



Synthesizing three decades of digital servitization: a systematic literature review and conceptual framework proposal

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Received: 28 September 2023 / Accepted: 16 April 2024 / Published online: 8 May 2024
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Abstract

This study, through a systematic literature review spanning 1990 to 2023, interrogates how servitization, and nowadays digital servitization, enhances manufacturing competitiveness. It introduces the DASOBI (Drivers, Actors, Strategies, Obstacles, Benefits, and Impact) framework for navigating the digital servitization transition, emphasizing strategic adaptability and technological alignment. Analysis of 157 articles reveals a significant increase in research, highlighting digital servitization's role in competitive enhancement and customer engagement. The DASOBI framework offers manufacturers a novel approach for managing this transition, marking a unique contribution by distilling extensive literature into actionable insights for both theory and practice in the evolving field of digital servitization.

Keywords Digital servitization · Industry 4.0 · Product-service system · Systematic literature review · Strategy · Business competitiveness

1 Introduction

1.1 Context, motivation, and research topic

In today's dynamic manufacturing sector, companies are increasingly acknowledging the importance of complementing their product offerings with value-added

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services. This strategic shift, known as servitization—and more specifically digital servitization—marks a fundamental turn in the contemporary business paradigm. This transformation involves not only a shift from a product-centric to a service-centric focus but also a deep integration of advanced digital technologies. While considerable research has been conducted on individual aspects of servitization, a comprehensive analysis that encompasses all essential facets of this phenomenon, from its motivations to its final outcomes, remains relatively unexplored. This research proposal aims to develop a holistic conceptual framework that synthesizes and extends existing knowledge, thereby providing a more complete and nuanced understanding of digital servitization. This exhaustive review examines this evolving business model, highlighting its key benefits and challenges, its intersection with digital technologies, and its theoretical and practical implications.

The foundational premise, supported by Bustinza et al. (2015), suggests that manufacturing companies can achieve higher returns by offering services in conjunction with their products, a claim echoed in seminal works by Davies et al. (2007), Johnstone et al. (2009), Martín-Peña et al. (2017), and Leoni and Aria (2021). These services, ranging from maintenance and support to more sophisticated and customized solutions, expand the revenue streams of these firms. In this context, the contributions of Baines et al. (2007) and Neely et al. (2011) are pivotal, as they underscore how transitioning to a service-oriented market is driving strategic transformations in manufacturing firms, emphasizing value creation and differentiation in increasingly competitive markets (Brady et al. 2005).

The current market dynamics almost make this shift imperative. As noted by Sandström et al. (2008) and Tukker (2015), companies that limit their offerings to products alone face formidable challenges in maintaining profitability, driving them toward business model innovation that incorporates services into their product portfolios, as discussed in the literature by Gebauer and Fleisch (2007), Visnjic and Van Looy (2013), and Díaz-Garrido et al. (2018).

Servitization requires effective coordination among multiple stakeholders. Alghisi and Sacconi (2015) address the critical importance of internal and external alignment, while Ayala et al. (2019) highlight the essential role of service providers in the successful adoption of servitization strategies. Moreover, Baines et al. (2011) and Lightfoot et al. (2013) explore how manufacturing firms can effectively integrate services into their product portfolio, emphasizing the importance of a strategically well-planned approach.

Beyond being a customer-facing strategy, the internal benefits are equally compelling. As delineated by Kamp and Alcalde (2014), servitization facilitates process optimization and extends the lifespan of machinery. These advantages are further enhanced with the incorporation of digital technologies, particularly in the era of Industry 4.0 (Kamp and Perry 2017). This digital servitization, explored in studies by Lee et al. (2014), Kans and Ingwald (2016), and Paiola and Gebauer (2020), offers an enhanced layer of value, encompassing innovative goods and services.

Researchers such as Favoretto et al. (2022) and Rabetino et al. (2023) have elucidated how technological advancements act as catalysts for developing differentiated products and services, thereby enhancing competitiveness (Müller et al. 2021). This leads to the formulation of hybrid business models, termed Product-Service Systems

(PSS), which are economically, socially, and environmentally sustainable. This PSS model provides a more holistic solution, meeting specific customer needs beyond just providing functional products (Barquet et al. 2013).

In this process, a demand for specific organizational and technological capabilities is identified. Coreynen et al. (2017) and Schroeder et al. (2022) have pinpointed the importance of organizational structure and technological capabilities, particularly in the context of digitalization, as key factors for a successful transition to digital servitization (Parida et al. 2014; Kanninen et al. 2017).

Implementing servitization, as highlighted by Mathieu (2001) and Yu and Sung (2023), is not without its challenges, ranging from internal organizational resistance to external factors, such as customer reluctance. Brax (2005) and Benedettini et al. (2015) provide a comprehensive analysis of these risks, emphasizing the importance of effective management to navigate potential obstacles in achieving successful servitization (Windahl and Lakemond 2006; Pessôa and Becker 2017). The process demands a well-structured and strategically informed approach, incorporating both business and customer perspectives. Proper implementation of servitization can lead to substantial benefits, as demonstrated by Baines et al. (2009b, 2017) and Wang et al. (2018), highlighting its potential for long-term value creation (Brady et al. 2005).

The phenomenon of servitization, particularly in its digital form, has emerged as a prominent area of study, characterized by its complexity and multidimensionality. Academic literature has thoroughly explored this concept, from underlying motivations to implementation strategies, examining both inherent challenges and potential benefits (Raddats et al. 2016; Rabetino et al. 2021).

1.2 Research gap

Despite the extensive body of knowledge on servitization amassed by previous studies, there remains a discernible gap characterized by fragmented examinations rather than a consolidated analytical approach. This study pinpoints a need for a unified framework that can effectively guide servitization strategies, addressing this lacuna as a pivotal area for forthcoming research (Calabrese et al. 2019; Kohtamäki et al. 2020a). The advent of the digital era has precipitated transformative shifts, underscoring the servitization concept—the transition from purely selling products to offering integrated product-service solutions. Nevertheless, the interaction between servitization and digital technologies, a realm referred to as digital servitization, remains a relatively uncharted territory. This area lacks a systematic and thorough review spanning the last three decades. This omission highlights the imperative need for an in-depth understanding of how servitization has evolved and the essential development of a framework to adeptly navigate the intricacies involved in implementing these strategies effectively.

1.3 Methodology proposed

To address the identified research gap, our study employs a comprehensive, multi-phased methodology structured as follows: Initially, we conduct an in-depth examination of the literature on servitization and digital servitization. This phase aims to

develop an integrative theoretical framework that captures the evolution of servitization over the past three decades, emphasizing the shift toward digital service delivery within the manufacturing sector. Subsequently, the study undertakes a systematic literature review to classify the existing body of work. This review specifically focuses on selecting pertinent studies that encompass both traditional and digital servitization, aiming to identify trends, patterns, and existing research gaps. Following the review, we perform a detailed analysis of the selected articles to explore how various aspects of servitization and digital servitization interact and influence each other. In the final phase, we synthesize the findings from the study to deepen the conceptual understanding of the servitization phenomenon, including its digital components. This synthesis will provide valuable insights into effectively managing the transition toward servitization and digital servitization, highlighting its practical applicability in a business context.

