



# Unpacking the triple Nexus: Environmental performance, economic performance and servitization – A systematic review and theoretical reflections

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## ABSTRACT

The manufacturing industry is facing a major challenge in balancing economic performance with environmental sustainability. To address this challenge, extant research has suggested that servitization could help align these objectives. However, the current evidence base is too scattered for policymakers to act on and support servitization in a targeted manner. Therefore, we conduct a systematic literature review to analyze over 120 research papers to establish the current understanding of the impact of servitization on the environmental and economic performance of a firm, and identify the contextual variables affecting this impact. The study identifies and critically appraises the body of literature that provides the current evidence base on the impact of servitization, the core areas of impact investigated and the methods that are used to establish this impact. Additionally, we conduct a thematic analysis of variables of impact to explore the theoretical perspectives that are used to explain the impact of servitization. Building on these theoretical perspectives we offer concrete propositions to further develop the research on the impact of servitization on environmental and economic performance.

## 1. Introduction

As governments around the world prioritize combating climate change, there are growing concerns about the sustainability of the manufacturing industry (Zhang et al., 2022). The manufacturing industry is directly responsible for a significant portion of global carbon emissions (World Economic Forum, 2023) through both their own operations, and indirectly through the customers' use of their products (Moran et al., 2020). Meanwhile, the manufacturing industry contributes a significant amount to national GDPs and employment, causing policymakers to question how much pressure they can put on decarbonising the manufacturing for fear of negative economic consequences (Semieniuk et al., 2021). There is a risk that environmental and economic priorities are not aligned, or worse, are being played against each other (Montabon et al., 2007; Muñoz-Villamizar et al., 2018; Whelan

and Fink, 2016). It is critical to identify opportunities for aligning environmental and economic benefit creation in the manufacturing industry and explore the contextual conditions that foster such an alignment. Doing so can make substantial contributions to industrial policy and manufacturing strategy.

Manufacturing companies are striving to reduce their carbon footprint by innovating their products and production processes (Wang et al., 2021). However, these innovations often require more effort in terms of management and are more expensive and complex (Zhao et al., 2018), which limits their adoption when offered through traditional product-focused business models (Yang et al., 2023). Relying solely on these innovations would not be enough to achieve significant results, and several studies suggest that manufacturers should also innovate their business models to have a more substantial impact (Geissdoerfer et al., 2018; Muñoz-Villamizar et al., 2019). In fact, a business model

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focused solely on products may hinder low-carbon innovation (Mylan, 2015).

There is lot of focus on servitization as a solution to the environmental and economic challenges manufacturers are facing (Baines et al., 2017; Szász and Seer, 2018). Servitization is a process in which manufacturers shift their focus towards providing a combination of products and services, with an emphasis on offering outcomes instead of just products (Baines et al., 2024b). This is usually achieved through pay-per-use or outcome-based revenue models. By taking responsibility for both the product and its outcome, manufacturers can introduce new technologies into their customers' operations more easily (Wei et al., 2022) and apply critical circular economy principles in their design, maintenance and replacements (Korkeamäki et al., 2021; Wannakrairoj and Velu, 2021). Furthermore, the use of pay-per-use or outcome-based revenue models in servitization removes the need for customers to invest in new technologies and manage their equipment to maintain critical efficiency (Polova and Thomas, 2020).

Servitized business models drive manufacturers to develop sustainable innovations, reducing energy consumption and carbon emissions by optimising customer processes. These models also unlock significant economic potential by ensuring a continuous revenue stream, as opposed to one-time payments typically used in product-based approaches (Abou-foul et al., 2021). Moreover, they allow manufacturers to centralise and optimise customer maintenance activities, which would enhance efficiency (Rabetino et al., 2017). Overall, servitization presents manufacturers with compelling growth and profit prospects, often surpassing those of traditional product-centric models.

Previous research has identified several pathways through which servitization can yield both environmental and economic benefits, demonstrating its potential alignment with policymakers' priorities (Lafuente and Vaillant, 2023). As a result, policymakers and advisors are increasingly acknowledging the potential of servitization, as evidenced by the emergence of position papers and reports from organizations such as the EU Commission, OECD, and the World Economic Forum (Laurent Probst et al., 2016; OECD, 2017; World Economic Forum, 2020). However, to provide meaningful and targeted support for servitization, policymakers need a robust evidence base confirming its impact. Currently, research has predominantly focused on examining the factors and challenges associated with the development and adoption of servitized business models, with less attention on details of their specific impact (Agrawal and Bellos, 2017; Yang et al., 2023). This gap results in a limited understanding of the joint environmental and economic benefits of servitization, along with the challenge of balancing these benefits. Moreover, many studies exploring the benefits of servitization have relied on qualitative research (Zhang et al., 2023), hindering policymakers' ability to quantify the impact and establish targeted initiatives to foster the widespread adoption of such innovative business models.

More research is, therefore, needed to comprehensively examine the integrated environmental and economic impacts of servitization. To accelerate the development of such an enquiry, we focused on consolidating the existing (but disparate) research on the environmental and economic impact of servitization in the form of a systematic literature review (Kolagar et al., 2022). This study differs from other servitization-focused literature reviews by concentrating on the outcomes of servitization and the factors influencing those outcomes. We have extensively reviewed and analysed over 120 research papers to investigate the nature and contextual variables affecting the relationship between servitization, and its environmental and economic benefits.

This paper offers multiple contributions. It presents a comprehensive overview of studies highlighting the environmental and economic benefits of servitization, evaluates the methods and measures used in these studies, and underscores the significance of examining the outcomes of servitization, including moderating and mediating variables influencing its impact. For manufacturers and policymakers, this paper not only confirms servitization as a driver for creating both environmental and economic benefits but also outlines several key areas that policymakers

should focus on to expand the development of the evidence base to better target supporting policy.

The remainder of the paper is structured in the following way. Firstly, we conduct a thorough literature review of articles that connect servitization with environmental and economic performance benefits. The aim is to identify the variables and how they impact the relationships of interest. Secondly, using the Gioia methodology (Gioia et al., 2012) as a guide, we create themes that explain the theoretical nature of the variables that influence the relationships, as well as the nature of their influence. Finally, based on these findings, we discuss gaps in the existing evidence base and recommend specific actions for future research to further develop the evidence base.

## 2. Research methodology

We conducted a systematic literature review (SLR) to support the development of a comprehensive evidence base on the environmental and economic performance benefits of servitization. Our review had three core objectives: to integrate the environmental and economic impact perspectives of servitization, identify the variables moderating and mediating this impact, and evaluate the range of measures and theoretical backgrounds adopted to execute these prior studies. The outcome of the SLR provided the basis for the subsequent thematic analysis.

### 2.1. Systematic literature review

The SLR method is a comprehensive and structured approach to review existing literature on a particular topic or research question. Its objective is to minimize bias and ensure transparency and reproducibility by following a predefined protocol that outlines the research question, search strategy, inclusion/exclusion criteria, and data extraction methods (Durach et al., 2017; Tranfield et al., 2003). The alternative *meta-analysis* method was considered unsuitable due to the high levels of heterogeneity in the prior servitization studies (Templier and Paré, 2018), and a *descriptive review* was considered too limiting given our objectives of advancing the integrated impact perspective and evaluating the current state of research.

This study stands out from previous literature reviews by explaining the integrated impact of servitization on both environmental and economic performance. Other literature reviews have focused on the features and drivers of servitization (Baines et al., 2009), the factors impacting its development (Zhang and Banerji, 2017), and the range of variables used to measure it (Calabrese et al., 2019). Recent reviews have centred on mechanisms to accelerate servitization, such as change management (Baines et al., 2017) and the role of the ecosystem (Khanra et al., 2021; Kolagar et al., 2022). In contrast, our study integrates environmental and economic impact as important impact domains to consider in understanding the outcomes of servitization.

Our SLR followed a five-step process (see Fig. 1) to build the base for the subsequent thematic analysis.

Step 1 focused on determining the scope of the review. To assess the gaps in the emerging research base and benchmark the quality of the research, we decided to prioritize high-quality peer-reviewed publications for the review and to limit our focus to ABS, ABDC, or ERA listed journals. As several trials showed that none of the databases comprehensively captured this range of publications or enabled similarly effective search functionalities, we spread our scope across EBSCO, Google Scholar, SCOPUS, Science Direct, Pro-Quest, and Emerald databases.

Step 2 involved identifying the search terms and executing the searches. We identified, tested and refined three different groups of search terms: for the servitization concept, we used 'servitization, servicization, service(s), product-service system, PSS, advanced services, integrated service(s)'; for the economic performance, we used

