Digital service innovation (DSI): a multidisciplinary (re)view of its origins and progress using bibliometric and text mining methods

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Rodrigo Rabetino
School of Management, University of Vaasa, Vaasa, Finland
Marko Kohtamäki
School of Management, University of Vaasa, Vaasa, Finland and Entrepreneurship and Innovation, Lulea University of Technology, Lulea, Sweden, and
Tuomas Huikkola
School of Management, University of Vaasa, Vaasa, Finland

Abstract

Purpose – This paper studies the Digital Service Innovation (DSI) concept by systematically reviewing earlier studies from various scholarly communities. This study aims to recognize how recent advances in DSI literature from different research streams complement and can be incorporated into the growing digital servitization literature to define better and understand DSI.

Design/methodology/approach – After systematically identifying 123 relevant articles, this study employed complementary methods, such as author bibliographic coupling, linguistic text mining/textual analysis and qualitative content analyses.

Findings – This paper first maps the intellectual structure and boundaries of the DSI-related communities and qualitatively assesses their characteristics. These communities are (1) Innovation for digital servitization, (2) Service innovation in the digital age and (3) Adoption of novel e-services enabled by information system development. Next, the composition of the DSI concept is examined and depicted to comprehend the notion's critical dimensions. The findings discuss the range of theories and methods in the existing research, including antecedents, processes and outcomes of DSI.

Originality/value – This study reviews, extends the understanding of origins and critically evaluates DSI-related research. Moreover, the paper redefines and clarifies the structure and boundaries of the DSI-concept. In doing so, it elaborates on the substance of DSI and identifies the essential themes for its understanding and conceptualization. Thus, the study helps the future development of the concept and allows knowledge accumulation by bridging adjacent research communities. It helps researchers and managers navigate the foggy emerging research landscape.

Keywords Digital service innovation, Digital servitization, Business models, Co-creation, Ecosystems

Paper type Literature review

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1. Introduction

At the sweet spot of service innovation and digitalization literature, Digital Service Innovation (DSI) transforms how digitally-enabled service offerings are designed, delivered, customized and consumed (Opazo-Basáez *et al.*, 2022a). The Internet of Things (IoT) (Markfort *et al.*, 2022), cloud computing (Nittala *et al.*, 2022), artificial intelligence (AI), Augmented/Virtual Reality (AR/VR) (Porter and Heppelmann, 2017), large language models (LLM) and big data analytics (BDA) (Lehrer *et al.*, 2018) drive DSI. Yet, it goes beyond digitization or the transition from analogic to digital. Instead, it embraces digitalization, that is applying these technologies to society in today's digital economy (Vial, 2019), thus becoming a vital source of competitive advantage for firms. The subject has attracted attention from researchers across disciplines, mainly marketing and information systems (Barrett *et al.*, 2015). Scholars have examined various aspects, such as the design and delivery of digital services, the development of new business models and revenue streams and the role of value-creation architectures (e.g. ecosystems or service systems) in driving innovation through co-creation (Lusch and Nambisan, 2015). Information systems research has focused on the technical aspects of DSI and digital transformation strategies (Soto Setzke *et al.*, 2023). Products are seen as carriers of digital technologies that merge the physical and digital worlds and enable service innovation (Chowdhury, 2016). In contrast, marketing research highlights the importance of adopting a user-centered approach to understanding users' needs, preferences and experiences in developing digital services to enhance satisfaction and acceptance (Kropp and Totzek, 2020; Lusch and Nambisan, 2015).

A significant share of the early research was conducted in the service industries and business-to-consumer (B2C) context (e.g. banking, healthcare, tourism, and peer-to-peer platforms). Scholars also studied DSI in a business-to-business (B2B) setting, mainly connected to digital servitization (Kohtamäki *et al.*, 2019) and smart product-service systems (Kropp and Totzek, 2020). B2B research has focused on integrating digital technologies into traditional service offerings to deliver advanced services, where digitally enabled innovation materializes in product-service-software offerings. Thus, manufacturers, previously focused on process and new product development (NPD), now face the need to incorporate new service development (NSD) activities in the form of product-service innovation (PSI) to provide smart solutions (Huikkola *et al.*, 2022a). While servitization scholars also acknowledge the interplay between digital offerings, business models, and ecosystems (Kohtamäki *et al.*, 2022a, b), it was initially done without explicitly referring to the DSI concept. Recently, they recognized DSI as a paradigm shift in technological innovation (Opazo-Basáez *et al.*, 2022a).

DSI is complex, calling for interdisciplinary research considering the technological, organizational, and human/societal factors that shape it (Bolton *et al.*, 2018; Häikiö and Koivumäki, 2016). Although the DSI notion is not new, it has been explicitly and implicitly embedded in somehow fragmented research across many disciplines. These circumstances hindered any conceptualization based on identifying the constituent elements that shape DSI (Opazo-Basáez *et al.*, 2022b). Indeed, facing the emergence of a multidisciplinary notion, the coexistence of various perspectives, methods and shared vocabularies restricts knowledge creation and accumulation (Rabetino *et al.*, 2021). Thus, an accurate understanding is needed to permit better conceptual integration of the ideas from different research communities. Moreover, understanding how marketing and information systems research on DSI contributes to and can be integrated into the digital servitization literature is essential for developing its research agenda.

Against this backdrop, this paper examines the DSI concept by systematically reviewing and integrating earlier studies from various research streams. The aim is to recognize how marketing and information systems literature (Barrett *et al.*, 2015; Lusch and Nambisan, 2015) set the ground to integrate DSI into digital servitization literature (Kohtamäki *et al.*, 2022a, b). The paper uses bibliometric and content analyses to connect different scholarly communities. We reviewed 123 articles using author bibliographic coupling (Waltman *et al.*, 2010), text mining based on thematic and semantic analyses (word co-occurrence) and a Bayesian machine-learning algorithm (Wilden *et al.*, 2016) and qualitative content analysis (Rabetino

et al., 2018; Schreier, 2012). First, the intellectual structure and boundaries of the field are mapped in clusters. Three scholarly communities emerged: 1) Innovation for digital servitization, 2) Service innovation in the digital age and 3) Adoption of novel e-services enabled by information system development). Next, we conducted linguistic text mining and textual analysis using the (full) text in the sampled journal articles. The study reveals 11 primary themes when the 123 are considered together. Finally, qualitative content analysis complemented the examination to comprehend the DSI concept.

Concerning its contributions, the paper connects past DSI-related interdisciplinary research, clarifies its structure and boundaries and identifies the essential themes of the DSI concept, allowing future knowledge accumulation and supporting its development. So far, only one comprehensive attempt to review the DSI concept exists, a paper focusing on the impact of big data analytics from an information systems perspective and covering the service industry (Rizk *et al.*, 2017). The present study extends it in two ways. First, this paper is not limited to the role of big data analytics but adopts a broader definition of digitalization. Second, it incorporates inputs from the digital servitization literature focused on manufacturing. Thus, this study offers a starting point for understanding the conceptual roots and the development of the key ideas, concepts and methods utilized by the different DSI-related communities and how they support the development of digital servitization research. Indeed, incorporating inputs from service innovation literature was pointed out as a gap in servitization research (Chester Goduscheit and Faullant, 2018). Finally, this study allows managers to benchmark, evaluate and advance their firms' digital service innovation-related practices and processes to enable a faster and smoother digital transformation and expand value creation, delivery and capture opportunities.

After this introduction, this article is organized into four sections. Section 2 presents the study's methodology, including the sample selection, analysis tools and analysis process. Section 3 structures the DSI-related research through bibliographic coupling and a systematic qualitative review of the three resulting clusters. Next, Section 4 moves from the clusters to a shared understanding and conceptualization of DSI based on text mining. As a result, we identify 11 themes (subthemes and concepts) that co-form a multidisciplinary understanding of DSI. While Section 3 aims to distinguish (clustering) and deeply understand different streams and their disciplinary basis (e.g. theories and methods), Section 4 seeks to create a unified idea and definition of DSI. Finally, Section 5 presents the takeaways and implications of our study, including contributions, future research suggestions and limitations. In particular, this section focuses on directions that digital servitization academics can envision for the future rather than a detailed agenda for each cluster.

