own predefined
	Only direct servitisation success (yes/no)	Yes
	Only success in the context of servitisation (yes/no)	No
	Cited success definition	None
General	Notes	-
	Suggested future research	-

4.2.1 The lessons learned from Publications 1 and 2

Publication 2 resulted in the identification of 12 success indicators consolidating the approximation of servitisation success. This approximation was identified as consisting of both financial and non-financial success measures, with financial measures being led by service-specific and company-specific measures (e.g. overall profitability versus service profitability). The non-financial indicators are more diffusely defined based on the managerial perception of servitisation. This increased the complexity of measuring servitisation success and spawned the notion of splitting the approximation of success into the four definitional types (see section 2.1). However, due to the exploratory approach of the study, the research team decided to include all 12 identified indicators of success in the adjusted SeMM in Publication 3. In conclusion, the lessons learned from Publications 1 and 2 led to the statistical validation of 24 significant items ($p < .001$), the rephrasing of five items and inclusion of 24 items (mainly for servitisation success, with 12 added and four rephrased items) identified through an additional review of literature suggested by the servitisation community at the SSC21.
The lessons learned from Publications 1 and 2 led to the adjustment of the SeMM, which resulted in distinct improvements in the statistical validation, as will be presented in the next publication.

4.3 Publication 3

Developing a substantiate servitisation maturity model in a multidimensional reality: A statistical investigation of the key dimensions

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Abstract

Purpose The purpose of the study is to increase the likelihood of a successful servitisation transformation within an organisation by identifying the importance of the six servitisation dimensions and the relational consequences between them. This is to facilitate a better understanding of the direct and indirect relational effects of the dimensions in a successful transformation.

Methodology The study develops a maturity model that highlights the multidimensional nature of servitisation, which is tested on the computation of a partial least squares structural equation model with a sample size of 159 servitised Danish SMEs.

Findings This study evidentially confirms the presence of eight relations between the key dimensions of servitisation; it also confirms the multidimensional reality through the identification of additional mediating effects.

Originality/Novelty These results are part of the first evidential maturity model within servitisation, and they are the first to validate and weight the relations between key dimensions and their maturity indicators within a multidimensional reality.

Keywords: Servitisation, Maturity, Operationalisation, Partial Least Squares Structural Equation Modelling, Multidimensional Perspective

1. Introduction

Servitisation is understood as a transition or transformation characterised as '*a linear and gradual move along a product continuum from less to more sophisticated services*' involving the entire business (Baines *et al.,*, 2020) through a process of increasing customer and organisational value (Brax & Visintin, 2017). Prior studies of *process* have generally focused on 'describing' (*have followed*) or 'prescribing' (*how to*) this transformation (Baines *et al.,*, 2020). The premise of the transformation as a predefined and structured path has been adapted within the servitisation literature (Oliva & Kallenberg, 2003), forming the foundations for multiple structured models prescribing the servitisation transformation (Brax & Visintin, 2017). Dimensions have been used to conceptualise such transformation-prescribing models within servitisation (Rapaccini *et al.,*, 2013), and several dimensions have been introduced and declared as important for servitisation to succeed as a strategy (Alvarez *et al.,*, 2015). Here, 'dimension' is defined as representing the context in which certain measures are analysed, and 'context' is specified by theory and concepts (Ahmed & Miquel, 2005, p. 29).

According to Kohtamäki *et al.,* (2019a), studies of servitisation dimensions have mainly followed a unidimensional perspective by investigating single organisational levels or function-specific areas (Kindström & Kowalkowski, 2014). While these studies have deepened the understanding of profound dimensions (e.g. Wikström *et al.,* (2009)), they lack the cross-organisational implications of the multidimensional servitisation reality (Kindström & Kowalkowski, 2014). This reality entails a series of contextual dimensions, representing specific areas of the transformation, which undertake a simultaneous evolution (Kindström & Kowalkowski, 2014). A growing emphasis on this perspective has emerged (Kohtamäki *et al.,*, 2019a), leading to important calls for attention (Baines *et al.,*, 2017;Lexutt, 2020). However, few studies have investigated this multidimensional perspective, which entails vital dimensions such as 'management' and 'strategic' dimensions (Madsen & Goduscheit, 2023), leaving the calls for attention unfulfilled.

On a multidimensional continuum, the transformation translates into a simultaneous progression of coexisting dimensions, which potentially entails a mutual relational influence (Madsen, 2021). Progression in one dimension therefore potentially has a positive effect on another dimension, having direct and indirect influences on the overall outcome. For this reason, a superior understanding of such relations is crucial to understanding the total effects in a successful transformation. To establish such understanding of the interrelationships between dimensions, a nomological network must be theorised and empirically tested to evolve the multidimensional understanding of servitisation. Although a few studies have investigated the multidimensional reality of servitisation (e.g. (Adrodegari & Saccani, 2020), none take such relations into account.

Investing to achieve competitive services has been shown to postpone servitisation success (Neely, 2008). Lütjen *et al.,* (2017) emphasised this pattern, while Baines *et al.,* (2017) identified significant challenges in efficiently transforming a manufacturing organisation. Managers must therefore allocate their resources carefully to avoid delaying the preferred success (Madsen & Goduscheit, 2023), while navigating this highly complex concept. This has led to an imperfect image of servitisation as a whole (Rabetino et al., 2017), and the perspectives have failed to take the fluctuating progression of SMEs into account (Kindström & Kowalkowski, 2014). Kowalkowski *et al.,* (2013) emphasised how the versatility of SMEs means that they succeed through various value constellations in a multifarious progression. Combined with an increased interest in servitisation among European SMEs, this renders them a particularly interesting group to investigate (European Commission, 2018). The maturity

modelling technique provides this much-needed overview, although prior models have lacked multidimensionality and overlooked important dimensions (Andersen *et al.,*, 2020). Consequently, important implications remain unsolved, highlighting the necessity for further research.

In particular, this research seeks to establish a better understanding of SME servitisation transformation by answering the following research question: *How do the relations between dimensions influence the success of the SME servitisation transformation, and to what extent do they impact the operational importance of the dimensions?*

The investigation follows the theoretical development of a nomological network, which is tested empirically through a partial least squares structural equation modelling (PLS-SEM) technique to statistically develop a truly multidimensional servitisation maturity model (MdSeMM). The theoretical novelty of established and weighted dimensions, relations and indicators is extraordinary.

2. Theoretical positioning

2.1 Servitisation maturity models (SeMMs)

Maturity models guide firms towards a reliable and sustainable outcome (Fahrenkrog *et al.,*, 2003). More recently, Adrodegari and Saccani (2020) described maturity models as a tool to assess and position firms during a transition, adding to the Röglinger *et al.,* (2012) definition as theoretical tools to specify the stage-by-stage evolution along an anticipated, desired or logical path.

Adrodegari and Saccani (2020) emphasised the importance of investigating servitisation maturity models (SeMMs) with a particular focus on reconfiguring the entire business model. This study emphasises two important aspects: first, embracing comprehensive servitisation dimensions to embed the diversity of the existing servitisation knowledge (Section 2.2); and, second, the necessity for multidimensional perspectives on SeMMs to understand the transitional complexity when several dimensions transform simultaneously (Kohtamäki *et al.,*, 2019a). This study taps into this reasoning, as the inclusion of relational influencers provides new insights into the coexistence. Reviewing prior SeMMs reveals a diversity in the contextual setting, which has induced varieties in both the degree of maturity (assessment/measurement of the maturing level) and the dimensions of the models (the context in which the measures are analysed(Ahmed & Miquel, 2005, p. 29)).

Prior SeMM studies have focused on the contextual dimensions of servitisation on a unidimensional level (e.g. Alvarez *et al.,* (2015)), which has had a positive impact on understanding these dimensions individually. However, while succeeding in incorporating contextual diversity, they still investigate them as separate, isolated dimensions (Coreynen *et al.,*, 2018;Adrodegari & Saccani, 2020). Prior calls have been made for such multidimensionality, but we believe that these calls remain unmet. For instance, although Coreynen *et al.,* (2018) succeeded in evaluating the degree of maturity on several servitisation dimensions, they failed to include the relations between them; something that exists for all SeMMs within the literature (Andersen *et al.,*, 2020). A gap therefore remains, as the incorporation of such relational influencers is absent in the existing servitisation literature.
To incorporate such relations into an understandable network of dimensions, a nomological network is considered essential in proposing a new multidimensional maturity model; this, as the nomological network constitutes a theory regarding its laws and constructs, which can then

be empirically tested (Cronbach & Meehl, 1955). While the laws (i.e. interrelationships) among dimensions are presented as hypotheses in section 3, each of the six dimensions is presented in section 2.2.

2.2 The six servitisation dimensions

Following Ahmed and Miquel (2005, p. 29), '*multidimensional structure*[s] *are based on the concept of facts or measures, and dimensions representing the context in which these measures are analyzed'.* Following this, the multidimensional reality posits a set of contextual dimensions, which, in this study, individually represent part of the progressive transformation of servitisation. However, several studies have proclaimed the importance of a variety of differing contextual dimensions to achieve servitisation as a strategy; for instance, 'goal' and 'key process' by Wikström *et al.,* (2009) and 'market' (competitors) and 'customer' by Alvarez *et al.,* (2015). This diversity of contextual settings emphasises how additional dimensions might exist within the concept. An exhaustive investigation into the existence of additional dimensions is therefore necessary to comprehend the complex nature of servitisation (Brax & Visintin, 2017). The research by Andersen et al. (2020) led to the notion of six extensive themes, which were believed to represent the context as dimensions (Ahmed & Miquel, 2005). These were identified through an extensive systematic literature review following the screening process by Brax and Visintin (2017), identifying thematic denominators within servitisation through a fine-grained content analysis of 880 academic papers with an additional backward citation search (Andersen *et al.,*, 2020). We are therefore confident that the most important aspects are included and that the extraction process was saturated. Table 18 outlines the established specification and definition of six servitisation dimensions.

Dimension	Definition	Key elements	Key references
Organisational governance	The ability of a firm to build, integrate and align the organisation with the transformational properties of embarking on the servitisation journey, from which new experiences and realities emerge for the manufacturer.	• The need to re-engineer new organisational structures to facilitate service design and delivery. • The accumulated organisational approach in managing servitisation processes and projects. • The awareness of managing strategic choices by developing clear and implementable service management policies, processes and resources. • The fundamental change in organisational culture as accommodating service provision.	Oliva and Kallenberg (2003);Tukker and Tischner (2006);Baines *et al.,* (2009b);Wikström *et al.,* (2009);Rapaccini *et al.,* (2013);Jin *et al.,* (2014);Alvarez *et al.,* (2015);Coreynen *et al.,* (2018);Lexutt (2020); Andersen *et al.,* (2020)
Strategic management	The ability of a firm to build and maintain strategies to successfully implement servitisation.	• The managerial commitment plays a fundamental role in maintaining and building transition strategies. • The fundamental change in the product mindset from a pure industrial context to a more customer-centric approach.	Fang *et al.,* (2008);Wikström *et al.,* (2009);Neff *et al.,* (2014);Jin *et al.,* (2014);Kindström and Kowalkowski (2014);Baines *et al.,* (2017);Coreynen *et al.,* (2018);Lexutt (2020); Andersen *et al.,* (2020)

Value function activities	The ability of a firm to embrace servitisation by developing new business models capable of creating and capturing the value that servitisation promises.	• The ability to create new partnerships to obtain a wider set of suppliers in upstream and downstream directions; and managing these effectively to leverage additional capabilities. • The support and ability to provide service products throughout the product life cycle; and finding innovative ways to make services more tradable with a functional cost structure. • The ability to manage value chain activities.	Spring and Araujo (2013);Baines and Lightfoot (2014);Cui *et al.,* (2019);Lexutt (2020);Adrodegari and Saccani (2020); Andersen *et al.,* (2020)
Market reach	The ability of a firm to scan the business environment to identify and apply external capabilities, resources and knowledge in supporting the servitisation journey through new and optimised service solutions in collaboration with unique customer insights.	• Involving customers and network partners to: educate on product and service features; co-create services with external partners; and build and enhance the customer experience and identify customer needs. • The ability to create a profound value proposition, which must focus on solving actual customer problems and building on measurable outcomes and capabilities.	Gebauer *et al.,* (2005);Tukker and Tischner (2006);Neely (2008);Bitner and Brown (2008);Rapaccini *et al.,* (2013);Jin *et al.,* (2014);Alvarez *et al.,* (2015);Neu and Brown (2016);Cui *et al.,* (2019);Andersen *et al.,* (2020) Lexutt (2020)
Digital integration	The ability of a firm to integrate new technologies, increase external accessibility and apply data as a resource for new service offerings.	• The ability to incorporate digital services into physical products with the aim of developing the capturing and processing of data and information, allowing manufacturers to develop new business models by exploiting the potential of their products. • The ability to enable better resource allocation and more accurate information-sharing within and outside the boundaries of the company through digitalisation.	Jin *et al.,* (2014);Neff *et al.,* (2014);Kindström and Kowalkowski (2014);Vendrell-Herrero *et al.,* (2017);Pistoni (2018);Coreynen *et al.,* (2018); Andersen *et al.,* (2020)
Service integration	The ability of a firm to integrate data application from service and product data, service infrastructure, and process and policy formalisation into the development of new, optimised service solutions.	• The ability to combine data appliance, service infrastructure and process policy formalisation to provide new value-creating and revenue-generating opportunities. • Accumulation of the role of services among the other dimensions.	Li *et al.,* (2013);Alvarez *et al.,* (2015);Vendrell-Herrero *et al.,* (2017);Coreynen *et al.,* (2018); Andersen *et al.,* (2020)

Table 18: *The six servitisation dimensions*

2.3 Servitisation success

The definition of servitisation varies and remains ambiguous within the field (Brax & Visintin, 2017), leading to variations in how to measure and perceive servitisation success (Madsen & Goduscheit, 2023). However, a relatively recent line of research embraces an understanding of servitisation success, comprising both financial and non-financial success indicators (Section 5.2). This study adopts the definition of success by Bustinza *et al.,* (2019) as a progression or development of the performance of the focal firm from one state towards another, and the notion developed by Fliess and Lexutt (2019) of taking industrial development into account, as such progression only proves successful when compared with others.

3. Development of hypotheses and research model

The six servitisation dimensions are developed in relation to the servitisation literature. Most studies have investigated several dimensions simultaneously while indicating potential relations. To leverage the relational structure of the model, such theoretical considerations from the literature have been adopted to construct seven hypothetical relations between dimensions and five towards 'servitisation success'.

3.1 Organisational governance (OG)

Organisational governance revolves around the re-engineering of the organisation to facilitate new service design and delivery (Jin *et al.,*, 2014) by formalising the firm's policies, processes and resources (Tukker & Tischner, 2006). While formalisation follows the organisational concept (Wikström *et al.,*, 2009), manufacturers must incorporate a servitisation mindset and strategic thinking to follow through with servitisation (Liu *et al.,*, 2019). Accordingly, formalised policies and processes have a positive impact on the ability of manufacturers to capitalise on service opportunities (Coreynen *et al.,*, 2018) and improve the service infrastructure (Reim *et al.,*, 2019), which is an important part of 'service integration'. Hence:

H_1: *The maturing level of 'organisational governance' is positively associated with the maturing level of 'service integration'.*

H_2: *The maturing level of 'organisational governance' is positively associated with 'servitisation success'.*

3.2 Strategic management (SM)

'Strategic management' refers to the ability to build and maintain strategies to implement servitisation successfully (Andersen *et al.,*, 2020). The strategic commitment plays an important role in maintaining and building the strategies of the transformation (Lexutt, 2020), as in the formalisation of company-specific policies (**H_4**). As the strategic mindset evolves and embraces the customer-centric logic (Kohtamäki *et al.,*, 2020), it facilitates better value propositions through customer integration, leading to new value creation and more integrated cost structures (Liu *et al.,*, 2019), which fundamentally changes the organisational culture by accommodating service provision (Baines *et al.,*, 2009b). Hence:

H_3: *The maturing level of 'strategic management' is positively associated with the maturing level of 'value function activities'.*

The managerial mindset and commitment influence the long-term resource focus (Crowley *et al.,*, 2018) and investment in the service business (Gebauer & Fleisch, 2007). This affects the willingness to allocate the necessary resources to, for example, establish specific sales tools,

methods and procedures (Adrodegari & Saccani, 2020), and/or to formalise policies and processes (Neff *et al.,*, 2014). Following this notion, changes in the managerial mindset towards servitisation impact 'organisational governance', as reorganising and allocating existing resources should be influenced by the strategic direction (Liu *et al.,*, 2019), as should formalising the manufacturers' service and customer policy (Tukker & Tischner, 2006). Hence:

H_4: *The maturing level of 'strategic management' is positively associated with the maturing level of 'organisational governance'.*

H_5: *The maturing level of 'strategic management' is positively associated with 'servitisation success'.*

3.3 Market reach (MR)

Past studies have emphasised the importance of leveraging external opportunities to precipitate the servitisation transformation. Collaboration and insourcing the capabilities of external partners have proven to be important for capturing additional servitisation value (Benedettini & Neely, 2019), similar to the ability to utilise network capabilities (Coreynen *et al.,*, 2017) and involve customers in value creation through co-creation. Hence:

H_7: *The maturing level of 'market reach' is positively associated with the maturing level of 'value function activities'.*

As the ability to identify and apply external capabilities, resources and knowledge is believed to enhance the servitisation journey, such an evolution is believed to have a positive, direct impact on servitisation success. Hence:

H_8: *The maturing level of 'market reach' is positively associated with 'servitisation success'.*

3.4 Digital integration (DI)

Digitalisation is seen as interrupting barriers among industry segments and changing the traditional value chains in service provision (Kuula *et al.,*, 2018). For instance, the incorporation of digitalisation has been found to enable the deeper integration of customers to reach new levels of network involvement (Grieger & Ludwig, 2019) and the value of co-creation (Coreynen *et al.,*, 2017). Hence:

H_9*: The maturing level of 'digital integration' is positively associated with the maturing level of 'market reach'.*

By utilising digital opportunities, manufacturers can better allocate resources and conduct more accurate information-sharing, internally and externally (Kindström & Kowalkowski, 2014), both of which are believed to have a positive influence on the 'market reach' of companies **(H_9)** and their 'organisational governance'. Hence:

H_{10}: *The maturing level of 'digital integration' is positively associated with the maturing level of 'organisational governance'.*

Digitalisation is believed to be essential for effective service delivery through the optimisation and reorganisation of manufacturers' service infrastructure and delivery processes (Reim *et al.,*, 2019). Hence:

H_{11}: *The maturing level of 'digital integration' is positively associated with the maturing degree of 'service integration'.*

As digital technologies are believed to enable the servitisation transformation (Sjödin *et al.,*, 2020), digital integration (DI) is believed only to have a mediating effect through market reach (MR), service integration (SI) and organisational governance (OG).

3.5 Value function activities (VF)

'Value function activities' refer to the ability to develop new business models capable of creating and capturing value from the servitisation transition (Andersen *et al.,*, 2020). As the ability to capture value evolves, the direct effects on servitisation success are also believed to evolve. Hence:

H_6: *The maturing level of 'value function activities' is positively associated with 'servitisation success'.*

3.6 Service integration (SI)

'Service integration' is the ability to integrate data applications from product and service data (**H_7**) (Sjödin *et al.,*, 2020) to utilise a service infrastructure (**H_1**) (Reim *et al.,*, 2019) and to integrate process and policy formalisation (Tukker & Tischner, 2006) into the development of new, optimised service solutions (**H_1**) (Andersen *et al.,*, 2020). Hence:

H_{12}: *The maturing level of 'service integration' is positively associated with 'servitisation success'.*

3.7 Theoretical structural model

The structural model is constructed, as illustrated in figure 14, to identify distinct drivers of servitisation success to understand the importance of both dimensions and relations (Hair *et al.,*, 2017b). The nomological network consists of the theorised constructs, which individually poses their own contextual area (Sarstedt *et al.,*, 2021) and the interrelationships between the constructs (i.e. the hypothesised relations) (Cronbach & Meehl, 1955).

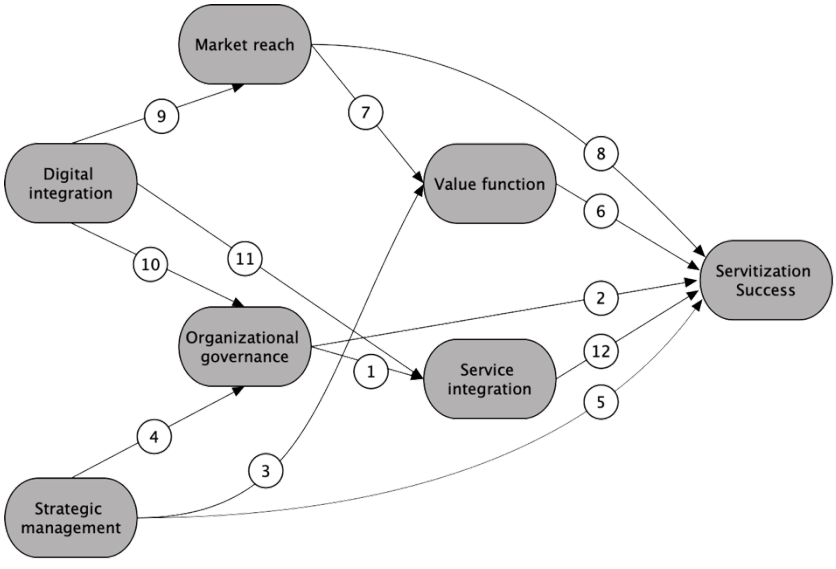

Figure 14: Theoretical (structural) model

4. Methodology

To explore the validation of coexisting dimensions, which allows for theoretical inter-relationships, structural equation modelling (SEM) is believed to be the best-suited methodology (Hair *et al.,*, 2011). The reason for choosing SEM for this study is three-fold. First, it is the best approach to predict target constructs and identify driver constructs in a nonlinear structure (Hair *et al.,*, 2017b). Second, the technique comprehends the nomological network and allows for testing the laws of interrelationships empirically (Cronbach & Meehl, 1955); and, third, it provides robust estimators despite small sample sizes or non-normality within the data (Hair *et al.,*, 2011). The study seeks to explore the relational structure among the dimensions to extend our theoretical understanding of the complexity within servitisation. With no prior validated nomological network structures (Section 2.1), dimensions (Section 2.2) or indicators of the latent constructs (Section 4.2), this study undertakes an exploratory approach to remain open-minded during our investigation. The study then adapts the partial least squares structural equation modelling (PLS-SEM) technique, which is preferred for theory exploration studies (Hair *et al.,*, 2019b). PLS-SEM aims to maximise the explained variance of the endogenous variable to increase the causal explanation of the model (Hair *et al.,*, 2011). Following the best practices proposed by Hair *et al.,* (2017a);Hair *et al.,* (2019b);Hair *et al.,* (2020), the exploratory approach follows a reduction of the theoretical model by estimating and evaluating the measurement model (Section 6.1) and structural model (Section 6.2).

