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What about digital servitization? Insights from a bibliometric-interpretative review.

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Abstract:
Purpose: Digital servitization regards two main trends which are changing manufacturing firms. Considering the academic interest and the potential to impact firms, the aim of this study is twofold: collecting and analysing the studies published on this topic, highlighting how this research field has developed and tracking a research agenda for future research.
Methodology: A systematic literature review is adopted to advance the existing literature on digital servitization. The scientific procedures and rationales for systematic reviews (SPAR-4-SLR) are applied as the review protocol and bibliometrics interpretative analysis is conducted as the review method.
Findings: The analysis reveals the recent increasing interest for digital servitization, calling for a clearer and more structured conceptualization of the phenomenon. The bibliometric analysis points out the emergence of four dominant topics in the digital servitization domain, such as: knowledge-driven management, technology-driven management, digital servitization's drivers and barriers, digital servitization consequences.
Research limitations/implications: Theoretical contributions regard systemizing the body of knowledge about digital servitization and proposing future research directions. Managerial implications are related to the need for companies to develop skills, capabilities, and competencies,

to readapt business models and to open-up to actors' network to exchange resources and information, so that digital servitization can be strategically embraced.
Originality/Value: Despite several literature reviews about digital servitization have been published, this study adopts the SPAR-4-SLR as a systematic process to review digital servitization both in its current trends and future directions.
Keywords: Servitization, Digitalization, Bibliometric analysis, Research agenda, SPAR-4-SLR protocol
Paper type: Research paper

1. Introduction:

In today's socio-economic context, industrial companies and whole industries are facing two megatrends that represent the cause of some disruptive changes (Linz et al., 2017; Coreynen et al., 2020). On the one hand, manufacturing firms are increasingly embarking on the servitization journey by shifting from the production of pure physical products to the provision of value-added integrated solutions, in response to customers' needs for higher quality service (Raddats et al., 2016; Kowalkowski et al., 2017a; Baines et al., 2020). On the other hand, the development of extraordinary technologies brought by the Fourth Industrial Revolution (i.e., Industry 4.0), known as digitalization, is radically transforming manufacturers' processes and business models through the expansion of service innovation opportunities (Kohtamäki et al., 2019; Bustinza et al., 2019; Grandinetti et al., 2020). Thus, servitization and digitalization are increasingly regarded as related concepts (Frank et al., 2019; Gebauer et al., 2020), whose combination, known as digital servitization, allows the provision of solutions via the adoption of digital technologies (Kohtamäki et al., 2019; Sklyar et al., 2019; Sjödin et al., 2020).

Digital servitization is a discussed topic in literature (Grubic and Jennions, 2018; Paschou et al., 2018). For a long time, in fact, servitization and digitalization have been treated as stand-alone areas within different research fields (Coreynen et al., 2017; Díaz-Garrido et al., 2018, Frank et al., 2019). The first focused on adding value to the customer in management literature, according to a demand-pull approach. Instead, in engineering and computer science literature, the latter centred on adding value to the manufacturing processes, following a technology-push approach. In the last decade, literature has begun to shed light on potential connections between servitization and digitalization being hot topics in relation to manufacturing activities (Porter and Heppelmann, 2015; Rymaszewska et al., 2017). In this regard, it is recognized that digitalization acts as both enabling factor and driver of servitization and that their convergence, if well exploited, can increase value-generating potential of firms (Vendrell-Herrero et al., 2017; Ardolino et al., 2018; Parida et al., 2019; Schroeder et al., 2019).

Addressing the debate of digital servitization, literature appears quite sparse in various research fields (e.g., marketing, economics, information systems, operations, strategy) (Paschou et al., 2020). In addition, Kohtamäki et al. (2019) highlight the lack of thorough definition and conceptualization of digital servitization being still in its infancy.
These gaps inspire the present paper aimed to identify, collect, and systematise the current scientific knowledge on digital servitization, providing an overview of existing research in such a domain in terms of contents and characteristics also providing further research avenue.

A literature review is performed using the Scientific Procedures and Rationales for Systematic Literature Reviews (SPAR-4-SLR) (Paul et al., 2021).
A research agenda is provided by focusing on seven specific research directions related to digital servitization. By doing so, this work extends the existing literature on such domain (Kohtamäki et al., 2019; Paschou et al., 2020), contributing to enhance the coherence of future research efforts and aiding the premises for interdisciplinary research on the digitalization and servitization crossing.