2. Methodology

The four-step methodology used in this study for the systematic literature review is depicted in Figure 1. We started by looking for a set of predetermined keywords in peer-reviewed academic articles published in English (published and in-press, excluding conference proceedings) accessible in Elsevier's Scopus, regarded as the most comprehensive tool for systematic literature searches (Rabetino *et al.*, 2021). The search string was carefully defined and included a variety of DSI-related keywords.

As seen from the search string, we follow a broad search due to the novelty and ambiguity of DSI as a concept. We knew from the outset that debugging the database would be arduous, but this strategy was preferred to a narrower search string, which could mean the loss of many relevant documents. Thus, the search string required potentially relevant articles to include one of the following terms in the title or authors' keywords: ("autonomous" OR "big data" OR "cloud computing" OR "artificial intelligence" OR "digital" OR "digitization" OR "digitisation" OR "internet-of-things" OR "IoT" OR "Internet of things" OR "connectivity*" OR "5g" OR "6g" OR "industry 4.0" OR "smart solution" OR "smart product") AND ("servic*"

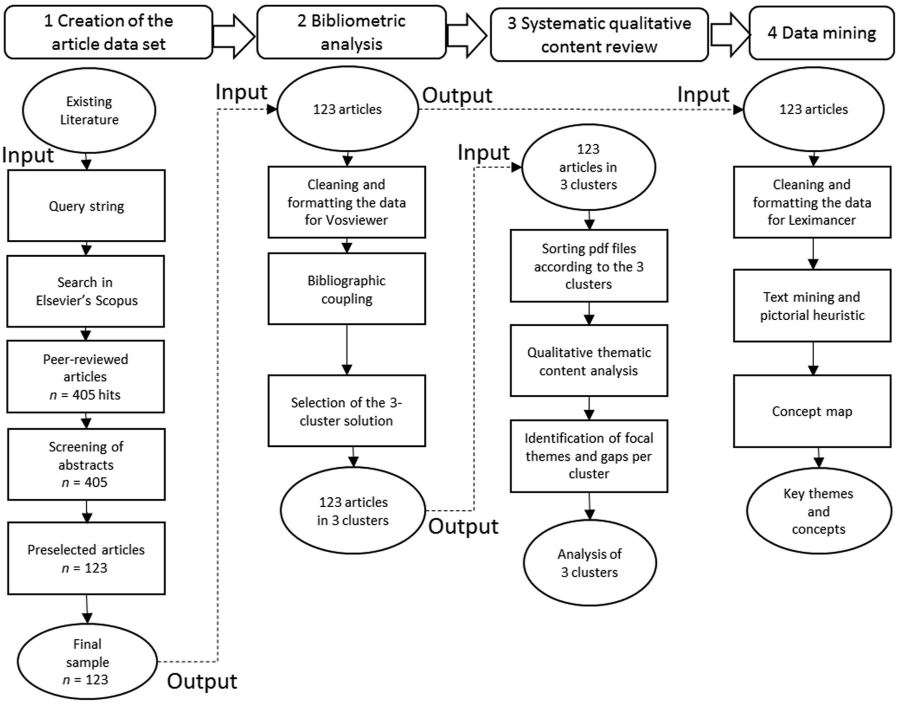


Figure 1.
The four-step methodology

Source(s): Authors own creation

OR "product-service-software*" OR "product, service, software*" OR "servitization" OR "servitisation") AND ("innovat*" OR "develop*").

Concerning the string, we started with the three essential components of the DSI concept: digital, services, and innovation. Keywords for each component were selected by brainstorming among the co-authors. In doing so, we considered existing studies. We first started from Kohtamäki *et al.*, 2022a, b, p. 254, who state, "*For the servitization search string, we used the keywords of "service infusion*", "servitization*", "servitisation*", "service transition*", and "service transformation*". For digitalization, we used the keywords of "digital", "internet-of-things", "Internet of things", "IoT", "remote", "industry 4.0", "smart solution", "smart product", "autonomous solution*", "artificial intelligence", and "AI"*". We also considered Sjödin *et al.* (2020, p. 478) definition, "*. . . the transformation in processes, capabilities, and offerings within industrial firms and their associated ecosystems to progressively create, deliver, and capture increased service value arising from a broad range of enabling digital technologies such as the Internet of Things (IoT), big data, artificial intelligence (AI), and cloud computing*".

The article search was limited to journals at levels 2, 3, 4, and 4* in Academic Journal Guide (AJG) to ensure the quality of the included outlets. We started by including only AJG3, AJG4, and AJG4* journals, as done by many earlier reviews (Khanra *et al.*, 2021; Raddats *et al.*, 2019). However, many articles on servitization are published in good journals at the AJG2 level (Rabetino *et al.*, 2018, 2021). In this case, we would leave good articles in reputable journals such as Research Technology Management, Journal of Business and Industrial Marketing, and Journal of Service Management. Still, we wanted to limit the search to AJG2 or above journals as a quality warranty.

As of 31 December 2022, the search produced 589 hits that were then checked for relevance. Based on the abstract review, we first eliminated papers that did not contribute to the DSI-related

discussion but merely referenced a few related keywords (the entire document was scanned in case the decision could not be made based on the abstracts). Due to the ambiguity of the concept under investigation, the lead author screened the 589 documents. This option would ensure the application of similar criteria when assessing each document. Only in those cases that raised doubts or were borderline were the co-authors involved in the decision on inclusion. Most unchosen papers were excluded because they did not concurrently address the three central notions at the core of the DSI concept. Concerning the digital servitization literature, we have chosen only articles that understand the phenomenon as a form of service innovation, an alternative means of innovation based on digital technologies (Opazo-Basáez *et al.*, 2022a).

The final sample comprised 123 articles from 41 journals. However, 23 outlets account for 95% of the papers, and eight journals account for 50% of the sample (Table 1).

Next, we conducted a bibliographic coupling including the selected documents using VOSViewer™ (Waltman *et al.*, 2010) to organize the available DSI research. The approach determines how closely related two documents are based on how many references they have in common. Bibliographic coupling is the best option for the present paper because it is more accurate and less biased toward the past than co-citation analysis. Therefore, it was shown to be the most appropriate bibliometric method for mapping trends in recent or emerging fields (within a limited timeframe) and understanding future research priorities (Vogel and Güttel, 2013; Zupic and Čater, 2015). The exercise produced three clusters: 1) Innovation for digital servitization, 2) Service innovation in the digital age and 3) Adoption of novel e-services enabled by information system development (labels reflect common citation structures rather than characterizing each cluster conclusively). For clarity, the outcome showing three clusters is presented in the final co-citation network rather than forcing these three to split into more clusters, which could be too specific and contain only a few documents. Finally, we performed an article content review by reading all the papers in each cluster and then categorizing them based on their primary research ideas and contents.

Finally, this article used the Leximancer™ software to determine through text mining and a pictorial heuristic illustration the most relevant DSI themes according to the co-occurrence of words, which considers their frequency and connectivity (Wilden *et al.*, 2019). Based on a Bayesian machine learning algorithm, the software performs thematic and semantic analyses of textual data (the full text of the selected articles). It provides a concept map including critical conceptual components of DSI depicted as a set of separate themes and concepts,

Journal	Number of publications
Journal of Business Research	16
Industrial Marketing Management	8
MIS Quarterly: Management Information Systems	8
Technovation	8
Journal of Cleaner Production	7
Technological Forecasting and Social Change	7
Journal of Service Management	6
International Journal of Information Management	5
Computers in Industry	4
Information Systems Frontiers	4
Journal of Product Innovation Management	4
Information and Management	3
International Journal of Electronic Commerce	3
International Journal of Production Economics	3
Research Technology Management	3

Source(s): Authors own creation

Table 1. Number of publications per journal in the sample (15 most relevant outlets, with at least three articles)

representing different edges from which to analyze DSI (Pinilla-De La Cruz *et al.*, 2020). As a preparation step, all articles were converted into text format. Some sections and other parts that may introduce noise in the analysis were removed (e.g. the reference list, the abstract and keywords, the methodology, authors' names and affiliations, the publication and journal details on each page and the tables and figures).