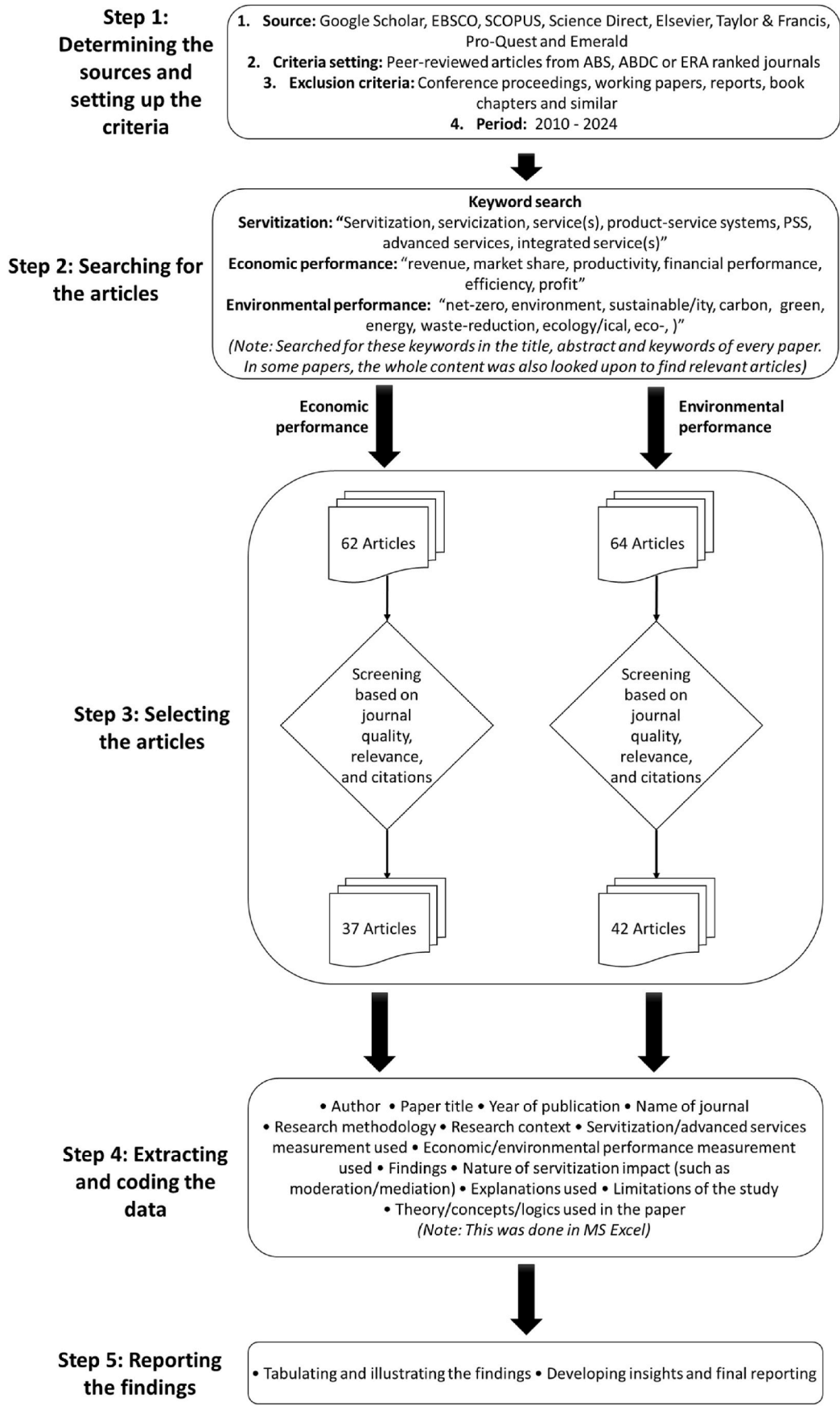


Fig. 1. SLR process.

**Table 1**  
Economic performance measures identified.

| Measures               | References  |
|------------------------|---|
| Profit                 | Crozet and Milet (2017); Neely (2008); Sousa and da Silveira (2017)<br>Johansson et al. (2019); Kharlamov and Parry (2020); Kohtamäki et al. (2024); Latifi et al. (2021); Lee et al. (2016); Yan et al. (2020); Zhou et al. (2020) |
| Revenue                | Guedes et al. (2022); Han et al. (2013); Johansson et al. (2019); Latifi et al. (2021); Martín-Peña et al. (2020); Neely (2008); Shah et al. (2020); Sousa and da Silveira (2017); Suarez et al. (2013); Zhou et al. (2020)         |
| Return on investment   | Eggert et al. (2022); Latifi et al. (2021); Yan et al. (2020); Zhou et al. (2020)   |
| Return on sales        | Benedettini and Neely (2019); Shah et al. (2020); Valtakoski and Witell (2018)  |
| Operating margins      | Aas and Pedersen (2011); Ambroise et al. (2018); Suarez et al. (2013)   |
| Return on asset        | Benedettini and Neely (2019); Kharlamov and Parry (2020); Zhou et al. (2020)  |
| Revenue growth         | He and Lai (2012); Kohtamäki et al. (2013b); Sjödin et al. (2020)   |
| EBIT Margin            | Kohtamäki et al. (2021); Visnjic et al. (2016)  |
| Tobin's Q              | Fang et al. (2008); Visnjic et al. (2016)   |
| Bankruptcy likelihood  | Benedettini et al. (2015)   |
| Employment             | Crozet and Milet (2017)   |
| Gross margin           | Korkeamäki et al. (2021)  |
| Growth in profit       | He and Lai (2012)   |
| Growth of market share | He and Lai (2012)   |
| Market share           | Johansson et al. (2019); Latifi et al. (2021)   |
| Net profit             | Ambroise et al. (2018)  |
| New product share      | Chen et al. (2016)  |
| Asset over turnover    | Benedettini and Neely (2019)  |
| Profit margin          | Kastalli and Van Looy (2013)  |
| Profit share           | Yan et al. (2020)   |
| Quality                | Lee et al. (2016)   |
| Revenue per labour     | Kharlamov and Parry (2020)  |
| Revenue share          | Szász et al. (2017)   |
| Subjective scales      | Abou-foul et al. (2021)   |
| Suppliers' profit      | Kohtamäki et al. (2013a)  |
| Trade credit           | Wang et al. (2023)  |
| Working capital        | Neely (2008)  |

'profit, productivity, efficiency'; for the environmental performance, we used 'sustainable/ity, net zero, environment, carbon, green'. We selected these terms to capture the wide range of terminologies applied in the research contexts, and confirmed their effectiveness through several trials and confirmation by industry experts. We

undertook multiple searches using combinations of these search terms across the several databases. When executing the searches, we targeted our search terms at the title, abstract, and keywords of the publications, but in some cases considered the wider content to confirm the suitability of individual papers. To further increase the

**Table 2**  
Environmental performance measures identified.

| Measures  | References   |
|---|--|
| Product life-cycle                                    | Agrawal and Bellos (2017); Geum and Park (2011); Kolling et al. (2022); Kristensen and Remmen (2019); Laperche and Picard (2013); Lindahl et al. (2014); Pialot et al. (2017); Xing and Liu (2023) |
| Sustainability  | Annarelli et al. (2016); Bhatti et al. (2023); de Jesus Pacheco et al. (2019); Ferasso et al. (2020); Kreye and van Donk (2021); Lelah et al. (2012); Marić and Opazo-Basáez (2019)                |
| Energy consumption                                    | Chaney et al. (2022); Doni et al. (2019); Mylan (2015); Song and Sakao (2017)  |
| Durability  | Fargnoli et al. (2018); Kanatlı and Karaer (2022); Kristensen and Remmen (2019); Örsdemir et al. (2019)  |
| Eco-design  | Laperche and Picard (2013)   |
| Eco-innovation  | Paiola et al. (2021)   |
| Electricity consumption                               | Naor et al. (2018)   |
| GHG emissions   | Naor et al. (2018)   |
| Green innovation                                      | Abadzhiev et al. (2022)  |
| Maintenance   | Kristensen and Remmen (2019)   |
| Material wastage                                      | Chaney et al. (2022)   |
| Power consumptions                                    | Song and Sakao (2017)  |
| Product life  | Fargnoli et al. (2018)   |
| Rational use of raw materials to optimise end of life | Pialot et al. (2017)   |
| Remanufacturing                                       | Spring and Araujo (2017)   |
| Repair  | Spring and Araujo (2017)   |
| Resource sharing                                      | Geum and Park (2011)   |
| Resource utilization                                  | Reim et al. (2015)   |
| Reuse   | Spring and Araujo (2017)   |
| Subjective likert scale on circular supply chains     | Kühl et al. (2022)   |
| Temperature measure                                   | Mylan (2015)   |
| Carbon emission in the export trade                   | Li et al. (2021)   |
| Carbon emission intensity                             | Tang et al. (2022)   |
| Circularity   | Kreye and van Donk (2021); Spring and Araujo (2017)  |
| CO2 emissions based on energy data                    | Zhao et al. (2021)   |
| Dematerialisation                                     | Pialot et al. (2017)   |

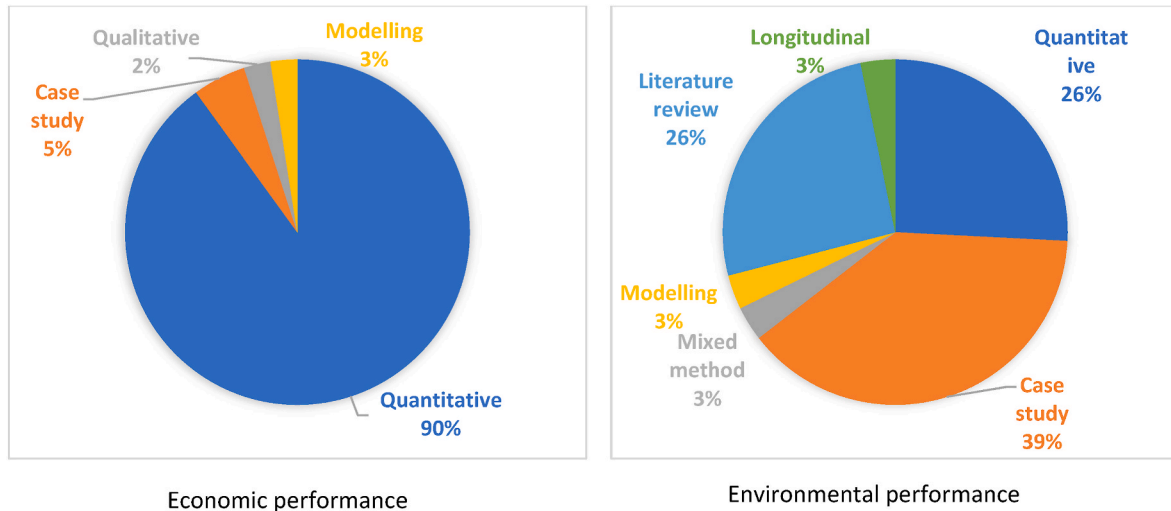


Fig. 2. Distribution of servitization papers by research methods.

relevance of the publications we limited our selection to papers published since 2010. The application of this step led to a pool of 64 publications targeting the environmental performance and 62 publications targeting the economic performance context. Step 3 focused on screening the pool of publications to identify those that had the highest chance of contributing to our core objectives. To further ensure the quality of the reviewed content, we narrowed down the scope to identify top-rated publications based on 3\*/4\* in ABS, A\*/A in ABDC, and 3/4 in ERA journal lists. However, we recognized that such a cut-off would exclude some insightful publications that were directly relevant to our research and included individual high-profile publications that fell outside this scope. We read all the selected publications in detail and dismissed articles that would not contribute to our objectives. Finally, we arrived at 37 and 42 publications focusing on the economic performance and environmental performance, respectively.