The paper is structured as follows. Section 2 describes the review methodology. Thereafter, Section 3 shows the review findings based both on the bibliometric analysis that is conducted, and it

advances future directions for digital servitization research. Finally, in Section 4, conclusions and limitations are drawn.

2. Methodology

With the aim to provide an overview of the current body of knowledge on the nexus between digitalization and servitization and to generate innovative insights for future research developments (Linares-Espinós et al., 2018) a literature review was carried out between March and June 2023.

Different protocols and reporting approaches are available to accomplish a domain-based literature review (Paul et al., 2023). In this study, we followed the SPAR-4-SLR protocol to enhance the replicability and dependability of our research (Paul et al., 2021). The SPAR-4-SLR protocol consists of three stages (and six sub-stages): assembling, arranging, and assessing (Paul et al., 2021). It was chosen because it ensures a thorough planning of the review from the start to the end. As the review method, a bibliometrics analysis was performed (Donthu et al., 2021), since it can manage a vast corpus of articles and allows the objective review of that corpus, due to its emphasis on quantitative techniques and statistical data (Mukherjee et al., 2022). The review methodology is deepened in the next sections.

2.1 Assembling

The first step of the SPAR-4-SLR protocol is to assemble the materials for review, which involves *identifying* and *acquiring* relevant scientific contributions.
In terms of *identification*, the protocol recommends that the *review domain,* the *research questions,* the *source type,* and the *source quality* should be identified.
In this case, digital servitization represents the review domain, in which the following questions (and related sub-questions) have been asked:

RQ1. How is the performance of digital servitization research?

RQ1.1 How does the literature define digital servitization?

RQ1.2 Which are the digital technologies most related to digital servitization?

RQ2. What are the major themes and topics in digital servitization research?

RQ2.1 What perspectives of analysis of the phenomenon can be distinguished and in which areas?

RQ3. What research directions can be pursued in the future for digital servitization?

The *source type* selected is journals, because they are highly scrutinized through a peer-review process (Lim et al., 2022), whereas the *source quality* selected is Scopus, since it provides an excellent coverage for social science research, serving 21 research institutions and contains more than 300 researchers and librarians (Burnham, 2006). Also, it has indexed over 14,200 journals and 12,464 social sciences titles from more than 5000 publishers (Elsevier 2020). In addition, Scopus has been used in relevant studies in the field (Grubic, 2014; Baines et al., 2009).

In terms of *acquisition*, the *search mechanism* and the *material acquisition*, the *search period*, the *search keywords*, and the *search string* need to be selected.

As the *search mechanism* and tool for *material acquisition,* Scopus has been chosen, in line with the recommendation of Donthu et al. (2021) and Paul et al. (2021). The *search period* was limited up to 2022, because this year is the last one that can be whole considered into the review. The *search keywords* were based on other relevant reviews (Favoretto et al., 2022; Paschou et al., 2020) covering

the domain investigated in this study. Servitization and digitalization were the main keywords, which have been combined through Boolean operators (AND-OR), by forming the *search strings* (Table 1). The *search strings* were used for search within the article title, abstract, and keywords in Scopus, as recommended by Kraus et al. (2022).

The assembling stage returned 26.633 documents in total.

Table 1. Search strings used in Scopus

Set's number	*Keywords*	*Records*
1	TITLE-ABS-KEY ((“Digital”) AND (“serviti*ation”))	278
2	TITLE-ABS-KEY (“Serviti*ation” OR “product (-) service system” OR “PSS/IPPS” OR “integrated solution*” OR “service transformation” OR “service infusion”)	8.436
3	TITLE-ABS-KEY ((“Digitization” OR “digitalization”)) AND (“technolog*” OR “3D printing” OR “additive manufacturing” OR “advanced manufacturing solutions” OR “artificial intelligence” OR “autonomous robots” OR “big data” OR “analytics” OR “cloud” OR “cyber security” OR “horizontal and vertical integration” OR “internet of things” OR “simulation of connected machines” OR “virtual reality” OR “augmented reality” OR “industry 4.0” OR “multichannel” OR “omnichannel”))	17.919

Legend: ABS= Abstract; KEY = Keywords

2.2 Arranging

The second step of the SPAR-4-SLR protocol consists in *organizing* and *purifying* the documents, through the categorization of the *document type*, the *publication stage*, and the *language*. Specifically, we chose inclusion criteria (Table 2) that were based on: international peer-reviewed journal articles (i.e., document type) in the areas of Business Management and Accounting, Engineering, Computer Science, Decision Sciences, Social Sciences and Economics, Econometrics and Finance that were published in English (i.e., language). Then, the articles that (1) were duplicated, (2) did not deal with digital servitization (i.e., off-topic), (3) addressed topics only focusing on digitalization or servitization (i.e., off-scope) were excluded. The authors independently analysed the titles, abstracts and keywords of retrieved articles and excluded the articles that fell within one of the three above categories.