We performed the analysis in steps, from general to detailed. We started with the smallest possible number of dimensions, themes (and concepts) and kept changing the settings to see how these themes were decomposed into a higher number of smaller and more focused themes (see Figure A in Appendix). Three main dimensions emerged in the first step (step A in Figure A): service, digital and Innovation. These unsurprising results help corroborate the selected articles' relevance and suggest a proper sample's reach and scope. Next, we further split each of the dimensions repeatedly. Other themes emerged separately, exposing the primary aspects of DSI, which helps us build a shared conceptualization of the idea. After a few rounds, we selected the 11-theme solution based on what we learned from analyzing the three clusters emerging from the bibliographic coupling exercise (step B in Figure A). The chosen solution is the one that best balances the possibility of understanding the themes and concepts behind the DSI dimensions with the possibility of providing sufficient detail without overlapping, duplications and complicating the interpretation.

3. Structuring DSI-related research: ontology, theory, context and boundaries

DSI-related research builds on a large body of multidisciplinary but commensurable research. When structuring the existing research based on the bibliometric coupling, three sub-streams emerged: 1) Innovation for digital servitization, 2) Service innovation in the digital age and 3) Adoption of novel e-services enabled by information system development. Figure 2 depicts the lead author's name and the year of publication for each article. The color indicates the cluster, and the circle size shows the number of citations in these data. The distance between two papers represents the number of shared citations in their reference lists. The visible line denotes the highest number of similar citations shared by a pair of documents (Kohtamäki *et al.*, 2022a, b).

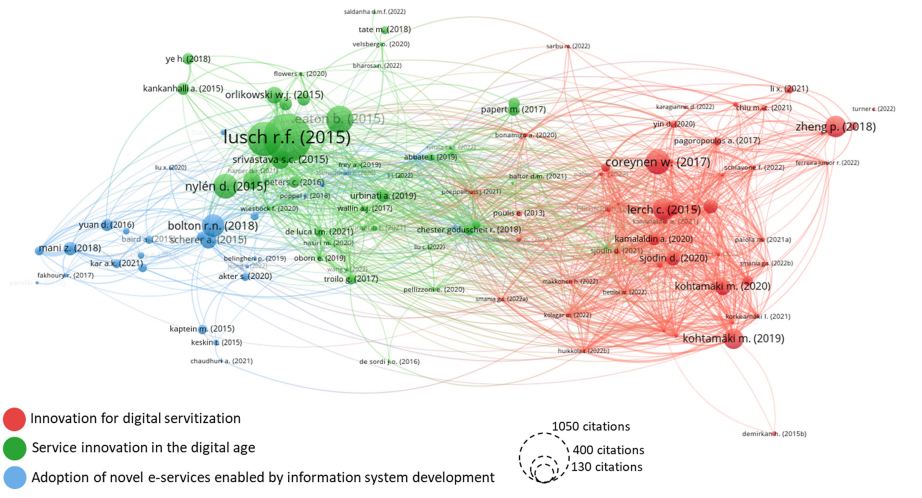


Figure 2.
Structure of DSI-related literature

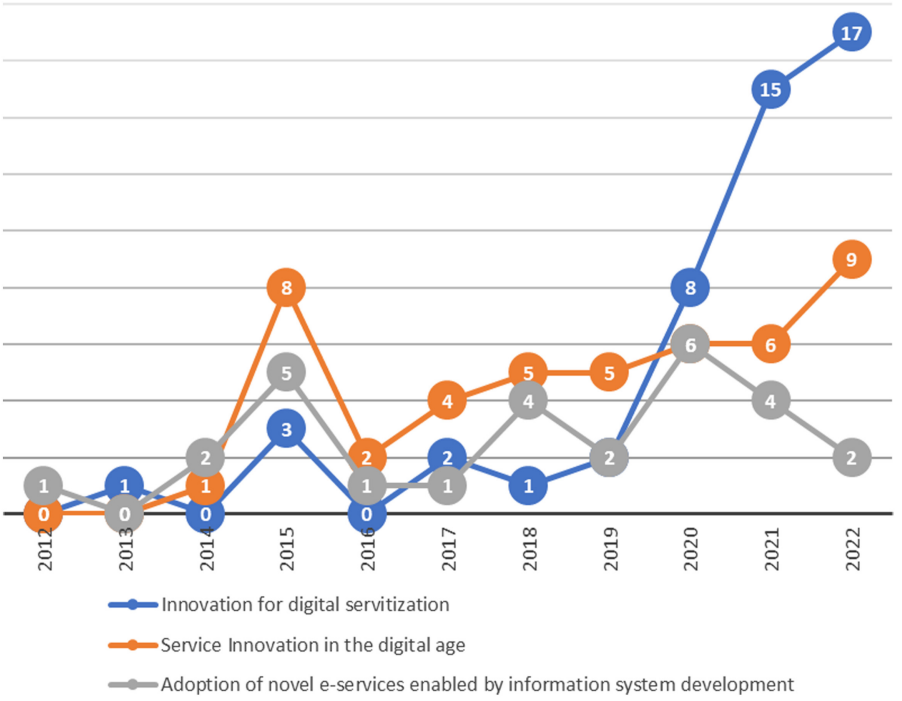
Source(s): Authors own creation

Figure 3 shows the cumulative number of publications in each cluster. The first articles date back ten years, consistent with the rise of digital innovation. A peak in 2015 was explained by a special issue in the MIS Quarterly (Barrett *et al.*, 2015) that focuses on service innovation from a service-dominant logic (S-D-L) at the intersection of marketing and information system research. S-D-L and service (eco) systems are present in several contributions (Barrett *et al.*, 2015; Lusch and Nambisan, 2015), whereas two articles are among the earlier adopters of the DSI concept (Lusch and Nambisan, 2015; Orlikowski and Scott, 2015). The figure also confirms the emergence of digital servitization literature, which brings several elements to the DSI discussion. Only a few authors use the DSI concept (purposefully or not) as a label (Bustinza *et al.*, 2018; Kowalkowski *et al.*, 2022; Raddats *et al.*, 2022; Sjödin *et al.*, 2020).

The following sections present each cluster in more detail, focusing on conceptual frameworks, methodologies, antecedents, processes and outcomes related to DSI (see Table A in Appendix for a summary).

3.1 Innovation for digital servitization

3.1.1 Central topics. Innovation for the digital servitization cluster builds on the core servitization literature, emphasizing digitalization. The concept of digital servitization underlines the role of digitalization in servitization. It understands the gravity of digitalization's effect on product manufacturing (Coreynen *et al.*, 2017; Kohtamäki *et al.*, 2019). In doing so, digitalization is a central means to implement service innovation (service logic). The interplay between digitalization and servitization can generate DSI in product



Source(s): Authors own creation

Figure 3.
The evolution of the number of articles per cluster

manufacturing companies. Research has demonstrated the potential of the above digital-servitization interaction to impact manufacturers' profit (Kohtamäki *et al.*, 2020).