Interest in servitisation has increased in the last decade among Danish SMEs (European Commission, 2018), leading to the investment of €3.9 million in an industrial project (called Alpha) through the Danish Industry Foundation, which is intended to disseminate and research the servitisation concept to strengthen Danish industry.

4.1 Data

The data collection consisted of two flows: the first containing data gathered from among the 130 Alpha members, and the second comprising probability sampling through stratification to attain the representativeness of the sample (Rowley, 2014). The strata were formed and proportioned upon the NACE industry code and industry sizes published by the Danish Central Company Register (CVR) (N = 8,741).[11] The questionnaire was distributed as an online survey to ease respondent participation, with several control mechanisms in place to ensure respondent anonymity (Rowley, 2014). The survey was distributed by email to all respondents with a publicly available email (n = 4065),[12] while additional respondents without public emails were contacted by phone (n = 1055) to retain the necessary stratification. Stratification was not fully achieved despite this effort, although acceptable representation of the majority of the strata was established. The collection provided 538 observations from stratified sampling and 35 from Alpha, which resulted in response rates of 10.8% and 26.9%, respectively. As a result of the data collection from non-service providers (194), non-manufacturers (60), non-

Firm size *(employees)*	*Frequency*	*Percentage*
0–25	*93*	58%
26–50	34	21%
51–100	20	13%
101–150	6	4%
151–200	5	3%
201–250	1	1%
Total:	**159**	**100%**

Service advancement	*Frequency*	*Percentage*
Basic services	117	74%
Advanced services	42	26%
Total:	**159**	**100%**

Firm age *(years)*	*Frequency*	*Percentage*
0–5	17	11%
6–15	49	31%
16–30	31	19%
31–60	37	23%
>61	25	16%
Total:	**159**	**100%**

Table 19: Data distribution

[11] CVR.dk databases – April 2022.
[12] *May, 2022.

SMEs (8) and partial completion of the questionnaire (152), 159 usable observations were collected in total, providing a final response rate of 3.1%. The feedback from non-responders identified a lack of time and interest and being out of scope as the main reasons for not participating. All partially completed observations above the recommended threshold for imputations (less than 5%) were removed. PLS-SEM is known for its robustness for non-normality and for comprehending small sample sizes (< 100) (Hair *et al.,*, 2011). However, normality was tested without the identification of critical values.

The 10-times rule is used to establish the preferred sample size (Hair *et al.,*, 2011). It prescribes sample size by the largest number of relations or the largest number of indicators for a construct, multiplied by 10 (Hair *et al.,*, 2017a). The largest denominator is 15 indicators for a single latent construct, causing a minimum of 150 observations, which were acquired (n = 159).

The data collection among Danish SMEs required profound translation, which was adopted from Sousa and Rojjanasrirat (2011) following their parallel forward–backward translation. This translation strives for the highest degree of conceptual (whether the items' concept exists in both cultures), semantic (the meaning of text and terms of the original questionnaire (SL) are present in the Danish questionnaire (DL)) and content equivalence (the relevance of text and terms in both cultures) among SL and DL. The inspection of all variables found neither outliers nor anomalous statistics (Table 22).

4.2 Measures

The identification of measures for the theoretical model was initially investigated through a pilot study. Based on feedback from the servitisation community, this study further elaborates on the existing measures of maturity, success and constraints.

4.2.1 Servitisation maturity measures

To consolidate the existing literature and to ease the complexity of the model, the integrated measures were adapted from previous SeMM studies. For instance, the measures presented by Coreynen *et al.,* (2018) were adopted, as the study incorporates a substantial part of prior knowledge. As emphasised in section 2.1, however, there are some limitations in their proposed model. Therefore, to ensure coherence within the measures, the identification and consolidation of the underlying components are necessary. Consolidation follows a thematic investigation of previous SeMM measures categorised according to the dimensional definitions, leading to the identification of several underlying components for each dimension (see Table 20). By representing the essential aspects of each dimension, these components ensure proper measurement during the investigation. This categorisation placed strong emphasis on the conceptual grounding and validation of the measures to identify strong indicators. Interestingly, the majority of measures from the SeMM literature were conceptualised and validated in only a few cases and (almost) with no statistical triangulation. Although similar validated indicators might exist in other fields, it is intriguing that none have been applied (or even exist) within servitisation maturity modelling. To ensure the quality, reliability, coherence and relevance of these measures, the research team cross-examined each indicator by seeking to falsify their presence. As Table 20 illustrates, previous studies have relied on theoretical and/or empirical conceptualisations of the measures without any prior statistical validation. Initial validation of the adapted measures was therefore crucial for the quality of this study, and thorough pilot testing was necessary (Section 4.2.4).

Dimension	Components	Previous measures from the SeMM literature	Stat. tested	Conceptualisation of SeMM	Method of testing
Organisational governance	Process formalisation	Management of processes and projects (Rapaccini *et al.,* (2013)	Untested	Theorised SeMM with five prescriptive levels of maturity	Qualitatively validated (one workshop and three in-depth interviews)
		Process maturity (Alvarez *et al.,* (2015)	Untested	Theorised SeMM with four phases of maturity	Qualitatively validated (four exploratory case studies)
		Process management (Adrodegari and Saccani (2020)	Untested	Literature-based SeMM with five prescriptive levels of maturity	Qualitatively evaluated with mean interpretations (two case studies)
		Process characteristics (Alvarez *et al.,* (2015)	Untested	Same as Alvarez *et al.,* (2015)	[…]
		Reconfiguring assets and processes (Coreynen *et al.,* (2018)	Untested	Theorised SeMM with 7-point Likert scales with mean interpretations	Qualitatively exemplified (two case studies)
	Policy formalisation	Organisational concept (Wikström *et al.,* (2009)	Untested	Theorised SeMM with five prescriptive levels of maturity	Qualitatively evaluated (six case studies, based on interviews and workshops)
		Systematic behaviour (Jin *et al.,* (2014b)	Untested	Theorised SeMM with five prescriptive levels of maturity	No evaluation, validation or exemplifying
	Resources	Approach to personnel (Wikström *et al.,* (2009)	Untested	Same as Wikström et al. (2019)	[…]
		Tools (Adrodegari and Saccani (2020)	Untested	Same as Adrodegari and Saccani (2020)	[…]
		Resource allocation – Jin *et al.,* (2014b)	Untested	Same as Jin *et al.,* (2014b)	[…]
	Capabilities	Capabilities (Adrodegari and Saccani (2020)	Untested	Same as Adrodegari and Saccani (2020)	[…]
		Organisation (Adrodegari and Saccani (2020)	Untested	Same as Adrodegari and Saccani (2020)	[…]
		Decentralisation (Lexutt (2020)	Tested | fsQCA	Theorised SeMM with three prescriptive levels of maturity	Quantitatively tested (fsQCA, n = 143)
Strategic management	Managerial behaviour	Service orientation of management behaviour (Coreynen *et al.,* (2018)	Untested	Same as Coreynen *et al.,* (2018)	[…]
	Management commitment	Strategic management (Jin *et al.,* (2014b)	Untested	Same as Jin *et al.,* (2014b)	[…]
		Performance measurement of industrial service (Neff *et al.,* (2014)	Untested	Conceptual SeMM based on literature, focus groups and 11 case studies with five prescriptive levels of maturity	Qualitatively evaluated (single expert focus group)
		Service orientation of management value (Coreynen *et al.,* (2018)	Untested	Same as Coreynen *et al.,* (2018)	[…]
		Management commitment (Lexutt (2020)	Tested | fsQCA	Same as Lexutt (2020)	[…]
	Culture	Culture (Jin *et al.,* (2014b)	Untested	Same as Jin *et al.,* (2014b)	[…]

		Culture (Wikström *et al.,* (2009)	Untested	Same as Wikström et al. (2019)	[…]
		Service orientation (Lexutt (2020)	Tested | fsQCA	Same as Lexutt (2020)	[…]
Value function activities	Value creation	Value proposition (Cui *et al.,* (2019)	Untested	Empirically proposed SeMM based on exploratory longitudinal single case study; four prescriptive stages of maturity suggested	No evaluation, validation or exemplifying
	Pricing	Revenue and profit model (Cui *et al.,* (2019)	Untested	Same as Cui *et al.,* (2019)	[…]
	Cost structure	Cost structure (Lexutt (2020)	Tested | fsQCA	Same as Lexutt (2020)	[…]
Market reach	Combined	Network management (Coreynen *et al.,* (2018)	Untested	Same as Coreynen *et al.,* (2018)	[…]
	Stage	Stage of customer involvement (Jin *et al.,* (2014b)	Untested	Same as Jin *et al.,* (2014b)	[…]
		Structures (Cui *et al.,* (2019)	Untested	Same as Cui *et al.,* (2019)	[…]
		Most important customer (Wikström *et al.,* (2009)	Untested	Same as Wikström *et al.* (2019)	[…]
	Role	Customer role (Jin *et al.,* (2014b)	Untested	Same as Jin *et al.,* (2014b)	[…]
	Involvement	Involvement of suppliers and other stakeholders (Rapaccini *et al.,* (2013)	Untested	Same as Rapaccini *et al.,* (2013)	[…]
		Involvement of customers (Rapaccini *et al.,* (2013)	Untested	Same as Rapaccini *et al.,* (2013)	[…]
		Customer involvement (Jin *et al.,* (2014b)	Untested	Same as Jin *et al.,* (2014b)	[…]
Digital integration	Digital application	Appliance (Neff *et al.,* (2014)	Untested	Same as Neff *et al.,* (2014)	[…]
		Digitalisation (Coreynen *et al.,* (2018)	Untested	Same as Coreynen *et al.,* (2018)	[…]
	Accessibility	Degree of implementation of technology (Jin *et al.,* (2014b)	Untested	Same as Jin *et al.,* (2014b)	[…]
		The integration of service and product data (Neff *et al.,* (2014)	Untested	Same as Neff *et al.,* (2014)	[…]
		Accessibility (Coreynen *et al.,* (2018)	Untested	Same as Coreynen *et al.,* (2018)	[…]
Service integration	Sensing	Sensing service opportunity (Coreynen *et al.,* (2018)	Untested	Same as Coreynen *et al.,* (2018)	[…]
	Seizing	Seizing service opportunities (Coreynen *et al.,* (2018)	Untested	Same as Coreynen *et al.,* (2018)	[…]
	Service infrastructure	Service level (Li *et al.,* (2013)	Untested	Theoretical SeMM with four phases of maturity. Quantified with 4-point scoring and mean interpretations	Exemplified through single case
		Types of services (Alvarez *et al.,* (2015)	Untested	Same as Alvarez et al. (2015)	[…]
		Service mass customisation (service level) (Coreynen *et al.,* (2018)	Untested	Same as Coreynen *et al.,* (2018)	[…]

Table 20: Thematic analysis of the dimensional components

4.2.2 Servitization success

When measuring servitisation success, both financial and non-financial indicators were incorporated as an important step forward in representing business performance (Raddats *et al.,*, 2015). Financial indicators provide an objective (quantifiable) view of economic achievements, whereas non-financial indicators provide a subjective (qualitative) view of process performance and user satisfaction (Neely, 2008). The adoption of both financial and non-financial indicators has been assessed as important to approximate a substantial success construct (Dossi & Patelli, 2010). The servitisation success measures were adopted from Madsen and Goduscheit (2023): 5 financial and 11 non-financial (see Table 21). These indicators were identified through a systematic literature review followed by thematic analysis (Madsen & Goduscheit, 2023). These 16 indicators are believed to establish the best approximation of the current conceptualisation of servitisation success, therefore fitting the purpose of this study. Few existing indicators have previously been validated. To adopt these indicators as items for our study, we therefore followed the reasoning of the success process (discussed in section 3.2).

4.2.3 Control variables

Constraints were incorporated as control variables to enable the segregation of observations based on relevant criteria. Therefore, firm size, industry, competitive environment and firm age were included, as they have all been found to be important servitisation contingencies for SMEs (Valtakoski & Witell, 2018). Geographical placement and service experience (years) were also added. The control variables were all formulated as factual items (except competitive environment).

4.2.4 Measurement model

The measurement model was designed in a reflective mode, as the progression of each indicator is a consequence of the construct, since an increase in maturity will theoretically improve the related indicators (Bollen, 1989). As the identification of each dimension was inspired by existing SeMMs, they are theoretically related to the adopted maturity indicators. Hence, the latent constructs are approximating a degree of maturity, which is a concept that exists independently of the presence of the indicator (i.e. reflective) (Coltman *et al.,*, 2008). For this reason, the dimensions are seen as traits explaining the outcome of the indicators. Thus, related indicators stemming from the same construct are also believed to be mutually interchangeable, as they are theoretically related (Jarvis *et al.,*, 2003).

While consistent indicator measures are necessary for PLS-SEM to compute a coherent measure of the constructs (Hair *et al.,*, 2017b), none of these measures has previously been statistically validated (see Table 20). For this reason, this study adopted (exact imitation, 20 items), adapted (slight adjustments, 13 items) and developed new items, taking inspiration from the existing literature (21 items), with identical phrasing and scaling (see Table 20). Each item was phrased as a statement to be assessed according to respondents' perceptions of the current state on a 7-point Likert scale (Hair *et al.,*, 2017a). With a few exceptions, the scaling of the items was anchored as disagree/agree statements (strongly disagree, disagree, somewhat disagree, neither disagree nor agree, somewhat agree, agree, strongly agree). Inspired by Rapaccini *et al.,* (2013), og1, og2, og3, og4, ss15 and sm1 were anchored through a stepwise progression based on related theory. Furthermore, items related to a periodic progression (e.g. ss1) were specified for the past 5 years to ensure consistent interpretation among respondents. The 5-year period was found to be the best measure due to the economic uncertainty of the last

2 years resulting from COVID-19.[13] Because of the adaptation of untested items and the necessity to formulate new ones, a three-step pilot investigation of the questionnaire was emphasised: the initial questionnaire was evaluated by a British linguistic expert (content validity); an adjusted version was evaluated by an industrial service-innovation expert (internal validity); and there was a statistical evaluation of the internal consistency, convergent and discriminant validity. The results and corrections indicate items and questionnaires obtaining an acceptable level of reliability and validity (Hair *et al.,*, 2017a).

[13] Study conducted summer 2022, COVID-19 pandemic outbreak spring 2020.

4.2.5 Descriptive statistics

Constructs and items (all measured on a 7-point Likert scale)	**Origin of indicator**	**Loading**	**Tested**
Servitization success (1 strongly disagree – 7 strongly agree)			
ss1: Our organization has increased its profitability significantly over the past 5 years, compared to the industry	Inspired by Lexutt	.787***	Reliable*
ss2: Our services have increased their profitability significantly over the past 5 years, compared to the industry	Inspired by Lexutt	.805***	Reliable*
ss3: Our organization has increased its revenue significantly over the past 5 years, compared to the industry	Inspired by Lexutt	.759***	Reliable*
ss4: Our services have increased their revenue significantly over the past 5 years, compared to the industry	Inspired by Lexutt	.808***	Reliable*
ss5: Our services possess a significant competitive advantage over our nearest competitors	Inspired by Lexutt	.725***	Reliable*
ss6: Our customers are very satisfied with our services and more so than with the services of our nearest competitors	Inspired by Lexutt	.651***	Unreliable
ss7: Our services have added significant customer value over the past 5 years, compared to the industry	Inspired by Lexutt	.716***	Reliable*
ss8: Our customer loyalty has increased significantly over the past 5 years, compared to the industry	Inspired by Lexutt	.638***	Unreliable
ss9: The recognition of our brand has increased significantly over the past 5 years, compared to our nearest competitors	Inspired by Lexutt	.614***	Unreliable
ss10: Our organization is able to maintain long-lasting partnerships	Inspired by Lexutt	.395***	Unreliable
ss11: Our organization's market share has increased significantly over the past 5 years	Inspired by Lexutt	.717***	Reliable*
ss12: Our services have contributed to the largest part of the total profit over the past 5 years	Adapted from Adrodegari	.378***	Unreliable
ss13: Our organization's ability to create new service innovations has been highly successful over the past 5 years, compared to the industry	Adapted from Adrodegari	.679***	Unreliable
ss14: Our organization has been able to increasingly achieve its own objectives over the past 5 years	Inspired by Lexutt	.563***	Unreliable
ss15: The current state of our most provided service offerings is... [no-optimized services]	Inspired by Rapaccini	.158	Insig.
Strategic management (1 strongly disagree – 7 strongly agree)			
sm1: Our organization's strategic development has mainly been led by a... [goods-centric - business-oriented]	Inspired by Wikström	.030	Insig.
sm2: Our organization pays close attention to service implementation	Adapted from Lexutt	.743***	Reliable*
sm3: Our organization recognizes services as a lasting differentiation strategy	Adopted from Coreynen	.722***	Reliable*
sm4: Our management sees services as a way to compensate for fluctuating product sales	Adopted from Coreynen	.753***	Reliable*
sm5: Our management coaches employees to behave in a service-oriented way and sets rewards for service-oriented employee behaviour	Adopted from Coreynen	.665***	Unreliable
sm6: Our management empowers employees to respond to a broad range of customer problems	Adopted from Coreynen	.652***	Unreliable
sm7: Our management supports employees in solving customer problems	Adopted from Coreynen	.600***	Unreliable
sm8: Our management aims to exploit the financial potential of services	Adopted from Coreynen	.798***	Reliable*
sm9: Our organization is able to formulate clear service-related strategies and objectives	Adopted from Lexutt	.752***	Reliable*
sm10: Our management considers the service potential to be highly profitable	Adopted from Coreynen	.810***	Reliable*
Digital integration (1 strongly disagree – 7 strongly agree)			
di1: Our applied technologies allow fully automated and optimized real-time data	Inspired by Coreynen	.836***	Reliable*
di2: [Our IT systems] give us integrated access to value-chain-related data (e.g. order status, handling requirements)	Adopted from Coreynen	.832***	Reliable*
di3: … give us integrated access to customer-related data (e.g. service contracts, feedback)	Adopted from Coreynen	.881***	Reliable*
di4: … give us integrated access to market-related data (e.g. promotion details, future forecasts)	Adopted from Coreynen	.869***	Reliable*
Organizational governance (1 strongly disagree – 7 strongly agree)			
og1: [Our organization] is currently following service-specific policies, that are… [non-optimized]	Inspired by Rapaccini	.525***	Unreliable
og2: The allocation of monetary resources to the development of service-oriented skills, tools and/or methods is... [non-optimized]	Inspired by Rapaccini	.730***	Reliable*
og3: [Our organization] has ensured a formal, optimized process for the service delivery that is… [no-optimized services]	Inspired by Rapaccini	.792***	Reliable*
og4: … is currently following organizational roles, that are... [no-optimized roles]	Inspired by Rapaccini	.708***	Reliable*
og5: … encourages its employees to prioritize process development over product development	Adapted from Wikström	.385***	Unreliable
og6: … is able to turn service activities into a professional business	Adopted from Coreynen	.753***	Reliable*
og7: … is able to turn service activities into a profitable business	Adopted from Coreynen	.742***	Reliable*
og8: … encourages employees to make decisions on their own	Adopted from Coreynen	.638***	Unreliable
og9: … has procedures and routines to minimize costs related to new service activities	Adopted from Coreynen	.665***	Unreliable
og10: … can overcome internal resistance and conflicts	Adopted from Coreynen	.514***	Unreliable

Market reach (1 strongly disagree – 7 strongly agree)			
mr1: [Our organization] analyses what we would like to achieve with each customer	Adopted from Coreynen	.819***	Reliable*
mr2: … analyses what we would like to achieve with each supplier	Adopted from Coreynen	.834***	Reliable*
mr3: … remains informed about the goals, potential and strategies of our customers	Adopted from Coreynen	.829***	Reliable*
mr4: … remains informed about the goals, potential and strategies of our suppliers	Adopted from Coreynen	.846***	Reliable*
mr5: … regularly discusses with our customers how we can support one another in our success	Adopted from Coreynen	.762***	Reliable*
mr6: … determines in advance possible suppliers with whom to discuss the building of relationships	Adopted from Coreynen	.699***	Unreliable
Service integration (1 strongly disagree – 7 strongly agree)			
si1: [Our organization] can easily observe and identify customers' needs	Adopted from Coreynen	.853***	Reliable*
si2: … has the capacity to commercialize new services and communicate changes to the customer	Adopted from Coreynen	.900***	Reliable*
si3: … can adjust its process design according to customer demand without significantly increasing costs	Adopted from Coreynen	.715***	Reliable*
si4: … can add product–service variety without sacrificing quality	Adopted from Coreynen	.519***	Unreliable
si5: … can easily add significant product–service variety without increasing costs	Adopted from Coreynen	.504***	Unreliable
si6: … can customize product–services, while maintaining high volume	Adopted from Coreynen	.638***	Unreliable
Value function (1 strongly disagree – 7 strongly agree)			
vf1: [Our organization] is able to provide a performance-based solution that guarantees the product's operational performance	Inspired by Cui	.732***	Reliable*
vf2: … is able to provide customized cost structures for our customers	Adapted from Cui	.788***	Reliable*
vf3: … evaluates the operating and financial risks and manages uncertainty continuously	Adapted from Cui	.810***	Reliable*

Loading: *** $p \leq 0.001$ ** $p \leq 0.01$ * $p \leq 0.05$, Tested: * if maintained within model

Table 21: Constructs and items

5. Analysis and results

The hypotheses were tested through PLS-SEM, which was programmed with the SEMinR package (Ray *et al.,*, 2022) in R version 4.1.3 (R Core Team, 2022). The procedure was based on the Hair *et al.,* (2021) manual and evaluated according to the recommendations in Hair *et al.,* (2017a);Hair *et al.,* (2019b) and Hair *et al.,* (2020). Following best practice (Hair *et al.,*, 2017a), the significance tests via bootstrapping were set to 5,000 replications. Recently, Hair *et al.,* (2020) emphasised confirmatory composite analysis (CCA) as the preferred approach for evaluating PLS-SEM. CCA is believed to be more applicable than the more traditional confirmatory factor analysis, as it facilitates the confirmation of the measurement and structural model together with predictions of the endogenous construct (Hair *et al.,*, 2020).

5.1 Measurement model

Following the CCA procedure by Hair *et al.,* (2020), the first step examined the indicator loadings and significance. The first run showed a large amount of indicators with low loadings (< .708) and insignificance (t_{crit} ± 1.97) (Hair *et al.,*, 2011). Insignificant indicators were removed and a reduced model prepared. Low outer loadings are expected when applying newly developed scales, which was the case for this study. However, following Hair *et al.,* (2011), indicators with outer loadings below .40 were eliminated, resulting in the stepwise exclusion of ss12 (.378), og5 (.385) and ss10 (.395). The remaining indicators with loadings below .708 were considered for removal, which led to a stepwise removal of 15 indicators (see Table 22 – column: status). Each removal was retained, as positive changes in the internal consistency reliability were identified, which produced no extreme consequences for content validity (Hair *et al.,*, 2017b). The second step examined the indicator reliability with threshold values of .50 (Hair *et al.,*, 2020) and identified no unreliable indicators, while the third step examined internal consistency and obtained the construct reliability with Jöreskog's composite reliability scores above .700 for the reduced model (.824–.917) (Hair *et al.,*, 2020) (see Table 22). The fourth step examined the convergent validity by the average variance extracted (AVE), and which were obtained for all constructs (see Table 22) (Hair *et al.,*, 2020); and the fifth step examined the discriminant validity. All constructs were truly distinct from other constructs in the model with HTMT values < .850. Examination of the cross-loadings identified an equivalent result (Hair *et al.,*, 2017b). The reduced model attained an acceptable level of indicator reliability, composite reliability, convergent validity, discriminant validity and construct validity, with no signs of multicollinearity.