The objective of step 4 was to extract and code the data to make it accessible for further analysis. First, we extracted general article data such as author, year, title, and journal. Second, we extracted data on the research methodology, the research context, the servitization measurement used, the economic/environmental impact measurement used, the moderation/mediation variables considered, the theory/concepts/

logics used in the core arguments of the paper and the limitations of the study. Throughout the whole process, the research team discussed, verified, and validated the coding.

The objective of step 5 was to draw insights from the captured data and present them in a digestible format. We presented the range of economic and environmental performance measures in summary tables (Tables 1 and 2). The distribution of research methods identified are presented in Fig. 2, while Figs. 3 and 4 detail the economic and environmental performance relationships, with a focus on mediating and moderating variables.

2.2. Thematic analysis

The findings of the SLR provided the foundation for our thematic analysis. Following Gioia et al. (2012) we identified the overarching themes affecting the impact of servitization on environmental and economic performances. In line with other studies (for e.g., Chaudhary et al., 2022; Khan et al., 2021; Sheridan et al., 2021), we apply the Gioia methodology (Gioia et al., 2012) to structure the findings of our SLR and to identify the overarching themes affecting the impact of servitization on environmental and economic performances. To begin, we created a data structure containing 1st-order variables that were shown to influence the relationship between servitization and environmental and

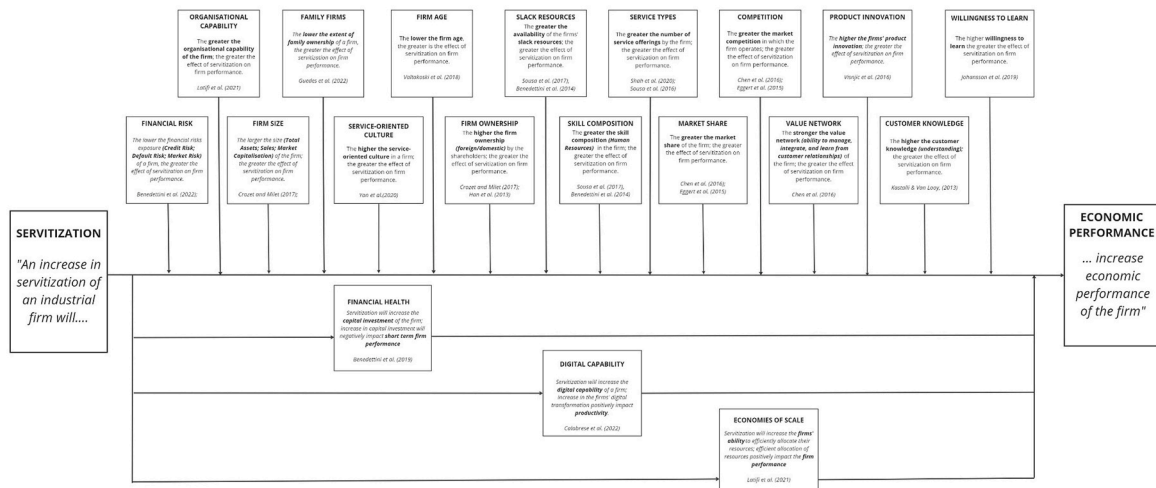


Fig. 3. Moderating and mediating variables affecting the servitization - economic performance relationship.

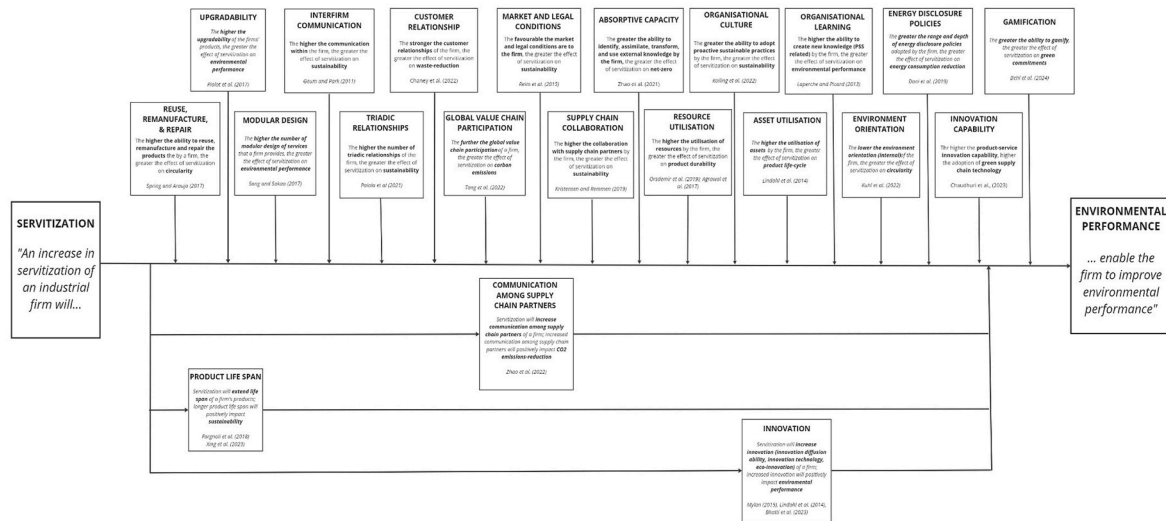


Fig. 4. Moderating and mediating variables affecting the servitization - environmental performance relationship.

economic performance. From there, we determined the roles of these variables, categorizing them into 2nd-order themes. We then grouped these 2nd-order themes into (3rd-order) aggregate dimensions based on their theoretical implications, to identify their underlying theoretical perspectives. To further ensure reliability and credibility our research team conducted an ‘investigator triangulation process’, where each member of the research team individually verified the results derived from the coding process (Maxwell, 1992). We reviewed the final sample of papers and the coding structure to ensure the entire coding process was credible. We then developed the thematic representations of the current research (Figs. 5 and 6) based on the obtained themes and dimensions.

### 3. Findings

Our findings from this study can be divided into two sections. First, we report the descriptive and bibliometric findings by discussing primary data such as measures for economic performance and environmental performance, then the methodology used, and most importantly, the variables. Second, we report the thematic insights from the Gioia analysis for both environmental performance and economic performance.

#### 3.1. Descriptive and bibliometric findings

The analysis identified the range of measures the prior studies used to capture the environmental and economic performance impact of servitization, the methodologies these studies use and the variables that moderate or mediate the servitization impact.

The analysis of the servitization literature showed a considerable range different ways the economic performance of servitization was captured (see Table 1). Altogether 27 distinct measures for capturing the economic performance impact of servitization were identified. By far the most used measures to capture the economic performance impact of servitization in the surveyed literature are the revenue and profit measures, which each represent around 16 per cent. These are followed by measures such as return on investment and return on sales. Other measures of economic performance such as EBIT and subjective Likert scales on financial performance are also used in the literature. It is important to point out that a large number of identified measures were only used in individual studies suggesting high levels of heterogeneity in the use of measures and a limited focus on consistency in the development in the research base.

The review of the environmental performance impact also showed a wide range of measures applied (see Table 2). The analysis identified altogether 26 distinct measures that were used to capture aspects of the environmental impact of servitization. These include (largely subjective) implications for the product-life-cycle, which is closely followed by subjective measures that encompass social, economic, and environmental sustainability. Other common measures include durability, and energy consumption. Studies also use, among others, measures such as carbon emission intensity, green innovation, resource utilization and repair. Similar to economic performance, a large number of identified measures were only used in individual studies suggesting high levels of heterogeneity in the research base.

The review also shows the range of research methodologies used to establish the impact of servitization (Fig. 2). To establish the economic performance impact studies have most commonly used quantitative methods – mostly regression based on survey data. This was followed by a small percentage of case studies and some use of modelling. Interestingly, to establish the environmental performance impact studies have largely relied on case-based methods. This was closely followed by quantitative studies, mostly applying surveys and regression. The most important difference in choice of research methods is the large extent of quantitative methods in the economic performance studies and the high level of case studies in the environmental performance studies. Also of interest is the limited use of modelling methods across both impact domains, which is normally widely used in financial and environmental studies.

The review also identified a wide range of variables that impact the relationship between servitization and economic or environmental performance (see Figs. 3 and 4). Among the range of variables that were shown to impact the economic performance of servitization are firm size, but also culture and skills. Among the variables that were shown to impact the environmental performance of servitization are customer relationships and supply chain collaboration as well as organisational learning. What is of interest is that some of these factors are conceptualized as mediating variables (explaining the performance impact of servitization) while others are conceptualized as moderating variables (affecting the strength of the performance impact of servitization). In other words: In some impact scenarios servitization is shown to have an impact on aspects of environmental or economic performance and a particular variable (e.g. absorptive capacity) enhances or limits this impact while in other cases servitization is shown to affect a particular variable (e.g. communication among supply chain partners) and it is this factor than that creates the impact. The identified variables form the