1.4 Expected contributions

The primary goal of this research is to construct an integrative framework that captures the evolution, current state, and future trajectory of servitization and digital servitization. This framework will delineate both the theoretical underpinnings and practical ramifications of servitization, illuminating the challenges and opportunities that have surfaced. Particularly, it will explore the transformative influence of Industry 4.0 technologies—such as the Internet of Things, Big Data analytics, and Artificial Intelligence—on traditional servitization models, steering them toward more advanced digital practices. This examination is crucial for understanding how digital technologies can enhance the competitiveness and value proposition of manufacturing firms engaged in servitization.

The overarching aim of this study is to deepen the comprehension of servitization by exploring its interplay with digitalization, thus broadening its theoretical and managerial relevance. The research intends to offer an integrated perspective that not only advances the academic discourse in this field but also aids manufacturing companies in adeptly navigating the complexities of servitization and digital servitization. Furthermore, this review will articulate a roadmap for manufacturers considering this transition, conceptually enriching a domain that, despite its increasing importance, remains underexplored in scholarly research. By highlighting the enduring interest in adopting servitization correctly and underscoring the necessity for a unified theoretical framework, this study responds to calls for theoretical consolidation and a more comprehensive research agenda (Pettigrew 1988; Pye and Pettigrew 2005).

In summary, our proposed study aims to provide a detailed analysis that integrates insights from various studies into a cohesive narrative, with a particular focus on the servitization and digital servitization processes within the manufacturing sector. This synthesis will significantly contribute to both academic knowledge and practical applications, emphasizing the complex and evolving nature of servitization in manufacturing, and marking a key conclusion of this thorough examination.

2 Research aims

This study is dedicated to a comprehensive analysis of the servitization phenomenon and its progression toward digital servitization within the manufacturing sector, meticulously examining the most significant research from the past 30 years. The aim is to understand the development and various applications of servitization, along with the challenges and obstacles it entails. The study seeks to identify the motivations driving companies toward servitization, examine the various actors involved in the process and their interplay, and explore the strategies necessary for successful implementation. Furthermore, the organizational and technological capabilities required for transitioning to servitization will be analyzed, as well as the associated risks and challenges, including both internal and external hurdles that companies must overcome to reap the potential benefits of servitization. This analysis is guided by key research in the field (Zhang and Banerji 2017; Khanra et al. 2021) offering a comprehensive perspective on this significant shift in business dynamics within the manufacturing sector.

Essentially, this study seeks to answer the main research question: *To what extent do servitization and digital servitization provide benefits that contribute to enhancing a company's competitiveness?* Alongside this primary question, the study intends to address the following aspects related to the development of servitization and digital servitization:

- *RQ1. Implementation of a digital servitization strategy.* How it should be affected by the company's business environment? How it should be the co-creation process in an international context? Which new knowledge and new skills need to be developed to be implemented correctly? Which benefits can be obtained by implementing the digital enablers of Industry 4.0? Which changes could it involve in the internal structure of the business? Which changes could it involve in the company's business environment (relations with suppliers or strategic partners)? How could it face the challenges and obstacles that arise during the transition process?
- *RQ2. Benefits of developing an effective digital servitization strategy.* How it provides greater value to the customer? How can product customization be optimized? How it encourages access to new markets? How it promotes gaining new customers? How it allows innovation in ideas or business models? How it allows the development of goods with novel services? How it effectively allows greater returns to be achieved? How it improves competitiveness?

The focus of this study is not only on analyzing servitization as a strategic shift for manufacturing companies but also on exploring how the integration of digital technologies can enrich and complicate this process. Additionally, the aim is to synthesize existing knowledge to provide a broader and more nuanced understanding of digital servitization, highlighting its key advantages, challenges, and intersection with digital technologies.

3 Methods

Four stages were established for this systematic literature review (Tranfield et al. 2003), one for each of the four phases outlined in the first section.

This collection focuses on four fields of research: business administration, marketing, operations management, and administration of services. The studies from the two main databases were examined: Web of Science and Scopus, as they are considered reference sources for the topic being analyzed. Once the information was screened, the most-cited studies were selected, which formed the basis for the present study.

3.1 Review process

In conducting a systematic literature review to gain a profound understanding of servitization and digital servitization within the manufacturing sector, our approach integrated multiple rigorous methodologies (Thomé et al. 2016). Initially, following the method proposed by Hertzberg and Rudner (1999), we conducted a meticulous keyword search in the Web of Science and Scopus databases, aiming to identify pertinent literature using terms like “servitization,” “digital servitization,” and their variants. This was instrumental in capturing the subject’s breadth and depth, allowing for the creation of search strings using the Boolean connector OR. The search strings were incorporated in titles, abstracts, and/or keywords, adhering to the time span of 1990 to 2023 in major databases, thus fulfilling the guidelines set by Tranfield et al. (2003) for inclusion criteria.

To further refine the search and ensure a robust database, we applied additional parameters and restrictions post-establishing the primary search strings for both databases. We limited our search to open access and hybrid gold journals, focusing on high-quality, readily available research outputs. Additionally, we set a citation threshold to include articles with significant field impact, thereby ensuring the inclusion of seminal works and recent influential studies. This strategy was pivotal in developing a comprehensive, relevant collection of literature, ensuring the inclusion of the most pertinent works in the field of digital servitization.

The approach was enhanced by strictly adhering to three key inclusion criteria: (a) considering publications from 1990 to 2023, to ensure a contemporary and comprehensive review, (b) prioritizing articles from prestigious academic journals within the relevant study areas, thus ensuring source quality and relevance, and (c) selecting articles focusing explicitly on key aspects of servitization and digital servitization. This approach, aligned with the study’s objectives and research questions, ensures a holistic and detailed understanding of the phenomenon, accurately reflecting the dynamics and transformations in the manufacturing sector.

The present study aimed to answer the research question and the various related questions. This was done via the PRISMA method (Preferred Reporting Items for Systemic Reviews and Meta-Analyses). The selection criteria produced 647 articles (from Web of Science) and 630 articles (from Scopus). Once identified, the abstracts

of each article were read to screen and select only those in line with the fourth study phase: to help properly understand the concept, how it is managed, and how it is applied. 157 articles were ultimately identified that met all of the inclusion criteria. Figure 1 outlines the PRISMA method used.

3.2 Descriptive analysis

Figure 2 offers an analytical synthesis of the publication trends within the realms of servitization and digital servitization over a span of more than three decades, utilizing data harvested from the Web of Science and Scopus databases. The blue bars across all three charts articulate the volume of literature pertaining to servitization, encompassing its theoretical underpinnings, industry applications, and cross-disciplinary studies. This scholarly corpus embodies the foundational and