	X_{min}	X_{max}	$\bar{x}$	sd	Loadings	SE	R^2_{adj}	Composite reliability	AVE
SS							0.374*	0.906	0.581
ss1	1	7	4.09	1.31	*.787***	.036			
ss2	1	7	4.16	1.22	*.805***	.037			
ss3	1	7	4.29	1.41	*.759***	.039			
ss4	1	7	4.30	1.26	*.808***	.030			
ss5	1	7	4.79	1.33	*.725***	.052			
ss7	1	7	5.10	1.23	*.716***	.045			
ss11	1	7	4.76	1.32	*.717***	.045			
SM							-	0.893	0.583
sm2	1	7	5.00	1.28	*.740***	.041			
sm3	2	7	5.62	1.07	*.719***	.049			
sm4	1	7	5.22	1.41	*.749***	.047			
sm8	1	7	5.50	1.18	*.798***	.031			
sm9	1	7	4.78	1.25	*.754***	.036			
	1	7	5.30	1.32	*.809***	.034			
sm10									
DI							-	0.917	0.734
di1	1	7	4.22	1.75	*.836***	.033			
di2	1	7	4.52	1.67	*.832***	.037			
di3	1	7	4.15	1.55	*.881***	.024			
di4	1	7	3.49	1.54	*.869***	.021			
OG							0.325*	0.863	0.557
og2	1	7	2.93	1.63	*.730***	.048			
og3	1	7	2.77	1.31	*.792***	.046			
og4	1	7	2.91	1.29	*.708***	.056			
og6	1	7	4.97	1.24	*.751***	.044			
og7	1	7	4.98	1.19	*.738***	.050			
MR							0.122*	0.911	0.672
mr1	1	7	4.14	1.39	*.819***	.033			
mr2	1	7	4.40	1.38	*.834***	.030			
mr3	1	7	4.36	1.39	*.829***	.033			
mr4	1	7	4.00	1.40	*.846***	.025			
mr5	2	7	5.09	1.12	*.762***	.038			
SI							0.244*	0.867	0.686
Si1	1	7	5.08	1.07	*.853***	.034			
Si2	1	7	4.92	1.23	*.900***	.024			
Si3	2	7	4.81	1.18	*.715***	.062			
VF							0.282*	0.824	0.609
vf1	1	7	5.05	1.12	*.732***	.067			
vf2	1	7	4.92	1.24	*.788***	.052			
vf3	2	7	4.91	1.19	*.810***	.043			
Size	1	250	32.8	42.4					
Age	1	99	31.4	27.9					

Note: Loading standard errors based on 5,000 bootstrap replications. R^2 (Hair *et al.,* 2019b): *weak, **moderate, ***substantial

Table 22: Descriptive and measurement evaluation

5.2 Structural model

The path coefficients represent the hypothesised relations of the structural model, and their presence is defined by their size and significance (Hair *et al.,*, 2017b). The path estimates illuminate the relative effect and importance of each construct for their endogenous variable (Hair *et al.,*, 2017b). Here, eight of the 12 hypotheses were found to be significant, with a 5% significance level (see Table 23), while two had a 10% significance level (H_{10}, H_{12}) (see Figure 15). Digital integration was theorised to obtain a mediating (indirect) effect; however, further examination identified several indirect effects (SM > SI, OG > SS, MR > SS, DI > VF and DI > SS). The indirect effects between strategic management and service integration through organisational governance and market reach to servitisation success through value function were tested and found to have a significant, indirect-only mediating effect for the former and a significant, competitive mediation effect for the latter (Hair *et al.,*, 2021). Furthermore, the indirect effects from organisational governance to servitisation success through service integration, and from digital integration to value function through market reach, were found to be insignificant.

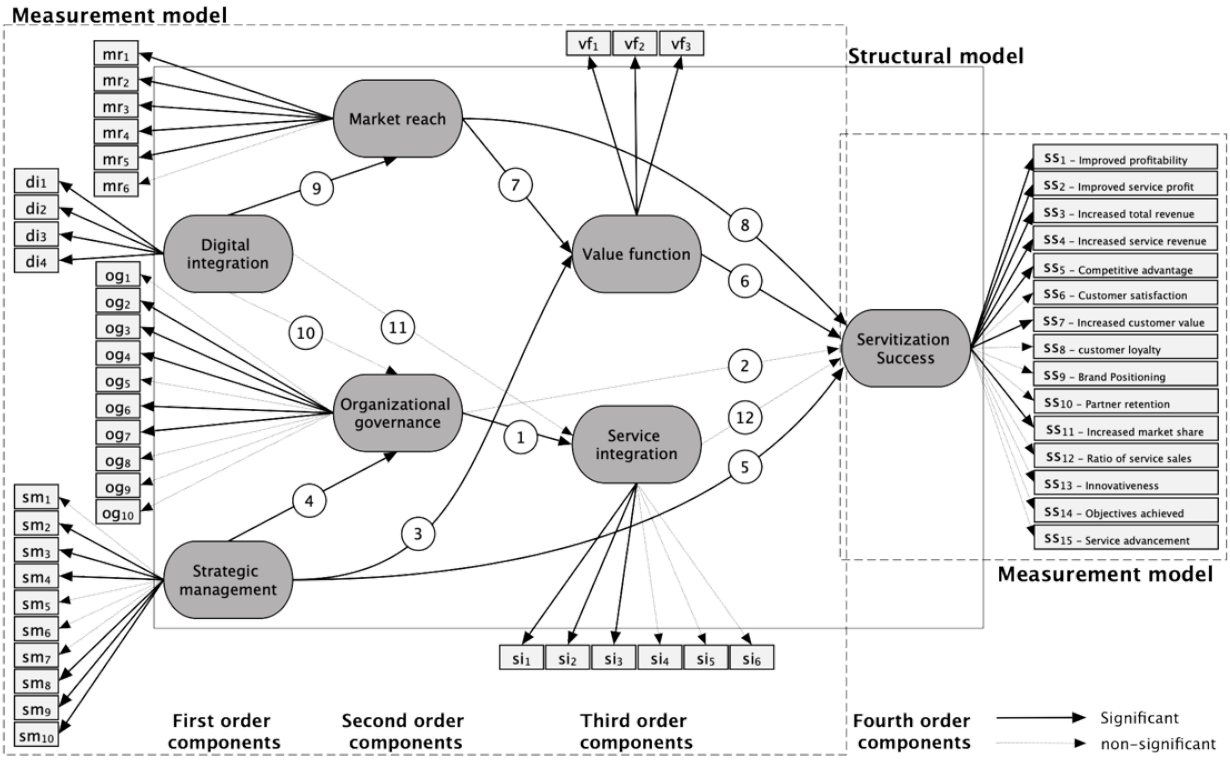

Figure 15: SeMM significance of relations and items

The predictive power of the models is assessed on the basis of the recommendations by Hair *et al.,* (2020); R^2_{adj}, f^2 and out-of-sample prediction:

- Following Chin (1998), an R^2_{adj} (in-sample prediction) < .250 is acceptable, as this study follows an exploratory theory development based on cross-industry data. Further comparison with previous studies identified incidences with R^2 as low as .042, which were deemed acceptable (Sousa & da Silveira, 2017).
- Acceptable levels of f^2 exceeding the minimum threshold were obtained by all significant path coefficients, ranging from small to strong effects, confirming the significance of the eight hypotheses (see Table 23).

- The out-of-sample prediction power was based on PLSpredict by Shmueli *et al.,* (2019). Here, the PLSmodel obtained a majority of dependent construct indicators with lesser predictive errors compared to the naïve LM benchmark, providing medium predictive power (Shmueli *et al.,*, 2019).

Hair *et al.,* (2019b) stress that thresholds for evaluating structural and measurement models are broad and should be assessed in the context of the current model. With respect to the exploratory nature of this study, these results were perceived as good when compared with relatable studies (e.g. Zhu *et al.,* (2018) Sousa and da Silveira (2017)).

Path	Estimate	SE	VIF	Effect size (f^2)	Total effect	Indirect effect	Hypotheses (direction)
OG → SI	*.450***	.074	1.134	.237**	.446	-	H_1 (+)
OG → **SS**	.112	.079	1.694	.012	.180	.067	H_2 (+)
SM → VF	.297***	.069	1.163	.083*	.293	-	H_3 (+)
SM → OG	*.516***	.068	1.209	.323***	.511	-	H_4 (+)
SM → **SS**	*.298***	.071	1.742	.082*	.309	.015	H_5 (+)
SM → SI	-	-	-	-	.228	.228	Mediating
MR → VF	*.357***	.071	1.163	.149**	.357	-	H_7 (+)
MR → **SS**	*.381***	.074	1.512	.151**	.285	-.094	H_8 (+)
DI → MR	*.364***	.077	1.144	.147**	.358	-	H_9 (+)
DI → OG	.134*	.073	1.209	.018	.131	-	H_{10} (+)
DI → VF	-	-	-	-	.128	128	Mediating
DI → SI	.127	.078	1.134	.020*	.186	.058	H_{11} (+)
DI → **SS**	-	-	-	-	.145	.145	Mediating
SI → **SS**	.148*	.084	1.695	.022*	.151	-	H_{12} (+)
VF → **SS**	*-.259****	.086	1.473	.077*	-.263	-	H_6 (+)

Note: Significant estimates: *p <0.10, **p <0.05, ***p <0,01 – based on 5,000 bootstrap replications. Effect sizes (f^2) (Hair *et al.,*, 2019b): *small effect, **medium effect, ***large effect.

Table 23: Structural model

5.3 Computational maturity modelling

The PLS-SEM is considered to be a composite-based SEM method, as it assumes that the concepts of investigation can be measured as composites (Jöreskog & Wold, 1982). For reflective measurement models, the indicator composite is based on a set of correlation weights (i.e. outer loadings), which accounts for the correlational interference in its explanation of the latent construct (Hair *et al.,*, 2011). Hence, the outer loadings possess the ability to reflect the approximated influence of the associated construct to interpret the maturity of the outer model (Hair *et al.,*, 2011). The computation of the exogenous maturity levels follows the composite score equation presented by Hair *et al.,* (2017b, p. 5). The dimension maturity level for each observation is identified through a weighted average of the stated observations (x_i) using the indicators' reflective weight (w_i) (i.e. outer loadings) as the base (see equation 1).

$$\boldsymbol{y_{di_i}} = w_{di1} * x_{di1_i} + w_{di2} * x_{di2_i} + w_{di3} * x_{di3_i}$$

Equation 1 Composite maturity level

This technique is not feasible in the computation of the endogenous score due to the relational influencers obtained from the model. The structural influence through direct (relational) and indirect (mediating) effects must be summarised to possess the full effect of each exogenous construct in their explanation of the endogenous construct (Matthews *et al.,*, 2018). Thus, to take the structural relation into account, the maturity of servitisation was computed by weighting the dimensions' composite values (y_{dim_i}) with the total effect (c_{dim_i}) (see Table 24) of the associated dimension towards servitisation success (see equation 2) (Matthews *et al.,*, 2018).

$$\hat{y}_{\textbf{Servitization Maturity}_i} = y_{di_i} * c_{di} + y_{sm_i} * c_{sm} + y_{vf_i} * c_{vf} + y_{mr_i} * c_{mr} + y_{si_i} * c_{si} + y_{og_i} * c_{og}$$

Equation 2 Servitisation maturity

In the above, the predictive value of the structural model through ŷ was computed for each observation to allow for the interpretation of their performance. For comparison, a mean interpretation of each dimension's maturity level was conducted, as visualised in Figure 16. Importantly, as the total effect accumulates the full effect on servitisation success of each dimension, it estimates the maturity level based on the performance of each dimension, which allows for better interpretation of their importance (Hair *et al.,*, 2021). Hence, these metrics prove important for managerial decision-making when allocating investments into the servitisation journey.

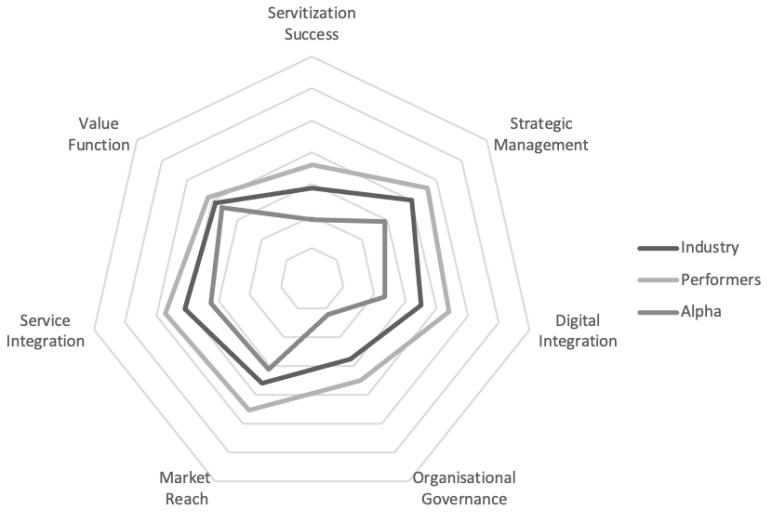

Figure 16: Servitization maturity assessment

These results clearly emphasise the maturity of the case of company Alpha in comparison with the industry as a whole and the top industry performers (third quartile of $\hat{y}_{ss}$). Combined with the statistical output of SeMM (see Table 24), it is possible to prioritise the transformational path with respect to the best influencers of the predicted success. By examining the importance of the least-performing dimensions, managers are allowed to give their attention to the most influential dimension, with the highest potential identified in Table 24 (e.g. increasing strategic management maturity by 1 will increase servitisation maturity by .309).

Transformative priority

1	Strategic management	.309***
2	Market reach	.285***
3	Organizational governance	.180
4	Service integration	.151*
5	Digital integration	.145**
6	Value function	-.263***

Table 24: Transformative priority based on total effects

6. Discussion

The negation of value function (VF) opposed the hypothesised positive impact on servitisation success. The further rejection of inverted items identified that all three items were correctly phrased in a positive manner. A simple explanation from theory could account for such a negative effect. Value function attributes the ability to develop new business models capable of creating and capturing value from the servitisation transition (section 3.3). The negation

indicates that the ability to guarantee the operational performance of a product (vf1), to customise cost structures (vf2) and to manage uncertainty and risks (vf3) is not simply a 'delighter' for customers but that it simply 'must be' (Kano, 1984). Thus, increased investment in these aspects does not accommodate the expected increase in customer willingness to pay (increase in revenue and profit) or finite customer value. Hence, the investment leads to a shortage in the outcome, as the aspects are order qualifiers and not order winners, which results in decreased success (Åke Hörte & Ylinenpää, 1997). Findings by Neely (2008) point towards this explanation, as servitised firms find it difficult to generate sufficient revenue to cover the additional costs; this is the servitisation paradox.

But other reasonable explanations for this phenomenon also exist. The value creation resulting from services has been found to have a time lag before value is realised (Arranz & de Arroyabe, 2012). The negation could therefore be explained by the fact that the value of the increased value function maturity has not yet been constituted as a value for servitisation success. For instance, the ability to manage risk and uncertainty (vf3) is associated with the value that is realised in avoiding risk, leading to a time lag, potentially resulting in higher investments with decreased profit and decreased maturity of servitisation success; however, this fails to explain the negations towards being more than profitable (ss2 and ss4).

The return of investment on service development has proven to take longer time to realise than for product development (Anderson *et al.,*, 1997). Despite its servitisation path, it is reasonable to believe that the managerial mindset might still be steered by a goods-centric perspective (Jin *et al.,*, 2014), leading to higher managerial expectations of immediately increased revenue and profit from the service development; however, an unaccounted time lag could result in disappointing numbers, leading to a lowered interpretation of their success. Would an increase in value function therefore result in higher expectations, while short-term results disappoint, resulting in lowered interpretation of servitisation success? Moreover, while the value function activities rely on a transactional mindset, activities such as increased customer value (ss7) and competitive advantage (ss5) are driven by more relational aspects (Bastl *et al.,*, 2012), which could ultimately reduce the relational success criteria when an increase occurs in the transactional value function criteria; however, this is a less reasonable explanation for the negation of value function.

The servitisation literature relies mainly on theoretical and empirical conceptualisations of the complex transformation from goods-oriented to product–service providers (Table 20) (Brax & Visintin, 2017). The findings of this study illuminate the understanding of these empirical theories by validating their presence and importance in the context of a multidimensional transformation (Table 22). The validation of the theories is two-fold, based on indicator significance and the relative importance of the respective concepts they represent. This validates the legitimacy of the theories, which are indeed within servitisation. The indicator loadings express the amount of indicator variance explained by the latent construct (Hair *et al.,*, 2017b), which illuminates the relative importance of the indicator for the associated dimension. The majority of indicators were found to be significant, which confirms their presence, albeit with differing relative importance. For instance, the goal for services to obtain the largest part of total revenue (ss12), adapted from Adrodegari and Saccani (2020), was found to exist but with very low importance for the explanation of servitisation success (SS).

Another example is the ability of IT systems to integrate market-related data (di4), adopted from Coreynen *et al.,* (2018), which was found to obtain strong importance for the digital integration dimension. This reflects the maturity of the servitisation literature, where indicators

are acknowledged but where few indications of the priority and importance of the indicators have been realised on the source of servitisation. This study is the first to do so by illuminating the relative importance of each theory, and it should be used to guide future research and avenues. This is in response to the gaps left by Rabetino *et al.,* (2018) and Kohtamäki *et al.,* (2019a, p. 233). This study undertook testing existing theories evidentially, allowing for acknowledgement of the truth of their existence in a multidimensional setting. Concepts previously investigated in isolation (e.g. 'market' (competitors) and 'customer' by Alvarez *et al.,* (2015)) have been examined in this study in structural relation to other concepts to reflect a more complete understanding of their coexistence. This is achieved through the tested nomological network of the model and the hypothetical relations between concepts. By doing so, we answer the gaps highlighted by Baines *et al.,* (2017);Lexutt (2020) and Kohtamäki *et al.,* (2019a). This is deemed essential to elaborating our explanation of servitisation in order to direct future research in our attempt to understand the concept.

7. Conclusion

The results provide new insights into the servitisation community in terms of three novel academic implications. First, this is the first statistical investigation to be conducted of maturity modelling in the servitisation context. It investigates and identifies the dimensional influence in terms of achieving servitisation to extend our understanding of the servitisation journey. Second, this is the first statistical investigation into the relational effects among contextual servitisation dimensions in a multidimensional reality. While previous studies have investigated the dimensions of servitisation in isolation and from unidimensional perspectives, this is the first to truly embrace and investigate these dimensions in a multidimensional reality by proposing and verifying a nomological network of servitisation, taking into account the coexisting influencers among dimensions. Third, this is the first statistical validation of prior theoretical and conceptualised maturity indicators within servitisation. This has led to the validation of 33 existing theories and prioritised their importance in a successful servitisation transformation. I believe that these findings will extend the community's understanding of the servitisation journey.

This study answers the research question – '*How do the relations between dimensions influence the success of the SME servitisation transformation?*' – in relation to each of the above aspects. Through PLS-SEM, an evidential explanation and prediction of the dimensions' true structure and insights into mutual influencers were discovered. The statistical outcome provides researchers with the weighted importance of the dimensions and their respective indicators, which allows for the better allocation of any future research focus. Eight of the twelve hypothetical relations were found to have a significant influence on the related dimension. Strategic management (SM), market reach (MR) and digital integration (DI) were found to have a significant and positive influence on the degree of servitisation success. Value function was proven to obtain a significant negative effect, which is believed to be caused by the absence of captured value (the servitisation paradox). Organisational governance (OG) and service integration (SI) were found to be insignificant. Yet as organisational governance has a significant positive influence on service integration, it remains relevant for the transition due to its mediating effect. Moreover, several significant mediation effects were established, which proves the multidimensional complexity within the model and confirms the nomological nets and laws that were proposed to constitute the servitisation transformation. Furthermore, strategic management, market reach and organisational governance were found to be most important, while service integration, digital integration and value function were found to be the least important.

These academic findings entail distinct managerial implications in terms of enhancing the managerial strategic reasoning, and they help to navigate the complex transformation. The combination of the explanatory and predictive power of PLS-SEM provides the maturity model with unique possibilities to guide future SMEs. The composite value of the dimension (based on indicator importance) allows managers to examine their current position and the degree of maturity for each of the six dimensions.

Through the weighted importance of each indicator, more precision regarding the current status is obtained compared to the well-used standard mean interpretation. The predictive power of the model stems from the ability not only to assess the current maturity level but also to identify the key dimensions and their underlying theories to improve the estimated servitisation maturity. The weighted importance of both dimensions and indicators allows managers to allocate their investments to areas with the greatest impact for the estimation of servitisation maturity. Furthermore, by examining the importance (i.e. loadings) of the indicators supporting the associated dimension, managers are able to give their attention to the most influential theory at the particular stage of their transition.

Hence, this model provides practitioners with the ability to identify focus areas with the greatest impact for a successful transformation. To answer the second part of our research question – '*To what extent does it impact the operational importance of the dimensions?'* – these implications are foreseen to have a tremendous impact on managerial decision-making and planning future servitisation efforts. Essentially, this study provides the literature with fertile ground to expand the explanatory ability of the servitisation concept by illuminating the multidimensionality and validating the relevance of the present theory. This study suggests that future research should develop servitisation maturity models in two ways: first, by elaborating when true customer value develops to improve the estimation of value function; and, second, by moderating the endogenous variable according to the preferred definitional understanding of servitisation (Madsen & Goduscheit, 2022).

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4.3.1 The lessons learned from Publication 3

The main objective of the PhD research was the development and submission of the adjusted SeMM. However, more aspects of the model must be elaborated to improve its ability to explain and predict the potential outcome of certain efforts. The lessons learned from Publication 3 are mainly based on the future avenues of the adjusted SeMM and presented as limitations in section 6.1.

4.4 Findings of the appended papers

The findings of each publication are highlighted individually in the following and summarised in Table 15. The table also contains a brief evaluation of how these findings address current calls and literature gaps; a more thorough discussion of these implications can be found in chapter 5. The individual findings are assembled in section 4.5 as a technical discussion of the accumulated findings across the three publications.