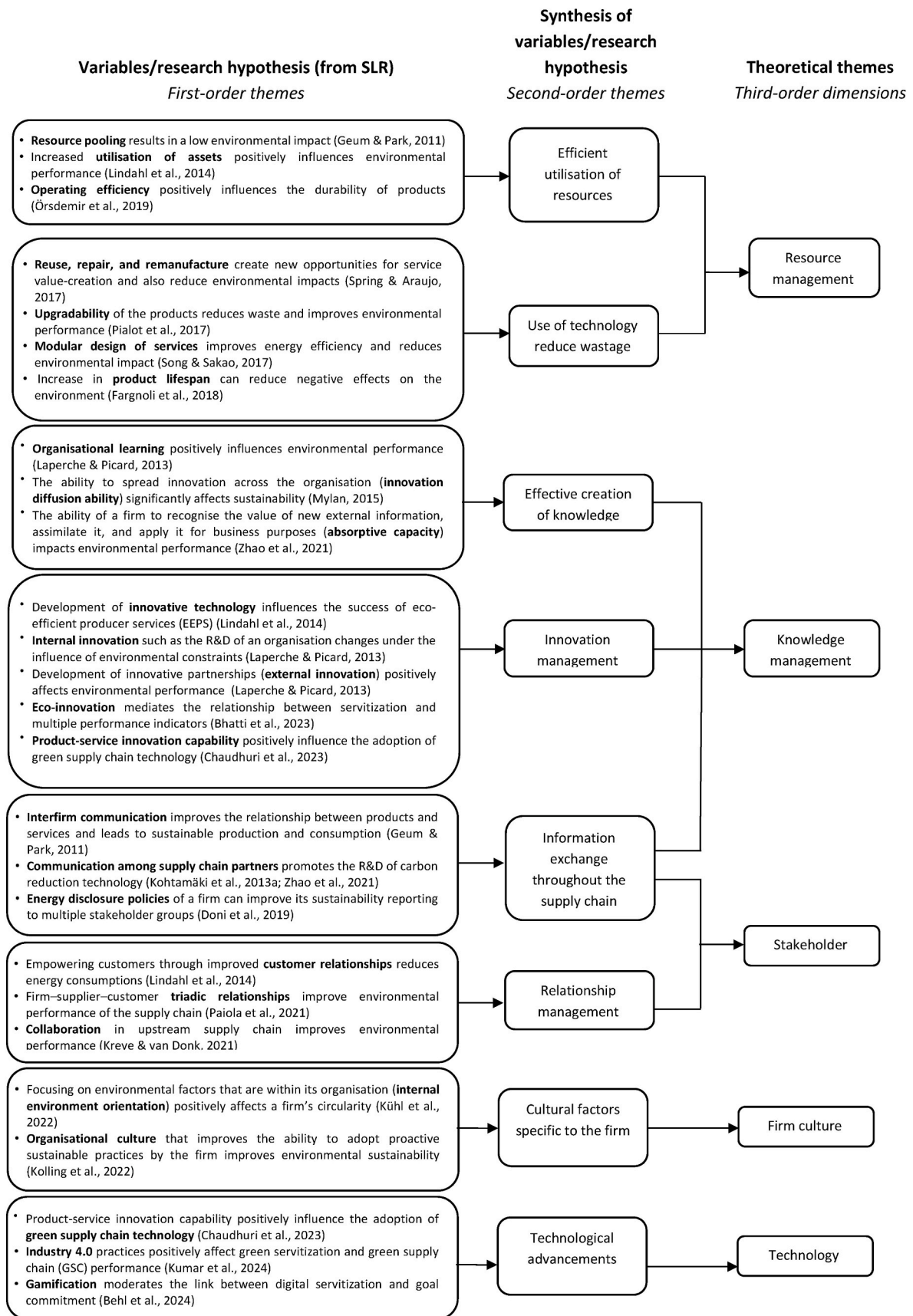


Fig. 5. Thematic analysis of servitization-environmental performance.

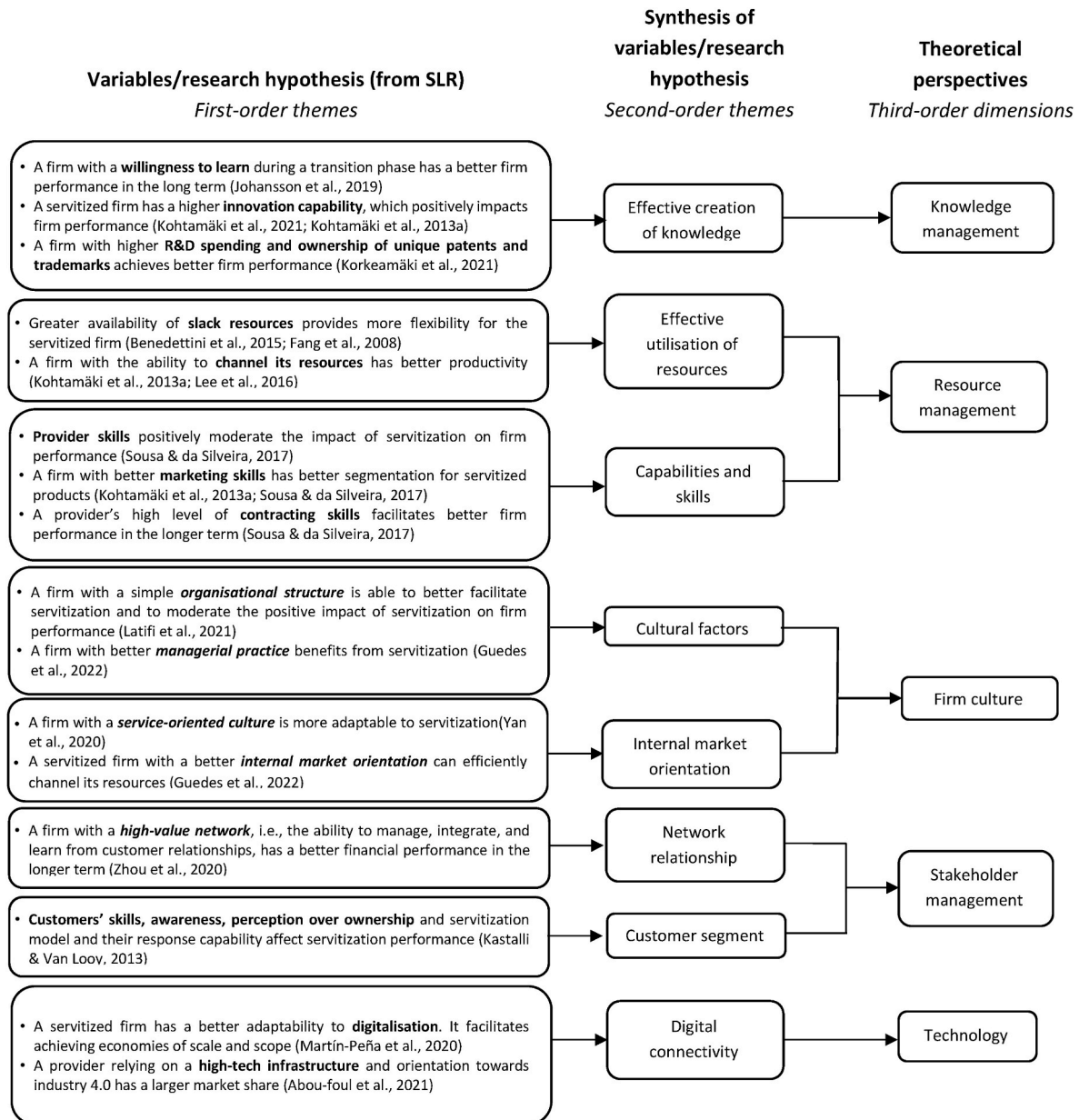


Fig. 6. Thematic analysis of servitization-economic performance.

basis for the subsequent thematic analysis.

### 3.2. Thematic analysis

The three-step thematic analysis helped to identify the theoretical perspectives that underly the prior research on the environmental and economic performance of servitization. Although the analysis yielded different sets of 2nd-order themes for the environmental and economic performance variables, they aligned around five overarching theoretical perspectives: Resource management, Knowledge management, Stakeholder, Firm Culture, and Technology (as shown in Figs. 5 and 6). These overarching theoretical perspectives allow us to explain the joint implications of the environmental and economic performance variables and themes. Using this approach, we can derive theory-driven propositions that will guide future research in exploring these implications in an integrated way.

#### 3.2.1. Resource management

The analysis has identified resource management as one of the most significant theoretical perspectives explaining the variations in the servitization performance impact. The perspective combines research hypotheses focusing on the impact of technology use, capabilities, skills and efficient resource utilization.

In environmental performance-focused studies this research perspective covers variables focused on the importance of resource pooling (Geum and Park, 2011), asset utilization (Lindahl et al., 2014), and operating efficiency (Örsemir et al., 2019). Additionally, it includes considerations of product design as it creates opportunities for reuse, repair, and remanufacture (Spring and Araujo, 2017), as well as upgradability, modular design, and product lifespan (Kanatlı and Karaer, 2022), which reduces waste. Variables related to resource management that affect economic performance include the availability of slack resources (Benedettini et al., 2015), the ability to channel resources (Lee et al., 2016) as well as customer skills, marketing skills, and contracting skills (Sousa & da Silveira, 2017).



RBV theory and propositions.

Several of the studies that have contributed to the resource management perspective explicitly draw on the resource-based view (RBV) theory as their theoretical foundation (e.g., Kühn et al. (2022); Yan et al. (2020) Chen et al. (2016)). Others implicitly draw on RBV by hypothesizing the impact of slack resources (Benedettini et al., 2015), skills (Sousa & da Silveira, 2017), and resource pooling (Geum and Park, 2011) on the servitization performance impact. In the realm of business research, RBV is a widely accepted theory that posits that a firm's performance is influenced by the availability of critical resources (Barney and Arkan, 2005).

However, although these studies (explicitly or implicitly) draw on the RBV in a broader sense, they do not yet adopt it in a narrower sense. RBV in a narrower sense, aims to explain the sustainable competitive advantage of a firm, not just its performance (Peteraf, 1993). Its core argument is that resources can only drive a firm's competitive advantage and long-term performance if they are valuable, rare, inimitable, and non-substitutable (VRIN)<sup>1</sup> (Barney, 1991). The current servitization research falls short of this narrower RBV focus by exploring resource-based variables in general, without considering the VRIN criteria. As manufacturing firms seek to compete with servitization, it is essential to further develop the use of RBV to capture these organisational ambitions. Importantly, manufacturers will not only compete on economic performance but also environmental performance, the further use of the RBV theory should focus on identifying VRIN resources that contribute to both outcomes.

It would also be valuable to broaden the focus of resource management theoretical perspective to not only focus on the availability of essential resources, but also their efficient deployment. Of particular interest here would be Sirmon et al.'s (2011) 'resource orchestration framework', which focuses on the resource management actions (i.e., structuring, bundling, and leveraging) to create the performance effects of resources. The currently used variables of 'resource channelling' (Lee et al., 2016) and 'resource pooling' (Geum and Park, 2011) already focus on this perspective but should be embedded in formalized theoretical frameworks to further advance the resource management research perspective.