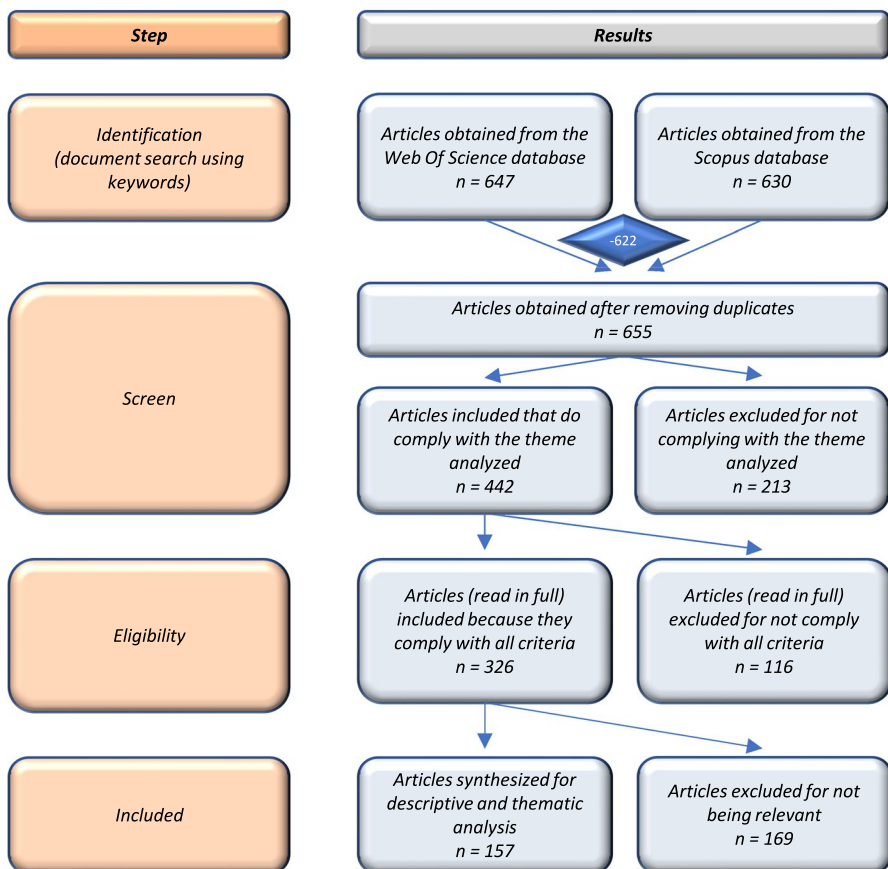


Fig. 1 Flow diagram, based on the PRISMA Method, for the selection of relevant documents for the systematic literature review. Source: Authors' own work from Web of Science and Scopus databases

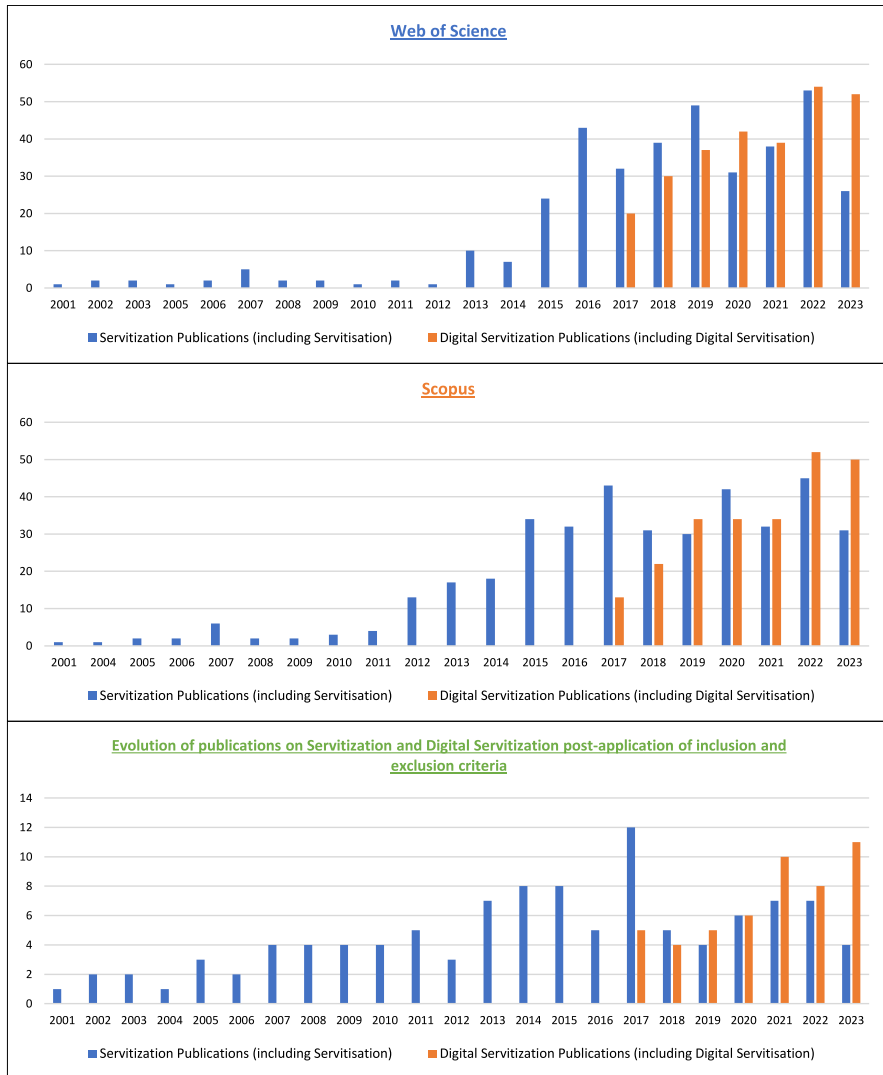


Fig. 2 Evolution of publications on Servitization and Digital Servitization (1990–2023). Source: Web of Science and Scopus databases and authors' own work

evolutionary aspects of servitization as a strategic paradigm shift in manufacturing and service industries.

In parallel, the orange bars specifically chart the trajectory of literature focused on digital servitization. This subset of research delves into the intricacies of embedding digital technologies within traditional servitization frameworks. It illuminates the burgeoning intersection of digital innovation and service strategies, reflecting a vibrant and rapidly advancing frontier of research.

The upward trend of both blue and orange bars in the separate charts for Web of Science and Scopus indicates a robust increase in scholarly output. This not only testifies to the growing academic and practical significance of servitization concepts but also their digital counterparts, which are pivotal in today's technology-driven marketplaces.

The application of inclusion and exclusion criteria to the study of servitization and digital servitization clarifies the focus of academic research, emphasizing the most relevant and impactful studies in these areas. This refined approach highlights the critical and emerging conversations shaping the future of manufacturing industries through servitization and its digital augmentation. The graph reflects the scholarly community's increasing investment in understanding these concepts and their application, suggesting a dual focus: the persistent importance of servitization in strengthening the interplay between manufacturing and services, and the transformative potential of digital technologies within this framework. Serving both as a retrospective and a forecast, the visualization indicates key areas for future research that promise to advance industrial practices and academic thought.

Regarding the countries in which the identified studies have been carried out, the visual data presented in Fig. 3 captures a comprehensive view of the global research output on servitization and digital servitization from 1990 to 2023, as indexed by the Web of Science and Scopus databases and further refined by the application of inclusion and exclusion criteria. The top section, shown in blue, delineates the Web of Science data, indicating a prominent concentration of scholarly activity within certain countries, possibly linked to their robust research infrastructures, funding provisions, or strong manufacturing sectors that are conducive to studies in servitization.

The middle section, in orange, portrays the Scopus data, revealing a parallel distribution pattern to that of the Web of Science but with slight variances that may be indicative of the different regional research emphases or variations in the databases' indexing methodologies. The countries with the highest volume of publications are recognized as potential centers of excellence and innovation in the field of servitization.

The bottom section of the graph, in green, represents the distilled essence of this academic output following the application of the inclusion and exclusion criteria. This section emphasizes the refined and concentrated scholarly work that aligns more closely with the specific nuances and requirements of servitization and digital servitization research as defined by the study. It presents a narrower but more focused spectrum of publications, suggesting a curated body of knowledge that serves as a critical resource for understanding the current state and future directions of servitization in the manufacturing sector.

Together, these three segments of Fig. 3 not only illustrate the quantitative aspects of the research output but also underscore the qualitative focus and depth of scholarly exploration achieved through rigorous selection. This tripartite analysis offers a lens through which to view the international dissemination and development of knowledge in servitization and digital servitization, highlighting established leaders in the field as well as regions with the potential for increased research activity, international collaboration, and contribution to the servitization discourse.