3.1.2 Theoretical background. Studies in the innovation for digital servitization cluster (n = 49) use multiple theoretical lenses, such as the Business model innovation (Linde *et al.*, 2020; Paiola and Gebauer, 2020), firm boundary theories (Kohtamäki *et al.*, 2019), resource-based view, strategic capabilities (Khan *et al.*, 2022) and dynamic capabilities (Coreynen *et al.*, 2017; Huikkola *et al.*, 2022b). Still, studies build much on the servitization literature approaching the manufacturer's transition from product logic to service logic as a strategic, organizational, offering or capability-related innovation process. Studies tend to see the transition in the business logic (from product to service) as a business model innovation, the most often referenced concept among these studies (Kohtamäki *et al.*, 2019). Moreover, many studies focus on strategic capabilities required in digital service innovation. These studies examine the processes and resources critical for digital service innovations. Dynamic capabilities reflect the adaptive perspective on service innovation, emphasizing the role of resource reconfiguration in the process. Dynamic capabilities are often referenced as the theoretical base for discussing digital service innovations. Some of the novelty aspects in this cluster include approaches such as managerial heuristics and simple rules (Huikkola *et al.*, 2022b), outcome-based services (Korkeamäki and Kohtamäki, 2020), microfoundations (Poeppelbuss *et al.*, 2022) and digital twins (Karagiannis *et al.*, 2022). For instance, Coreynen *et al.* (2017) find various digitalization options leading to three alternative servitization paths: 1) commercial (front-end digitalization), 2) industrial (back-end digitalization) and 3) value servitization (offering digitalization, e.g. process delegation services, and hybrid solutions). Many of the studies in this cluster may not be particularly strong regarding using specific theoretical lenses but, instead, have a mainly pragmatic approach to digital service innovation.

Digital servitization studies have identified various antecedents of digital service innovation. Antecedents include offerings (Korkeamäki *et al.*, 2021) or the customization of offerings (Bonamigo and Frech, 2020; Kohtamäki *et al.*, 2019) and digitalization (Sjödin *et al.*, 2020). The list also includes resources and capabilities (Kamalaldin *et al.*, 2020; Kolagar *et al.*, 2022a; Paiola *et al.*, 2022) and the institutionalization of new capabilities (Pagoropoulos *et al.*, 2017), pricing logic (Kohtamäki *et al.*, 2019) and technical and organizational architectures (Lerch and Gotsch, 2015). As often in rapidly growing literature, and should be, models regarding the use of antecedents, processes and outcomes vary much, which has to be understood when reading the list of antecedents above.

Regarding processes, mediators and moderators, many factors can be identified. The studies tend to conceptualize the process as a digital servitization path, servitization process (Ferreira Junior *et al.*, 2022). Instead, they consider various sub-processes and concepts, such as business model innovation (Markfort *et al.*, 2022), co-creation processes (Sjödin *et al.*, 2020) or platform development (Zheng *et al.*, 2018). Some studies tend to look at the primary mediating or moderating variables, such as firm boundary decisions (Kohtamäki *et al.*, 2019), service innovation (Smania *et al.*, 2022) or the nature of the operating environment such as the sector (e.g. low vs high-tech) (Blichfeldt and Faullant, 2021; Paiola and Gebauer, 2020) study a large set of cases identifying three progressive levels of servitization: product-, process- and outcome-based. It considered the role of technologies concerning these progressive paths. Sjödin *et al.* (2020) identify an agile co-creation for digital servitization, stressing the microservices' role. Kohtamäki *et al.*, (2022a, b) highlight the interplay between product-service-software technologies, business models and ecosystems and the resulting environment-strategy-structure configurations that could feed digital service innovations towards smart, autonomous solutions.

Finally, studies consider many innovation-related outcome variables, such as business model innovation (Paiola *et al.*, 2022), innovation performance (Sarbu, 2022), digital service

innovation (Smania *et al.*, 2022), product innovation (Bettiol *et al.*, 2022) and scalable offerings and market expansion (Kolagar *et al.*, 2022b). Also, various financial outcome variables, such as gross margin (Korkeamäki *et al.*, 2021), profit increase (Kohtamäki *et al.*, 2020), financial performance (Sjödin *et al.*, 2019; Smania *et al.*, 2022), decreased service costs (Pagoropoulos *et al.*, 2017) and return on sales (Blichfeldt and Faullant, 2021). Although we can identify these outcome variables, we conclude that very little empirical evidence exists on the relationship between digital service innovation, various financial outcomes and the role of mediators and moderators in the process.

3.1.3 Methodological emphasis. These studies look at digital service innovation at the company level, often focusing on the company as a unit of analysis. Some studies tap into the ecosystem level, but even then, they view the ecosystem from the company perspective. Relational or network perspectives are rarer in the context of digital service innovation (Kamalaldin *et al.*, 2020; Parida *et al.*, 2019). Studies on innovation in digital servitization clusters emphasize multiple and single case studies (only very few processual studies) (Tian *et al.*, 2021).

These studies include conceptual papers and a few reviews (n = 9) (Kohtamäki *et al.*, 2019). They set the foundation of service innovation in the digital age, many of which are among the highest-cited papers. Empirical articles dominate this cluster (n = 40), including a significant share of qualitative research (n = 32), some using fuzzy set qualitative comparative analysis (Chester Goduscheit and Faullant, 2018; Opazo-Basáez *et al.*, 2022a; Soto Setzke *et al.*, 2023). Articles implement single-case longitudinal, multiple-case or inductive studies, typically based on archival data, semi-structured interviews and observations. In contrast, few studies follow a quantitative methodology (n = 6), applying various methods that are usually survey-based. Structural equation modeling is common (Iden *et al.*, 2020; Jain *et al.*, 2021; Kankanhalli *et al.*, 2015; Nasiri *et al.*, 2020). Finally, a few articles use other approaches, such as modeling (Marttonen-Arola *et al.*, 2019), simulation (Ruutu *et al.*, 2017), scale development (De Luca *et al.*, 2021) and mixed methods (n = 2).

3.2 Service innovation in the digital age

3.2.1 Central topics. The papers in the cluster (n = 46) cover a wide range of themes around knowledge sharing, organizational capabilities, resource integration and value co-creation for DSI in (digitally-enabled) smart service systems, including self-service (Demirkan *et al.*, 2015; Demirkan and Spohrer, 2014). DSI is envisioned as transitioning from product-centric to service-centric business models based on digital technologies (Soto Setzke *et al.*, 2023). It involves creating innovative services by combining the internet of Things (IoT), Cloud computing (Nittala *et al.*, 2022) and big data analytics (Lehrer *et al.*, 2018; De Luca *et al.*, 2021). DSI also comprises new ways to provide services using digital platforms (Frey *et al.*, 2019; Wiesböck *et al.*, 2020) to liquefy resources and increase resource density among stakeholders in a service system (Lusch and Nambisan, 2015). Big data analytics are central to service automation, enabling human–material service practices (Lehrer *et al.*, 2018) and algorithms enact specific service materializations (Orlikowski and Scott, 2015). Moreover, research suggests how distributed optimization actively outlines the boundary resources of digitally enabled service systems, involving accommodation and rejection actions from a network of heterogeneous actors and artifacts. Thus, power plays a dualistic role in distributed tuning (Eaton *et al.*, 2015). DSI calls for user innovation (Kankanhalli *et al.*, 2015; Ye and Kankanhalli, 2018) and to consider user experience (e.g. usability, aesthetics and engagement). It forces firms to challenge prior assumptions concerning product and service portfolios, their digital environment and ways of organizing innovation work (Nylén and Holmström, 2015).

3.2.2 Theoretical background. The cluster gets its conceptual foundation in the marketing approach to service innovation and the technological innovation literature, finding as glue

research on digital innovation by information systems scholars. Some conceptual approaches, such as user innovation (Kankanhalli *et al.*, 2015; Ye and Kankanhalli, 2018), affordance theory (Lehrer *et al.*, 2018; De Luca *et al.*, 2021), institutional entrepreneurship (Wallin and Fuglsang, 2017) and absorptive capacity (Li *et al.*, 2022) appear in the sample. However, most papers find their common ground and conceptual underpinnings in the S-D-L (Frey *et al.*, 2019; Lusch and Nambisan, 2015), and embedded concepts such as value co-creation, alone or in combination with other approaches such as practice theory and socio-materiality (Eaton *et al.*, 2015; Lehrer *et al.*, 2018; Orlikowski and Scott, 2015) and service systems and service science (Demirkan and Spohrer, 2014; Peters *et al.*, 2016; Srivastava and Shainesh, 2015).