### 3.2.2. Knowledge management

The theoretical perspective of knowledge management involves research hypotheses that focus on effective knowledge creation, innovation management, and information exchange throughout the supply chain to explain the difference in the environmental and economic performance impact of servitization.

This perspective covers a variety of knowledge-related variables that are utilized in the studies focusing on environmental performance. These include organizational learning (Laperche and Picard, 2013), innovation diffusion (Mylan, 2015), and absorptive capacity (Zhao et al., 2021). In addition, the manufacturers' emphasis on interfirm communication (Geum and Park, 2011), particularly communication among supply chain partners (Zhao et al., 2021), and the implementation of energy disclosure policies (Doni et al., 2019) are shown to enhance the environmental performance impact of servitization. When it comes to economic performance, variables related to knowledge management such as willingness to learn (Johansson et al., 2019), innovation capability (Kohtamäki et al., 2021) and R&D spending (Korkeamäki et al., 2021) were examined in the research.

Knowledge management theory and propositions.

The reviewed studies highlighted that knowledge management is seldom used as a formal theory based on clear and strong propositions, but as an umbrella that encompasses arguments around innovation practices, absorptive capacity, and organizational learning. To

strengthen the theoretical grounding of the research on servitization performance, it would be beneficial to utilize the formal theoretical frameworks underlying these concepts.

Given the range of variables already considered, the dynamic capabilities theory (Teece, 2018) could form an important theoretical backdrop. This theory explains how a firm's ability to build, integrate, and reconfigure its capabilities in response to changing market conditions and strategic challenges creates performance implications. By incorporating concepts such as those expressed in the variables 'willingness to learn' (Johansson et al., 2019) 'innovation capabilities' (Kohtamäki et al., 2021) and 'internal innovation diffusion' (Mylan, 2015) it would be possible to formally integrate the dynamic capability perspective.

In fact, several core propositions of dynamic capability theory overlap with the challenges of servitization. For many manufacturers, servitization requires the acquisition of new skills and knowledge to be effective (i.e. customer relationship management, service innovation and service provision). Understanding how manufacturers develop and leverage this knowledge can provide critical insights into the performance impact of servitization. Teece (2018), provides an important framework that conceptualizes the components of dynamic capabilities by focusing on sensing (identifying the opportunities), seizing (designing and refining the business model accordingly), and transforming (realigning structure and culture) and explores how these components develop performance implications. Adopting this framework would not only align the knowledge management theme with the wider research base, but also structure the approach for studying this critical servitization performance challenge.

### 3.2.3. Stakeholder management

The analysis also identified stakeholder management as a theoretical perspective that explains variations in servitization performance impact. It combines research hypotheses that explore information exchanges, relationship management, and wider network relationship themes. This perspective covers a range of specific stakeholder management-focused variables such as the role of high-value networks Zhou et al. (2020), customers' skills and awareness (Kastalli and Van Looy, 2013) and collaboration (Kreye and van Donk, 2021).

**3.2.3.1. Stakeholder theory and propositions.** One formal theoretical angle that could be proposed to integrate these variables is stakeholder theory (Wagner Mainardes et al., 2011). This theory suggests that organizations should consider the interests of all their stakeholders, not just their shareholders, in their decision-making processes. It emphasizes the importance of understanding and balancing the needs of various stakeholders, including employees, customers, suppliers, and communities, to achieve long-term sustainability and success.

As servitization involves a deeper engagement with customers, moving from transactional relationships to ongoing service provision stakeholder theory has particular relevance for servitization and its performance implications. By exploring the performance impact of servitization through a stakeholder lens, researchers can examine how these relationship dynamics evolve and contribute to overall performance. In the context of servitization, the integration of stakeholders into the decision-making processes of organizations (Laplume et al., 2008) is of particular interest. Considering the extent to which partners are involved in the entire process of developing new business models in a servitization context would be a highly valuable angle to explore when considering the performance implications of servitization.

### 3.2.4. Firm culture

The manufacturer's firm culture is another core theoretical perspective that was identified in the analysis. This perspective includes themes such as internal market orientation and cultural factors, involving 'internal environment orientation' (Kühl et al., 2022),

<sup>1</sup> Studies alternatively propose the VRIO framework: value, rarity, imitability and organization (Barney, 1995).

'service-oriented culture' (Yan et al., 2020), and 'organizational structure' (Latifi et al., 2021) as core variables.

**3.2.4.1. Firm culture and propositions.** As with some of the other theoretical perspectives the studies employing the variables do not directly follow formalized theories to guide their approaches although their choice of variables falls into these theories. In this case, the variables point towards cultural alignment theory (Büschgens et al., 2013) as an overarching theoretical angle. This theory proposes that a firm's organizational culture must be aligned with its strategy in order to enhance performance. When the culture and strategy are congruent, employees are more likely to understand and support the strategic objectives of the firm, leading to better implementation and execution of its strategy.

Given the shift from traditional product-centric business models to service-oriented ones brought about by servitization, these key tenets of cultural alignment theory become highly relevant. Future research should therefore not just focus on cultural aspects on their own but on how different kinds of organizations require different cultural elements to ensure the environmental and economic performance implications of servitization. The concept of 'strategy-culture fit' (Yarborough et al., 2011) is particularly important in this context and can be used to conceptualize further research.

### 3.2.5. Technology

Another important theoretical perspective identified is focused on technology, specifically digital technology. The variables included under this perspective include digitalisation (Martín-Peña et al., 2020) and high-tech infrastructure (Abou-foul et al., 2021).

**3.2.5.1. Technology and propositions.** The current research on servitization performance has limitations in how it conceptualizes technology. The studies focus solely on the technology itself, rather than the benefits it provides. These benefits include creating insights through the analysis of data from external sources and assets. To achieve environmental and economic performance through servitization, it's not enough to have the right technologies in place. Manufacturers must also have contracts and agreements that grant them access and usage rights to the data and emerging insights.

Resource dependency theory provides important contributions to these challenges (Drees and Heugens, 2013). Resource dependency theory focuses on the external resources, including technology, organizations rely on, to achieve their goals. The theory helps to examine how organizations manage their dependencies and how these dependencies influence organizational behavior and performance. The use of digital technology is a pathway to create access to resources, such as data, and the resource dependency theory provides an important focal point for understanding that. It is particularly relevant to the environmental and economic performance implications of servitization as it highlights the power dynamics in interorganizational relationships. In servitization, there can be power shifts as firms become more reliant on each other for resources. Resource dependency theory can help analyze how these power dynamics influence performance outcomes, such as service quality, innovation, and overall competitiveness.

## 4. Discussion

This study consolidates existing but disparate research on the environmental and economic performance impact of servitization through a systematic literature review. Specifically, we identified the variables that affect how servitization impacts environmental and economic performance, analysed their underlying themes, and explored the theoretical nature of these relationships. Our findings provide several contributions to research and practice.

### 4.1. Research contributions

Firstly, our review provides a consolidated overview of the research studies that indicate the environmental and economic benefits of servitization as well as the specific methods and measures applied in these studies. This overview can help subsequent researchers identify gaps in the literature, position their work, and build on the range of the prior research conducted. Importantly, it helps researchers understand why the environmental and economic benefits of servitization should be looked at together and how they complement each other, supporting the development of integrated research models that explore the balance between these outcomes.

Secondly, our research highlights the importance of focusing on the 'outcome' of servitization. While previous research has primarily focused on the factors driving servitization (Dmitrijeva et al., 2020; Zhang and Banerji, 2017), it becomes crucial to expand the research scope to focus in detail on the servitization outcome. This outcome-focus is of most interest to policymakers as it enables them to carefully direct the investments required. Importantly, our research emphasizes the context that affects the outcome of servitization by focusing on the mediating and moderating variables. Developing this fine-grained understanding of how context determines environmental and economic benefits is crucial for advancing servitization research.

Third, our study has showcased the shared themes that drive the impact scenarios of servitization. By integrating the analysis of moderating and mediating variable that explain the environmental and economic benefits of servitization, we identified overarching theoretical perspectives and outline specific propositions on the basis of these. These propositions will help advance the shared investigations of these variables in a theoretically grounded way.

#### 4.1.1. Appraisal of the evidence base and room for further research

Our research has also identified specific shortcomings in the evidence base that future research should address in a targeted way. Although prior studies have identified a diverse range of variables that moderate or mediate the link between servitization and environmental and economic outcomes (Bhatti et al., 2023; Lafuente and Vaillant, 2023), there are still significant gaps in this range of variables considered. Few of these identified variables offer opportunities for policy makers to develop initiatives or interventions to maximize the benefits of servitization in a targeted way. Future research should consider the opportunities for subsequently exploiting the research findings in a policy context and explicitly investigate variables that fit into this policy decision-making context. Dedicated innovation research, for example, has established research programs that examine the impact of training and taxation on innovation exploitation (Stantcheva, 2021; Tether et al., 2005) which could also be of relevance for a servitization context.

The research also shows the variety of measures used to capture the environmental and economic benefits of servitization. While these shed light on different aspects they do not necessarily align with the measures used in the respective fields, particularly when considered for industry applicability. Dedicated economic-focused measures frequently draw on aspects of productivity (Guedes et al., 2022; Korkeamäki et al., 2021), while sustainability-focused measures often draw on aspects of life-cycle analysis (Carballo-Penela and Castromán-Diz, 2015; Chiarini, 2014). Adopting these established measures would make it easier for future servitization research to integrate with the wider research and align with the prevailing narrative.

An important revelation of the study was also the absence of specific theories to guide the research in the selected publications. Most of the studies are either lacking an explicit theoretical angle or are very generic in their adoption of theory. Therefore, to ensure that future servitization studies are well-integrated with wider research and draw on the insights that have been integrated in the prior theory building process, it would be essential for future research to have a more explicit and rigorous identification with the theories that can guide the research in the

different areas.