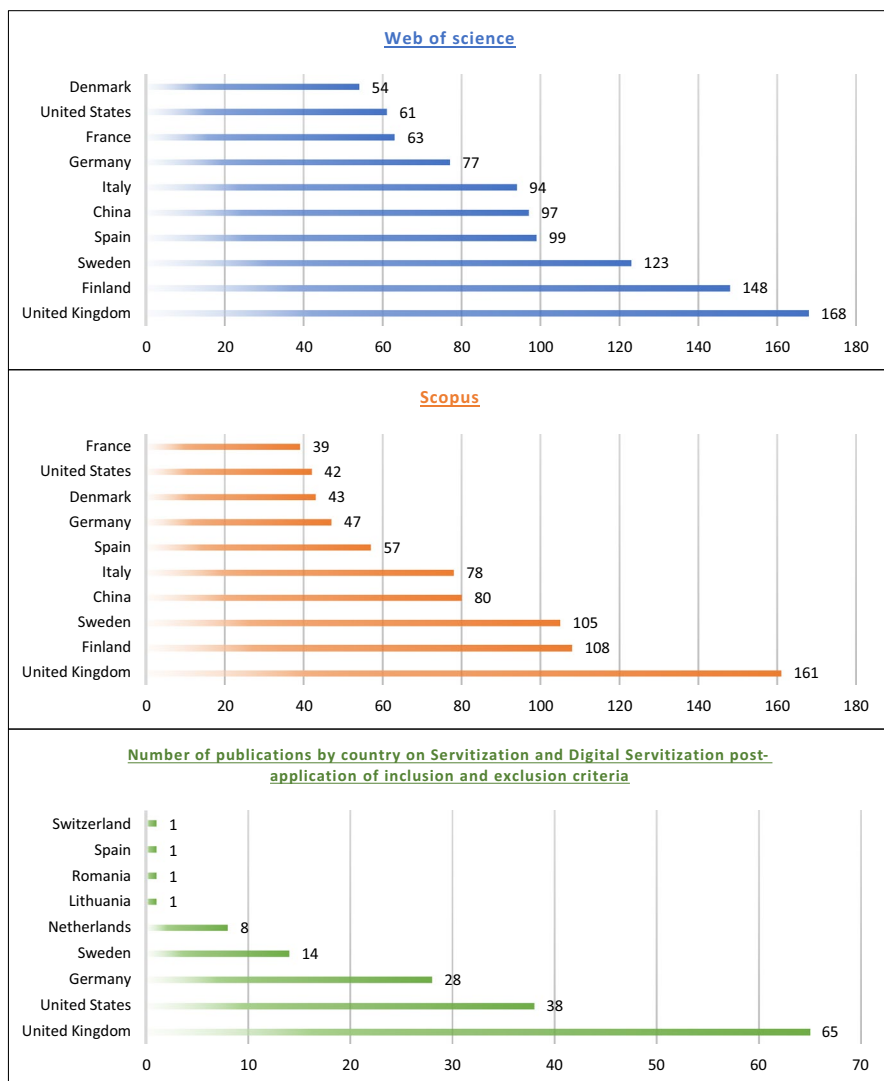


Fig. 3 Number of publications by country on Servitization and Digital Servitization (1990–2023). Source: Web of Science and Scopus databases

In Fig. 4, the Web of Science data (represented by the blue graph) lists Oscar Bustinza as the author with the highest number of publications, closely followed by Marko Kohtamäki and Vinit Parida. In contrast, the Scopus data (illustrated by the orange graph) also positions Vinit Parida prominently, yet Marko Kohtamäki's publication count is lower than that reported in the Web of Science, presenting a notable discrepancy.

When the inclusion and exclusion criteria are applied (as shown in the green graph), there is a decrease in the number of publications, which aligns with

expectations, given that these criteria aim to omit publications failing to meet the predetermined standards of quality and relevance. Following this filtration, Tim Baines emerges as the author with the most publications, indicating the significant relevance of his research work to the focused aims of this systematic literature review. Consequently, the filtration process underscores those authors whose contributions are particularly central or foundational to the field.

The comparison across the three graphs demonstrates the influence of database selection and methodological rigor on the perceived prominence of authors within the academic community. This analysis goes beyond merely highlighting the leading figures in servitization research; it underscores the importance

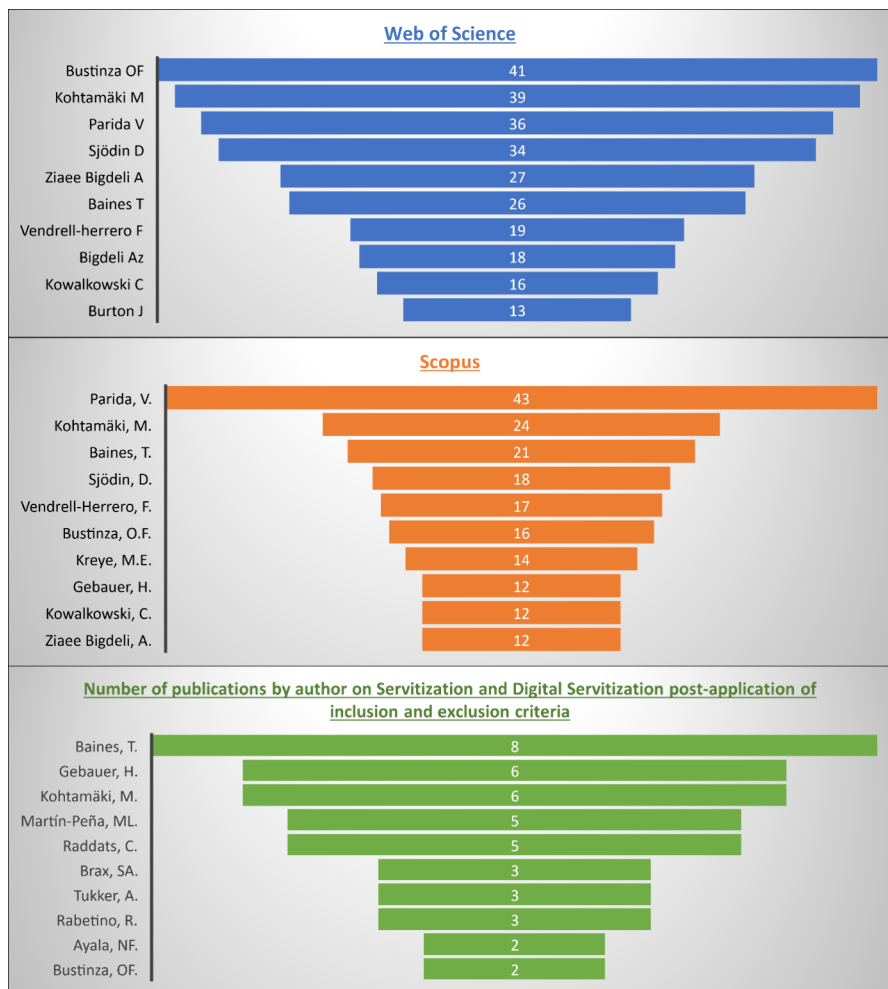


Fig. 4 Number of publications by author on Servitization and Digital Servitization (1990–2023). Source: Web of Science and Scopus databases and authors' own work

of thorough evaluation in literature reviews to identify research of substantial impact.