As a result, a total of 249 articles that fulfilled these criteria were included, whereas 265 were duplicated and 26.119 articles were off-topic and off-scope, so they were excluded in the review.

Table 2. Inclusion criteria

Criteria	*Description*
Literature type	International peer-reviewed journal articles
Language	English
Areas	Business Management and Accounting, Engineering, Computer Science, Decision Sciences, Social Sciences and Economics, Econometrics and Finance

2.3 Assessing

The third and final step of the research protocol involved the *assessment* of selected items,

through the activities of *evaluation* and *reporting*.

In terms of *evaluation*, a descriptive and a bibliometric analysis have been conducted. Particularly, a data extraction form was developed to summarize the publication year, citations, geographic distribution, journals type, subject area, methods, industries, and author(s). Then, a keyword co-occurrence analysis was carried out to unpack the major themes and topics in digital servitization research. Co-occurrence analysis allows an understanding of how often two or more lexical units are present at the same time within the analysed texts.

Thus, the overall analysis allowed to investigate i) definition of digital servitization and digital technologies adopted; and ii) perspectives of analysis and opportunities and constraints of digital servitization. These analyses were performed using the analytics functions in Scopus and VOSviewer (Van Eck and Waltman, 2010) in line with the recommendations of Donthu et al. (2021).

In terms of *reporting*, findings were first reported in words and then were supported with supplementary relevant visuals such as figures depicting network diagrams and tables presenting key statistics.

The next sections show the review findings of the 249 articles included in the present review.

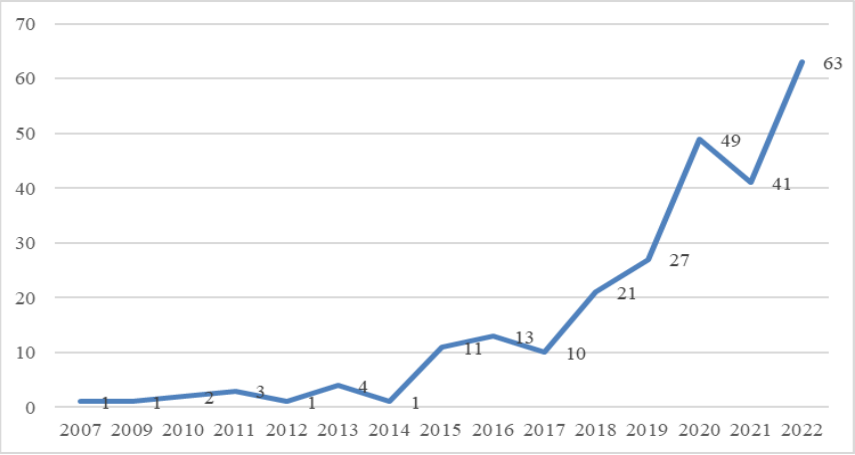
3. Findings

3.1 Performance of Digital servitization research (RQ1)

The time scale of the selected articles can be divided into two temporal segments: i) from 2007 to 2014; and ii) from 2015 to 2022 (Figure 1). In the first segment, publications were few and unrelated to each other. The elder articles - such as Baines et al. (2007) and Neely (2008) - addressed the issue of servitization and product-service systems in isolation, focusing on financial performance or competitive advantage resulting from differentiation. Then, we can set 2007 as the first year in which digital servitization arose. Only in 2013, we find the first contribution of Belvedere et al. (2013) who began to investigate the role of Information and Communication Technologies (ICTs) in the implementation of the product-service system.

In the second segment, there is an increasing number of publications per year, in which the convergence between ICTs and servitization was deepened, by setting 2022 as the peak of publications (63).

Figure 1. Articles published per year



In terms of citations, the most cited article is also the oldest, i.e., Baines et al. (2007) with 2792 citations, followed by Neely (2008), Ostrom (2015), and Meier (2010) with 1912, 1755 and 1213 citations respectively.

Table 3 shows the ten most cited articles of the sample. In Baines et al. (2007), it has been conducted one of the first clinical reviews of the literature on Product-Service Systems. The major outcomes of each study are analysed to better define the PSS, also providing businesses cases and related benefits.