The research has shown that various measures are used to capture servitization, such as the percentage of service revenue against total sales (e.g. Wang et al., 2013) and the use of service keywords in shareholder communication (e.g. Kohtamäki et al., 2021). While this range of measures may provide a comprehensive understanding of different aspects of servitization, it makes it challenging to consolidate research findings and gain a coherent understanding of servitization outcomes. Future research should go beyond measuring servitization as a binary decision (e.g. Korkeamäki et al., 2021) or the number of service activities (e.g. Benedettini et al., 2015) and instead focus on measures that identify the sophistication of services (base, intermediate, advanced) in order to capture and compare organizational priorities. Especially in the case of 'advanced services' where the manufacturer focuses on delivering outcomes (Baines et al., 2024a) future research should develop detailed measures to differentiate between various offerings in order to create a detailed understanding of their performance implications. Advanced services offer a considerable range of opportunities for creating and aligning environmental and economic benefits. The IT outsourcing literature, such as Goo (2010), could serve as a starting point for future researchers to explore sophisticated approaches to measure outcome-based offerings.

#### 4.2. Policy and management implication

The study has also provided important insights for both management and policy. One practical contribution for management is the outcome focus that the study proposes. While many manufacturers focus on accelerating servitization (World Manufacturing Forum, 2023), our study shows that servitization is not the end goal. Instead, manufacturers should view servitization as a means to create critical benefits. But creating these critical benefits require the careful development of contextual conditions. This perspective is often overlooked, and manufacturers should think about how to measure the diverse benefits of servitization and ensure that the contextual conditions are in place to ensure the desired benefits will be achieved.

An important critical contribution for policymakers is the clear identification of servitization as driver for creating both environmental and economic benefits. Although previous studies have suggested these benefits, our research consolidation reveals the research base supporting them. Importantly, while there is still a need to further develop the evidence base, the existing evidence already justifies policymakers acting on this opportunity.

Servitization should also be appreciated for its capacity to respond to social challenges. For instance, Kristensen and Remmen (2019) develop a framework mapping the societal benefits of product-service systems (PSS). They argue that the shift from materiality (i.e., products) to non-materiality (i.e., systems) implies a shift from the non-social to the social, as the focus changes from products and user satisfaction to solve societal challenges, which includes multiple stakeholder relations. Similarly, Yang and Evans (2019) claim that the outcomes from advanced services should be evaluated in terms of poverty alleviation, social justice, and improved health. Spadafora and Rapaccini (2024) demonstrate that servitization is a form of social innovation. Therefore, we propose that the potential impacts on people's well-being and societal progress should also drive the adoption of servitization.

There are three key areas that policymakers should focus on to drive the development of the evidence base forward:

1. Policymakers should provide clear guidance on the questions that need to be answered and the evidence that is required to justify full-scale support. Without clear direction it will be difficult to direct the further development of the evidence base.
2. Policymakers should support systematic and rigorous pilots that drive the development of the evidence base. Often the effectiveness of interventions can only be identified in the context of experiments.

It is important to evaluate these initiatives and their findings as part of the development of the evidence base.

3. Policymakers should demonstrate that they are interested in having consultations on this topic. This is already done in some instances (e.g. Government of the United Kingdom, 2019). But the focus should not just be on accelerating the adoption of servitization as it is critical to consider how the development of the benefits can be supported.

## 5. Conclusion

The manufacturing industry is faced with the challenge of balancing economic performance with environmental sustainability. While technical innovations are helpful, they are not enough to solve the issue at the necessary scale. Servitization represents a business model that can help address this challenge by aligning these objectives. However, the current evidence base is too scattered for policymakers to act on and support servitization in a targeted way. This study has consolidated the current evidence, identified the gaps, and suggests future research directions to further develop the evidence base.

It is important to acknowledge the limitations of this paper and the implications these may have for future studies. SLRs and thematic analysis require researchers to make decisions on scope, keyword selection and interpretation. While our study has been transparent in our choices, there is a possibility that other researchers may make different decisions that could impact the findings. In our study, we treated environmental and economic performance as two separate impact scenarios, which is common in the literature. However, they could also be interpreted as nested systems (see Wasserbaur et al., 2023 for an example). Research that explores these nested interactions would be useful in guiding future policy and management decisions. Although informing policy was a primary motivation for this study, we did not consider how servitization may interact with national priorities as the main drivers of policy. Aligning supportive policy and interventions with national priorities will be an essential aspect of future servitization research. We hope our study provides a foundation to guide future research in this area.

### CRediT authorship contribution statement

**Raveen R. Menon:** Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Ali Bigdeli:** Writing – review & editing, Writing – original draft, Conceptualization. **Anwar Adem:** Visualization, Conceptualization. **Andreas Schroeder:** Writing – original draft, Supervision, Investigation, Conceptualization. **Mustabsar Awais:** Visualization, Conceptualization. **Tim Baines:** Writing – original draft, Project administration, Investigation, Conceptualization. **Giuliana Battisti:** Investigation, Conceptualization. **Nigel Driffield:** Supervision, Conceptualization. **Shereen Fouad:** Supervision, Conceptualization. **Mirjam Roeder:** Supervision, Conceptualization.

### Declaration of competing interest

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

### Data availability

No data was used for the research described in the article.