Thus, the filtration process distinctly recognizes authors whose contributions are considered pivotal to the discipline.

Figure 5 provides a succinct overview of journal publication volumes on servitization and digital servitization from 1990 to 2023, based on data from Web of Science and Scopus databases. Prior to applying inclusion and exclusion criteria, the journals listed in the Web of Science (blue) and Scopus (orange) indicate a diverse quantity of publications.

Post-application (green), the data are refined to highlight the top ten journals that are most aligned with the research criteria. It is noteworthy that the application of these criteria significantly alters the landscape of the considered literature. Some journals that initially (in the Web of Science or Scopus databases) had a high volume of publications appear to have fewer articles meeting the requirements, which may reflect on the specificity and relevance of their contributions to the field.

The graphic serves as an insightful metric of the research landscape, indicating not only the journals that are most prolific in the domain but also the robustness of articles surviving rigorous scholarly scrutiny. This visual representation is integral to the academic discourse, as it not only informs researchers of the core journals within the field but also reflects the evolving standards and focal areas within the literature on servitization and digital servitization.

The descriptive analyses included in this section serve as a pivotal foundation for the authors' elaboration, shedding light on the trajectory of academic inquiry into servitization and digital servitization. It encapsulates the dual analysis conducted using the Web of Science and Scopus databases and the meticulous selection process leading to the corpus of papers employed in the systematic literature review. The synthesis of these findings offers valuable insights into the progression of research in this domain, indicating a maturing yet dynamically expanding field of study.

3.3 Classification process

Upon identifying studies that met the established selection criteria, a thorough examination of each was conducted to categorize them according to specific themes. These encompassed the motivations driving companies toward servitization, namely the reasons why manufacturers transition from producing solely goods to combining these with services, including the anticipated benefits of such a transformation. The various actors involved in the servitization process and the nature of their interactions were scrutinized, as well as the strategies necessary for successful implementation, which entailed identifying potential needs for external partners, commonly service providers (Martínez et al. 2010; Bastl et al. 2012; Spring and Araujo 2013; Ziaee et al. 2018). The types of services commonly offered were analyzed, categorized as basic, intermediate, or advanced, along with the specific servitization strategies adopted by the companies. Furthermore,

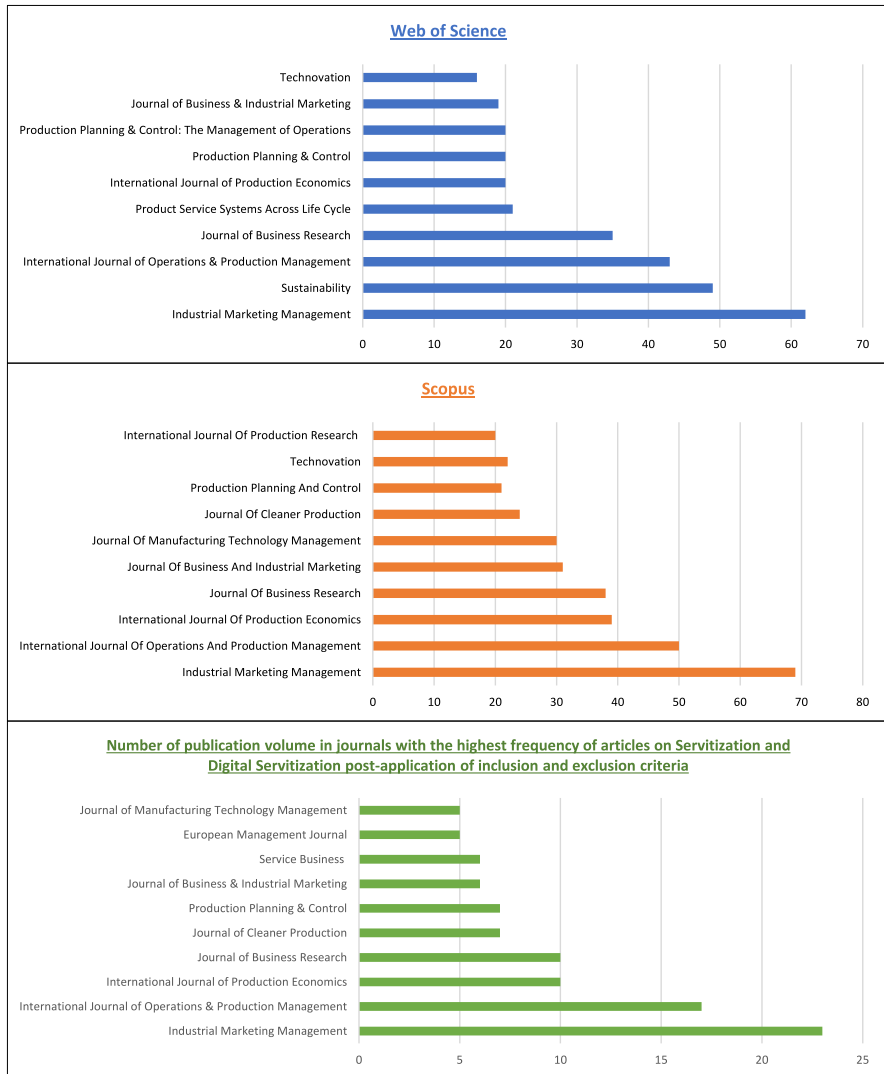


Fig. 5 Number of publication volume in journals with the highest frequency of articles on Servitization and Digital Servitization (1990–2023). Source: Web of Science and Scopus databases and authors' own work

the study delved into the organizational and technological capabilities required for an effective transition to servitization (Momeni et al. 2023), as well as the potential risks and challenges arising in these transition processes, including both internal and external obstacles that must be overcome to fully capitalize on the potential benefits of servitization (Raddats et al. 2017; Reim et al. 2019; Minaya et al. 2023).

4 Results: theoretical background

4.1 From servitization to digital servitization

The concept of servitization, which has significantly evolved over the years, has achieved solid recognition in both the academic and industrial spheres. Initially defined by Levitt (1972) and Vandermerwe and Rada (1988) as the process of adding value through services (Johnson and Mena 2008; Baines et al. 2011; Lindman et al. 2016; Ruiz-Martín and Díaz-Garrido 2021), servitization has expanded to encompass multiple strategic objectives, such as competitive advantage (Baines et al. 2009a; Raddats et al. 2019), financial goals, and marketing benefits (Khanra et al. 2021).

The shift toward servitization entails a redefinition of traditional business models, focusing on innovation (Sandström et al. 2008; Martín-Peña et al. 2018; Qi et al. 2020; Xing et al. 2023), and transforming manufacturers into service-centric companies (Cusumano 2008; Santamaría et al. 2012; Mosch et al. 2021). In this regard, manufacturing companies are fundamentally reorienting their business models and operational strategies to include value-added services (Gebauer and Kowalkowski 2012; Hyun and Kim 2021). Baines and Lightfoot (2013) and Luoto et al. (2017) highlight the widespread changes this implies in management, marketing, and operations. The change is so substantial that over 50% of a company's activities and personnel can be involved in providing these newly implemented services, as indicated by multiple studies cited by Martín-Peña and Ziaee (2016). This is because research has shown that servitization not only adds value but also increases profitability with relatively low asset investments (Davies et al. 2007; Kharlamov and Parry 2021).