Lusch and Nambisan (2015) claim that the research on service innovation shows an overdependence on notions and theories from a goods-dominant logic viewpoint and fails to provide insights into emerging digital service innovations. They call for a broader view of service innovation that considers the meta-theoretical foundations of the S-D-L and three elements: service ecosystems (actor-to-actor networks), service platforms (resource liquefaction and density) and value co-creation (resource integration). In doing so, it is possible to understand better the role of information technology (IT) or information and communications technology (ICT) as an operant and operand resource. Thus, "*. . . in the former role, IT becomes an active agent in the service ecosystem and can trigger or initiate service innovation impacting other actors and their choices; as such, decisions about IT affect the design and development of the offering, in turn expanding or restricting service innovation opportunities. In the latter role, IT plays an enabling role and ensures that the collaborative value creation process that underlies service innovation is efficient and effective. The research implications of these two roles are likely to diverge, drawing on different management areas. Specifically, the issues related to the first role potentially emphasize concepts and insights from technology development, design science, marketing, platforms and standards, and so on. The issues related to the second role sharpen the focus on concepts and insights from prior research on strategic alliances and collaboration, knowledge management, network governance, orchestration processes, and so on.*" (p. 170).

The studies in this cluster recognize several antecedents of digital service innovation, such as service innovation strategies (Urbinati *et al.*, 2019), digital technologies (Troilo *et al.*, 2017; Wallin and Fuglsang, 2017) and big data-related investments (De Luca *et al.*, 2021), and numerous resources, including digital platforms (Nittala *et al.*, 2022), staff and experience (Iden *et al.*, 2020) and resources (e.g. technology and knowledge) from providers, users and other stakeholders (Pellizzoni *et al.*, 2020; Srivastava and Shainesh, 2015). In this regard, users provide critical inputs to the innovation process (Jain *et al.*, 2021; Patroni *et al.*, 2022). Moreover, various types of capabilities were also shown to be relevant, including digital platform capabilities (Wang *et al.*, 2022), IT or technological capabilities (Randhawa *et al.*, 2018; Wiesböck *et al.*, 2020), marketing and co-creation capabilities (Randhawa *et al.*, 2018) and digital collaboration capabilities (Li *et al.*, 2022).

The review shows several processes that moderate, mediate, augment or diminish the impact of antecedents on digital service innovation through different mechanisms. For instance, a central process in many articles concerns stakeholder engagement and involvement (including clients) and management (Jain *et al.*, 2021; Pellizzoni *et al.*, 2020; Randhawa *et al.*, 2018). Also, knowledge sharing (Pellizzoni *et al.*, 2020), interaction (Urbinati *et al.*, 2019) and value co-creation (Nittala *et al.*, 2022; Srivastava and Shainesh, 2015) may enable innovation and value creation and capture. De Luca *et al.* (2021) discuss the role of marketing affordance and service innovation for profitable big data investments. They find customer behavior pattern spotting, real-time market responsiveness and data-driven market ambidexterity as key to the innovation process. Troilo *et al.* (2017) introduce the data density concept as involving three distinct processes (pattern spotting, real-time decisions and

synergistic exploration). The notion connects data-rich environments with service innovation opportunities and organizational enablers that moderate the associations among technology, data density processes and service innovation. Finally, Wallin and Fuglsang (2017) highlight the centrality of institutional change efforts.

Concerning the relevant outcomes, research on service innovation in the digital age includes different innovation-related measurements, being, of course, digital service innovation (Iden *et al.*, 2020; Soto Setzke *et al.*, 2023) and, especially, service innovation the most relevant ones (Frey *et al.*, 2019; Li *et al.*, 2022; De Luca *et al.*, 2021; Nittala *et al.*, 2022; Orlikowski and Scott, 2015; Troilo *et al.*, 2017; Wallin and Fuglsang, 2017; Wang *et al.*, 2022). However, the articles also include alternative outcome measurements such as open service innovation (Randhawa *et al.*, 2018), new digital service development (Pellizzoni *et al.*, 2020) and media-driven innovation (Patroni *et al.*, 2022), among others.

3.2.3 Methodological emphasis. Most of the studies in the cluster were conducted in service industries such as cell phone platforms and digital services (Eaton *et al.*, 2015; Kankanhalli *et al.*, 2015; Ye and Kankanhalli, 2018), retail (Demirkan *et al.*, 2015; Demirkan and Spohrer, 2014; Patroni *et al.*, 2022), public sector (Randhawa *et al.*, 2021; Tate *et al.*, 2018; Velsberg *et al.*, 2020), healthcare (Srivastava and Shainesh, 2015; Wallin and Fuglsang, 2017) and IT/software (Li *et al.*, 2022), among others. Some articles include multiple sectors, adding to the earlier list a wide range of sectors such as education and training, banking, insurance and finance, mobility services and postal services (Lehrer *et al.*, 2018; Wang *et al.*, 2022; Wiesböck *et al.*, 2020). Few other studies focus on manufacturing, and they are found at the intersection of the service innovation and digital servitization clusters, mixing concepts and references from both research streams (Chester Goduscheit and Faullant, 2018; Marttonen-Arola *et al.*, 2019; Opazo-Basáez *et al.*, 2022a).

Empirical articles dominate this cluster (n = 36), but there are purely theoretical studies (Barrett *et al.*, 2015; Lusch and Nambisan, 2015; Peters *et al.*, 2016) or conceptual (n = 6) studies using illustrative cases (Orlikowski and Scott, 2015). They set the foundation of service innovation in the digital age, many of which are among the highest-cited papers. This cluster includes a significant share of qualitative research (n = 22), 3 using fuzzy set qualitative comparative analysis (Chester Goduscheit and Faullant, 2018; Opazo-Basáez *et al.*, 2022a; Soto Setzke *et al.*, 2023). Articles implement single-case longitudinal, multiple-case or inductive studies, typically based on archival data, semi-structured interviews and observations. In contrast, few studies follow a quantitative methodology (n = 8), applying various methods that are usually survey-based. Structural equation modeling is common (Iden *et al.*, 2020; Jain *et al.*, 2021; Kankanhalli *et al.*, 2015; Nasiri *et al.*, 2020). Finally, a few articles use other approaches, such as modeling (Marttonen-Arola *et al.*, 2019), simulation (Ruutu *et al.*, 2017), scale development (De Luca *et al.*, 2021) and mixed methods.

3.3 Adoption of novel e-services enabled by information system development

3.3.1 Central topics. Digital services, also framed as e-services, have become central across industries, from manufacturing to consumer and public sectors. Wearables, car assistant features, banking and financial services and healthcare services are examples of how consumers adopt and experience digital services enabled by the internet of Things (IoT), artificial intelligence (AI) and large language models (LLM), augmented reality (AR) and big data. Notably, during the recent Covid-19 pandemic, digital services have been emphasized as they provide easy access to services (e.g. banking, healthcare and public services) in a contactless, cost-efficient and convenient manner. Besides system connectivity (Porter and Heppelmann, 2014), other central features of digital services concern *ubiquity,* that is service availability and accessibility 24/7/365 (Pöppel *et al.*, 2018) and *scalability* (Kleinschmidt *et al.*, 2020), enabled by the general development of ICT infrastructure and technology (e.g. cloud

and quantum computing, digital platforms and AI). Therefore, most studies in this cluster contribute to service innovations, service science and service systems by studying how digital services are adopted/perceived (or rejected) among customers. Among the central topics, the cluster focuses on understanding the adaptation/adoption of new digital services (Kropp and Totzek, 2020), resistance/barriers to their usage (Chouk and Mani, 2019; Mani and Chouk, 2018), pricing strategies (e.g. game-theory-based Hoteling model) (Keskin and Taskin, 2015) and capability development actions (Akter *et al.*, 2020).

3.3.2 Theoretical background. Studies (n = 28) in this cluster vary regarding its underlying conceptual foundations, which include the institutional theory (Kropp and Totzek, 2020), (dynamic) capability approach (Akter *et al.*, 2020), cognitive fit theory (Liu *et al.*, 2020), executive cognitions (Wiredu *et al.*, 2021), and, in a lesser extent, the service-dominant logic (Scherer *et al.*, 2015). While the theoretical foundations are not unified, studies in this cluster develop and extend established frameworks, such as the 7P marketing (Kuester *et al.*, 2018) or create new frameworks tested in the research paper.