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## References

- Aas, T.H., Pedersen, P.E., 2011. The impact of service innovation on firm-level financial performance. *Serv. Ind. J.* 31 (13), 2071–2090.
- Abadzhev, A., Sukhov, A., Sihvonen, A., Johnson, M., 2022. Managing the complexity of green innovation. *Eur. J. Innovat. Manag.* 25 (6), 850–866.
- Abou-foul, M., Ruiz-Alba, J.L., Soares, A., 2021. The impact of digitalization and servitization on the financial performance of a firm: an empirical analysis. *Prod. Plann. Control* 32 (12), 975–989.
- Agrawal, V.V., Bellos, I., 2017. The potential of servitizing as a green business model. *Manag. Sci.* 63 (5), 1545–1562.
- Ambrose, L., Prim-Allaz, I., Teyssier, C., Peillon, S., 2018. The environment-strategy-structure fit and performance of industrial servitized SMEs. *J. Serv. Manag.* 29 (2), 301–328.
- Annarelli, A., Battistella, C., Nonino, F., 2016. Product service system: a conceptual framework from a systematic review. *J. Clean. Prod.* 139, 1011–1032.
- Baines, T., Ziaee Bigdeli, A., Bustinza, O.F., Shi, V.G., Baldwin, J., Ridgway, K., 2017. Servitization: revisiting the state-of-the-art and research priorities. *Int. J. Oper. Prod. Manag.* 37 (2), 256–278.
- Baines, T., Ziaee Bigdeli, A., Kapoor, K., 2024a. Servitization, advanced services and outcomes. In: Baines, T., et al. (Eds.), *Servitization Strategy: Delivering Customer-Centric Outcomes through Business Model Innovation*. Springer Nature Switzerland, Cham, pp. 17–48.
- Baines, T., Ziaee Bigdeli, A., Kapoor, K., 2024b. Strategic resilience and sustainability of the firm. In: Baines, T., et al. (Eds.), *Servitization Strategy: Delivering Customer-Centric Outcomes through Business Model Innovation*. Springer Nature Switzerland, Cham, pp. 111–126.
- Baines, T.S., Lightfoot, H.W., Benedettini, O., Kay, J.M., 2009. The servitization of manufacturing. *J. Manuf. Technol. Manag.* 20 (5), 547–567.
- Barney, J., 1991. Firm resources and sustained competitive advantage. *J. Manag.* 17 (1), 99–120.
- Barney, J.B., 1995. Looking inside for competitive advantage. *Acad. Manag. Perspect.* 9 (4), 49–61.
- Barney, J.B., Arian, A.M., 2005. The resource-based view: origins and implications. *The Blackwell Handb. Strateg. Manag.* 123–182.
- Benedettini, O., Neely, A., 2019. Service providers and firm performance: investigating the non-linear effect of dependence. *J. Serv. Manag.* 30 (6), 716–738.
- Benedettini, O., Neely, A., Swink, M., 2015. Why do servitized firms fail? A risk-based explanation. *Int. J. Oper. Prod. Manag.* 35 (6), 946–979.
- Bhatti, S.H., Rashid, M., Arslan, A., Tarba, S., Liu, Y., 2023. Servitized SMEs' performance and the influences of sustainable procurement, packaging, and distribution: the mediating role of eco-innovation. *Technovation* 127, 102831.
- Büschgens, T., Bausch, A., Balkin, D.B., 2013. Organizational culture and innovation: a meta-analytic review. *J. Prod. Innovat. Manag.* 30 (4), 763–781.
- Calabrese, A., Levaldi Ghiron, N., Tiburzi, L., Baines, T., Ziaee Bigdeli, A., 2019. The measurement of degree of servitization: literature review and recommendations. *Prod. Plann. Control* 30 (13), 1118–1135.
- Carballo-Penela, A., Castromán-Diz, J.L., 2015. Environmental policies for sustainable development: an analysis of the drivers of proactive environmental strategies in the service sector. *Bus. Strat. Environ.* 24 (8), 802–818.
- Chaney, D., Gardan, J., De Freyman, J., 2022. A framework for the relationship implications of additive manufacturing (3D printing) for industrial marketing: servitization, sustainability and customer empowerment. *J. Bus. Ind. Market.* 37 (1), 91–102.
- Chaudhary, S., Dhir, A., Battisti, E., Klietstik, T., 2022. Mapping the field of crowdfunding and new ventures: a systematic literature review. *Eur. J. Innovat. Manag. ahead-of-print*(ahead-of-print).
- Chen, K.-H., Wang, C.-H., Huang, S.-Z., Shen, G.C., 2016. Service innovation and new product performance: the influence of market-linking capabilities and market turbulence. *Int. J. Prod. Econ.* 172, 54–64.
- Chiari, A., 2014. Sustainable manufacturing-greening processes using specific Lean Production tools: an empirical observation from European motorcycle component manufacturers. *J. Clean. Prod.* 85, 226–233.
- Crozet, M., Milet, E., 2017. Should everybody be in services? The effect of servitization on manufacturing firm performance. *J. Econ. Manag. Strat.* 26 (4), 820–841.
- de Jesus Pacheco, D.A., ten Caten, C.S., Jung, C.F., Navas, H.V.G., Cruz-Machado, V.A., Tonetto, L.M., 2019. State of the art on the role of the theory of inventive problem solving in sustainable product-service systems: past, present, and future. *J. Clean. Prod.* 212, 489–504.
- Dmitrijeva, J., Schroeder, A., Ziaee Bigdeli, A., Baines, T., 2020. Context matters: how internal and external factors impact servitization. *Prod. Plann. Control* 31 (13), 1077–1097.
- Doni, F., Corvino, A., Bianchi Martini, S., 2019. Servitization and sustainability actions. Evidence from European manufacturing companies. *J. Environ. Manag.* 234, 367–378.
- Drees, J.M., Heugens, P.P.M.A.R., 2013. Synthesizing and extending resource dependence theory: a meta-analysis. *J. Manag.* 39 (6), 1666–1698.
- Durach, C.F., Kembro, J., Wieland, A., 2017. A new paradigm for systematic literature reviews in supply chain management. *J. Supply Chain Manag.* 53 (4), 67–85.
- Eggert, C.-G., Winkler, C., Volkmann, A., Schumann, J.H., Wunderlich, N.V., 2022. Understanding intra- and interorganizational paradoxes inhibiting data access in digital servitization. *Ind. Market. Manag.* 105, 404–421.
- Fang, E., Palmatier, R.W., Steenkamp, J., 2008. Effect of service transition strategies on firm value. *J. Market.* 72 (5), 1–14.
- Fargnoli, M., Costantino, F., Di Gravio, G., Tronci, M., 2018. Product service-systems implementation: a customized framework to enhance sustainability and customer satisfaction. *J. Clean. Prod.* 188, 387–401.
- Ferasso, M., Beliaeva, T., Kraus, S., Clauss, T., Ribeiro-Soriano, D., 2020. Circular economy business models: the state of research and avenues ahead. *Bus. Strat. Environ.* 29 (8), 3006–3024.
- Geissdoerfer, M., Vladimirova, D., Evans, S., 2018. Sustainable business model innovation: a review. *J. Clean. Prod.* 198, 401–416.
- Geum, Y., Park, Y., 2011. Designing the sustainable product-service integration: a product-service blueprint approach. *J. Clean. Prod.* 19 (14), 1601–1614.
- Gioia, D.A., Corley, K.G., Hamilton, A.L., 2012. Seeking qualitative rigor in inductive research: notes on the gioia methodology. *Organ. Res. Methods* 16 (1), 15–31.
- Goo, J., 2010. Structure of service level agreements (SLA) in IT outsourcing: the construct and its measurement. *Inf. Syst. Front* 12 (2), 185–205.
- Government of the United Kingdom, 2019. West midlands local industrial strategy. *Pol. Pap.*
- Guedes, M.J., Patel, P.C., Kowalkowski, C., Oghazi, P., 2022. Family business, servitization, and performance: evidence from Portugal. *Technol. Forecast. Soc. Change* 185, 122053.
- Han, S.H.U., Kuruzovich, J., Ravichandran, T., 2013. Service expansion of product firms in the information technology industry: an empirical study. *J. Manag. Inf. Syst.* 29 (4), 127–157.
- He, Y., Lai, K.K., 2012. Supply chain integration and service oriented transformation: evidence from Chinese equipment manufacturers. *Int. J. Prod. Econ.* 135 (2), 791–799.
- Johansson, A.E., Raddats, C., Witell, L., 2019. The role of customer knowledge development for incremental and radical service innovation in servitized manufacturers. *J. Bus. Res.* 98, 328–338.
- Kanatli, M.A., Karaer, Ö., 2022. Servitization as an alternative business model and its implications on product durability, profitability & environmental impact. *Eur. J. Oper. Res.* 301 (2), 546–560.
- Kastalli, I.V., Van Looy, B., 2013. Servitization: disentangling the impact of service business model innovation on manufacturing firm performance. *J. Oper. Manag.* 31 (4), 169–180.
- Khan, I.S., Ahmad, M.O., Majava, J., 2021. Industry 4.0 and sustainable development: a systematic mapping of triple bottom line, Circular Economy and Sustainable Business Models perspectives. *J. Clean. Prod.* 297, 126655.
- Khanra, S., Dhir, A., Parida, V., Kohtamäki, M., 2021. Servitization research: a review and bibliometric analysis of past achievements and future promises. *J. Bus. Res.* 131, 151–166.
- Kharlamov, A.A., Parry, G., 2020. The impact of servitization and digitization on productivity and profitability of the firm: a systematic approach. *Prod. Plann. Control* 32 (3), 185–197.
- Kohtamäki, M., Bhandari, K.R., Rabetino, R., Ranta, M., 2024. Sustainable servitization in product manufacturing companies: the relationship between firm's sustainability emphasis and profitability and the moderating role of servitization. *Technovation* 129, 102907.
- Kohtamäki, M., Bhandari, K.R., Ranta, M., Salo, J., 2021. The role of ambidextrous innovation in servitization: the nonlinear relationship between servitization and company profitability and the moderating role of ambidextrous innovation. Available at: SSRN: <https://ssrn.com/abstract=3845255>.
- Kohtamäki, M., Partanen, J., Möller, K., 2013a. Making a profit with R&D services — the critical role of relational capital. *Ind. Market. Manag.* 42 (1), 71–81.
- Kohtamäki, M., Partanen, J., Parida, V., Wincent, J., 2013b. Non-linear relationship between industrial service offering and sales growth: the moderating role of network capabilities. *Ind. Market. Manag.* 42 (8), 1374–1385.
- Kolagar, M., Parida, V., Sjödin, D., 2022. Ecosystem transformation for digital servitization: a systematic review, integrative framework, and future research agenda. *J. Bus. Res.* 146, 176–200.
- Kolling, C., de Medeiros, J.F., Duarte Ribeiro, J.L., Moreira, D., 2022. A conceptual model to support sustainable Product-Service System implementation in the Brazilian agricultural machinery industry. *J. Clean. Prod.* 355, 131733.
- Korkeamäki, L., Kohtamäki, M., Parida, V., 2021. Worth the risk? The profit impact of outcome-based service offerings for manufacturing firms. *J. Bus. Res.* 131, 92–102.
- Kreye, M.E., van Donk, D.P., 2021. Servitization for consumer products: an empirical exploration of challenges and benefits for supply chain partners. *Int. J. Oper. Prod. Manag.* 41 (5), 494–516.
- Kristensen, H.S., Remmen, A., 2019. A framework for sustainable value propositions in product-service systems. *J. Clean. Prod.* 223, 25–35.
- Kühl, C., Bourlakis, M., Aktas, E., Skipworth, H., 2022. Product-service systems and circular supply chain practices in UK SMEs: the moderating effect of internal environmental orientation. *J. Bus. Res.* 146, 155–165.
- Lafuente, E., Vaillant, Y., 2023. Greening as a competitiveness optimizer of servitization. *Technovation* 127, 102849.
- Laperche, B., Picard, F., 2013. Environmental constraints, Product-Service Systems development and impacts on innovation management: learning from manufacturing firms in the French context. *J. Clean. Prod.* 53, 118–128.
- Laplume, A.O., Sonpar, K., Litz, R.A., 2008. Stakeholder theory: reviewing a theory that moves us. *J. Manag.* 34 (6), 1152–1189.
- Latifi, M.-A., Nikou, S., Bouwman, H., 2021. Business model innovation and firm performance: exploring causal mechanisms in SMEs. *Technovation* 107, 102274.
- Laurent Probst, L.F., Benoît, Cambier, Ankeras, Sarah, Jesper, Lidé, 2016. Servitisation: Service and Predictive Maintenance Contracts. European Commission. Available at:

- <https://ec.europa.eu/docsroom/documents/16594/attachments/1/translations/en/renditions/native>.
- Lee, S., Yoo, S., Kim, D., 2016. When is servitization a profitable competitive strategy? *Int. J. Prod. Econ.* 173, 43–53.
- Lelah, A., Mathieux, F., Brissaud, D., Vincent, L., 2012. Collaborative network with smes providing a backbone for urban pss: a model and initial sustainability analysis. *Prod. Plann. Control* 23 (4), 299–314.
- Li, X., Wang, X., Zhang, Y., Miao, X., 2021. Spatial differences in emission reduction effect of servitization of manufacturing industry export in China. *Emerg. Mark. Finance Trade* 57 (8), 2331–2355.
- Lindahl, M., Sundin, E., Sakao, T., 2014. Environmental and economic benefits of Integrated Product Service Offerings quantified with real business cases. *J. Clean. Prod.* 64, 288–296.
- Marić, J., Opazo-Basáez, M., 2019. Green servitization for flexible and sustainable supply chain operations: a review of reverse logistics services in manufacturing. *Global J. Flex. Syst. Manag.* 20 (1), 65–80.
- Martín-Peña, M.-L., Sánchez-López, J.-M., Díaz-Garrido, E., 2020. Servitization and digitalization in manufacturing: the influence on firm performance. *J. Bus. Ind. Market.* 35 (3), 564–574.
- Maxwell, J., 1992. Understanding and validity in qualitative research. *Harv. Educ. Rev.* 62 (3), 279–301.
- Montabon, F., Sroufe, R., Narasimhan, R., 2007. An examination of corporate reporting, environmental management practices and firm performance. *J. Oper. Manag.* 25 (5), 998–1014.
- Moran, D., Wood, R., Hertwich, E., Mattson, K., Rodriguez, J.F.D., Schanes, K., Barrett, J., 2020. Quantifying the potential for consumer-oriented policy to reduce European and foreign carbon emissions. *Clim. Pol.* 20 (Suppl. 1), S28–S38.
- Muñoz-Villamizar, A., Santos, J., Garcia-Sabater, J.J., Lleo, A., Grau, P., 2019. Green value stream mapping approach to improving productivity and environmental performance. *Int. J. Prod. Perform. Manag.* 68 (3), 608–625.
- Muñoz-Villamizar, A., Santos, J., Viles, E., Ormazábal, M., 2018. Manufacturing and environmental practices in the Spanish context. *J. Clean. Prod.* 178, 268–275.
- Mylan, J., 2015. Understanding the diffusion of Sustainable Product-Service Systems: insights from the sociology of consumption and practice theory. *J. Clean. Prod.* 97, 13–20.
- Naor, M., Druehl, C., Bernardes, E.S., 2018. Servitized business model innovation for sustainable transportation: case study of failure to bridge the design-implementation gap. *J. Clean. Prod.* 170, 1219–1230.
- Neely, A., 2008. Exploring the financial consequences of the servitization of manufacturing. *Operat. Manag. Res.* 1 (2), 103–118.
- OECD, 2017. Servitization mapping: a practical tool to explore strategic directions in a servitization shift. *Livework Insight*.
- Örsemir, A., Deshpande, V., Parlaktürk, A.K., 2019. Is servitization a win-win strategy? Profitability and environmental implications of servitization. *Manuf. Serv. Oper. Manag.* 21 (3), 674–691.
- Paiola, M., Schiavone, F., Grandinetti, R., Chen, J., 2021. Digital servitization and sustainability through networking: some evidences from IoT-based business models. *J. Bus. Res.* 132, 507–516.
- Peteraf, M.A., 1993. The cornerstones of competitive advantage: a resource-based view. *Strat. Manag. J.* 14 (3), 179–191.
- Pialot, O., Millet, D., Bisiaux, J., 2017. “Upgradable PSS”: clarifying a new concept of sustainable consumption/production based on upgradability. *J. Clean. Prod.* 141, 538–550.
- Polova, O., Thomas, C., 2020. How to perform collaborative servitization innovation projects: the role of servitization maturity. *Ind. Market. Manag.* 90, 231–251.
- Rabetino, R., Kohtamäki, M., Gebauer, H., 2017. Strategy map of servitization. *Int. J. Prod. Econ.* 192, 144–156.
- Reim, W., Parida, V., Örtqvist, D., 2015. Product-Service Systems (PSS) business models and tactics – a systematic literature review. *J. Clean. Prod.* 97, 61–75.
- Semieniuk, G., Campiglio, E., Mercure, J.-F., Volz, U., Edwards, N.R., 2021. Low-carbon transition risks for finance. *WIREs Clim. Chang.* 12 (1), e678.
- Shah, S.A.A., Jajja, M.S.S., Chatha, K.A., Farooq, S., 2020. Servitization and supply chain integration: an empirical analysis. *Int. J. Prod. Econ.* 229, 107765.
- Sheridan, A., Newsome, L., Howard, T., Lawson, A., Saunders, S., 2021. Intergenerational farm succession: how does gender fit? *Land Use Pol.* 109, 105612.
- Sirmon, D.G., Hitt, M.A., Ireland, R.D., Gilbert, B.A., 2011. Resource orchestration to create competitive advantage: breadth, depth, and life cycle effects. *J. Manag.* 37 (5), 1390–1412.
- Sjödin, D., Parida, V., Kohtamäki, M., Wincent, J., 2020. An agile co-creation process for digital servitization: a micro-service innovation approach. *J. Bus. Res.* 112, 478–491.
- Song, W., Sakao, T., 2017. A customization-oriented framework for design of sustainable product/service system. *J. Clean. Prod.* 140, 1672–1685.
- Sousa, R., da Silva, G.J.C., 2017. Capability antecedents and performance outcomes of servitization. *Int. J. Oper. Prod. Manag.* 37 (4), 444–467.
- Spadafora, M., Rapaccini, M., 2024. Bridging the gap between servitization and social innovation. *J. Clean. Prod.* 452, 142178.
- Spring, M., Araujo, L., 2017. Product biographies in servitization and the circular economy. *Ind. Market. Manag.* 60, 126–137.
- Stantcheva, S., 2021. The Effects of Taxes on Innovation: Theory and Empirical Evidence. National Bureau of Economic Research Working Paper Series, 29359.
- Suarez, F.F., Cusumano, M.A., Kahl, S.J., 2013. Services and the business models of product firms: an empirical analysis of the software industry. *Manag. Sci.* 59 (2), 420–435.
- Szász, L., Demeter, K., Boer, H., Cheng, Y., 2017. Servitization of manufacturing: the effect of economic context. *J. Manuf. Technol. Manag.* 28 (8), 1011–1034.
- Szász, L., Seer, L., 2018. Towards an operations strategy model of servitization: the role of sustainability pressure. *Operat. Manag. Res.* 11 (1), 51–66.
- Tang, Y., Zhu, S., Luo, Y., Duan, W., 2022. Input servitization, global value chain, and carbon mitigation: an input-output perspective of global manufacturing industry. *Econ. Modell.* 117, 106069.
- Teece, D.J., 2018. Business models and dynamic capabilities. *Long. Range Plan.* 51 (1), 40–49.
- Templier, M., Paré, G., 2018. Transparency in literature reviews: an assessment of reporting practices across review types and genres in top IS journals. *Eur. J. Inf. Syst.* 27 (5), 503–550.
- A literature review on skills and innovation. How does successful innovation impact on the demand for skills and how do skills drive innovation. In: Tether, B., Mina, A., Consoli, D., Gagliardi, D. (Eds.), 2005. *ESRC Centre for Research on Innovation and Competition*. University of Manchester, United Kingdom.
- Tranfield, D., Denyer, D., Smart, P., 2003. Towards a methodology for developing evidence-informed management knowledge by means of systematic review. *Br. J. Manag.* 14 (3), 207–222.
- Valtakoski, A., Witel, L., 2018. Service capabilities and servitized sme performance: contingency on firm age. *Int. J. Oper. Prod. Manag.* 38 (4), 1144–1164.
- Visnjic, I., Wiengarten, F., Neely, A., 2016. Only the brave: product innovation, service business model innovation, and their impact on performance. *J. Prod. Innovat. Manag.* 33 (1), 36–52.
- Wagner Mainardes, E., Alves, H., Raposo, M., 2011. Stakeholder theory: issues to resolve. *Manag. Decis.* 49 (2), 226–252.
- Wang, M., Li, Y., Li, J., Wang, Z., 2021. Green process innovation, green product innovation and its economic performance improvement paths: a survey and structural model. *J. Environ. Manag.* 297, 113282.
- Wang, W., Chen, S., Shao, J., Chu, J., Yuan, Z., 2023. The impact of servitization on trade credit in manufacturing firms: a signaling theory perspective. *Int. J. Oper. Prod. Manag.* 43 (2), 373–398.
- Wannakrairoy, W., Velu, C., 2021. Productivity growth and business model innovation. *Econ. Lett.* 199, 109679.
- Wasserbauer, R., Schroeder, A., Beltagui, A., 2023. Heat-as-a-Service (HaaS): a complex adaptive systems perspective on servitization. *Prod. Plann. Control* 1–15.
- Wei, Z., Huang, W., Wang, Y., Sun, L., 2022. When does servitization promote product innovation? The moderating roles of product modularization and organization formalization. *Technovation* 117, 102594.
- Whelan, T., Fink, C., 2016. The comprehensive business case for sustainability. *Harv. Bus. Rev.* Available at: <https://hbr.org/2016/10/the-comprehensive-business-case-for-sustainability>.
- World Economic Forum, 2020. What is servitization, and how can it help save the planet? *Pioneers Chang. Summit*. Available at: <https://www.weforum.org/agenda/2020/11/what-is-servitization-and-how-can-it-help-save-the-planet/>.
- World Economic Forum, 2023. Reducing the carbon footprint of the manufacturing industry through data sharing. Available at: <https://www.weforum.org/impact/carbon-footprint-manufacturing-industry/>.
- World Manufacturing Forum, 2023. New business models for the manufacturing of the future. Available at: [https://worldmanufacturing.org/wp-content/uploads/28/6-WMF-Report-2023\\_E-Book\\_b-ok-1.pdf](https://worldmanufacturing.org/wp-content/uploads/28/6-WMF-Report-2023_E-Book_b-ok-1.pdf).
- Xing, Y., Liu, Y., 2023. Integrating product-service innovation into green supply chain management from a life cycle perspective: a systematic review and future research directions. *Technovation* 126, 102825.
- Yan, K., Li, G., Cheng, T.C.E., 2020. The impact of service-oriented organizational design factors on firm performance: the moderating role of service-oriented corporate culture. *Int. J. Prod. Econ.* 228, 107745.
- Yang, M., Evans, S., 2019. Product-service system business model archetypes and sustainability. *J. Clean. Prod.* 220, 1156–1166.
- Yang, Z., Luo, J., Feng, T., Pan, R., 2023. How servitization affects firm performance: the moderating roles of corporate social responsibility and green innovation. *J. Manuf. Technol. Manag. ahead-of-print*(ahead-of-print).
- Yarborough, L., Morgan, N.A., Vorhies, D.W., 2011. The impact of product market strategy-organizational culture fit on business performance. *J. Acad. Market. Sci.* 39 (4), 555–573.
- Zhang, J., Chen, M., Zhang, M., Liu, H., 2023. Environmental performance of servitized manufacturing firms: the (mis)alignment between servitization strategies and inter-organizational information technology capabilities. *Ind. Manag. Data Syst.* 123 (3), 722–745.
- Zhang, J., Qi, L., Wang, C., Lyu, X., 2022. The impact of servitization on the environmental and social performance in manufacturing firms. *J. Manuf. Technol. Manag.* 33 (3), 425–447.
- Zhang, W., Banerji, S., 2017. Challenges of servitization: a systematic literature review. *Ind. Market. Manag.* 65, 217–227.
- Zhao, J., Dong, X., Dong, K., 2021. How does producer services’ agglomeration promote carbon reduction?: the case of China. *Econ. Modell.* 104, 105624.
- Zhao, X., Hwang, B.-G., Lu, Q., 2018. Typology of business model innovations for delivering zero carbon buildings. *J. Clean. Prod.* 196, 1213–1226.
- Zhou, D., Yan, T.T., Zhao, L.L., Guo, J.J., 2020. Performance implications of servitization: does a Manufacturer’s service supply network matter? *Int. J. Prod. Econ.* 219, 31–42.