The types of services offered range from basic to advanced (Gebauer et al. 2013; Kindström and Kowalkowski 2014; Sousa and Da Silveira 2017), with advanced services contributing to greater profitability (Eggert et al. 2014) and generating higher customer satisfaction (Mont 2002; Ostrom et al. 2010), leading to improved competitive positioning (Oliva and Kallenberg 2003; Durugbo 2014). Baines et al. (2011) argue that servitization involves creating distinctive and sustainable capabilities (Raddats 2011; Kimita et al. 2022), requiring not just the provision of goods, but also the innovation of value through added services (Tukker and Tischner 2006; García Martín et al. 2019; Zighan and Abualqumboz 2022), enabling companies to maintain their competitive edge (Tuli et al. 2007; Brax and Jonsson 2009; Nordin and Kowalkowski 2010).

While the goal of servitization is to enrich product offerings and drive competitiveness (Neely et al. 2011; Gaiardelli et al. 2014; Benedettini et al. 2015), companies must avoid the “service paradox,” where the focus on new services undermines existing production capabilities (Gebauer et al. 2005; Hyun and Kim 2021). To this end, various researchers advocate for a comprehensive analysis covering customer needs, pricing strategies, delivery infrastructure, and organizational change (Manzini and Vezzoli 2003; Kohtamäki and Partanen 2016; Ziaee et al. 2017). In summary, moving away from product-centric thinking and engaging in product and servitization logic.

In this context, Santamaría et al. (2012) and Rabetino et al. (2017) underscore three fundamental considerations for a successful servitization strategy: the content, process, and context of organizational change. This involves determining what to change, how to change, and why the change is necessary (Kreye et al. 2015).

The complexity of servitization also demands internal and external alignments within companies (Gebauer 2008; Alghisi and Sacconi 2015; Kohtamäki et al. 2019a; Zhang et al. 2023). Internally, this involves harmonizing the organization's strategy with the service portfolio and aligning this strategy throughout the organization (Oliva and Kallenberg 2003; Yan et al. 2020). Externally, alignment extends to the service provider network and customer expectations (Ceci and Masini 2011; Paiola et al. 2013). Similarly, servitization applies in B2B and B2C domains, serving as a differentiator and pathway to future alliances and customer loyalty (Baines et al. 2017; Pombo and Franco 2023).

On the other hand, technological advancements act as significant facilitators in the transition toward servitization, particularly the digital elements of Industry 4.0 (Dalenogare et al. 2018; Paschou et al. 2020; Opazo-Basáez et al. 2021; Tian et al. 2022; Le-Dain et al. 2023). This involves both internal and external organizational changes, focusing on disruptive innovations and addressing legal and financial challenges (Bustinza et al. 2018; Tronvoll et al. 2020; Kolagar et al. 2022), leading to what is known as digital servitization.

Digital servitization represents the integration of enabling technologies from Industry 4.0 into the servitization process, generating additional benefits and creating value for the customer (Ibarra et al. 2018; Grandinetti et al. 2020; Ciasullo et al. 2021; Bettiol et al. 2022). This digital transformation expands the scope of traditional services, allowing for greater customization and efficiency (Frank et al. 2019; Chen et al. 2021).

Digitalization facilitates data collection and analysis, improving decision-making, and enabling more predictive and proactive services (Lee et al. 2014; Chen et al. 2022a; Rakic et al. 2022). Moreover, data-based digital capabilities are fundamental for the success of digital servitization, as they enhance both product support services and customer support services (Chen et al. 2023).

Digital servitization also promotes value co-creation and collaboration among manufacturers, suppliers, and customers, optimizing service delivery and strengthening relationships (Coreynen et al. 2017; Vendrell-Herrero et al. 2017; Kohtamäki et al. 2020b; Sjödin et al. 2020). The business models of digital servitization are also influenced by Industry 4.0 technologies, such as Internet of Things and Big Data, enabling the development of more integrated and customer-centric solutions (Naik et al. 2020; Bortoluzzi et al. 2022; Minaya et al. 2023).

Furthermore, an integral aspect of the servitization landscape, especially in the digital era, is the evolution of Product-Service Systems (PSS). PSS represents a strategic approach that shifts the focus from selling products to offering a combination of products and services designed to fulfill specific customer needs more efficiently (Tukker and Tischner 2006; Baines et al. 2017). This transition to PSS reflects a broader industry movement toward sustainable and customer-centric business models, where the value proposition extends beyond the physical product to include personalized services. The advent of Industry 4.0 technologies has further propelled

this evolution, leading to the development of Smart PSS. Smart PSS integrates digital technologies, such as the Internet of Things, Big Data, and Artificial Intelligence to enhance service delivery, improve customer experience and enable new forms of value creation (Chowdhury et al. 2018; Bortoluzzi et al. 2022). The adoption of these advanced technologies within PSS frameworks represents a significant leap in how companies' approach servitization, allowing for greater customization, efficiency, and proactive engagement with customers. Therefore, understanding the role and impact of PSS, particularly Smart PSS, is crucial for comprehending the full scope of digital servitization and its implications for future business strategies.

4.2 Integrating smart product-service systems (smart PSS) into digital servitization: evolution, challenges, and opportunities

Product-Service Systems (PSS) epitomize an evolution in business models, integrating goods and services to fulfill customer needs sustainably and effectively (Galbraith 2002; Gebauer et al. 2011; Oliveira et al. 2015; Haase et al. 2017; Gaiardelli et al. 2021; Zhou and Song 2021). Tukker (2004) categorizes PSS into product oriented, use oriented, and result oriented, with each type offering distinct benefits, such as improved profit margins and differentiation from competitors (Tukker and Tischner 2006; Reim et al. 2015; Baines et al. 2017; Rabetino et al. 2017). Service-oriented PSS prioritize personalized customer experiences, requiring greater customer involvement (Matthyssens and Vandenbempt 2010; Cusumano et al. 2014; Zighan and Abualqumboz 2022).

The advent of Industry 4.0 technologies has given rise to Smart PSS, enhancing traditional PSS frameworks with digital capabilities and aligning with digital servitization's goals to maximize customer value and competitive advantage (Chowdhury et al. 2018; Zheng et al. 2019; Wang et al. 2021; Bortoluzzi et al. 2022; Chen et al. 2023). Smart PSS incorporate Internet of Things, Big Data, and Artificial Intelligence to offer tailored services and predictive maintenance, thus improving product reliability and customer experience. However, transitioning to Smart PSS necessitates overcoming internal challenges, such as developing digital capabilities and adapting organizational culture, and external challenges like aligning strategies with customer and supplier expectations (Alghisi and Saccani 2015; Baines and Shi 2015; Ceci and Masini 2011; Mosch et al. 2021).

Business models in the context of Smart PSS vary from product centered to service oriented, depending on the company's servitization maturity and technological capacity, leading to greater competitive differentiation and new market opportunities (Kowalkowski et al. 2017; Zheng et al. 2019; Baines et al. 2020; Chen et al. 2021). Implementing Smart PSS calls for a holistic approach, from strategic planning to system design and operational management, with a focus on how digital capabilities enhance PSS offerings and the overall value chain (Coreynen et al. 2017; Zheng et al. 2018).

In sum, the transition from traditional servitization to digital servitization, through the deployment of Smart PSS, marks a critical shift in value creation and sustaining customer loyalty, propelled by Industry 4.0 innovations (Vandermerwe

and Rada 1988; Frank et al. 2019; Pinillos et al. 2022; Raddats et al. 2022; Schroeder et al. 2022; Chen et al. 2023; Martín-Peña et al. 2023). Realizing the potential of digital servitization demands an understanding of technological capabilities, fostering innovation, and market adaptability (Kohtamäki et al. 2019b; Zhang et al. 2023). Successful digital servitization and Smart PSS rely on integrating technology with strategic vision and customer centricity, cultivating a business model focused on collaboration, innovation, and value co-creation (Naik et al. 2020; Chen et al. 2021; Zhou et al. 2021; Kolagar et al. 2022).