Then Neely (2008), through an empirical data analysis based on more than 10.000 firms, studied the correlation between the firm dimension and the results in terms of revenues and sales, showing how generating profits was more difficult for large dimension companies.

Ostrom et al. (2015) identified 12 research priorities with the aim to advance the potential of servitization. Topics and areas of greatest value to enhance understanding of service and create new knowledge were highlighted. At the same time, opportunities and challenges, in terms of customers, organizations, and society, were addressed.

Finally, Meier et al. (2010) focused on product service systems in industry (IPSS), emphasising the need for a paradigm shift from a separate consideration of products and services to their integration to create innovation and increase competitiveness.

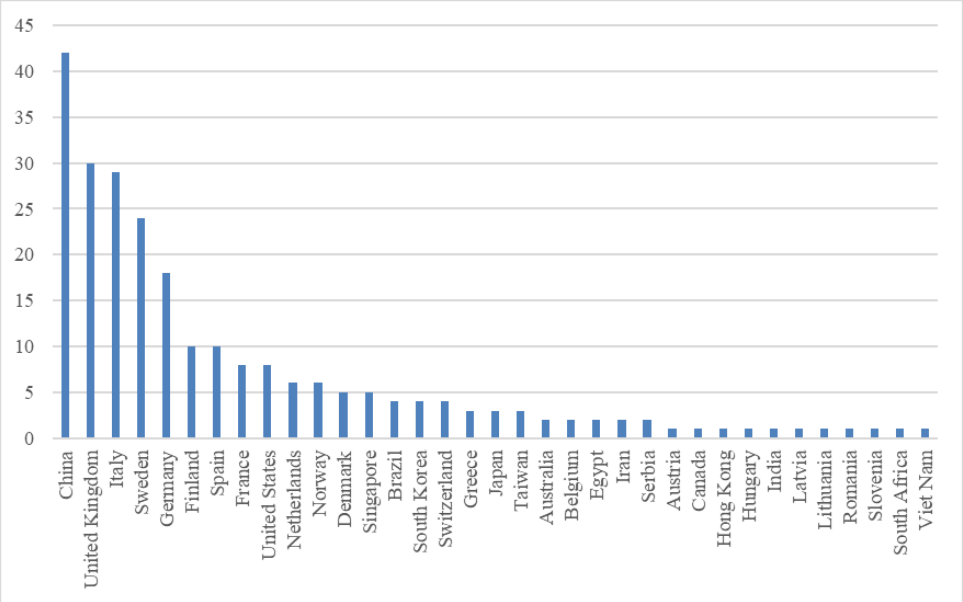
Table 3. Articles most cited

Authors	**Article**	**No. of Citations**
Baines et al., (2007)	State-of-the-art in product-service systems	2792
Neely, (2008)	Exploring the financial consequences of the servitization of manufacturing	1912
Ostrom et al., (2015)	Service Research Priorities in a Rapidly Changing Context	1755
Meier et al., (2010)	Industrial product-service systems-IPS2	1213
Frank et al., (2019)	Servitization and Industry 4.0 convergence in the digital transformation of product firms: A business model innovation perspective	752
Baines et al., (2017)	Servitization: revisiting the state-of-the-art and research priorities	733
Baines and Lightfoot, (2014)	Servitization of the manufacturing firm: Exploring the operations practices and technologies that deliver advanced services	691
Coreynen et al., (2017)	Boosting servitization through digitization: Pathways and dynamic resource configurations for manufacturers	687
Vendrell-Herrero et al., (2017)	Servitization, digitization and supply chain interdependency	627
Opresnik and Taisch, (2015)	The value of big data in servitization	603

Regarding the country of published articles, 35 different countries show interest in digital servitization. This topic is investigated mainly in China (42 articles), United Kingdom (30) and Italy (29).