Publication 1
The objective of Publication 1 was to identify the existence of coexisting dimensions to establish the first multidimensional servitisation maturity model by proposing and confirming the nomological network of servitisation. This was done through the statistical identification of seven significant relations (DI > OG, DI > MR, DI > SI, OG > SI, OG > SM, SM > VF, MR > VF) and two insignificant relations (DI > VF, OG > VF). These results support the claim that the dimensions of servitisation do exist in coexistence and close the gaps identified by Kindström and Kowalkowski (2014) and Lexutt (2020). The statistical outputs also supported and validated 25 of the adopted maturity indicators and three servitisation success indicators. This was the first validation of maturity indicators within the servitisation literature, and it allows researchers to adopt empirically based and statistically verified indicators for the future investigation of the servitisation transformation. This further taps into the emphasis on more consolidated knowledge by Szasz and Seer (2018), and these findings add to the call by Kowalkowski *et al.,* (2017b) for more quantitative validations. The study identified no significant relations negatively influencing another dimension. This reflects how the dimensions are positively influenced by each other, as the hypothesis postulates, and it is reasonable to conclude that an increase in one dimension leads to a positive increase in another related dimension. Despite the questionable ability of the model to approximate the servitisation success theoretically, these results still prove the justification of the dimensions, verify 28 empirical indicators and seven significant relations, and they obtain an acceptable fit of the model, which proves the existence of the structural and measurement model (SRMR of .098); hence, these results justify additional investigations into an adjusted version of the SeMM.

Publication 2
The SLR of servitisation success (SLR2) led to the identification of definitional differences within the servitisation literature. In terms of assessing and defining success, a great variety was identified, and the definition of success was found to be too implicit within the majority of the existing servitisation literature. This highlights the necessity to enhance the consistency within servitisation to strengthen the outcome of future research. In that sense, this study represents an important work for the field, as it challenges the previous, inconsistent and frivolous treatment of servitisation success. The objective of Publication 2 then became to

understand the inherent tensions arising from the paradoxes of measuring servitisation success differently. The study identified and presented four paradoxes stemming from the conflicting definitions and measurements of success as well as the underlying internal and external tensions arising from such paradoxes. The results emphasise how the applied success indicators should be divided according to the managerial perception of servitisation by using the definitional types to categorise them; this to avoid the paradoxical situation leading to tensions within and between organisations. The study presents an overview of existing indicators of servitisation success and specifies 16 success indicators based on the existing knowledge and indicators. This conceptualisation provides academia with common indicators for future research to adopt and to align the concept of servitisation success, which addresses the call from Szasz and Seer (2018) to consolidate the existing knowledge. Based on the patterns from SLR2, this study further proposed a 2 × 2 matrix for assessing and choosing servitisation success indicators based on four elements: objective, subjective, financial and non-financial indicators.

Publication 3

Publication 3 was intended to explore how the interrelationships between dimensions influence the assessed servitisation success and how these interrelationships impact the relative importance of each dimension; that is, testing the proposed nomological network of the servitisation transformation with the direction and influential strength of the inherent laws. This was achieved by estimating the direct, indirect (mediating) and total effects of each dimension on success and the related dimensions. The study identified and validated six significant relations between the six servitisation dimensions (OG > SI, SM > VF, SM > OG, MR > VF, DI > MR and DI > OG) as well as five significant direct effects on servitisation success (OG > SS, SM > SS, MR > SS, SI > SS and VF > SS). Importantly, additional tests identified three mediating effects within the model, which substantiated the proposed nomological network and addressed the call made by Kindström and Kowalkowski (2014). The study further validated and weighed the importance of 26 indicators (theories) for maturity and seven indicators for servitisation success, addressing the call from Kowalkowski *et al.,* (2017b). Similarly, the study succeeded in statistically weighting the importance of the six dimensions for servitisation success by estimating their total effects (computed on direct and mediating effects). These weights, the understanding of the nomological network and the estimation of the total effect of the dimensions enabled the development of a visualised multidimensional servitisation maturity model tool (presented in greater detail in chapter 5). Importantly, this breaks with and challenges the prior approach to structuring such multidimensionality by including and calculating the real interrelationships among dimensions, but also by incorporating a weighted mean interpretation to account for the actual importance of each dimension. Additionally, these findings confirm several of the proposed nets and laws constituting the nomological network of servitisation (Cronbach & Meehl, 1955), which is emphasised as one of the core findings of this PhD and should guide future research investigating the servitisation transformation.

Publication 1 *Initial SeMM SSC21*	• Identified and verified 7 significant relations between dimensions (DI > OG, DI > MR, DI > SI, OG > SI, OG > SM, SM > VF, MR > VF) as well as 2 insignificant relations. • Validated and weighed 25 empirical maturity indicators and 3 success indicators. • Showed that none of the relations had a negative influence, confirming the hypotheses that an improvement of all dimensions has a positive effect on servitisation success.

	• Identified a lack of insight into the predictors of organisational governance and servitisation success.
Publication 2 Success study *Accepted by IJTM*	• Identified and summarised the definitional differences within the servitisation literature. • Identified indicators of servitisation success and established 16 new composed indicators based on the existing knowledge within servitisation. • Presented two main streams of success paradoxes stemming from definitional differences along with the paradoxical measurement of success, resulting in 4 paradoxes with related internal and external tensions. • Proposed a new tool for assessing and combining servitisation success indicators based on objective/subjective and financial/non-financial indicators.
Publication 3 Adjusted SeMM *Submitted to IJOPM*	• Identified and verified 6 significant relations between dimensions (OG > SI, SM > VF, SM > OG, MR > VF, DI > MR and DI > OG). • Identified and verified 5 significant direct effects on servitisation success (OG > SS, SM > SS, MR > SS, SI > SS and VF > SS). • Identified and verified 3 mediating effects among dimensions and on servitisation success (MR > VF > SS, SM > OG > SI and DI > MR > SS). • Validated and weighed 26 indicators for maturity and 7 indicators for servitisation success. • Statistically weighed the importance of 6 dimensions for servitisation success (total effect). • Verified the claim of multidimensionality through the identification of several mediating effects among coexisting dimensions. • Confirmed several suggested nets and laws constituting the nomological network of servitisation transformation. • Proposed a visual tool for assessing the maturity level.

Table 25: Summarised findings of Publications 1, 2 and 3

The next section discusses the implications of this project for academia and practitioners, further presenting how the findings from Publications a, 1, 2 and 3 collectively answer the PhD research question.

4.5 The core findings of the PhD research

The individual paper findings presented in the prior section can be summarised in three core findings of the PhD project. Firstly, the project proposes a nomological network of servitisation based on the current literature by conceptualising servitisation constructs (Publication a), identifying indicators of these constructs (LR1), proposing laws of interrelationships among the constructs, and laws of associated observable indicators (Publications 1 and 3). It then confirms several laws and nets of the servitisation transformation, thereby providing academia with a nomological network of the concept (Publications 1 and 3). Secondly, the PhD project sheds much needed light on the ambiguous definition of what defines servitisation success (as emphasised in Publication 2). This, through the identification of the four definitional types together with the statistical validation of several financial and non-financial indicators of servitisation success. Thirdly, the PhD project develops a new, multidimensional servitisation maturity model based on the proposed nomological network, which implicates statistical, weighted measures of the observable indicators and constructs allowing for predicting the maturity through reconfiguration. The academic and managerial implications of these three core findings are elaborated in section 5, while a further clarification of the findings regarding servitisation success (4.5.1) and the maturity model (4.5.2 and 4.5.3) are presented below; this, to establish the applicability of the combined findings from the appended papers.

4.5.1 Assessing suitable success indicators for the achievement of the focal orientation

The lessons learned while carrying out this project enable managers to identify and implement validated indicators of success for their servitisation transformation. Publication 2 emphasised how managers should seek a composition of success indicators related to how they perceive servitisation. This includes the identification of both service- and company-specific financial indicators, but in particular associated non-financial indicators of success. The composition of success indicators was deemed important to avoid paradoxes stemming from adopting contradictory measures of success. Hence, the success indicators should be composed on the basis of the managerial perception of servitisation; for instance, managers with a firm-focused orientation towards servitisation should adopt a competitive comparison (Fliess & Lexutt, 2019), increased market share (Cestino & Berndt, 2017), competitive advantage (Bustinza *et al.,*, 2019) and level of objectives achieved (Weigel & Hadwich, 2018) as non-financial indicators of success. The validation of the success indicators in Publication 3 enhanced the managerial understanding of such indicators by testing their relevance for success as well as validating the developed scale of the indicators. This eventually led to the validation of competitive comparison, competitive advantage and market share as reliable indicators of firm-focused transformation, while 'level of objectives achieved' was found unreliable. Due to the sample size (154 observations), however, a segregation of the dataset into the four definitional types was not feasible. Hence, the research took a generic approach towards the servitisation orientation. This limitation of the research is further elaborated in section 6.1.
This PhD project provides managers with reliable indicators of servitisation success together with validated scales and items for indicators ready for implementation. Table 26 below is an adjusted version of Table 14 in Publication 2. The statistically reliable and validated indicators are marked in bold type, while the unreliable (less influence on success (loadings < .708); (Hair *et al.,*, 2011)) but significant ($t_{crit} \pm 1.97$) indicators are marked in italics.

	Non-financial indicators of success	**References**
Offering performance	*Innovativeness*	Weigel and Hadwich (2018)
	Increased customer value	Cestino and Berndt (2017), Martin-Pena et al. (2019)
Process performance	[None found]	
Firm performance	**Competitive comparison**	Fliess and Lexutt (2019), Bustinza et al. (2019)
	Increased market share	Lexutt (2020), Cestino and Berndt (2017)
	Competitive advantage	Bustinza et al. (2015, 2019)
	Level of objectives achieved	Weigel and Hadwick (2018)
Business model performance	*Customer satisfaction*	Parida et al. (2014), Garcia-Magro and Soriano-Pinar (2019), Weigel and Hadwich (2018), Bustinza et al. (2019), Lexutt (2020), De Oliveira et al. (2018)
	Customer loyalty	De Oliveira et al. (2018)
	Partner retention	Weigel and Hadwich (2018)
	Brand positioning	Huikkola et al. (2016), De Oliveira et al. (2018)

Table 26: Validated non-financial servitisation success indicators adopted from Pub. 2

For the financial success indicators, all but the 'ratio of service sales' were found to be significant and reliable for the assessment of servitisation success. These indicators are applicable for all managers regardless of conceptual perception, as the financial indicators were identified as cutting across perceptions.

	Indicators / measures of success	References
Service-specific level	**Increased service revenue**	Parida et al. (2014), Garcia-Magro and Soriano-Pinar (2019)
	Improved service profit	Garcia-Magro and Soriano-Pinar (2019)
	Ratio of service sales	Lexutt (2020)
Company-specific level	**Increased total revenue**	Raddats et al. (2015), Colen et al. (2013), Cestino et al. (2017), Lexutt (2020), Martin-Pena et al. (2019), Parida et al. (2014)
	Improved profitability	Lexutt (2020), Huikkola et al. (2016), Colen et al. (2013), Hwang and Hsu (2019), Bustinza et al. (2019), Parida et al. (2014), Chiarini and Vagnoni (2017), Weigel and Hadwich (2018)

Table 27: Validated financial servitisation success indicators adopted from Publication 2.

These findings are expected to have great influence on how practitioners assess and determine servitisation success due to the usefulness of unified indicators and tested items for assessing them. This is in line with the call for more unification and coherent operationalisation made by Kohtamäki *et al.,* (2019a) and Szasz and Seer (2018), all of whom provide practitioners with more manageable assessments of the operationalisation (Brax & Visintin, 2017).

4.5.2 Assessing the servitisation maturity level of the focal firm

The assessment of the focal firm's maturity level follows the equations and computations described in Section 5.3 of Publication 3. To improve the readability and clarification, this assessment is presented and elaborated further in the next chapter with elements from Publication 3.

> *The PLS-SEM is considered a composite-based SEM method (Hwang et al.,, 2019), as it assumes that the concepts of investigation can be measured as composites (Jöreskog & Wold, 1982). For reflective measurement models, the indicator composite is based on a set of correlation weights (i.e. outer loadings), which accounts for the correlational interference in its explanation of the latent construct (Hair et al.,, 2011;Rigdon, 2012). Hence, the outer loadings possess the ability to reflect the approximated influence of the associated construct to interpret the maturity of the outer model (Hair et al.,, 2011). The computation of the maturity level follows the composite score equation presented by Hair et al., (2017b, p. 5). The maturity level of the dimension for each observation is identified through a weighted average of the stated observations (x_i) using the indicators' reflective weight (w_i) (i.e., outer loadings) as base (see equation 1).*

Paragraph from section 5.3 in Publication 3.

$$\boldsymbol{y_{di_i}} = w_{di1} * x_{di1_i} + w_{di2} * x_{di2_i} + w_{di3} * x_{di3_i}$$

Equation 3: Composite maturity level adopted from Publication 3.

A similar technique is not feasible for computing the maturity score of servitisation success, as this endogenous variable is predicted based on the relational influence of the exogenous variables due to the nomological network of the model. Hence, a composite score based on the indicator weights of servitisation success would not take the relational effects into account, instead merely presenting the maturity level perceived by respondents (Hair *et al.,*, 2017b, p.

5); this, because it relies on the outer model specification estimated based on the outer loadings of the success indicators (Hair *et al.,*, 2017b, p. 5). To incorporate the multidimensionality of the MdSeMM in the assessment of the focal firm's maturity level, such relational influences must therefore be presented in the computed success. Otherwise, the interpretation would be based on the respondent's own perception of success instead of relying on the weighted importance of each dimension.

> *The structural influence through direct (relational) and indirect (mediating) effects must be summarised to possess the total effect of each exogenous constructs in their explanation of the endogenous construct (Matthews et al.,, 2018). Thus, to take the structural relation into account, the maturity of servitisation is estimated by weighting the dimensions' composite values (y_{dim_i}) with the total effect (c_{dim_i}) of the associated dimension towards servitisation success (see equation **2**) (Matthews et al.,, 2018).*

Paragraph from section 5.3 in Publication 3.

The total effect$_{(c'+(a*b))}$ is the accumulated direct$_{(c')}$ and indirect effect$_{(a*b)}$, with the indirect effects being the mediations, and the direct effects being the relational structure (Matthews *et al.,*, 2018;Hair *et al.,*, 2021).

$$\hat{y}_{\boldsymbol{Servitization\ Maturity}_i} = y_{di_i} * c_{di} + y_{sm_i} * c_{sm} + y_{vf_i} * c_{vf} + y_{mr_i} * c_{mr} + y_{si_i} * c_{si} + y_{og_i} * c_{og}$$

Equation 4: Servitisation maturity adopted from Publication 3

The predictive value of the structural model through ŷ is estimated for each observation to allow for the interpretation of the respondent's performance. Calculating the composite scores allows practitioners to assess their own maturity level based on the indicator importance and in relation to the efforts they have made in terms of the dimensions. To allow for comparison according to industry, a mean interpretation of the maturity level of each dimension is conducted using simple mean computations on the observed composite scores following the two equations: mean computation for composite dimensions (Equation 3) and mean computation for servitisation success (Equation 4).

$$\boldsymbol{y_{di}} = \sum_{i=1}^{n=159} y_{di_i}$$

Equation 5: Industry mean maturity of digital integration

$$\boldsymbol{\hat{y}_{ss}} = \sum_{i=1}^{n=159} \hat{y}_{ss_i}$$

Equation 6: Industry mean maturity for servitisation success

The assessment of a firm's maturity level is shown in Figure 17 by comparing own performance with the industry and through the interpretation of the relative importance of the dimensions for success. This is in agreement with the definition of success as only proving successful in comparison with others (Fliess & Lexutt, 2019) (Publication 2). The firm in question, named Alpha, is positioned in the model (Figure 17) on the composite value for each dimension (y_{dim_i}) and the estimated score of servitisation success (ŷ). The industry is represented by the weighted mean for each dimension, including servitisation success. As the relational effects are incorporated in ŷ, the mean computed for servitisation success comprises these relations as well. The top performers were identified by extracting the third quartile of $\hat{y}_{ss}$ and then accumulating the mean composite values for each dimension, including success. This provides the pattern of each servitisation maturity for the industry, Alpha and the performers in Figure 17.

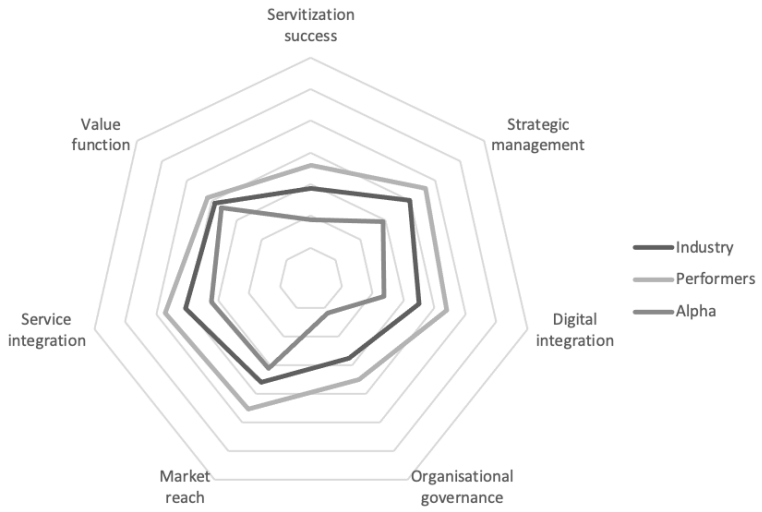

Figure 17: The multidimensional servitisation maturity model's assessment adopted from Publication 3.

The illustration indicates that Alpha has a low maturity level in all but one dimension, namely value function, compared to the industry and top performers. This is equivalent to Alpha's lower level of servitisation success. To achieve greater servitisation success, Alpha could seek to align its maturity pattern to a dimensional focus similar to that of the top performers to align with industry best practices. However, as servitisation success is based on the relational importance (weights) of each dimension, an increase in one dimension does not necessarily equally increase the servitisation success in other dimensions, as their relational influence differs (see Table 28). Practitioners should therefore assess the maturity level of each dimension in comparison to the total effect of that dimension. For instance, while organisational governance could be an obvious choice for improving the servitisation transformation, as it has the lowest maturity level for Alpha, this dimension only exerts the third-highest relational influence among the dimensions.

Consequently, strategic management or market reach might stand a better chance of improving the maturity level of servitisation success, despite their higher maturity level compared with organisational governance. The maturity pattern thus provides practitioners with an overview of their current transformation, but it should be combined with the total effect of the dimensions to help interpret the relevance of each dimension. This sheds important light on the understanding of the multidimensionality within servitisation, as called for by Kindström and Kowalkowski (2014). As discussed in section 2.4, previous maturity models have assessed the maturity level based on prescriptions or mean interpretations. Doing so in the Alpha case would have suggested focusing solely on organisational governance, with no further attention on strategic management or market reach, which in reality exert more influence on success in a multidimensional setting. In this sense, these computations and weighted interpretations provide practitioners with a more precise assessment of their current position within the servitisation transformation. The assessment of the current maturity level should also concentrate on the maturity level of each dimension individually by assessing the maturity of each indicator in relation to its relative importance for the associated dimensions (see Figures 19–24); this, in a similar notion to the assessment

	Transformative priority	
1	Strategic management	.309***
2	Market reach	.285***
3	Organisational governance	.180
4	Service integration	.151*
5	Digital integration	.145**
6	Value function	-.263***

***Note**: Significant estimates: *p <0.10, **p <0.05, ***p <0,01 – based on 5,000 bootstrap replications.*

Table 28: Transformative priority based on total effects adopted from Publication 3.

of the maturity of servitisation. These are further explained in the following chapter. The examination of the maturity level and identification of potential focus areas should always be assessed on the basis of the individual situation of the focal SMEs. This, as the findings do not seek a generalisable maturity pattern, as emphasised by pragmatism, but strive to calculate ideal solutions for each practitioner.

4.5.3 Predicting and configuring the potential outcome of servitisation efforts

In continuation of the discussion in section 5.0.2, the total effect accumulates the weighted influence of each dimension in the estimation of servitisation success. Estimating the level of success ($\hat{y}_{ss}$) based on the performance of each dimension (y_{dim_i}) allows for a better interpretation of their respective influence on the success (Hair *et al.*,, 2021), because it incorporates the relational effects in the estimation of success through the total effects (direct and mediating effects). More importantly, as the level of success is estimated based on the degree of maturity per dimension, these insights also allow for predicting a potential level of success through simulated estimations by configuring the maturity of the dimensions (y_{dim_i}).

As the maturity level of the dimensions is calculated based on their associated indicators ($w_i * x_i$), it is possible to estimate the potential change in the maturity level of a dimension when configuring the observed value (x_i) of an associated indicator with *j* representing the change (x_j). Based on the reflective structure, indicators are predicted by their related constructs through a simple linear regression resulting in the outer loadings (Hair *et al.*,, 2011). These indicator loadings determine the absolute contribution of an item to its assigned construct (Hair *et al.*,, 2017b, p. 323).

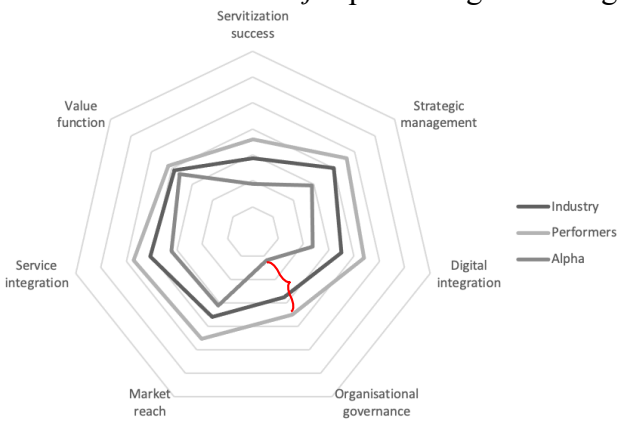

Figure 18: MdSeMM with the maturity gap of OG between Alpha and the performers.