4.3 Digital servitization: crafting superior value in the modern era

As previously noted, servitization, as it evolves into digital servitization, catalyzes a profound and strategic transformation of business models and operational paradigms, emphasizing the importance of both internal and external strategic alignments. This process not only optimizes existing service offerings but also unlocks significant potential for service innovation and market competitiveness. Specifically, the integration of advanced technologies in digital servitization allows companies to create superior and customized value for their customers. This expanded value creation is achieved through a synergistic combination of technological resources and human capabilities, facilitating more predictive, personalized, and proactive services. Thus, digital servitization emerges as an essential and transformative step in business strategy, driving not only efficiency and strategic alignment but also fostering innovation and strengthening competitive positioning in the market.

Digital servitization, a contemporary evolution of traditional servitization, integrates Industry 4.0 technologies into the service domain, creating significant value for the customer. This value manifests in several key dimensions, all driven by digitalization and the emerging capabilities it offers.

- Enhanced personalization and customer experience. The ability to collect and analyze large volumes of data using digital technologies enables companies to better understand the needs and preferences of their customers (Tao and Qi 2017; Chen et al. 2023). This leads to the creation of more personalized service offerings, tailored specifically to individual customer requirements. For instance, data analytics capabilities enhance servitization by enabling service personalization, which is fundamental for improving customer satisfaction and fostering long-term loyalty (Chen et al. 2022b).
- Efficiency and proactivity in service delivery. Digital servitization allows companies to be more efficient and proactive in delivering services. Technologies like the Internet of Things and Artificial Intelligence facilitate remote monitoring and predictive maintenance, anticipating problems before they occur and minimizing downtime (Lee et al. 2014; Tao and Qi 2017; Raddats et al. 2022). This not only improves product reliability but also reduces costs for the customer.
- Creation of new opportunities and business models. The integration of digital services opens new avenues for innovative business models. For example, companies can offer usage-based solutions or subscriptions, where customers pay for

performance or outcomes rather than the product itself (Vendrell-Herrero et al. 2017; Martín-Peña et al. 2020; Bortoluzzi et al. 2022). This can result in greater flexibility and more attractive cost options for the customer.

- Enhanced customer–supplier relationships. Digital servitization fosters greater collaboration and value co-creation between suppliers and customers (Coreynen et al. 2017; Sjödin et al. 2020; Harrmann et al. 2023). This is because digital capabilities enable smoother communication and more transparent information exchange, resulting in stronger and more reliable relationships (Davies et al. 2023).
- Continuous improvement of products and services. Ongoing feedback and data analysis enable continuous improvement of the products and services offered. Companies can quickly adjust their offerings in response to customer feedback or market changes, ensuring that their services remain relevant and of high quality (Chen et al. 2021).
- Access to new markets. Digital servitization enables companies to access new markets and customer segments. By offering digital solutions, companies can overcome geographical and logistical barriers, reaching customers who were previously inaccessible (Münch et al. 2022; Rakic et al. 2022).

In summary, digital servitization not only enhances existing service offerings but also opens new opportunities for service innovation, strategic alignment, and market competitiveness. Its successful implementation is key to creating substantial value for the customer, highlighting the importance of a well-planned and executed strategy in the context of modern servitization.

5 Proposed conceptual framework: guiding the transition to digital servitization

Digital servitization represents a pivotal shift in the business landscape, where manufacturing companies evolve into providers of comprehensive solutions that seamlessly integrate products and services, augmented by digital technologies. This transformation is driven by the need for enhanced competitiveness, customer engagement, and value creation in a rapidly changing digital economy.

The development of our DASOBI conceptual framework, designed to guide the transition to digital servitization, is grounded in a rigorous methodological approach, underpinned by a comprehensive systematic literature review. This review meticulously synthesized three decades of academic research and industry insights, incorporating a total of 157 articles. Our comprehensive review process involved a deep analysis of the most influential and relevant publications in the field, among which notable contributions include Alghisi and Saccani (2015); Ayala et al. (2017, 2019); Coreynen et al. (2017); Tao and Qi (2017); Vendrell-Herrero et al. (2017); Bustinza et al. (2018); Frank et al. (2019); Baines et al. (2020); Martín-Peña et al. (2020); Naik et al. (2020); Brax et al. (2021); Gaiardelli et al. (2021); Kohtamäki et al. (2021); Bettiol et al. (2022); Bortoluzzi et al. (2022); Marcon et al. (2022); Münch et al. (2022); Brekke et al. (2023); Chen et al. (2023); Chirumalla et al.

(2023); Shen et al. (2023). These articles were particularly significant for identifying emerging trends, key challenges, and effective strategies in digital servitization. By systematically analyzing this extensive body of literature, we identified critical themes, challenges, strategies, and outcomes associated with the digital servitization journey. This analysis not only highlighted the multifaceted nature of digital servitization but also emphasized the critical importance of aligning strategic considerations, technological capabilities, and stakeholder roles to successfully navigate this complex transition. The structured framework presented herein not only reflects the evolution of the field but also provides clear guidance for manufacturing companies advancing toward more sophisticated and digitalized servitization practices.

The DASOBI framework, while empirically grounded in a comprehensive literature review, also draws extensively on classical and emerging theories to provide a robust theoretical foundation. For instance, diffusion of innovations theory (Rogers 2003) elucidates the “Drivers” and “Obstacles” in the adoption of digital servitization by explaining the rate and process through which new technological innovations spread within industries. Furthermore, the resource-based view (Barney 1991) is instrumental in understanding the “Strategies” component of the framework, emphasizing the importance of internal capabilities and resources in gaining a competitive advantage through digital transformation. These theoretical integrations not only enhance the academic rigor of our framework but also offer a deeper understanding of the multifaceted nature of digital servitization.

Therefore, the proposed DASOBI (Drivers, Actors, Strategies, Obstacles, Benefits, and Impact) model emerges as a synthesis of empirical evidence and theoretical insights, designed to offer a coherent and actionable guide for organizations seeking to embrace digital servitization.

This conceptual framework delineates a roadmap for organizations to navigate this complex transition. The framework identifies the core components essential for a successful journey toward digital servitization:

Underlying reasons for the shift (Drivers). Recognizing the strategic imperatives for transitioning toward a digital servitization model is critical. This includes understanding market dynamics, competitive pressures, and technological advancements driving this change.

Key actors involved (Actors). Successful digital servitization necessitates the involvement and alignment of various stakeholders, including internal teams, customers, technology partners, and suppliers. Their roles, expectations, and contributions are pivotal in shaping the servitization journey.

Strategic considerations and tools (Strategies). This encompasses adopting strategic frameworks, methodologies, and digital tools that are conducive to servitization. These tools and strategies should facilitate the integration of digital technologies with traditional product-service offerings, ensuring a seamless transition.

Potential challenges and obstacles (Obstacles). Identifying and addressing challenges such as cultural resistance, skill gaps, technological complexities, and integration issues with existing processes is crucial. Proactive strategies and contingency plans are essential to mitigate these barriers.

Anticipated benefits of the transition (Benefits). The transition to digital servitization should bring about significant benefits, including enhanced customer value, increased revenue streams, and improved competitive positioning. This component focuses on quantifying these benefits and aligning them with organizational goals.