There exist different antecedents regarding the adoption of new innovative digital services. Typically, barriers to adopting new digital services are related to trust issues (Chong and Zhou, 2014; Kar, 2021), as people may not want providers to gain access to their data. Chouk and Mani (2019) categorize these antecedents into functional, psychological and individual (e.g. gender and age) barriers and how these affect the resistance to smart services. They find that perceived security is significant for consumers when exchanging sensitive data. On the other hand, they conclude that, in addition to general skepticism toward IoT, perceived complexity and government surveillance promote consumer resistance to smart services. Furthermore, exogenous factors such as competitive pressure, market share (Keskin and Taskin, 2015), institutional pressures (mimetic, normative and coercive pressures) (Kropp and Totzek, 2020) and maturity of general ICT infrastructure (Fakhoury and Aubert, 2017) impact on the adoption of digital services (e-services) among citizens, consumers and B2B clients.

The processes of this third cluster are related to value co-creation between providers and clients (Bolton *et al.*, 2018), which can manifest, for instance, in the process of self-service (Scherer *et al.*, 2015), interaction (Bolton *et al.*, 2018), knowledge sharing (Yuan *et al.*, 2016) or capability development (Akter *et al.*, 2020). Often the emphasis is on how these processes impact on adoption, perception, value and quality of new digital services (Kuester *et al.*, 2018; Peltier *et al.*, 2020) or technologies such as AR (Klinker *et al.*, 2020) in different contextual settings (e.g. services, public services, manufacturing). In general, co-creation in terms of increased (and mutual) knowledge-sharing, interaction and learning benefits both parties. However, there may be an inverted U-shape and non-linearity between these actions and the adaptability of new digital services, indicating that only a limited number of resources may be helpful to allocate to co-creation activities (optimal instead of maximal). These co-creation activities can be facilitated by utilizing different visualization and blueprinting techniques (Pöppel *et al.*, 2018) that effectively enable clients to understand whether using certain new digital services is reasonable.

Studies in this final cluster typically measure the adoption of new e-services among clients, users and citizens. For instance, studies investigate the perceived value, experience, acceptance and satisfaction of such unique and innovative services among customers in B2B, B2C and public sectors. Conversely, some studies investigate the resistance towards these new e-services and why their scaling may be tricky.

3.3.3 Methodological emphasis. Concerning the methodological aspects, this cluster is attractive as a large body of quantitative (n = 13) and qualitative research studies (n = 6). However, a few conceptual papers (n = 5) are included in this cluster, and one guest editorial paper (Belingheri and Neirotti, 2019). Moreover, innovative methods such as the text analysis from Twitter data (Kar, 2021), the Delphi study (Ebel *et al.*, 2022) and (laboratory) experiments

(Klinker *et al.*, 2020; Liu *et al.*, 2020) have been executed in this cluster. Some surveys have been conducted, and structural equation modeling (SEM) or partial lease squares (PLS) dominate among quantitative papers. Qualitative studies build frameworks by delving deeper into single (e.g. province) or multiple cases. No comparative cases have been applied in this cluster.

Researchers have obtained real (customer) data from platforms and private companies when testing and verifying their frameworks and models. This extensive use of actual customer data is exciting and noteworthy, especially for B2B scholars who rarely access (real-time) customer data (this is understandable not only because of sensitivity issues but because this data is strategic for manufacturers and their industrial clients). Furthermore, laboratory experiments are novel and valuable to understand how new (digital) innovations are adopted in practice – laboratory experiments are something B2B scholars could benefit from in the future. Data obtained from digital platforms (Chaudhuri *et al.*, 2021; Wiredu *et al.*, 2021) and social media (Kar, 2021) are helpful when researchers try to understand why and how people behave like they behave (opposite to what clients say how they behave).

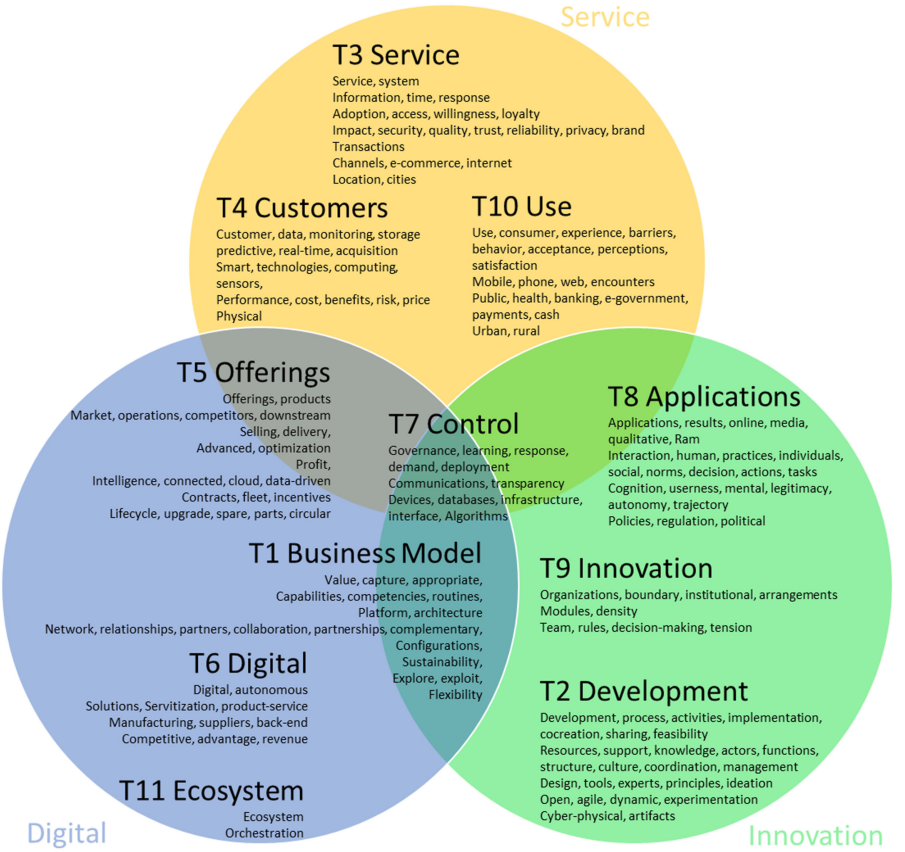
Studies in this cluster have examined digital service innovations and their adoption among clients across different sectors. Studies have focused on studying digital innovations in traditional service sectors (e.g. airports, banks, healthcare), the manufacturing industry (e.g. automotive, asset-heavy manufacturing) and the public sector (e.g. e-governance). For instance, studies have investigated mobile payments (Kar, 2021), manufacturing-as-a-service (Chaudhuri *et al.*, 2021) and e-government services (Fakhoury and Aubert, 2017; Paroški *et al.*, 2015) through customer adoption lenses. Generally, studies in this cluster are versatile in terms of theories, methods and contexts applied – this brings richness inside this cluster that focuses primarily on service adaptability or resistance from different viewpoints.

4. From clusters to a shared conceptualization of DSI

This section moves from clusters to a shared understanding and conceptualization of DSI, part of a multidisciplinary discussion combining complementary elements of each cluster. Based on text mining, Figure 4 shows the emerging three dimensions (*Digital, Service, Innovation*), the intersections (digital service, digital innovation and service innovation) and the 11 themes (and related concepts). Seven themes belong to single dimensions, and four are located at intersections of the DSI-constituent dimensions.