By fixing the statistical weights of the indicators (outer loadings (w_i)) and the dimensions (total effects (c_i)), it is possible to estimate the consequence of the configured value (x_j) to estimate a potential increase in the level of success; for instance, by computing the relative change of the maturity level in organisational governance (y_{OG}), if the indicator value of og_2 is increased by 1 (x_j = 1). The effect of the configured value (x_j) is calculated following the same reasoning as the equation of composite value by accumulating the weighted effect for the maturity level of the dimension $(w_i \cdot x_j)$ (Hair *et al.*, 2017). Through the total effect (c_i), it is possible to estimate the potential consequences for the level of servitisation success. The estimated change in servitisation success is then represented as $\hat{y}_{ss_j}$, with *j* being the changed value by extracting $\hat{y}_{ss}$ (from Equation 2) with the configured $\hat{y}_{ss+1}$ through $(\hat{y}_{ss}(x_i + 1) - \hat{y}_{ss}(x_i))$.

$$\hat{y}_{ss}(x_i) - \hat{y}_{ss}(x_{i+1}) = \big((w_i \cdot x_i) \cdot c_i\big) - \big((w_i \cdot x_{i+1}) \cdot c_i\big)$$

$$\Downarrow$$
$$\hat{y}_{ss_j} = \left((w_i \cdot x_j) \cdot c_i\right)$$
$$\Downarrow$$
$$\hat{y}_{ss_j} = \left(y_{i,j} \cdot c_i\right)$$

Equation 7: The estimated change of servitisation success through the configured values

Continuing the example from section 5.2.2, organisational governance potentially provides opportunity to increase the estimated success of servitisation, as its maturity level is distinctively lower than the rest of the dimensions and, importantly, in comparison with the performers (see Figure 18).
Similar reasoning is given for the validated indicators. By examining the indicators' current level and comparing their relative influence on the dimension (outer loadings (w_i)), managers are able to identify the indicators (i.e. theories) with the largest potential influence on achieving a successful servitisation transformation. Figures 19–24 display the industrial maturity of each dimension on the associated indicators in comparison with Alpha, the performers and a priority line. The priority line shows the absolute contribution from the indicator for the maturity of the associated dimension (Hair *et al.*,, 2017b, p. 323). This is similar to the weighted importance of the dimensions in estimating success. Examining the underlying indicators of organisational governance in Figure 19 illuminates the potential of improving 'resource allocation' (og_2), 'optimised processes' (og_3) and 'formalised roles and teams' (og_4). From here, the priority line stresses the importance of 'optimised processes' as the preferred next step for Alpha. This, as the 'optimised processes' contributes the most to OG's maturity level, closely followed by og_2 and og_4 (see Table 29). Following Equation 5, the accumulated change of the estimated servitisation success ($\hat{y}_{ss_j}$) is estimated by calculating the relative change in the maturity level by increasing og_3 by 1. The outer loading for og_3 is .792, while the total effect of organisational governance is .180, leading to the following reasoning:

$$\hat{y}_{ss}(x_i) - \hat{y}_{ss}(x_{i+1})$$
$$=$$
$$\left((w_i \cdot x_i) \cdot c_i\right) - \left((w_i \cdot x_{i+1}) \cdot c_i\right)$$
$$=$$
$$\left((0.792 \cdot 1) \cdot 0.180\right) - \left((0.792 \cdot 2) \cdot 0.180\right)$$
$$=$$
$$0.4256 - 0.28512$$
$$\Downarrow$$
$$\hat{y}_{ss_j} = 0.14256$$

or simplified:

$$\hat{y}_{ss_j} = \left((w_i \cdot x_j) \cdot c_i\right)$$
$$\Downarrow$$
$$\hat{y}_{ss_j} = \left(y_{i,j} \cdot c_i\right)$$
$$=$$
$$0.14256 = ((0.792 \cdot 1) \cdot 0.180)$$
$$=$$
$$0.14256 = (0.792 \cdot 0.180)$$

Equation 8: Calculating the estimated improvement of servitisation success through og_2

Thus, configuring og_3 by configuring the observed value by +1 yields an improvement of organisational governance of .792, which accumulates an increased estimation of servitisation success of .142 points. This, as the construct explains .792 of the value of 1 added to the indicator, which increases the maturity by .792.

To exemplify, Table 29 calculates the estimated improvements of servitisation success through the configuration of the OG indicators by increasing their observed value by 1. While these outcomes are useful as guidelines for practitioners to evaluate potential efforts, they are limited in terms of three aspects: First, the observations are based on how managers perceive the current performance, which makes it difficult to identify how to anticipate the amount of effort that lies behind an increase in the observed value of a single indicator. Second, these interpretations are based on statistical tests with a 5% significance level, which implies a degree of uncertainty. Hence, these results should (at best) be anticipated as the most likely outcomes of the given situation and effort. Third, while it is impossible to predict the future, we can do our best to make an educated guess based on these statistical tests. These interpretations of the maturity levels and the predictive anticipation of the configurations of the dimensions' indicators therefore provide new lessons for how to increase the likelihood of a successful servitisation transformation through the configuration of specific indicators – and their dimensions.

	$(w_i * x_j)$	c_i	$((w_i * x_i) * c_i)$
og_2	0.730	0.180	+ 0.134
og_3	0.792	0.180	**+ 0.142**
og_4	0.708	0.180	+ 0.127
og_6	0.753	0.180	+ 0.135
og_7	0.742	0.180	+ 0.133

Table 29: Estimated impact of configured organisational governance indicators.

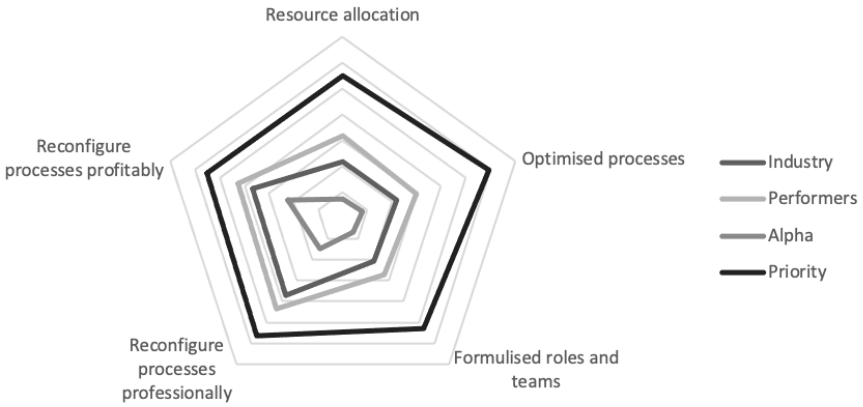

Figure 19: Maturity level of organisational governance

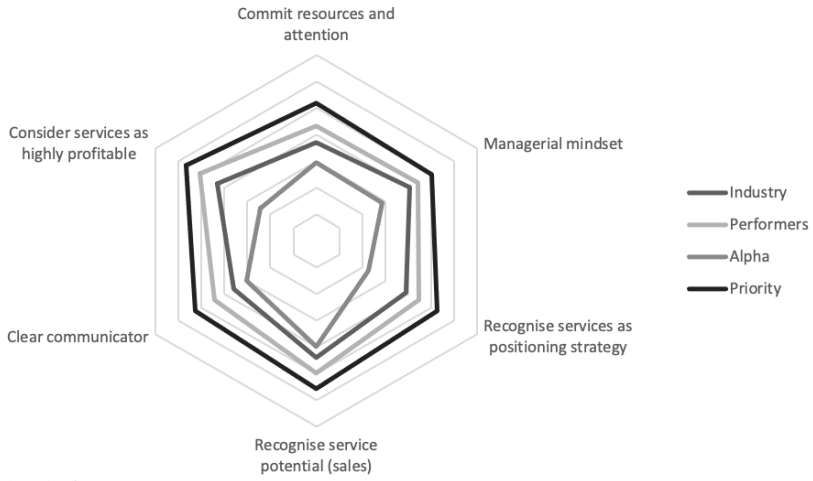

Figure 20: Maturity level of strategic management

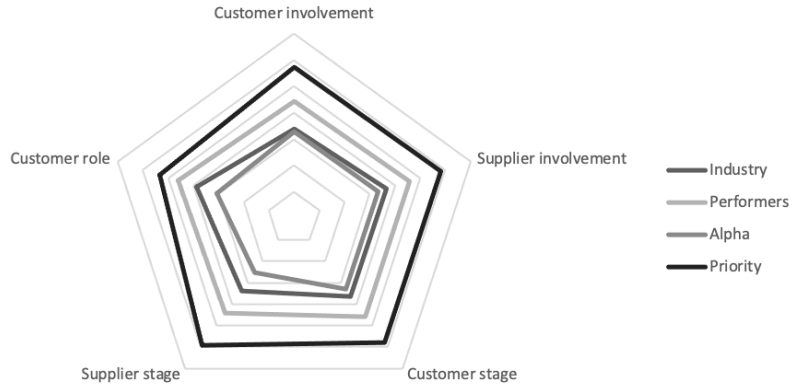

Figure 21: Maturity level of market reach

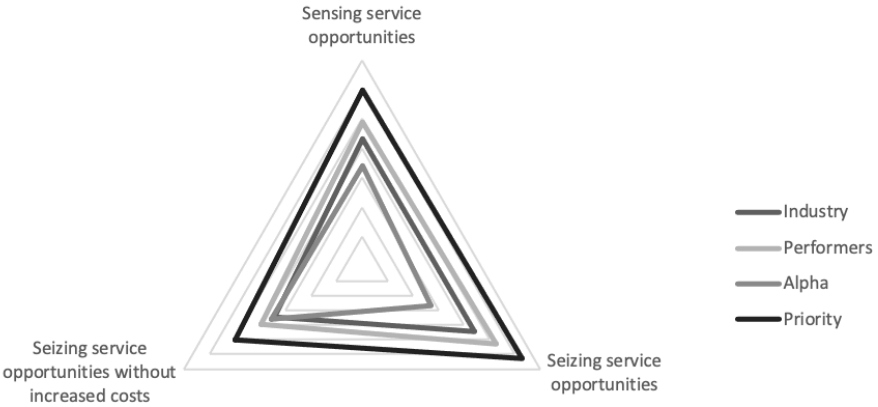

Figure 22: Maturity level of service integration

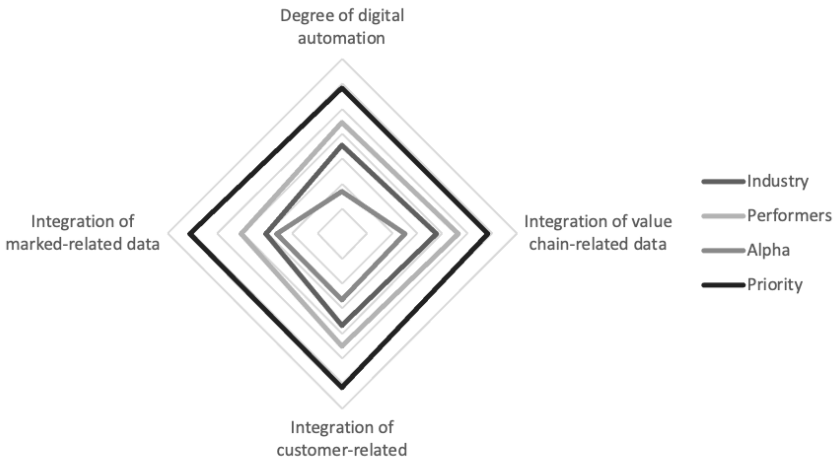

Figure 23: Maturity level of digital integration

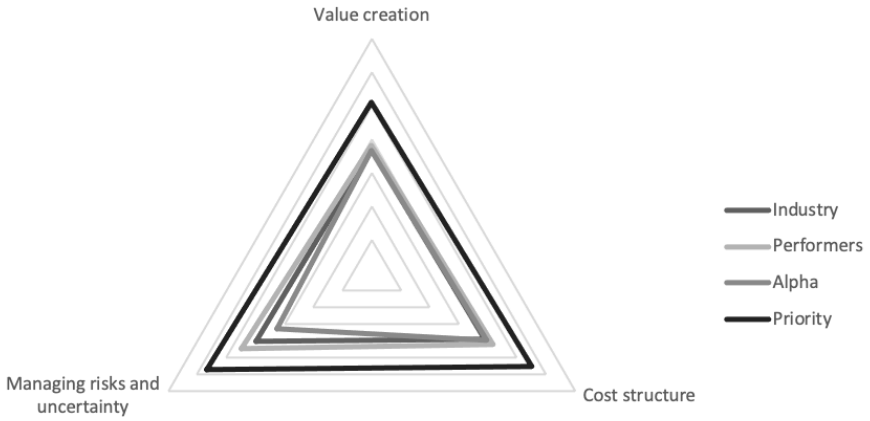

Figure 24: Maturity level of value function

These results allow practitioners to evaluate potential configurations of their current MdSeMM pattern before executing them. Accordingly, they are important for managerial decision-making when allocating investments to the servitisation journey. A better allocation and consideration of investments could reduce the consequences of the intensified investments, which have been identified as an antecedent for the failed servitisation transformation (Visnjic & Van Looy, 2013). Combined with the statistical output of PLS-SEM (see Table 25 in Publication 3), it is possible to prioritise the transformational path with respect to the indicators with the greatest influence for increasing the level of servitisation success. However, the applicability of these metrics would improve if a better understanding of the cost of increasing the level of an indicator could be reached. This would permit a comparison of the statistical impact of increasing an indicator with its relative costs to identify the most cost-efficient efforts in a cost–impact ratio.

This PhD research has developed a tool for operationalising the servitisation transformation by examining the current maturity and estimating and evaluating the likely outcome of configuring the servitisation operations. These estimations and evaluations are based on the current positioning of the SME, and they seek to make recommendations on the basis of the contextual setting; thereby deviating from the generalisable recommendation, which is consistent with the limited ability of pragmatism to draw generalisations. With a pragmatic perspective and an abductive approach, this research developed the tool through conceptualisation of the 'most likely explanation' (see section 3.3) and refined it through validation and reconceptualisation, as presented in the PhD's methodology (Chapter 3).

PART THREE
Discussion and Conclusion

"Chance only favours the prepared mind"
Louis Pasteur, Chemist,
Discovered the principles of pasteurization and vaccination

5. Discussion

The research presented in this PhD represents a gradual development of a nomological network of servitisation dimensions and their interrelationships, which has been intended to understand the concept in a multidimensional manner. The lessons learned from the research have shaped the network in terms of specifying the constructs and identifying relevant indicators for both servitisation dimensions (Publication 1 and SLR2) as well as the achievement of it (Publication 2). Publication 1 identified several significant results, but more importantly, it identified areas that were too loosely defined as expressed by Cronbach and Meehl (1955) (e.g. servitisation success). These lessons and findings from Publication 1 were the first step towards the new proposed network with improved construct specifications and better-aligned indicators; for instance, the conversion of digital integration as a mediating construct was established on the basis of these findings. Furthermore, it is on the basis of the findings and lessons from Publication 1 that each law of interrelationship was revisited, resulting in several adjustments. For instance, the removal of the law of interrelationships between organisational governance and value function due to its insignificant results and insufficient theoretical meaning. The refinement of the nomological network was intended to explicate the structure of the multidimensional perspective of servitisation to allow for the testing and confirming of the proposed network of constructs and laws (Cronbach & Meehl, 1955). This, both in term of addressing the calls for understanding servitisation in a multidimensional perspective ((Baines *et al.,*, 2017;Lexutt, 2020) as well as enabling the development of a multidimensional servitisation maturity model. Thus, the first core finding of this PhD is the refinement and confirmation of the nomological network of servitisation, which acts as the foundation for answering the research question. The development and confirmation of a nomological network is important for future research and practices of servitisation, as it enables subsequent research into specific areas of measures, construct development and/or interrelationships (Peterson & Zimmerman, 2004), which guides research and the mapping of the servitisation concept. Further, it addresses and answers SQ_1 by identifying which dimensions are key to the servitisation transformation. Due to the amount of refinement in the network from its original proposal and the specification of servitisation success, a comparison of the two models' results makes no sense, as it is nearly two separate models.

In continuation, the success of servitisation was found to be specified (and approximated) too loosely in the first tested network and had to be properly conceptualised to enable the approximation of success in Publication 3. This was already evident in Publication 1, as two of the four indicators of servitisation success were found unreliable (loading < .708; (Hair *et al.,*, 2020)), while a third was insignificant ($p \leq .05$). This leaves 'service-specific profitability' as the only significant, reliable indicator to approximate the endogenous variable (SS). This concern was further emphasised by the servitisation community at the SSC21 conference, which stressed several (but differing) non-financial indicators of success. These comments from the community and the need to specify the construct for the nomological network led to the second core finding of this PhD stemming from SLR2 and resulting in Publication 2; which outlines the paradoxical perceptions of servitisation success articulated as the four definitional types of servitisation and the identification of several indicators of servitisation success. Interestingly, the inconsistent perceptions of what termed servitisation success was found to correspond with the differing perspectives of the servitisation community at SSC21. This core finding is crucial when answering the research question, as it is establishing the approximated target of the maturity model and answers SQ_2 (i.e. 'How is servitisation success defined and quantified in the literature?'); hence, allowing to specify whether the maturity of servitisation

has improved. Conclusively, this core finding challenges the view of servitisation success and how scholars handle such terms inconsistently while also highlighting the need to consolidate a common denominator of success within servitisation. This is crucial for future servitisation research.
The refinement of the nomological network (first core finding) and the approximation of servitisation success (second core finding) were steered by the research objective to establish a multidimensional servitisation maturity model (MdSeMM). The dimensionality of the MdSeMM was confirmed in Publication 3, which, through PLS-SEM, established the weighted influence to compute the maturity level of the manufacturing firm in combination with the six dimensions. Confirming the nomological network in this manner explicates how the dimensions do in fact coexist, while the statistical output both specifies the strength of the interrelationship and the impact on servitisation success answering both SQ_3 and SQ_4. While Publication 3 solely computes the necessary measures and outlines the interpretation of these measures, this dissertation elaborates on the applicability of the maturity model in sections 4.5.2 and 4.5.3 by coupling the findings of the three papers. This is the third core finding of this PhD and answers the main research question, as it emphasises how SMEs increase the likelihood of successful servitisation transformation through reconfiguration by computing the predicted maturity of the proposed configuration. For a technical explanation of this, please revisit section 4.5.3. This finding is crucial for the development of more capable maturity models within servitisation, as it handles two of the main limitations of previous SeMMs: multidimensionality through interrelationships and a weighted computation of the maturity level.
The academic and managerial implications of the three core findings are discussed in the following. These implications are based on the individual and accumulated findings of the PhD project in its entirety. The academic implications are presented and discussed in section 5.1, while the managerial implications are presented in section 5.2. Following the perspective of pragmatism, a particular focus is placed on the applicability of the findings.

5.1 Academic implications of the PhD

From the beginning, this PhD has strived to understand how SMEs can increase the likelihood of a successful servitisation journey. It was clear from the outset that several unanswered or unknown areas had to be understood to obtain this objective and to answer the research question of this PhD. These unanswered or unknown areas were explicated during the theoretical grounding of the project, and further discussion of how the findings of the three appended papers add to the academic literature is unfolded in the following; this, with respect to the three core findings of the PhD project.

The nomological network is built of constructs and laws, which together constitute a network of interrelationships among conceptual constructs (Cronbach & Meehl, 1955). In the servitisation context, such a nomological network represents the conceptual elements of the transformation (referred to as dimensions), and the influential interrelationships among these elements. While a growing emphasis on understanding servitisation in a multidimensional perspective with coexisting dimensions has emerged (Kindström & Kowalkowski, 2014;Kohtamäki *et al.,*, 2019a), very few studies have engaged in the investigation of the multidimensionality (Adrodegari & Saccani, 2020;Coreynen *et al.,*, 2018). The multidimensionality has been emphasised as the existence of multiple dimensions that coexist in a concept and which simultaneously change within the concept (Kindström & Kowalkowski,

2014;Lexutt, 2020). Notably, to our knowledge from SLR1, SLR2 and the engagement with the servitisation community, no prior studies have engaged in understanding the interrelationships between coexisting dimensions; which makes it impossible to understand the coexistence and structure of the multiple dimensions. Furthermore, a crucial element for a network to become a true nomological network is the laws of interrelationships among dimensions and to the observable indicators (Cronbach & Meehl, 1955); none of which have been claimed, to our knowledge, within the servitisation literature. In that sense, this nomological servitisation network is the first proposed network of key servitisation dimensions with associated observable indicators and weighted interrelationships; and perhaps more importantly, the first to be confirmed. The development of this nomological network produces several findings and conclusions, which are presented individually hereafter; the six key dimensions; the verification of the multidimensional structure; the validation of the weighted interrelationships among the dimensions; and the validation of observable maturity indicators.
The identification of unified dimensions for comprehending the transformation of the entire organisation helps the dissemination of servitisation as a concept (Publication a) by providing academia with a common denominator or common language for addressing specific aspects of this transformation, which has been called for by Baines *et al.,* (2017). The findings of Publication 2 emphasised how the development of common definitions and beliefs helps to reduce the ambiguity of servitisation, which avoids a paradoxical situation. Hence, the previously proven deviations in operational implications due to the definitional ambiguity (Brax & Visintin, 2017) are believed to be enriched by the introduction of common denominators of the concept through the identification of dimensions of servitisation. Further along these lines, following the notion by Szasz and Seer (2018), the servitisation field has reached a maturity where consolidation and consistency is needed. This consistency is believed to be sorely improved by establishing six key dimensions of servitisation unifying the field, as stated by Schaarschmidt *et al.,* (2018). Nevertheless, a corresponding perspective of such predefined dimensions being too steering and confining the exploratory element of the servitisation research, has been presented to me on several occasions (e.g. SSC21). While this perspective is essential for science within and outside of servitisation, the project in hand challenges such perspectives by complying with the notion developed by Szasz and Seer (2018) of how servitisation has reached a point where the consolidation of our knowledge is needed to strengthen the field in the future. Moreover, from a pragmatic perspective, such common denominators (i.e. dimensions) will focus the future research to strengthen our knowledge in these areas. For instance, more investigation into each of the dimensions is important to elaborate our knowledge of these dimensions individually. As was evident from Publication 3, more knowledge about what true value is for the customers in the context of servitisation and how this value is captured is needed to develop the value function dimension further. Nonetheless, I encourage researchers to extend the nomological network with additional proposed and confirmed constructs and laws by investigating areas outside of the six dimensions. The statistical validation of the model (Publications 1 and 3) legitimised the six dimensions as estimators of the transformation through discriminant validity (uniqueness or distinctiveness from other constructs), composite reliability (the ability of the constructs to explain the indicators) and out-of-sample prediction (the ability of the dimensions to predict generalisable outcomes for the industry). This provides academia with the first statistically validated dimensions of servitisation, which establishes thorough and fertile grounds for developing and consolidating the field.
This PhD research provides academia with statistical verification of the multidimensionality within servitisation by validating the relational effects among the dimensions. These results prove the coexistence of multiple dimensions, which is the premise of the multidimensionality (Kohtamäki *et al.,*, 2019a). This advances the existing literature, as previous studies have solely

emphasised such coexisting dimensions through theoretical conceptualisations or empirical cases (Adrodegari & Saccani, 2020;Coreynen *et al.,*, 2018) without any test for validation nor with interrelations. In continuation, the multidimensional perspective integrates organisation-wide elements of the transformation (Kindström & Kowalkowski, 2014), which enhances our understanding of the transformation as a whole. In line with this, the mediating effects provided by Publication 3 shed important light on the more latent laws within the nomological network. This helps researchers to understand the transverse mechanisms within the transformation by understanding the visible and inherent laws that a nomological network consists of and how they are formed; for instance, the mediating effect of digital integration proves the role of digitalisation as an enabler for servitisation success, as emphasised by previous studies (Ntanos *et al.,*, 2018;Lenka *et al.,*, 2017). This PhD project found that such interrelationships exist among the dimensions, thereby proving their coexistence within the nomological network and confirming the network itself (Cronbach & Meehl, 1955, p. 291). For this PhD, the understanding of the degree of relational influence among the dimensions is just as important as the identification of the interrelationships in the nomological network of the servitisation transformation. The nomological network creates an understanding of where interrelationships exist through the confirmation of laws (Cronbach & Meehl, 1955), while the relational influence emphasises the strength of that interrelationship (Hair *et al.,*, 2017b). This helps scholars not only to identify which dimensions are influenced by others (from the nomological network) but to identify which dimensions are influencing the dimension the most, which directs their attention towards the dimensions with the greatest relational effect. This advances the understanding among scholars of which dimensions could be the most interesting to extend within the literature. Moreover, these relational results confirm the hypothesised direction of the relational effects to further refine the academic understanding of the structure among multiple dimensions within servitisation (as done by Queiroz *et al.,* (2020)). In this respect, the study advances the understanding of the consequential effects within the multidimensional network, which allows researchers to comprehend how the dimensions influence each other, then evolving on the call by Lexutt (2020) and Baines *et al.,* (2017). However, while these results are believed to turn the attention of researchers towards important research areas of importance to the servitisation transformation, these areas are not exhaustive for servitisation research, as no one dimension is exhaustive and they must all be developed further, and adjustments must be made to the nomological network accordingly (Peterson & Zimmerman, 2004;Cronbach & Meehl, 1955). However, these relational and structural results are a good foundation for future research.