Expected outcomes and impact (Impact). The final component of the framework revolves around the tangible outcomes and impacts of digital servitization. This includes enhanced customer satisfaction, increased market share, and improved operational efficiency.

In the digital servitization framework, the transition toward digital servitization, driven by market dynamics, competitive pressures, and technological advancements, is intrinsically linked to the roles and contributions of key stakeholders, such as internal teams, customers, and technology partners. Strategic considerations and tools must be selected in light of potential challenges, like cultural resistance and skill gaps, ensuring alignment with stakeholder capabilities and expectations for a seamless integration of digital technologies with traditional offerings. This strategic alignment is pivotal in overcoming obstacles and realizing anticipated benefits, such as enhanced customer value and competitive positioning. These benefits, in turn, lead to tangible outcomes, like improved customer satisfaction and operational efficiency, which feedback into the market, influencing ongoing strategic imperatives and shaping the evolution of digital servitization strategies. This dynamic interplay highlights a continuous feedback loop where outcomes inform underlying reasons, reinforcing the need for adaptability and strategic foresight in the digital servitization journey.

The contribution of the DASOBI framework to the existing literature is manifold. By synthesizing empirical findings with theoretical insights from servitization and digital transformation research, this framework addresses identified gaps, such as the integration of digital technologies in traditional servitization models and the management of organizational changes associated with such transitions (Baines and Lightfoot 2013; Vargo and Lusch 2008). Specifically, the DASOBI framework aids in conceptualizing how companies can strategically navigate the complexities of digital servitization, providing a structured approach that is missing in previous studies. This not only extends the theoretical discourse around servitization but also sets a foundation for future research to explore the dynamic interactions between digital technologies and service strategies in manufacturing sectors.

In conclusion, this conceptual framework serves as a comprehensive guide for firms embarking on the digital servitization journey. It provides a structured approach to understanding and implementing the necessary changes, ensuring a smooth transition and realization of the potential benefits of digital servitization. Figure 6 summarizes this meticulously formulated model (DASOBI), referred to as the Drivers (underlying reasons for the shift), Actors (key actors involved), Strategies (strategic considerations and tools), Obstacles (potential challenges and obstacles), Benefits (anticipated benefits of the transition), and Impact (expected outcomes and impact) of Digital Servitization Strategy, offers a robust framework for scholarly exploration, grounded in an exhaustive review of extant literature.

The DASOBI framework orchestrates the shift from traditional service strategies to digitally-enhanced service offerings, underpinned by the alignment of core elements: Drivers, Actors, Strategy, Obstacles, Benefits, and Impact. The model emphasizes a strategic approach, incorporating digital catalytic factors to augment adaptability, customer-centric analytics, and the pursuit of novel revenue streams through digital innovations.

Within this framework, the digital knowledge and capability development are crucial. Firms must harness Big Data to distill customer insights, leverage Artificial Intelligence for identifying opportunities, and increase the flexibility of their service offerings via digital platforms. The role of digital service providers is pivotal, offering expertise to mitigate transition risks, assure service quality, and bolster productivity with cutting-edge technological solutions.

However, the shift is not without its challenges. The resistance to digital transformation and the complexity of measuring profitability in the digital service landscape can impede progress. Moreover, the implications of Industry 4.0 are profound, necessitating organizational restructuring, workforce upskilling, and technological investments to realize the potential of digital servitization.

The anticipated benefits of this digital shift are manifold. Enhanced customer understanding through sophisticated data analytics, improved market positioning through digital innovation, and elevated creative capability with advanced technology are but a few of the advantages. Furthermore, embracing Industry 4.0 technologies within digital servitization amplifies these benefits, leading to superior product quality via smart manufacturing, greater adaptability in production, and increased operational efficiency ensuring timely delivery.

In summary, the DASOBI model meticulously integrates the transition to digital servitization with the digital economy's imperatives, presenting a coherent

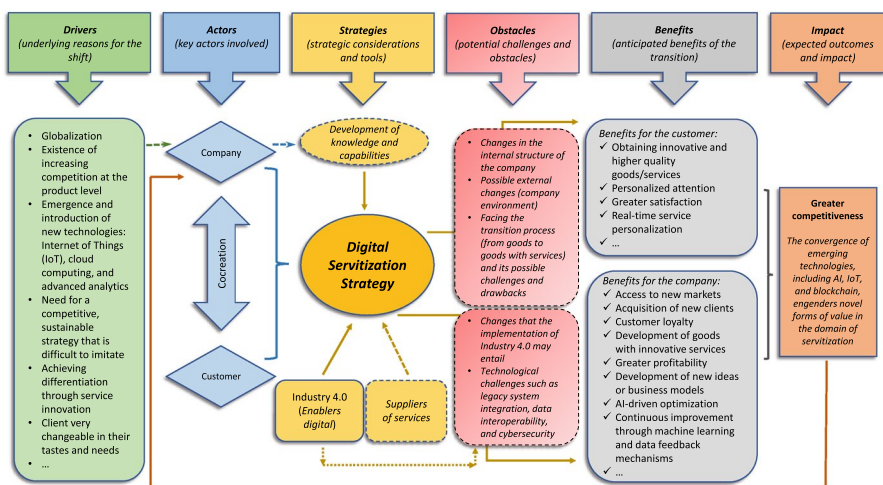


Fig. 6 Conceptual theoretical model for the analysis of Digital Servitization. Source: Authors' own work

roadmap for firms aspiring to harness the full spectrum of benefits offered by Industry 4.0 innovations.

6 Conclusions, limitations, and further research

This study embarked on an exhaustive journey through three decades of literature on servitization and its evolution toward digital servitization within the manufacturing sector. Through a systematic literature review, we explored the strategic transformation that involves integrating advanced services and digital technologies into product offerings, a change driven by the need to enhance competitiveness, customer engagement, and value creation in a rapidly evolving digital economy.

Our research findings have identified key drivers, actors, strategies, challenges, and benefits associated with the transition toward digital servitization. The DASOBI conceptual framework tries to provide a structured guide for understanding and managing this complex transition. This framework emphasizes the importance of recognizing the underlying reasons for adopting digital servitization models, the necessity of aligning and collaborating with diverse stakeholders, and the use of specific strategies to overcome the inherent challenges of this process.

Despite this study's contribution to the body of knowledge on digital servitization, we acknowledge several limitations. The geographical concentration of the research activity analyzed might limit the generalizability of our findings across diverse cultural and economic contexts. The rapid evolution of digital technologies and business models also suggests that the relevance of our discoveries could be challenged by future developments. Additionally, our research focused primarily on manufacturing firms, which limits the applicability of the findings to other sectors.

These limitations open several avenues for future research. It is imperative to validate and test the generalizability of the DASOBI framework across various organizational and industry contexts. Further research is also needed to develop specific metrics that can measure the impacts of digital servitization. Longitudinal studies could provide a deeper understanding of how servitization strategies influence business outcomes over time.

This study contributes to the academic discussion by clarifying and deepening the concept of servitization and its intersection with digitalization, offering an integrative view that can assist manufacturing firms in navigating the complex landscape of servitization and digital servitization. Although we have tried to establish a solid foundation for future research, it is evident that the field of digital servitization remains dynamic and evolving, requiring ongoing examination to fully comprehend its impact on business strategy and practice.

Funding Open Access funding provided thanks to the CRUE-CSIC agreement with Springer Nature.

Data availability The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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