First, three themes emerge from the *Service* dimension: *T3 Service, T4 Customers* and *T10 Use*. *T3 Service* relates to the design of smart services (systems), determining the price, benefits, risks, costs and data management required and the channels to offer them. It highlights essential service qualities customers expect, such as (use) value, security, trust, price, ease of use and reliability (Chong and Zhou, 2014). *T4 Customers* involves the (mechanisms of) production, capture, acquisition, monitoring and storage of customer data related to using technology or a product (Orlikowski and Scott, 2015), where the digital technology is embedded and acts as an enabler. *T10 Use* relates to the human dimension of the service notion, which includes users' perception of value and satisfaction (Yuan *et al.*, 2016) and a behavioral component linked to users' decisions (Liu *et al.*, 2020), such as (technology) acceptance/resistance, complexity, satisfaction and adoption of services (Buchanan and McMenemy, 2012). The real-time data generated during the user experience is critical for designing new processes and value propositions through service innovation (Chong and Zhou, 2014).

Although *T10 Use* seems strongly influenced by research on device-independent digital services (Chowdhury, 2016) in specific sectors (banking, healthcare and e-government), these considerations seem relevant in B2C, B2B and public sector contexts. They may also affect end-users, consumers and customers' behaviors and real-time decisions in product-dependent



Source(s): Authors own creation

Figure 4.
Main DSI-related dimensions, themes and concepts

digital services. They involve user experience and perception motives, considering privacy and trust, especially when the service requires privacy issues, the traffic and storage of sensitive information or money, as in the banking and health sectors (Baird and Raghu, 2015). In this context, (cyber) security and reliability are essential, even thresholds for the suppliers in this sector. The above themes highlight the relevance of customer and user-centric service design and innovation (Lusch and Nambisan, 2015). Indeed, this *Service* dimension recalls the interconnection between critical aspects of service innovation in data-rich environments proposed by Troilo *et al.* (2017): service concept, service process and customer experience innovation, which must be facilitated by technological and organizational enablers.

Second, four themes emerge from the *Digital* dimension and must be interpreted together—two as part of the dimension itself (*T6 Digital* and *T11 Ecosystem*), and two at the intersection between *Digital* and *Service* dimensions (*T5 offerings*) and *Digital* and *Innovation* dimensions (*T1 business models*). *T6 Digital/Digitalization* is essential for companies to realize competitive and service-oriented value propositions. In the service industry, but also in manufacturing, where selling smart connected products (Porter and Heppelmann, 2014, 2015) is vital since physical products are carriers of embedded smart technologies that facilitate the configuration of alternative lifecycle-oriented service offerings (Rabetino *et al.*, 2015).

Product-service-software integration does not occur by chance but should be emphasized by the company management (Kohtamäki *et al.*, 2022a, b). Indeed, tight integration may generate an advantage in the market, with the products bringing profits from sales, upgrades and spare part selling. The effective integration can also produce additional customer benefits generated by the improved use of data as part of the value-creation process (Huikkola *et al.*, 2022a, b).

Companies can explore opportunities based on solutions that involve different suppliers in the value chain and enable the transition toward digital servitization for value creation and capture, which may take the form of a platform business model (Tian *et al.*, 2021). Digitalized B2B platforms (Cusumano and Gawer, 2002) and internal product platforms (Baldwin and Clark, 1997) enhance service innovation opportunities (Jovanovic *et al.*, 2021; Lusch and Nambisan, 2015). Modularity plays a key role. It allows reusability and flexibility (Chowdhury, 2016; Schiavone *et al.*, 2022) that will be reflected in opportunities for business model innovation. The results highlight the importance of relational capabilities linked to digital business models and ecosystems (orchestration, complementarity, relationship and partnership) and innovation (exploration and exploitation, integration, collaboration and co-creation). Digital technologies allow a variety of co-creation and co-design practices for information sharing among actors across firms within ecosystems enabling service innovation (Lusch and Nambisan, 2015).

Third, three themes are split from the *Innovation* dimension. They must be interpreted together—two as part of the dimension (*T9 Innovation* and *T2 Development*) and one at the intersection between *Service* and *Innovation* dimensions (*T8 Applications*). The first two elements represent DSI's innovation process, including open and agile innovation and other innovation-related concepts, such as the need for modularity (modular architecture). Indeed, the simultaneous existence of layered modular architecture in physical products and layered digital technology that decouples material from non-material components (cyber-physical) and is critical to developing digital artifacts (Chowdhury, 2016), enabling digital service innovation through recombination, a property named generativity (Lusch and Nambisan, 2015; Yoo *et al.*, 2012). While ICTs have a role as a resource for service innovation (Barrett *et al.*, 2015), enabler and initiator/actor (Lusch and Nambisan, 2015), the exploitation of generativity and industry-related modular advantages calls for developing and orchestrating the ecosystems, which means collaboration and resource integration, as discussed above. Thus, *" . . . innovation occurs as actors seek better densities and improved ways for value cocreation"* (Lusch and Nambisan, 2015, p. 161). Conversely, the third theme represents the technical side of service innovation (applications, Ram, etc.) but also considers cognition-related issues (Liu *et al.*, 2020). Moreover, since the value and digital service innovation are context-specific (Lusch and Nambisan, 2015; Orlikowski and Scott, 2015; Scherer *et al.*, 2015), social norms, policies, regulations and political concerns are also highlighted.

Finally, *T7 Control* emerges at the junction of the three main dimensions, which denotes the importance of digital innovation for service innovation (Barrett *et al.*, 2015). Digital infrastructure and service provision cannot be decoupled (Kohtamäki *et al.*, 2020). Thus, *T7 Control* refers to the need for some infrastructural control, e.g. enabling structures that facilitate resource integration and service co-creation by powerful actors in heterogeneous ecosystems governed by standards and institutional logic (Eaton *et al.*, 2015; Kohtamäki *et al.*, 2022a, b). Boundary resources evolve, and there is a paradox of control and generativity (Eaton *et al.*, 2015) in such evolution (tuning), represented as a power-agency game that includes action, reactions and tensions. In this context, control enables the combination of several digital and non-digital platform assets (Lusch and Nambisan, 2015) and generated data to leverage digital technology generativity (Chowdhury, 2016; Eaton *et al.*, 2015). Thus, control may become a condition for generative innovation and value creation for service innovation and the evolution of the service system (Barrett *et al.*, 2015; Eaton *et al.*, 2015).

T7 Control is directly interlinked with other themes, such as *T6 Digital*, *T9 Innovation*, *T8 Applications* and *T10 Use*. Controlling content and customer data is one critical element where apps (and their distribution) play a central role (Eaton *et al.*, 2015). In addition, the role and performance of intelligent algorithms in shaping material-discursive practices of service innovation have been increasingly highlighted and pointed out as a direction for further research (Korkeamäki and Kohtamäki, 2020; Orlikowski and Scott, 2015).

The preceding 11 themes manifest differently in the three clusters (see Table B in Appendix), which cover the DSI dimensions differently. As the first cluster illustrates, digital technology in manufacturing is embedded in a product and enables services and service innovation. Until recently (Opazo-Basáez *et al.*, 2022a), the DSI concept was rather implicit and emerged through a narrative at the sweet spot between technological innovation and digital servitization. The focus is more on digital offerings and business model configurations (the digital dimension) and customer service/service offerings rather than the user and customer experience (the service dimension). Instead, the two other clusters focus more on the service industry (e.g. knowledge-based and personal services) and device-independent digital services (Chowdhury, 2016) as web-based services. The user experience viewpoint and the generative potential of IT technologies/architecture are deeply explored. The second cluster combines inputs from marketing and information services (IS) disciplines and is heavily influenced by the S-D-L and service science literature. Accordingly, papers focus on the intersection of service and digital innovation. Compared to the third cluster, the second one deepens some aspects of IT architecture. Finally, the ecosystem perspective is relevant in clusters one and two, although these studies focus on different aspects.

Based on the above discussion, we propose the following integrative definition. DSI is the application of digital technology to create new services and configure a value-creation ecosystem composed of different resources and stakeholders that co-create with someone (or something), in an automated form or not, value in a novel way and achieve a specific outcome. Thus, DSI refers to developing customer-centric services and related business models configurations allowed by digitalization, using technology and software as enablers of information flow and stakeholder co-creation in (eco)systems to integrate digital and non-digital assets into (device-dependent or device-independent) offerings and create valuable customer experiences and value for businesses through improved operations, new revenue streams and data gathering regarding the use of technology to develop future offerings.