The final element of the nomological network is the identification and association of observable indicators. Most of the existing maturity indicators have been constructed on the basis of empirical evidence from case studies and interviews without any statistical validation. This became evident during the evaluation of existing maturity indicators when working on Publication 3 (see Table 20). However, following the notion by Kowalkowski *et al.,* (2017b), this was no surprise, as the majority of the servitisation literature is found to be based on case studies and interviews. Again, Szasz and Seer (2018) argue that the servitisation field needs more consistency by consolidating the existing knowledge, while Kowalkowski *et al.,* (2017b) argue that such consistency is achieved through the statistical validation of the existing knowledge. This research has achieved both ends by identifying 42 empirical maturity indicators within the literature (LR1) and compiling them into 39 consistent maturity indicators of servitisation. These were validated through the computation of PLS-SEM by estimating the indicator reliability and their significant relevance of the associated dimension (Hair *et al.,*, 2020). This led to the validation of 26 pre-existing maturity indicators mainly adopted from the study by Coreynen *et al.,* (2018). Since the indicators are theoretically founded within prior maturity models, the maturity indicators represent a theoretical aspect of the servitisation

transformation. These results then provide Kowalkowski *et al.,* (2017b) and Szasz and Seer (2018) with statistical validation of the existing knowledge and advance academia with validated indicators, items and scales to be adopted by future research. Further, these findings validate the associations of the observable indicators to the key dimensions, which provides academia with measures of each key dimension. Despite 13 maturity indicators being found unreliable or not significant for explaining the associated dimensions, these results still add to academia. Only two indicators were insignificant, while the rest were identified as unreliable due to low loading scores. These results establish a basis for elaborating on the underlying theories and their relevance or association in the servitisation transformation. While these indicators are not exhaustive for each of the dimensions, they consolidate and extend the existing understanding of servitisation. However, further research should be dedicated to improving the comprehension of the key dimensions as well as the unreliable indicators to understand their presence in the transformation; although they have too little relevance, they still have some.

In the course of this PhD project, the definition of servitisation success was found to be ambiguous, as academia defined or implied the achievement of servitisation in various and inconsistent ways (finding of Publication 2). Furthermore, it became evident that although numerous studies investigated the success of servitisation (e.g. the investigation of success factors within servitisation by Polova and Thomas (2020)), they did not define success. As such, this study has endeavoured to steer the research towards a common understanding of success by highlighting the consequences of such ambiguity and consolidating the existing perspectives through a literature review. This is in line with Brax and Visintin (2017), who stressed the ambiguity of the servitisation definition, which is believed to be a source of the inconsistent measure of success. Publication 2 highlighted the potential paradoxes and inherent tensions of the inconsistent definition of what characterises a servitisation success; this, to challenge the existing studies within the field that have been investigating this perspective without recognising the importance of such clarification. Additionally, the differing perceptions of servitisation and when and how it is achieved vary greatly, as observed by Brax and Visintin (2017) and which was distinct within the servitisation community at SSC21. Based on these observations, Publication 2 incorporated the conceptualisation of servitisation as seen from four definitional perspectives as proposed in Publication a – all perspectives that influence how scholars and managers perceive success. Despite these four definitional types being highly conceptual, they are seen as relevant propositions of how to understand and cope with the ambiguity of servitisation and servitisation success. Of great importance for this PhD project was the composition of several financial and non-financial indicators of servitisation success in SLR2 and Publication 2. The categorisation of servitisation success indicators was adopted from the current literature as financial and non-financial indicators (Raddats *et al.,*, 2015;Lexutt, 2020). Following the same notion as the previous indicator discussion, identifying success indicators helps academia to consolidate the existing knowledge. The validation of success indicators not only provides academia with validated items and scales, but also a validated approximation of what signifies servitisation success. This validation could help researchers to establish a thorough and reliable approximation of what success is and what comprises it more precisely and, in so doing, establish the missing common denominator of servitisation success with the community to explicate the meanings and to establish consistency among future studies. However, findings from Publication 2 also indicate that servitisation success should be assessed based on the conceptual understanding of servitisation, as the perception of the concept influences the composition of success indicators, as success is a social construct (Smith-Doerr *et al.,*, 2004). I therefore suggest continuing the research to divide the MdSeMM into the four definitional types by incorporating a moderation effect.

The development of the MdSeMM extends the servitisation maturity literature by consolidating the extant literature, as done by Adrodegari and Saccani (2020), but with a particular focus on incorporating the multidimensionality (through the establishment of the nomological network) and advancing the computation of firm maturity. As Publications 1 and 3 emphasise, although few SeMMs incorporate multiple dimensions to accommodate the call of multidimensionality, they do not incorporate the interrelationships between such dimensions, meaning that their models neglect the coexistence, as emphasised by Kindström and Kowalkowski (2014);Lexutt (2020). This project has worked to advance the servitisation maturity literature by incorporating multiple dimensions with emphasis on their interrelationships to comprehend the coexistence of such dimensions. This also addresses the call for 'utilize different, more complex operationalizations' in future maturity models, as stated by Lexutt (2020, p. 121). LR2 proved how previous SeMMs have computed maturity levels using a standard mean interpretation, which fails to take the conceptual importance of each dimension into account. This has made sense in previous studies, as the relational influences were unknown and the mean interpretation eases the dissemination of the models. Through a mean interpretation, however, each dimension is assessed as equally important for the maturity of servitisation, which statistically makes no sense without theoretical specification; specification that has not been present in any of the identified SeMM studies in LR2. The development of a weighted mean interpretation based on the relational influences from the nomological network challenges such standard mean interpretation (e.g. by Wikström *et al.,* (2009) Coreynen *et al.,* (2018) Adrodegari and Saccani (2020)) or predefined prescriptions of the maturity levels (e.g. by Alvarez *et al.,* (2015) Rapaccini *et al.,* (2013) Jin *et al.,* (2014)), and it advances the use of maturity modelling in the field of servitisation by enriching and detailing the narrative of the transformation. Lastly, this PhD dissertation provides academia with an extension to the Hair *et al.,* (2017b) composite scores formula by developing a new formula for predicting the weighted outcome of the endogenous variable based on the outcome of each dimension, and their total effect in explaining the endogenous variable (servitisation success). This can be used to predict the potential change in maturity levels if changes happen in one of the dimensions, hence predicting the outcome of a reconfiguration in the maturity model. This aspect challenges the existing technique of importance-performance map analysis (IPMA), as this technique solely identifies the importance of each dimension based on their performance towards the endogenous variable (Ringle & Sarstedt, 2016). Additionally, IPMA does not calculate the performance of the endogenous variables with the relational influencers (inner loadings) (Hair *et al.,*, 2017c, pp. 106-107); hence, it is unable to provide practitioners with an overall maturity score for the endogenous variable. While the IPMA is highly relevant and provides a better visualisation to identify the most important dimension, our proposed equation (in sections 4.5.2 and 4.5.1) therefore enables the manager to compute the configured maturity with limited statistical knowledge. This advances the SeMM literature by providing a novel approach to developing applicable maturity tools while building on the same mechanisms as composite scores (Hair *et al.,*, 2017b) and the IPMA's incorporation of the total effects of constructs (Ringle & Sarstedt, 2016).

These academic implications are important for elaborating the limitations of the field (presented as areas 1–4 in Figure 3, Chapter 2). These four areas are visualised in Figure 25 (next page) along with the associated publications and academic implications presented above.

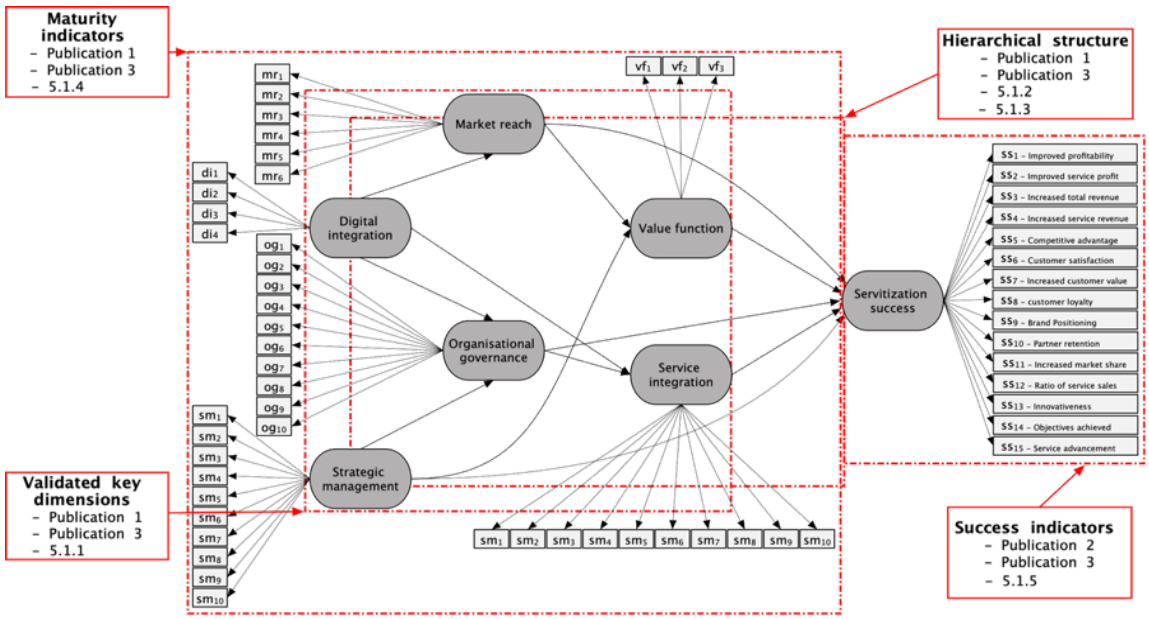

Figure 25: The publications' role for the adjusted MdSeMM.

5.2 Managerial implications of the dissertation

The managerial implications of the dissertation in hand are mainly constituted through the applicability of the MdSeMM and are represented by steps 3–5 in Figure 26 (next page). The technicalities behind the examination and configuration of the MdSeMM have been presented in sections 4.5.2 and 4.5.3, and they will form the foundation for the following implications. Here, a practical orientation is used to explicate the application of these results.

Inspired by the conceptual reasoning presented by Brax and Visintin (2017), the assumption for applying the MdSeMM is that managers are working deliberately with servitisation as a strategy and that they acknowledge the inherent process of change. This, as the true value of the MdSeMM emerges in the configuration of the entire organisation, which requires a willingness to change among the managers and the organisation (step 1). However, the MdSeMM is valuable for assessing the current maturity level in comparison with the industry despite the managers' lack of willingness to change. Whereby, managers could obtain detailed insight of their transformation by solely investigating steps 1–3 without a focus on configuring. As the initial step, managers are asked to fill in all of the items in the MdSeMM survey to enable a coherent analysis of their current state (step 2). Experience from the data collection for Publication 3 acknowledges that managers consider the questionnaire to be rather lengthy, which resulted in a high number of incomplete surveys. However, given that the managers actually signed up for the test and they are promised the results immediately after completing the test, which acts as a motivator to complete the survey, this should provide added incentive to answer the questions as accurately as possible. This again taps into the willingness to change among the managers and organisations.

Upon completing the survey, managers are provided with the necessary information to compute the maturity scores of each of the six dimensions to evaluate their performance together with the maturity score of servitisation success (SS) to anticipate their overall maturity. To compute these scores, managers are provided with the weighted importance of each associated indicator to compute the maturity score of the related dimension (as emphasised in section 4.5.3). For instance, the maturity score of service integration (SI) is the weighted mean of the six associated indicators using their relational importance as weight. For example, if the managers 'somewhat agree' (4) that they are able to 'observe and identify customer needs' (si1), then the weighted score of si1 is (4 · 0,853) = 3,412, which is then added to the weighted scores of si2 and si3, and divided by the number of items (3 items) to obtain the average score of that dimension while taking their weighted influence into account. This is repeated for all six dimensions. The servitisation success (SS) dimension is representing the overall maturity level of the manufacturer and is computed differently by using the total effect of each dimension, which is multiplied by the maturity score of the dimension; this, to incorporate the relational effects of the nomological network and to predict the maturity level based on the dimension performance. The managers then compute the overall maturity level by using the calculated maturity level of each dimension and multiplying the score with its total effect. For example, service integration, which has a total effect of .151, is providing the overall maturity level with (3,412 · 0,151) = 0,515 maturity points on a 7-point scale. The weighted importance of the associated indicators and the total effect of each dimension are provided from the industrial investigation in Publication 3, meaning that no requirement of statistical proficiency to run a new PLS-SEM is necessary. However, managers require a basic set of mathematical skills to understand weighted mean computations, which potentially creates a barrier for using the MdSeMM. To overcome this barrier, an online tool might be necessary to develop to compute and plot the maturity scores instantly based on the managers' answers, which would likewise enable the continuous sampling of additional observations for future adjustments made to the model. For now, however, a prepared Excel worksheet has been developed to allow managers to fill in their answers in predefined areas, which computes the scores and plots the figures automatically. While this enables all SMEs to apply the MdSeMM, it can at this point only be

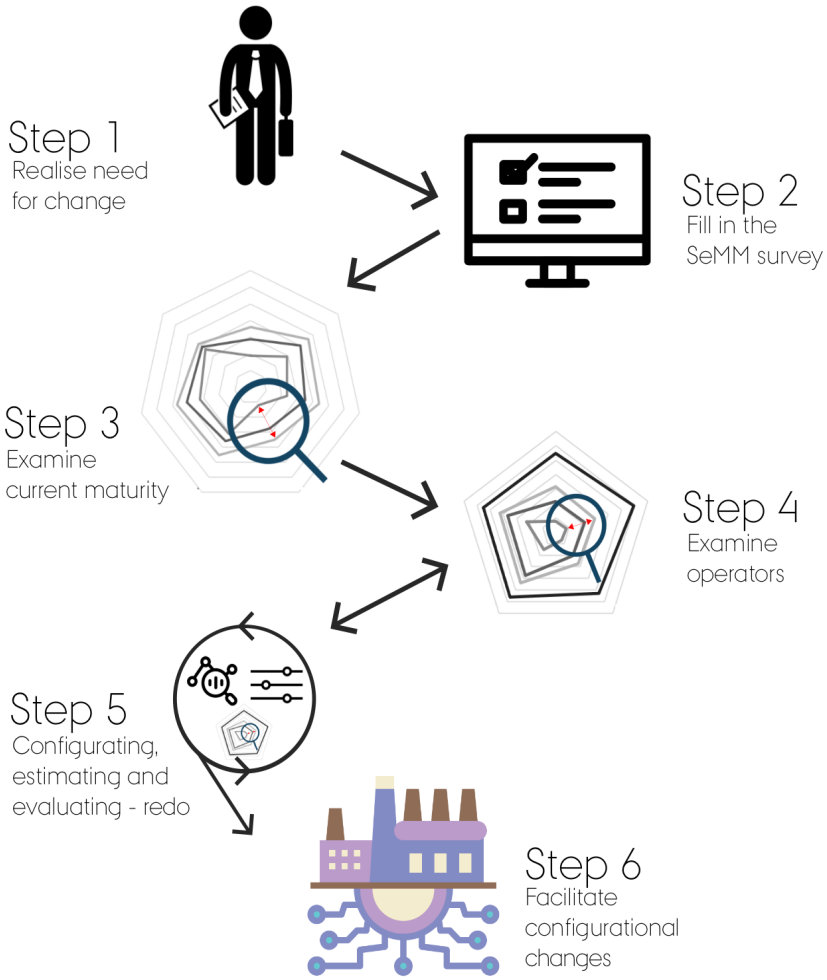

Figure 26: The process of facilitating the MdSeMM.

obtained through direct contact with the authors. The Excel worksheet provides managers with one figure that visualises the maturity of each dimension in comparison, and seven individual figures for each of the dimensions (including SS) visualising the maturity of each indicator. The experience from the Servitize.DK project is that the overall maturity figure is seen as a desired and important tool for managers to anticipate their performance compared to the industry and to identify potential focus areas.[14] Furthermore, the project consultants anticipated the figure forming a common standpoint and language to serve as the basis upon which the managers could develop the transformation.

The comparable figure illustrates the current maturity of each dimension while also comparing the current state of servitisation within the industry in general as well as the top industry performers (the 25% highest success scores) (see section 4.5.2). By visually examining the dissimilarities between their own maturity level and those of other performers, managers are able to identify potential focus areas by following the best practices within the industry. The maturity pattern provided by the comparable figure (indicated by the connected dots) highlights the proportional focus among the dimensions, and managers could learn from the performers by examining their respective patterns. Given how servitisation is a continuum that is modified and changed in a continuous transformation, a single improvement made to one dimension is not enough; rather, the managers must focus on improving the dimensions continuously and try to adapt a pattern of maturity levels rather than a specific level for one dimension. When choosing a focus area for improving the maturity, managers are recommended to examine the total effect of the relevant dimension to specify their importance for the achievement of servitisation. For example, if strategic management and organisational governance obtain comparably low maturity scores, the total effect suggests improving strategic management (.309) before improving organisational governance (.180), as strategic management obtains the highest total effect for the overall servitisation maturity. As such, the dimensions with the highest total effect should be prioritised unless the maturity level of another dimension is particularly low compared to the industry. Hence, providing managers with two evaluation criteria to identify specific focus areas: the gap between industry maturity and own maturity; and the total effects of each dimension. By providing the managers with knowledge of the total effect (see section 4.5.2), they are able to prioritise future operations according to the dimension with the largest effect on estimating success, which reduces the risk of intensifying investments in less important areas, which has previously been proven to postpone servitisation profitability (Baveja *et al.,*, 2004;Benedettini *et al.,*, 2015). Combined with examining the visualised MdSeMM, managers are able to identify focus areas based on the greatest dissimilarity and prioritise according to their relevance for achieving servitisation success.

Once the focus area is identified, managers concentrate on the associated indicators of the respective and chosen dimensions (step 4). These indicators represent theoretical operations of servitisation and provide managers with validated methods for improving the maturity. Managers identify the most favourable operators by following the same reasoning as for the maturity levels: examining gaps in dissimilarities to performers in the dimension figure; comparing the gaps with the indicators' weighted importance; and identifying favourable operators to increase the maturity level of the respective dimension. The validation of indicators (from Publication 3) helps managers to pick and choose easily among relevant operators to boost the maturity level of the preferred dimension. This enables the managers to make swift decisions based on the current operational maturity and relevance despite limited managerial understanding of servitisation, which eases the execution of servitisation by prioritising future operators to refine the execution. This is evidently lacking today (Neely *et*

[14] Knowledge exchange with Servitize.DK consultants during the knowledge-sharing meeting in November 2021, based on the results from Publication 1.

al.,, 2011). Similar to prior SeMMs (e.g. Coreynen *et al.,* (2018)), this model allows managers to identify relevant focus areas for the future development of servitisation. With the incorporation of weighted importance, however, these novel findings provide managers with more precision. Hence, once managers have chosen the target dimension for improvement, they examine the target dimension figure, which illustrates the development of the associated indicators, and they choose the operator to be improved. From here, however, a barrier arises as managers must understand and translate how this operator can be improved and implemented. For example, it is not necessarily clear for a manager how to improve customer involvement (mr1) or how to integrate access to value-chain-related data (di2). To overcome this, a development of guidelines or prescribed suggestions for each indicator would be useful for managers to operationalise servitisation. However, this has not been achieved by this PhD research. Nevertheless, the MdSeMM has been found useful as a tool for the Servitize.DK project consultants to identify and guide SME transformations, while the model still accommodates the ease of identifying future operators to improve relevant focus areas of the transformation.

Importantly, as stressed in section 4.5.2, the calculated weights from Publication 3 make it possible to estimate success by configuring the indicators of each dimension (step 5). The configuration is based on the numerical increase in the observed value for the respective indicator provided by the manager survey answers in step 2. Here, the configured increase can both be computed as the summed value (e.g. from 2 to 3) or the exact expected increase in points (e.g. by 1). Hence, once the manager has identified the indicator of the respective dimension that they want to improve, they can estimate the expected increase in that particular indicator: either as the summed value of that indicator or the exact increase. The manager then calculates the estimated increase in the maturity of the specific dimension and in the overall maturity level by following Equation 5 (section 4.5.2). This provides the manager with an estimated configuration of the dimension and the overall maturity level. As these weights are statistically grounded, they at best predict the most likely estimation of success with a degree of uncertainty. However, this gives the manager the estimated and statistically most likely increase in the overall success of the servitisation transformation, which provides them with tangible and comparable metrics for evaluating alternative operators. However, these estimated improvements of each indicator (configurations) are highly objective and steered by the managers' own beliefs and estimations. For example, the manager must anticipate how much they improve on a 7-point scale by introducing new cost structures. Nonetheless, the reconfiguration still provides the manager with insight into the relevance of a configuration and establishes an understanding of its importance. This then improves the managerial decision-making and allocation of investments and resources (Visnjic & Van Looy, 2013). For instance, I recommend managers to configure a desired maturity pattern for each dimension to identify specific focus areas and to calculate the predicted overall maturity to compare with the industry and their current state. The results of this PhD dissertation provide managers with a tool to simulate an alternative maturity pattern by configuring each indicator and calculating the new estimation of servitisation success for a better evaluation. In conclusion, this is believed to increase the likelihood of a successful servitisation transformation for Danish SMEs. Furthermore, through these findings, managers are able to structure their transformation in accordance with their examined and evaluated configurations, providing them with more qualified predictions of the future.

6. Conclusion

For me as a PhD fellow, working to increase the likelihood of servitisation success has been an exploratory and expansive journey. Starting with more questions than answers, this dissertation has strived to improve the operationalisation of servitisation by establishing a better and more coherent understanding of the concept with the objective of helping managers to succeed in their journey towards servitisation; a journey that has proven problematic for many, preventing them from achieving success. However, while such problematic transformations have been investigated, the understanding of how to cope with them has been limited.