5. Takeaways and implications

5.1 Contributions

This review sheds light on the DSI concept, coined and explored by related but unconnected interdisciplinary research streams. It uses bibliometric and text-mining tools to structure the conceptual connections, emphasizing the existing contact points, crossroads and conceptual disjunctions. The contributions of the study are threefold. First, it illustrates heterogeneity and details the difference in DSI between the service and manufacturing sectors (e.g. comparing the first cluster with the others). Despite the heterogeneity, digital services in both sectors also have common elements. By constructing a map overlaying inputs from both sectors, this paper can also open windows to encourage multidisciplinary research or indicate elements that researchers in different streams could incorporate into their research to examine the phenomena studied in breadth and depth. The paper also presents an integrative definition of DSI, overcoming the lack of a shared conceptualization based on identifying the constituent elements of DSI (Opazo-Basáez *et al.*, 2022b). An accurate understanding is needed to permit better conceptual integration of the ideas from different research communities.

Second, our review considers elements from the three clusters to clarify the DSI concept, which is critical for any effort to build a more comprehensive research stream. Rather than rival

alternatives, these complementary approaches bring together commensurable ideas. Jointly considered, they enrich our understanding and the conceptualization of DSI. The text mining tool objectively identifies shared vital themes and concepts from different research communities to conform to a big picture illustrating the critical dimensions of DSI. The proposed objective representation of the literature concerns the most typical concepts, providing a valuable lens to conceptualize DSI. Third, managers can use this study to benchmark, assess and improve their firms' digital service innovation-related practices and procedures to facilitate a quicker and more seamless digital transformation, increase value creation and seize opportunities.

5.2 Future DSI research for digital servitization

DSI involves related but different multidisciplinary research streams building on diverse conceptual underpinnings and emphasizing different DSI aspects of digital transformation to leverage digital technologies, improve business operations and create customer value. Our aim is not to suggest an agenda for each cluster but to highlight research directions to support the development of the DSI concept in the digital servitization stream, which we organize into critical areas and related research questions (Table 2). Research combining marketing and information systems literature first coined the DSI notion in a B2C setting, emphasizing issues that may also be relevant in the B2B setting. They include value co-creation/resource integration in service (eco) systems, user innovation/experience (personalized services), service affordances and generativity and human–material service practices. Research acknowledges algorithms as enactors of service materialization and the role of layered (digital and physical) architectures and generativity in decoupling material and non-material components and enabling DSI. Finally, the infrastructure control idea to facilitate resource integration is also considered. Instead, digital servitization emphasizes integrating products, services and software to create customer value and transform existing products into product-service software systems. Still, B2B companies may need to understand user experience better, and digitalization may push them to move further downstream.

Additionally, as digital service innovations are increasingly developed across boundaries, future studies could investigate how (open) innovation processes are synchronized within and between boundaries and ecosystems – how knowledge should be shared and integrated into settings where digital services and products are converged. Laboratory experiments could be more extensively utilized in the B2B innovation development context. Hence, understanding individual users' microfoundations, namely cognitions, biases and heuristics, could further understand why new services are adopted or rejected among clients. These psychological foundations could better explain what types of innovations or pricing methods are likely to work in real-life occasions and how these should be identified in the design phase (e.g. how framing and anchoring errors could be mitigated).

5.3 Limitations

Our study has limitations. First, using search strings, although done broadly, can lead to not identifying all the relevant studies. This problem is primarily a potential one in multidisciplinary reviews. For instance, some work in the field of information systems may not have been recognized because, as Barrett *et al.* (2015, p. 141) argue, *" . . . assumptions about service are for the most part implicit, and the implications of ICTs for service innovation are generally not articulated explicitly"*. Additionally, we recognize a great deal of research, especially in information systems, published in conference proceedings, which were excluded from our search string. Finally, we see our three-theme outlines as illustrative, a first attempt to bridge different multidisciplinary research areas. However, not all sub-themes are present in all three clusters. Some of them are biased and heavily influenced by the content of one of the clusters (clusters are heterogeneous and focused on different types of services and sectors, such as B2B or B2C).

Key research questions
Research Area 1: Managing digital service innovation
a) How to manage the process of DSI during digital servitization?
b) What are the sociomaterial practices for managing product-service integration?
c) How to manage DSI across firm boundaries in digital servitization?
d) How to manage the balance between products, services and software when developing smart product-service systems?
Research Area 2: Digital-physical interaction and digital technologies
a) How can manufacturers use digital technologies for product-service-software integration?
b) How can manufacturers leverage the affordances of digital technologies for DSI?
c) What role do APIs play in enabling generativity in developing smart solutions?
d) How can digital and material resources shape DSI?
e) How can manufacturers leverage the materiality of physical products to enhance the user experience and create value in smart solutions?
f) How does infrastructural control facilitate or hinder generativity in DSI?
Research Area 3: DSI and value co-creation in product-service ecosystems based on B2B digital platforms
a) How does transitioning to product-service ecosystems based on B2B digital platforms impact the actor-network organization at the ecosystem level and the role, routines, practices and organizational boundaries of different stakeholders?
b) How can B2B digital platforms enable learning, co-creation and DSI for product-service-software offerings configuration?
c) How can stakeholders operating in product-service ecosystems based on technology-enabled B2B platforms capture value by leveraging and profiting from novel business models enabled by data and modularity-based reconfigurability?
d) How do B2B digital platforms enable resource liquefication and increment resource density among product-service ecosystem stakeholders?
e) How does open innovation enable collaboration and co-creation for DSI in service ecosystems based on B2B digital platforms?
Research Area 4: The role of customer value and user experience in facilitating innovations
a) What do customers and end users value in digital services, and how can this knowledge spur innovations (e.g. through laboratory experiments)?
b) What factors hinder the adoption of digital services among clients? What sources of inertia prevent innovation (e.g. through the e-Delphi method)?
c) What psychological barriers cause resistance to new, innovative digital services (e.g. framing and anchoring errors)?
d) How could customer and end-user data be utilized better when designing and developing new digital services?

Table 2. Future research agenda

Source(s): Authors own creation

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Appendix

The supplementary material for this article can be found online.

About the authors

Rodrigo Rabetino (Ph.D.) is a Professor of Strategic Management at the School of Management and the Vaasa Energy Business Innovation Centre at the University of Vaasa. His current research activities concern servitization and product-service systems, business model innovation and strategy as practice. He has published articles in international journals such as the *International Journal of Management Reviews*, *International Journal of Operations and Production Management*, *Regional Studies, Industrial Marketing Management*, *International Journal of Production Economics*, *Technovation*, *Journal of Business Research* and *Journal of Small Business Management*. Moreover, Dr Rabetino has served as a guest editor in many outlets, such as *Industrial Marketing Management, International Journal of Operations and Production Management, International Journal of Management Reviews, International Journal of Production Economics, Journal of Cleaner Production* and *Small Business Economics*. Rodrigo Rabetino is the corresponding author and can be contacted at: rodrigo.rabetino@uwasa.fi

Marko Kohtamäki (Ph.D.) is a Professor of Strategy at the University of Vaasa and an adjunct professor at the University of South-Eastern Norway, USN Business School. Kohtamäki is particularly interested in digital servitization, strategic practices, business models, business intelligence and strategic alliances in technology companies. Kohtamäki has published in distinguished international journals such as *Strategic Management Journal, International Journal of Operations and Production Management, Industrial Marketing Management, Long Range Planning, Strategic Entrepreneurship*

Journal, International Journal of Production Economics, Technovation and *Journal of Business Research*, amongst others.

Dr Tuomas Huikkola is an Associate Professor at the School of Management at the University of Vaasa. In his research, he studies incumbent firms' strategic practices and routines that facilitate a firm's strategic renewal through business model innovation. He has published in several academic journals and managerial books, including *Technovation*, *Industrial Marketing Management* and *Journal of Service Management*.