Therefore, this dissertation has sought to answer the following research question:

How do Danish industrial SMEs increase the likelihood of a successful servitisation transformation through the reconfiguration of key dimensions in a multidimensional perspective?

The dissertation has attempted to answer this question by developing a multidimensional servitisation maturity model (MdSeMM), which allows managers to examine their own maturity level and evaluate the estimated increase in success through the configuration of key coexisting dimensions. This builds on two main aspects:

- First, by calculating the present maturity of the focal SME, managers are presented with an understanding of their performance in each key dimension and their underlying indicators. The illustrated outcome of the MdSeMM provides managers with an overview of their current performance, while the assessment of the underlying indicators uncovers the preferred focus areas to increase the likelihood of success. This provides managers with an overview of the transformation to grasp the complexity of servitisation and to better understand it. This addresses some of the identified reasons for transformation failure, including poor execution (Neely *et al.,*, 2011) and the need to understand how to transform the focal firms efficiently and effectively (Tenucci & Supino, 2019).
- Second, by evaluating simulated configurations of the MdSeMM, managers are better equipped to make more educated guesses about what their decisions might entail, supporting informed decision-making and resource allocation (e.g. investments). The configuration of a single indicator permits managers to evaluate the estimated increase of success, which translates into whether an operation has a sufficient impact on the transformation. This allows managers to prioritise and intensify investments in operations that seem more likely to increase the servitisation success based on the statistical estimations, thereby facilitating well-considered future investments. This improves the conditions for a successful transformation by addressing the same reasons for transformation failure presented above along with the lack of internal capabilities (Eggert *et al.,*, 2011;Eggert *et al.,*, 2015), culture (Tenucci & Supino, 2019) and intensified investments (Visnjic & Van Looy, 2013). Furthermore, the weights of the indicators and dimensions being fixed enables managers to apply the tool without statistical proficiency, enhancing the applicability and dissemination of the tool.

The research journey has been guided by an abductive approach, acknowledging that research produces lessons, which must be adjusted to develop our knowledge and research strategy. From the beginning, to establish the 'most likely explanation' for increasing the likelihood of servitisation success (following abduction), several knowledge gaps were identified. These

were presented in the introduction of Chapter 2 and involved the 'identification of key dimensions', 'the multidimensional structure', 'the indicators approximating success' and 'the indicators approximating each dimension'; that is, the need to establish a profound nomological network of the servitisation transformation. It was necessary to close these gaps, presented as sub-questions 1–4, to construct the servitisation maturity model (SeMM) in a multidimensional perspective (MdSeMM). This led to establishing three core findings of the dissertation: confirmed nomological network of servitisation; unfolding the servitisation success; and the development of the MdSeMM.

The fundamental element in the dissertation and the MdSeMM in particular is the six dimensions of servitisation. The dissertation has established six dimensions of servitisation believed to be key dimensions. These were identified through a systematic literature review, categorised through a thematic analysis and tested several times through peer feedback from the servitisation community and in close collaboration with scholars from Aston University and the University of Cambridge. The six key dimensions are strategic management (SM), organisational governance (OG), digital integration (DI), market reach (MR), value function (VF) and service integration (SI), and their identification answers the first sub-question (SQ_1): *What are the key dimensions explaining the servitisation transformation existing within the servitisation literature?* These findings formed the foundation of the PhD research, but also responded to the call for attention by Ulaga and Reinartz (2011) and Schaarschmidt *et al.,* (2018). In so doing, this research is the first to consolidate and conceptualise key dimensions of the servitisation transformation.

The premise of assessing whether a configuration has an effect on success is the understanding of what 'being successful' means. Limited by the existing literature, a profound systematic literature review (SLR2) was needed to establish this knowledge. This led to an understanding of servitisation success as being influenced by the managerial perception of servitisation, but in terms of both financial and non-financial indicators (Publication 2). Financial indicators were less influenced by perceptions and contained service-specific and company-specific financial measures. The non-financial indicators were influenced more by the perceptions and were based on the managers' expected servitisation outcome (e.g. customer loyalty or market share). Quantifiable indicators were established and validated through PLS-SEM in Publications 1 and 3. These findings answer SQ_2: *How is servitisation success defined and quantified in the literature?* and responds to the call by Szasz and Seer (2018) to consolidate existing knowledge towards establishing a common denominator within servitisation. Furthermore, as emphasised in the discussion chapter, the success study challenges how success has been treated in the servitisation field and stresses the need for the field to establish common denominators and consistency.

The perspective of servitisation as a multidimensional transformation has been adopted, and it has formed the MdSeMM mechanism by incorporating the coexistence of the key dimensions with their respective relational influences on each other. However, a better understanding of the nomological network was necessary to incorporate such coexistence fully. The relations between the dimensions were theorised to identify the nomological nets among dimensions based on their theoretical relevance. The validation of the relations and their coexistence through PLS-SEM confirmed the nomological network through the significance of several direct and mediating relations, adding to the calls by Kindström and Kowalkowski (2014) and Lexutt (2020), while also answering SQ_3. As the discussion concludes, this confirmation of the developed nomological network advances the servitisation field in as much as it is the first to structure the concept, which has been labelled as highly ambiguous (Brax & Visintin, 2017), but also as it allows scholars to extend the network by identifying and investigating specific aspects of the concept (Peterson & Zimmerman, 2004).

Furthermore, although all relations were hypothesised to have a positive relational effect, PLS-SEM accumulated the true effect of associated interrelationships, which incorporates the potential of both positive and negative consequential effects, as called for by Baines *et al.,* (2017). An accumulation of the total effect of the respective dimension, in its estimation of servitisation success, was enabled by validating the direct and mediating effects of the dimensions. This answers SQ_4 and lays the foundation for estimating servitisation success to answer the research question. These findings are the first statistical validation of the multidimensional coexistence of servitisation dimensions, as called for by Baines *et al.,* (2017) and Lexutt (2020), but also the first to establish the weighted importance among these dimensions for estimating the servitisation success, adding to the call made by Rabetino *et al.,* (2018) and Kohtamäki *et al.,* (2019a, p. 233). Additionally, the statistical validation of the MdSeMM provides academia with 33 validated theories and associated indicators, as called for by Kowalkowski *et al.,* (2017a).

I believe these findings constitute an important basis for future research into servitisation, both related to the development and usage of the MdSeMM but in particular through the adaptation and further elaboration of the key elements of the nomological network and MdSeMM: the dimensions, the confirmed interrelationships, the validated indicators, the tested and quantified items, the four definitional types of servitisation and the assessment of servitisation success. I have strived to be objective but curious regarding the emerging knowledge while welcoming the experience and knowledge of my peers, which has resulted in five novel contributions to the literature. This is the first study to consolidate and conceptualise key dimensions of the servitisation transformation based on the entirety of existing literature; the first study to investigate dimensions in a multidimensional perspective to propose and confirm a nomological network of servitisation; the first study to deliberately investigate the definitions of servitisation success and what it means to be successful in a servitisation context; the first study to deliver specific propositions on composing indicators for measuring servitisation success; the first statistical investigation into maturity modelling in the context of servitisation that takes multidimensionality into account; and the first statistical validation of prior theoretical and conceptualised maturity indicators within servitisation.

6.1 Limitations and future avenues for research

Following the abductive learning cycle of going back and forth from conceptualisation to evidence-based testing, it is hardly surprising that new lessons from the final discussion shed new light on additional elements, which would have been important to include. The following chapter briefly presents the limitations of the dissertation together with proposed future explorations inspired by the findings and discussions, as well as a concluding note on potential directions of future research.

Limitations of the research

- The theoretical groundwork of the dimensions was based on a systematic literature review, which was first presented at the CINet conference 2020. These dimensions were further presented and discussed with highly cited servitisation scholars, who agreed on their existence and the covering of existing servitisation knowledge. However, encapsulating a phenomenon as complex as servitisation within six main areas will inevitably result in broad concepts. The broadness of these dimensions leads to a great variety of indicators to approximate these concepts, which makes it difficult to capture the full meaning without numerous indicators. This raises two fundamental questions regarding the MdSeMM. Firstly, as the variety of indicators results in approximating the construct with a certain broadness, these indicators might as well be formatted in a formative manner (as opposed to a reflective manner). Secondly, due to the complexity of each dimension, it might have been better to approximate these through lower-level constructs of each dimension, so that certain areas of each dimension (e.g. based on the components) were designed to approximate the main dimension. This would have provided better interpretations of the results, as it would allow for more nuanced approximations while also increasing the number of necessary items, which again would have reduced the completion rate of the questionnaire. Looking back on the past 3 years, and in particular on the data collection for Publication 3, an increased number of items would have been devastating for the outcome and possibility for accomplishing this study. Therefore, although the broadness of the dimensions might not be optimal, this is a much-needed, highly relevant basis for academia.
- The endogenous variable of servitisation success is approximated using validated success criteria of servitisation. However, Publication 2 argues that the definitional understanding of servitisation influences how practitioners interpret ‘being successful’. Following the definitional discussion of servitisation, differing conceptual understandings of servitisation might result in differing sets of success criteria, whereby the outcome of servitisation (to be successful) should be assessed on the definitional understanding of servitisation. Accordingly, it would contribute positively to the managerial implications if the MdSeMM focused on identifying the optimal maturity pattern for each definitional type (i.e. managerial perception of servitisation). However, this test of grouping the observations according to definitional understanding would require the splitting of the dataset into these definitional types, which requires a larger sample size than is currently available. As highlighted above, the completion rate of the survey combined with respondent comments indicate that the questionnaire ideally should have included fewer items to increase the response rate. By doing so, however, the model would lose further nuance, which emphasises the balance of obtaining a satisfying completion rate and sustaining a nuanced approximation of the concept. Furthermore, this research did not incorporate the definitional types of servitisation, since doing so is believed to have had consequences for the data collection. This is due to the fact that the further segregation of the population (Danish industrial SMEs) would have complicated the data collection process and

increased the time required to identify potential respondents. The assessment at the time was therefore that such segregation should be carried out in future research with particular focus on a single group.

- In continuation of the conceptualisation of the six dimensions, this study has strived to exhaustively approximate the dimensions by including the most important areas within servitisation. In hindsight, however, important elements might have been excluded that otherwise could have shed important light on the transformation; for digital integration, for example, with an additional focus on how digitalised the manufacturing solutions were in terms of coping with their ability to utilise the digital possibilities. Another example is the abilities and competences of managers as part of the organisational governance, as Benedettini *et al.,* (2015) finds this to be a risk for companies possibly leading to a failed transition. Additionally, the strategic orientation of servitisation incorporated the extent to which manufacturing solutions were service-oriented (sm1); it might have been better to incorporate it as a separate item or lower-order construct focused on the strategic orientation of managers, employees and/or which orientation the solutions and strategies obtained.
- From a managerial perspective, the applicability of the MdSeMM presents a number of barriers and/or limitations that must be addressed to ensure a workable and convenient process to be able to develop a tool to help managers to overcome these barriers. These barriers stem from the computation of manufacturer maturity levels, which requires a basic set of mathematical skills and the identification of how to improve each indicator when the focus has been allocated. The solution could include an online tool that can ease the computation of the maturity scores and plotting these scores into the figures. This has partly been accomplished through the development of an automated Excel spreadsheet, but a more intuitive solution might be beneficial. The solution also includes developing five or six suggestions for each indicator to help managers to identify how they can improve the particular operator. This could be a focus for future exploration of the model.
- Prior importance-performance map analysis (IPMA) has been suggested by Ringle and Sarstedt (2016) and elaborated in the acknowledge SEM book by Hair *et al.,* (2017c), which identifies which constructs practitioners should focus on when improving their overall performance. These established techniques would provide the MdSeMM with substantiated analysis, as these have previously been academia-tested, which our developed equations have not. However, the IPMA requires that practitioners rescale their observed values, which are believed to complicate the treatment of the data and, hence, requires additional mathematical skills. Further, the purpose with maturity modelling is to provide practitioners with a tool for own assessment, which demands that it be applicable without the need for external support. On that background, I believe that the newly developed approach is more applicable for practitioners due to its simplicity. Further, the IPMA does not compute the overall maturity level based on relations, but solely focusing on the performance of each construct, thereby leaving the relational effects of the inner model out of the equation of the endogenous variable (servitisation success).

Future research avenues

Due to the findings of this dissertation, a new foundation of knowledge is constituted upon which future research can build further, while addressing some of the limitations of the work. In line with the discussion and conclusion, the call for future research is moulded around the key findings presented in this dissertation. Additionally, specific future avenues have been suggested and promoted for academia as priorities to develop these results even further.

The confirmed nomological network provide academia with an overview of servitisation transformation as a concept, and it is a useful tool in terms of consolidating the existing knowledge and steering future research to fill the identified gaps. The main stream of research stemming from this study is steered by this network, and the servitisation field should adapt the findings of this model to design new research to develop and elaborate the elements within the network. For instance, more knowledge about the dimensions is necessary to extend the network with new constructs (e.g. lower-order constructs to enable a true hierarchical structure); more knowledge of what drives the interrelationships among the dimensions is needed to establish a better understanding of the influential elements; and more knowledge is needed about the associated constructs. A particular focus is recommended for two research areas:

- Reflections on the negative influence exerted by value function led to new perspectives and discussions from a customer perspective (Section 6 in Publication 3). Further along these lines, more insight is needed into what true value is for the customers in a servitisation context, when true value rises, and how this value is captured to further elaborate value function. The more exploratory nature of the research presented in this dissertation has had a particular focus on exploring potential solutions to the research question rather than elaborating the details of such solutions, such as exploiting the knowledge of value function to improve the dimension. Therefore, in general, I suggest additional explanatory research to exploit and deepen our understanding of specific elements of MdSeMM and servitisation success, including value function or success indicators for process-focused perceptions.
- With the MdSeMM as baseline, future investigation could try to expand each construct individually by developing lower-order constructs based on the components identified in this study. Doing so could potentially develop our understanding of how each dimension is composed of its underlying indicators and extend the nomological network even further. Investigating one single construct at a time might render it more feasible to collect usable, completed data.

Future research must strengthen the treatment of servitisation success in terms of definitional clarity and quantifying the extent to which it is achieved. This would establish a more rigorous conceptual terminology while also clarifying the meaning within the servitisation field. Despite our findings in Publication 2 regarding how the quantification of servitisation success is difficult to obtain, as it is both subjectively defined and measured, some studies have tried to quantify the achievement of servitisation. However, to establish a better understanding of when and how to become successful, more research is needed. The literature reviews made obvious how the servitisation field has been limited by the lack of clear definitions (e.g. Kohtamäki *et al.,* (2019a)), which highlights this as an important future stream of research. In continuation, a profound focus on the four definitional types of servitisation and how these four types influence the success is believed to be crucial for the future research. This, as the four types potentially could cope with the problematic ambiguity of the concept and integrate a new terminology for the researcher's differing viewpoints on the concept, which currently exist. A particular focus is recommended for two research areas:

- The findings of Publication 2 emphasised how no indicators have previously been determined for the process-focused definition of servitisation before an approximation of servitisation success based on the definitional types is feasible. More knowledge of the process-focused perception is therefore needed to identify potential indicators.
- While the definitional types of servitisation are theorised to influence the managers' preferred success indicators and to identify suitable indicators for success, more research into the real meaning of these definitional differences is needed to establish whether they do in fact have an impact on the measurement of success; and, if so, how strong this influence is. This is to be achieved through more exploratory qualitative investigations.

The future research of servitisation maturity modelling should incorporate the multidimensionality of the concept, which has been emphasised numerous times in the literature (e.g. Kindström and Kowalkowski (2014)). While I encourage scholars to extend and -test the MdSeMM in future research to develop its precision (by adding and adjusting indicators or develop new constructs) and validate the model findings, a more realistic proposition is to strongly encourage scholars to adopt the confirmed nomological network of servitisation transformation in their development of new maturity models. Previous maturity models have been assessed upon a standard mean interpretation, which cannot take the interrelationships into account. This prevents them from being able to measure multidimensionality. However, I do appreciate the prior ease of the use of SeMM due to the simplistic computations of the maturity levels, which increases the dissemination of their application. From a practical perspective, more research is needed to address the balance of embracing the complex theoretical aspects of servitisation through several coexisting dimensions, while maintaining an applicable and simplistic SeMM; or, put differently, how the servitisation field disseminates the complexity of servitisation to practitioners without misinterpretations. This would help to prevent the failed transformations of manufacturers. A particular focus is recommended for three research areas:

- Incorporation of a moderating effect would shed light on how different groups perform and how these groups achieve success through servitisation. In particular, an investigation into the moderating effect on basic service offerings and advanced service offerings would be interesting and in line with recent research (Sousa & da Silveira, 2017).
- To enhance the implications of the configured estimation of servitisation success, more financial knowledge is relevant to establish the estimated cost of increasing the level of the indicators. Through a better interpretation of how much effort is needed to practically increase the level of a single indicator with respect to the associated cost, it will be possible to assess the most cost-efficient operators, thereby increasing the applicability and managerial understanding of the outputs.
- Finally, to validate the applicability of the MdSeMM, a case study is appropriate for testing and evaluating the usability and applicability of the findings for a Danish SME. This, both in terms of establishing whether this is indeed true value (in the eyes of pragmatism) and to improve the dissemination of the model through practical cases. Insights from SMEs could be valuable for shedding light on additional parameters (like financial knowledge), which would improve the managerial usability of the MdSeMM.

Appendix

Appendix I – Co-author statement, Publication 2

AARHUS BSS SCHOOL OF BUSINESS AND SOCIAL SCIENCES
AARHUS UNIVERSITY

Declaration of co-authorship*

Full name of the PhD student: Michael Engkær Engsig Madsen

This declaration concerns the following article/manuscript:

Title:	The Untold Story of the Inherent Tensions in the Assessment of Servitization Success – a Conceptual Approach
Authors:	Madsen, Michael E. E. and Goduscheit, René C.

The article/manuscript is: Published ☒ Accepted ☐ Submitted ☐ In preparation ☐

If published, state full reference:

If accepted or submitted, state journal: International Journal of Technology Management

Has the article/manuscript previously been used in other PhD or doctoral dissertations?

No ☒ Yes ☐ If yes, give details:

The PhD student has contributed to the elements of this article/manuscript as follows:

A. Has essentially done all the work
B. Major contribution
C. Equal contribution
D. Minor contribution
E. Not relevant

Element	Extent (A-E)
1. Formulation/identification of the scientific problem	A
2. Planning of the experiments/methodology design and development	B
3. Involvement in the experimental work/clinical studies/data collection	A
4. Interpretation of the results	C
5. Writing of the first draft of the manuscript	A
6. Finalization of the manuscript and submission	B

Signatures of the co-authors

Date	Name	Signature
25/1 2023	René Goduscheit	

In case of further co-authors please attach appendix

Date: 16/01/2023

Michael Madsen

Signature of the PhD student

*As per policy the co-author statement will be published with the dissertation.

Appendix II – Co-author statement, Publication 3

AARHUS BSS SCHOOL OF BUSINESS AND SOCIAL SCIENCES
AARHUS UNIVERSITY

Declaration of co-authorship*

Full name of the PhD student: Michael Engkær Engsig Madsen

This declaration concerns the following article/manuscript:

Title:	Developing a Substantiate Servitization Maturity Model in a Multidimensional Reality – A Statistical Investigation of the Key Dimensions.
Authors:	Madsen, Michael E. E; Martinez-Hernandez, Veronica; Goduscheit, René, C.; Bigdeli, Ali, Z.; Kapoor, Kawal; Olesen, John V.

The article/manuscript is: Published ☐ Accepted ☐ Submitted ☒ In preparation ☐

If published, state full reference:

If accepted or submitted, state journal: International Journal of Operation and Production Management

Has the article/manuscript previously been used in other PhD or doctoral dissertations?

No ☒ Yes ☐ If yes, give details:

The PhD student has contributed to the elements of this article/manuscript as follows:

A. Has essentially done all the work
B. Major contribution
C. Equal contribution
D. Minor contribution
E. Not relevant

Element	Extent (A-E)
1. Formulation/identification of the scientific problem	B
2. Planning of the experiments/methodology design and development	B
3. Involvement in the experimental work/clinical studies/data collection	A
4. Interpretation of the results	C
5. Writing of the first draft of the manuscript	B
6. Finalization of the manuscript and submission	B

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Date: 16/01/2023

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*As per policy the co-author statement will be published with the dissertation.

Appendix III – Co-author statement, Publication a

AARHUS BSS SCHOOL OF BUSINESS AND SOCIAL SCIENCES
AARHUS UNIVERSITY

Declaration of co-authorship*

Full name of the PhD student: Michael Engkær Engsig Madsen

This declaration concerns the following article/manuscript:

Title:	Key dimensions of Assessing Servitization Towards a Conceptual Maturity Model
Authors:	Andersen, Troels, A.; Madsen, Michael E. E.; Goduscheit, René, C.

The article/manuscript is: Published ☒ Accepted ☐ Submitted ☐ In preparation ☐

If published, state full reference: Andersen, T. A., Madsen M.E. E. & Goduscheit R. C. 2020. Key dimensions of Assessing Servitization Towards a Conceptual Maturity Model. 25th CINet Conference 2020

If accepted or submitted, state journal:

Has the article/manuscript previously been used in other PhD or doctoral dissertations?

No ☒ Yes ☐ If yes, give details:

The PhD student has contributed to the elements of this article/manuscript as follows:

A. Has essentially done all the work
B. Major contribution
C. Equal contribution
D. Minor contribution
E. Not relevant

Element	Extent (A-E)
1. Formulation/identification of the scientific problem	B
2. Planning of the experiments/methodology design and development	C
3. Involvement in the experimental work/clinical studies/data collection	A
4. Interpretation of the results	B
5. Writing of the first draft of the manuscript	C
6. Finalization of the manuscript and submission	C

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Date: 16/01/2023

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*As per policy the co-author statement will be published with the dissertation.

Appendix IV – Co-author statement, Publication b

AARHUS BSS SCHOOL OF BUSINESS AND SOCIAL SCIENCES
AARHUS UNIVERSITY

Declaration of co-authorship*

Full name of the PhD student: Michael Engkær Engsig Madsen

This declaration concerns the following article/manuscript:

Title:	Tensions in the Assessment of Servitization Success - A Conceptual Approach
Authors:	Madsen, Michael, E. E.; Goduscheit, René, C.

The article/manuscript is: Published ☒ Accepted ☐ Submitted ☐ In preparation ☐

If published, state full reference: Madsen M. E. E. & Goduscheit R. C. 2021. Tensions in the Assessment of Servitization Success - A Conceptual Approach. 26st CINet Conference 2021

If accepted or submitted, state journal:

Has the article/manuscript previously been used in other PhD or doctoral dissertations?

No ☒ Yes ☐ If yes, give details:

The PhD student has contributed to the elements of this article/manuscript as follows:

A. Has essentially done all the work
B. Major contribution
C. Equal contribution
D. Minor contribution
E. Not relevant

Element	Extent (A-E)
1. Formulation/identification of the scientific problem	A
2. Planning of the experiments/methodology design and development	B
3. Involvement in the experimental work/clinical studies/data collection	A
4. Interpretation of the results	B
5. Writing of the first draft of the manuscript	A
6. Finalization of the manuscript and submission	A

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In case of further co-authors please attach appendix

Date: 16/01/2023

Michael Madsen

Signature of the PhD student

*As per policy the co-author statement will be published with the dissertation.

Appendix V – Stratification for Publication 3

	Industry distribution		Stratification					
NACE industry codes	**Size of Industry[1]**	**Industri proportion (Strafi)**	**Number of usable answers upon industry**	**Contacted firms upon industry (email)**	**Contacted firms upon industry (Phone)**	**Full proportion of contacted firms**	**Stratification of sample**	**Proportional difference**
C10 - Manufacture of food products	1000	**11,4%**	10	340	67	8,9%	**6,3%**	**-5,15%**
C11 - Manufacture of beverages	138	**1,6%**	1	81	25	2,3%	**0,6%**	-0,95%
C12 - Manufacture of tobacco products	4	**0,0%**	1	2	1	0,1%	**0,6%**	0,58%
C13 - Manufacture of textiles	216	**2,5%**	5	87	23	2,4%	**3,1%**	0,67%
C14 - Manufacture of wearing apparel	224	**2,6%**	3	73	14	1,9%	**1,9%**	-0,68%
C15 - Manufacture of leather and related products	40	**0,5%**	0	22	5	0,6%	**0,0%**	-0,46%
C16 - Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	314	**3,6%**	4	108	34	3,1%	**2,5%**	-1,08%
C17 - Manufacture of paper and paper products	89	**1,0%**	1	34	10	1,0%	**0,6%**	-0,39%
C18 - Printing and reproduction of recorded media	386	**4,4%**	0	169	49	4,8%	**0,0%**	**-4,42%**
C19 - Manufacture of coke and refined petroleum products	5	**0,1%**	0	3	1	0,1%	**0,0%**	-0,06%
C20 - Manufacture of chemicals and chemical products	202	**2,3%**	1	107	25	2,9%	**0,6%**	**-1,68%**
C21 - Manufacture of basic pharmaceutical products and pharmaceutical preparations	69	**0,8%**	1	22	9	0,7%	**0,6%**	-0,16%
C22 - Manufacture of rubber and plastic products	379	**4,3%**	4	153	34	4,1%	**2,5%**	**-1,82%**
C23 - Manufacture of other non-metallic mineral products	311	**3,6%**	2	104	26	2,8%	**1,3%**	**-2,30%**
C24 - Manufacture of basic metals	102	**1,2%**	4	38	11	1,1%	**2,5%**	1,35%
C25 - Manufacture of fabricated metal products, except machinery and equipment	1879	**21,5%**	19	743	245	21,6%	**11,9%**	**-9,55%**
C26 - Manufacture of computer, electronic and optical products	421	**4,8%**	8	194	67	5,7%	**5,0%**	0,22%
C27 - Manufacture of electrical equipment	339	**3,9%**	9	172	54	4,9%	**5,7%**	**1,78%**
C28 - Manufacture of machinery and equipment n.e.c.	1286	**14,7%**	60	496	170	14,6%	**37,7%**	**23,02%**
C29 - Manufacture of motor vehicles, trailers and semi-trailers	116	**1,3%**	1	33	7	0,9%	**0,6%**	-0,70%
C30 - Manufacture of other transport equipment	106	**1,2%**	2	42	15	1,2%	**1,3%**	0,05%
C31 - Manufacture of furniture	387	**4,4%**	5	164	55	4,8%	**3,1%**	-1,28%
C32 - Other manufacturing	728	**8,3%**	18	334	108	9,7%	**11,3%**	**2,99%**
Observation with unregistrered industry code + servitize.dk	-	**-**	-	544	-	-	**-**	-
Full count of companies =	**8741**	**100%**	**159**	**4065**	**1055**	**100%**	**100%**	**0%**

1 Only counting companies that are activ and SMEs

Appendix VI – Screenshots of the MdSeMM tool in Excel worksheet

Questionnaire for the MdSeMM analysis

Questions — Put an X at the choose best fitting answer

Servitization success (1 strongly disagree – 7 strongly agree)

		Strongly disagree	Disagree	Somewhat disagree	Nor agree or disagree	Somewhat agree	Agree	Strongly agree
ss1:	Our organization has increased its profitability significantly over the past 5 years, compared to the industry						x	
ss2:	Our services have increased their profitability significantly over the past 5 years, compared to the industry						x	
ss3:	Our organization has increased its revenue significantly over the past 5 years, compared to the industry				x			
ss4:	Our services have increased their revenue significantly over the past 5 years, compared to the industry			x				
ss5:	Our services possess a significant competitive advantage over our nearest competitors			x				
ss6:	Our customers are very satisfied with our services and more so than with the services of our nearest competitors		x					
ss7:	Our services have added significant customer value over the past 5 years, compared to the industry			x				
ss8:	Our customer loyalty has increased significantly over the past 5 years, compared to the industry		x					
ss9:	The recognition of our brand has increased significantly over the past 5 years, compared to our nearest competitors				x			
ss10:	Our organization is able to maintain long-lasting partnerships			x				
ss11:	Our organization's market share has increased significantly over the past 5 years				x			
ss12:	Our services have contributed to the largest part of the total profit over the past 5 years			x				
ss13:	Our organization's ability to create new service innovations has been highly successful over the past 5 years, compared to the industry					x		
ss14:	Our organization has been able to increasingly achieve its own objectives over the past 5 years				x			
ss15:	The current state of our most provided service offerings is... [no-optimized services]			x				

Strategic management (1 strongly disagree – 7 strongly agree)

		Strongly disagree	Disagree	Somewhat disagree	Nor agree or disagree	Somewhat agree	Agree	Strongly agree
sm1:	Our organization's strategic development has mainly been led by a... [goods-centric - business-oriented]				x			
sm2:	Our organization pays close attention to service implementation				x			
sm3:	Our organization recognizes services as a lasting differentiation strategy				x			
sm4:	Our management sees services as a way to compensate for fluctuating product sales				x			
sm5:	Our management coaches employees to behave in a service-oriented way and sets rewards for service-oriented employee behaviour				x			
sm6:	Our management empowers employees to respond to a broad range of customer problems				x			
sm7:	Our management supports employees in solving customer problems				x			
sm8:	Our management aims to exploit the financial potential of services				x			
sm9:	Our organization is able to formulate clear service-related strategies and objectives				x			
sm10	Our management considers the service potential to be highly profitable				x			

Digital integration (1 strongly disagree – 7 strongly agree)

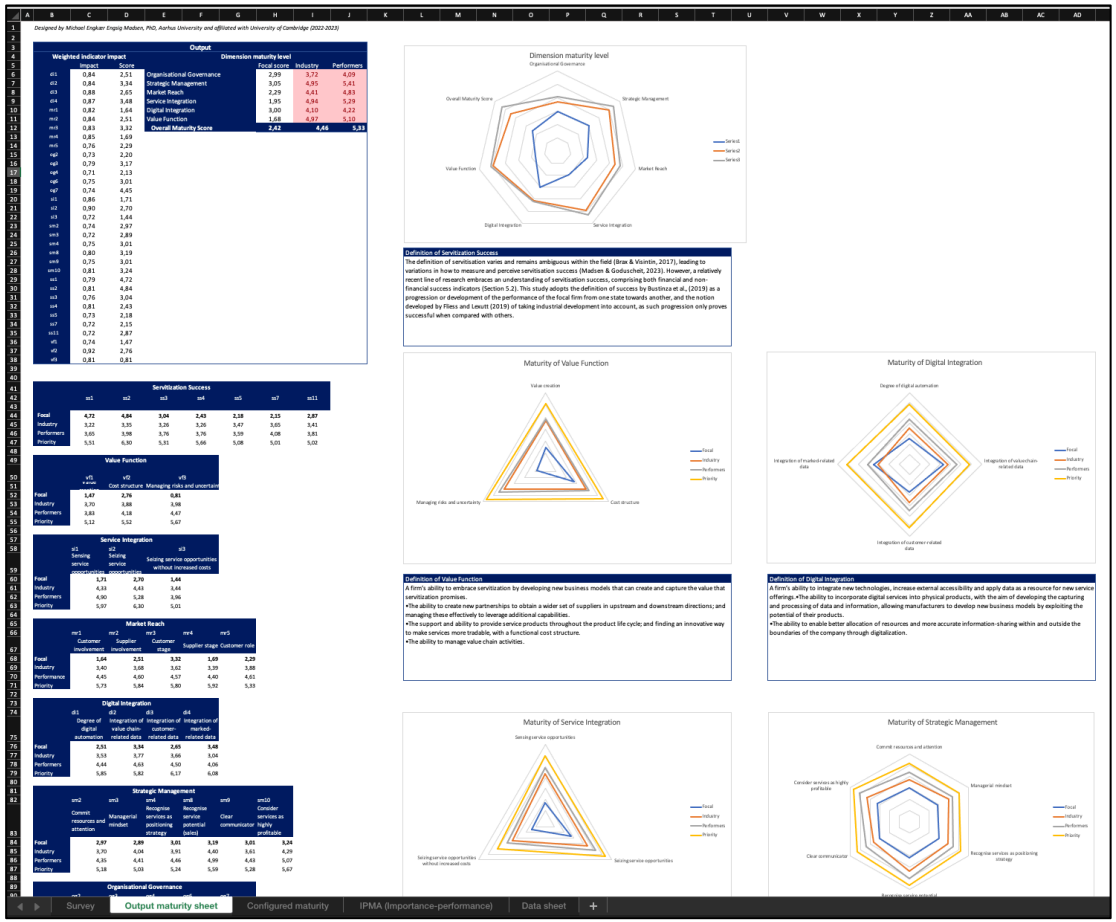
		Strongly disagree	Disagree	Somewhat disagree	Nor agree or disagree	Somewhat agree	Agree	Strongly agree
di1:	Our applied technologies allow fully automated and optimized real-time data			x				
di2:	[Our IT systems] give us integrated access to value-chain-related data (e.g. order status, handling requirements)				x			
di3:	... give us integrated access to customer-related data (e.g. service contracts, feedback)			x				
di4:	... give us integrated access to market-related data (e.g. promotion details, future forecasts)				x			

Organizational governance (1 strongly disagree – 7 strongly agree)

		Strongly disagree	Disagree	Somewhat disagree	Nor agree or disagree	Somewhat agree	Agree	Strongly agree
og1:	[Our organization] is currently following service-specific policies, that are... [non-optimized]		x					
og2:	The allocation of monetary resources to the development of service-oriented skills, tools and/or methods is... [non-optimized]			x				
og3:	[Our organization] has ensured a formal, optimized process for the service delivery that is... [no-optimized services]				x			
og4:	... is currently following organizational roles, that are... [no-optimized roles]			x				
og5:	... encourages its employees to prioritize process development over product development					x		
og6:	... is able to turn service activities into a professional business				x			
og7:	... is able to turn service activities into a profitable business						x	
og8:	... encourages employees to make decisions on their own				x			
og9:	... has procedures and routines to minimize costs related to new service activities			x				
og10:	... can overcome internal resistance and conflicts				x			

Survey | Output maturity sheet | Configured maturity | IPMA (Importance-performance) | Data sheet

Screenshot of the survey tab in the MdSeMM worksheets
The managers provide their answers in the first tab by choosing the best suited answer for their current situation. The tab includes a small introduction to the survey.



Designed by Michael Engkær Ingiorgi Madsen, PhD, Aarhus University and affiliated with University of Cambridge (2022-2023)

Output

Weighted indicator impact	Impact	Score
di1	0,84	2,51
di2	0,84	3,34
di3	0,88	2,65
di4	0,87	3,48
mr1	0,82	1,64
mr2	0,84	2,51
mr3	0,83	3,32
mr4	0,85	1,69
mr5	0,76	2,29
og2	0,73	2,20
og3	0,79	3,17
og4	0,71	2,13
og6	0,75	3,01
og7	0,74	4,45
si1	0,86	1,71
si2	0,90	2,70
si3	0,72	1,44
sm2	0,74	2,97
sm3	0,72	2,89
sm4	0,75	3,01
sm8	0,80	3,19
sm9	0,75	3,01
sm10	0,81	3,24
ss1	0,79	4,72
ss2	0,81	4,84
ss3	0,76	3,04
ss4	0,81	2,43
ss5	0,73	2,18
ss7	0,72	2,15
ss11	0,72	2,87
vf1	0,74	1,47
vf2	0,92	2,76
vf3	0,81	0,81

Dimension maturity level	Focal score	Industry	Performers
Organisational Governance	2,39	3,72	4,09
Strategic Management	3,05	4,95	5,41
Market Reach	2,29	4,41	4,83
Service Integration	1,95	4,94	5,29
Digital Integration	3,00	4,10	4,22
Value Function	1,68	4,97	5,10
Overall Maturity Score	2,42	4,46	5,33

Servitization Success

	ss1	ss2	ss3	ss4	ss5	ss7	ss11
Focal	4,72	4,84	3,04	2,43	2,18	2,15	2,87
Industry	3,22	3,35	3,26	3,26	3,47	3,65	3,41
Performers	3,65	3,98	3,76	3,76	3,59	4,08	3,81
Priority	5,51	6,30	5,31	5,66	5,08	5,01	5,02

Value Function

	vf1 Value creation	vf2 Cost structure	vf3 Managing risks and uncertainty
Focal	1,47	2,76	0,81
Industry	3,70	3,88	3,98
Performers	3,83	4,18	4,47
Priority	5,12	5,52	5,67

Service Integration

	si1 Sensing service opportunities	si2 Sensing service opportunities without increased costs	si3 Seizing service opportunities without increased costs
Focal	1,71	2,70	1,44
Industry	4,33	4,43	3,44
Performers	4,90	5,28	3,96
Priority	5,97	6,30	5,01

Market Reach

	mr1 Customer involvement	mr2 Supplier involvement	mr3 Customer stage	mr4 Supplier stage	mr5 Customer role
Focal	1,64	2,51	3,32	1,69	2,29
Industry	3,40	3,68	3,62	3,39	3,86
Performance	4,45	4,60	4,57	4,40	4,61
Priority	5,73	5,84	5,80	5,92	5,33

Digital Integration

	di1 Degree of digital automation	di2 Integration of value chain-related data	di3 Integration of customer-related data	di4 Integration of market-related data
Focal	2,51	3,34	2,65	3,48
Industry	3,53	3,77	3,66	3,04
Performers	4,44	4,63	4,50	4,06
Priority	5,85	5,82	6,17	6,08

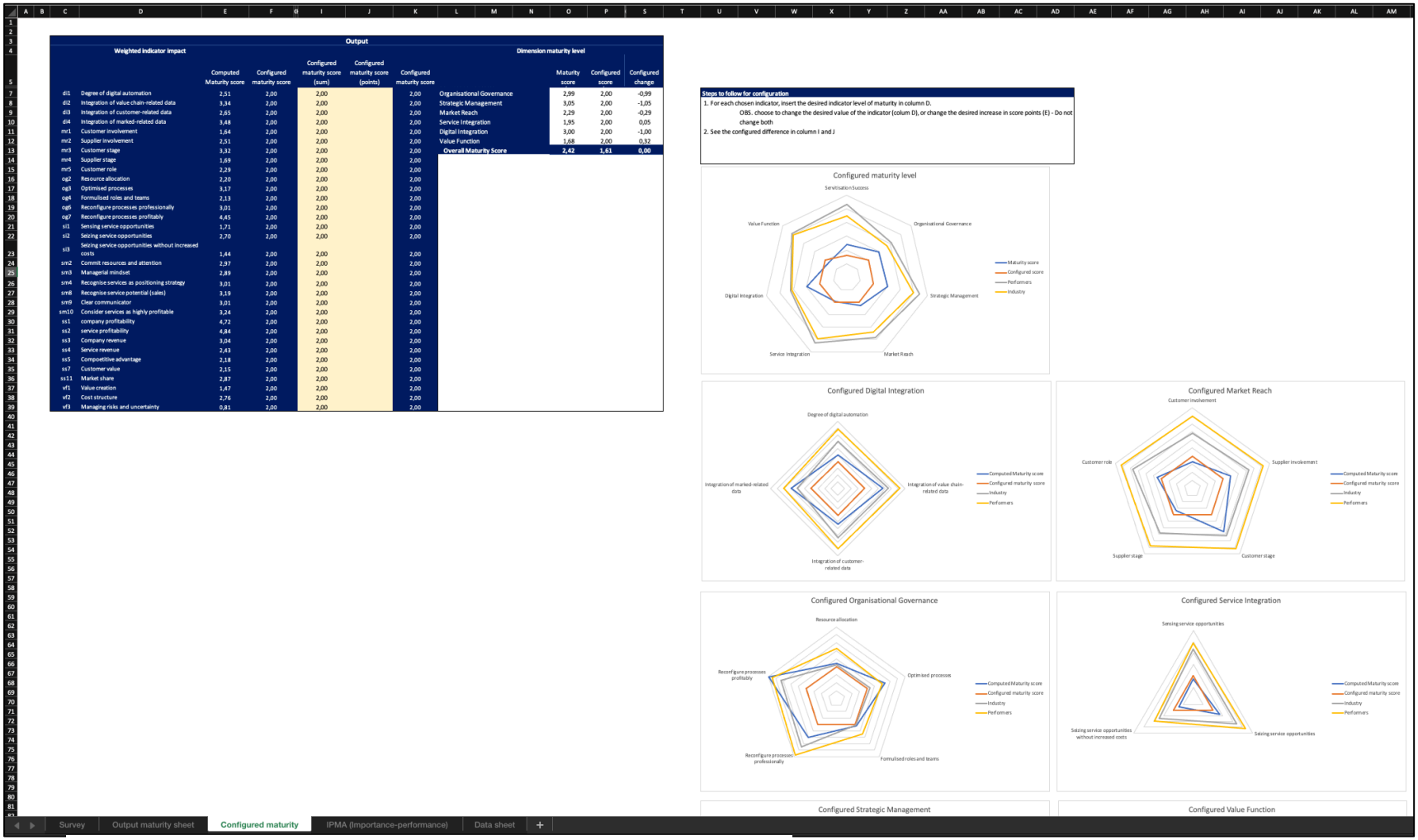
Strategic Management

	sm2 Commit resources and attention	sm3 Managerial mindset	sm4 Recognise services as positioning strategy	sm8 Recognise service potential [sales]	sm9 Clear communicator	sm10 Consider services as highly profitable
Focal	2,97	2,89	3,01	3,19	3,01	3,24
Industry	3,70	4,04	3,91	4,40	3,61	4,29
Performers	4,35	4,41	4,46	4,99	4,43	5,07
Priority	5,18	5,03	5,24	5,59	5,28	5,67

Organizational Governance

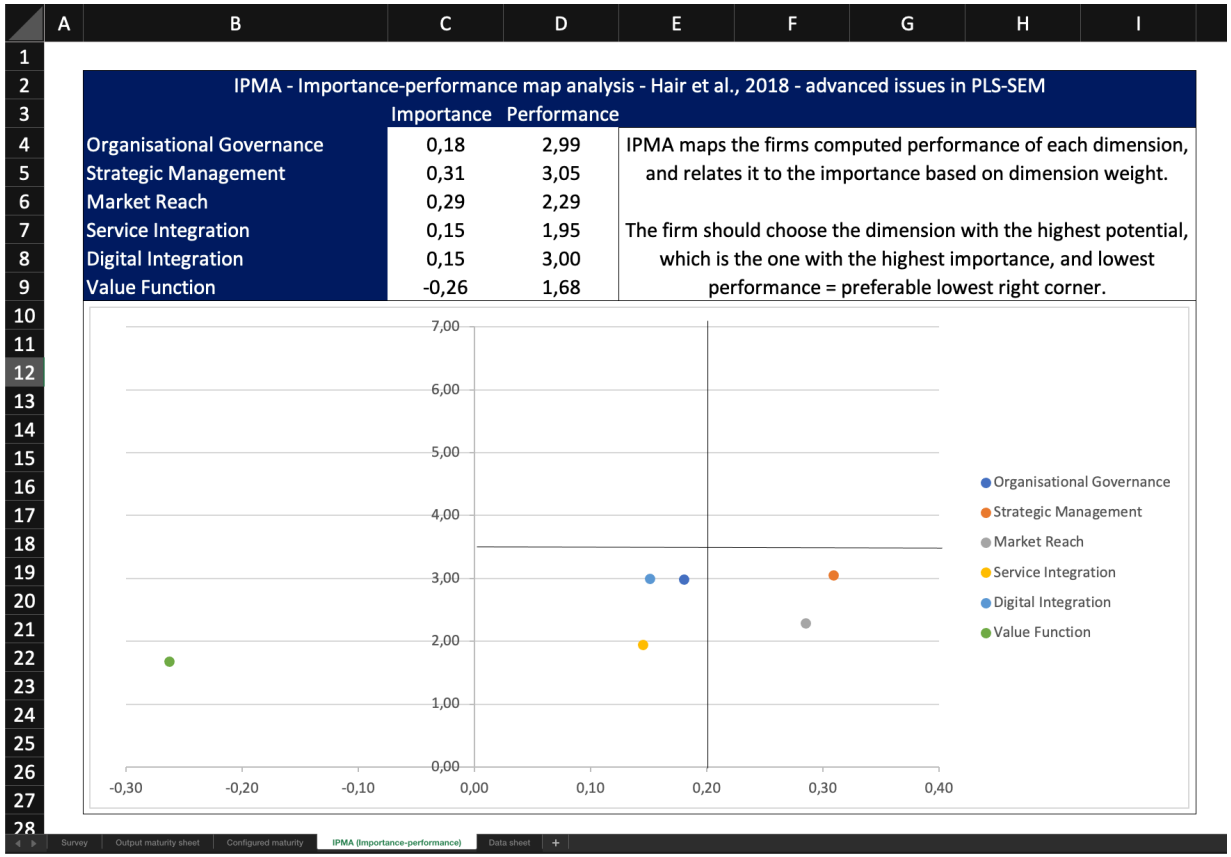
Survey | Output maturity sheet | Configured maturity | IPMA (Importance-performance) | Data sheet

Screenshot of the computed maturity sheet
Provide the manager with a present overview of their maturity upon each of the six dimensions in comparison with the industry, and the top performers within the dataset.



Screenshot of the configured maturity sheet

The configuration sheet which allows managers to configure their scores to establish and evaluate the potential impact on their predicted success. In each figure are the computed maturity (blue line) and the configured maturity (orange line) presented to provide an easier interpretation of the difference.



Screenshot of the Importance-Performance Map Analysis (IPMA)

Although the IPMA are not included within the papers, this tool has been added to the excel sheet to provide an additional way to assess which dimension need the management' attention. This, with the lower right corner as the preferred focus areas as these have high unfulfilled potential, and the higher left corner as these are less important.

The performance has not been indexed as suggested by Ringle and Sarstedt (2016), but are following the maturity of each dimension to ease the usage of the tool.

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