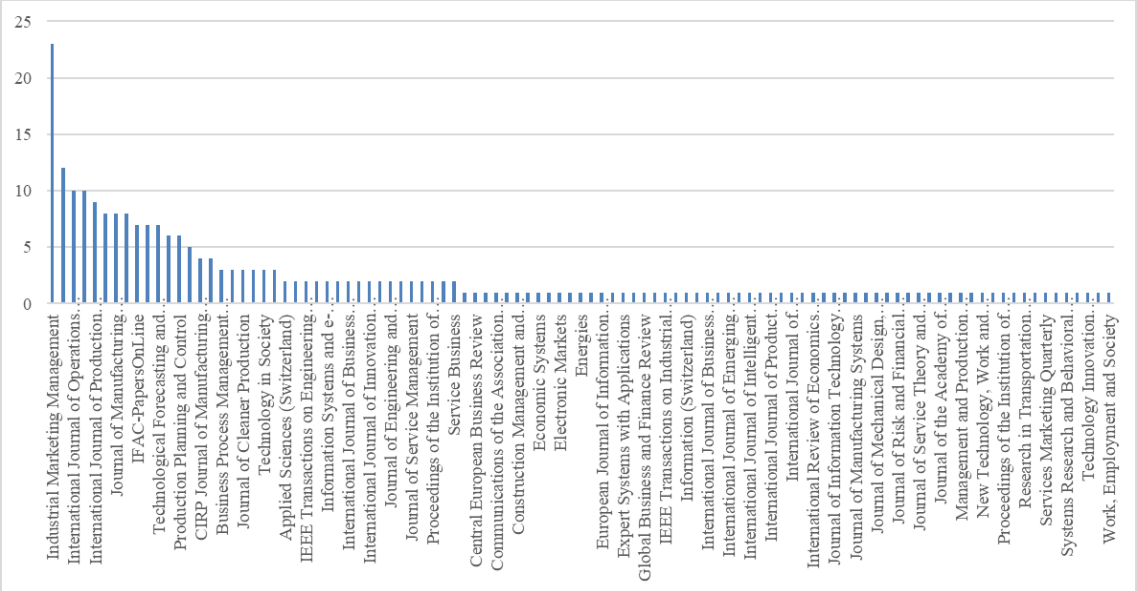
Other European countries, such as Sweden (24), Germany (18), Finland (10), Spain (10) and France (8), contribute to the research on the topic under discussion. Some contributions come from the American continent and Asian Countries (Figure 2).

Figure 2. Articles per country



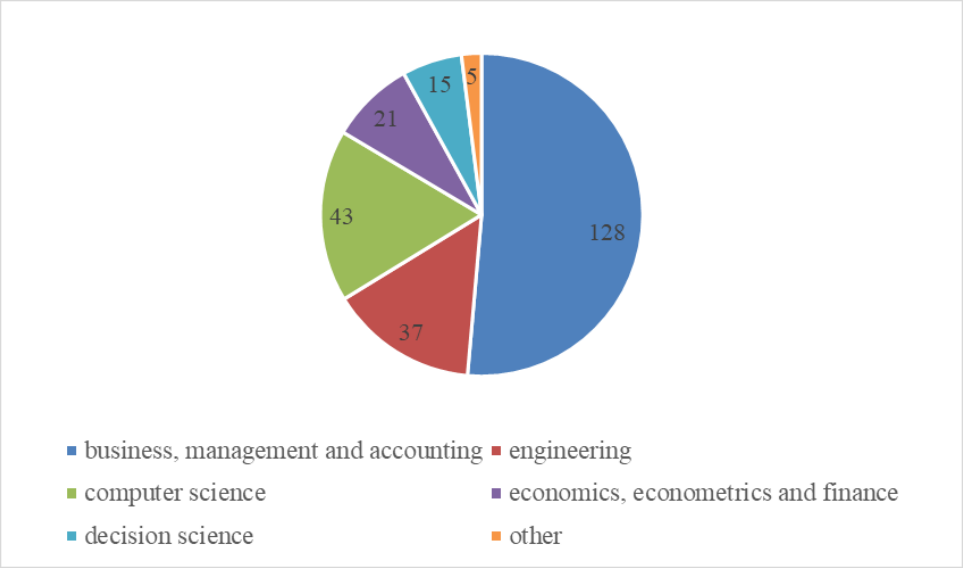
The articles included in the systematic review are published in 101 different journals. Most of them is published in *Industrial Marketing Management* (23 articles), followed by *Advanced Engineering Informatics* (13 articles), *International Journal of Operations and Production Management* and *International Journal of Production Economics* (10 articles), *International Journal of Production Research* (9 articles), and *Journal of Business Research*, *Journal of Manufacturing Technology Management* and *Sustainability* (8 articles) (Figure 3). This can indicate that digital servitization research is accepted across various domains.

Figure 3. Articles per journals



The articles included in the research belong mostly to business, management and accounting (128), computer science (43), engineering (37), economics, econometrics and finance (21) and decision science (15) (Figure 4). Thus, a highly fragmented picture of the subjects through which digital servitization is studied emerges due to the debated nature of the research topic.

Figure 4. Articles per research area (updated in June 2023)



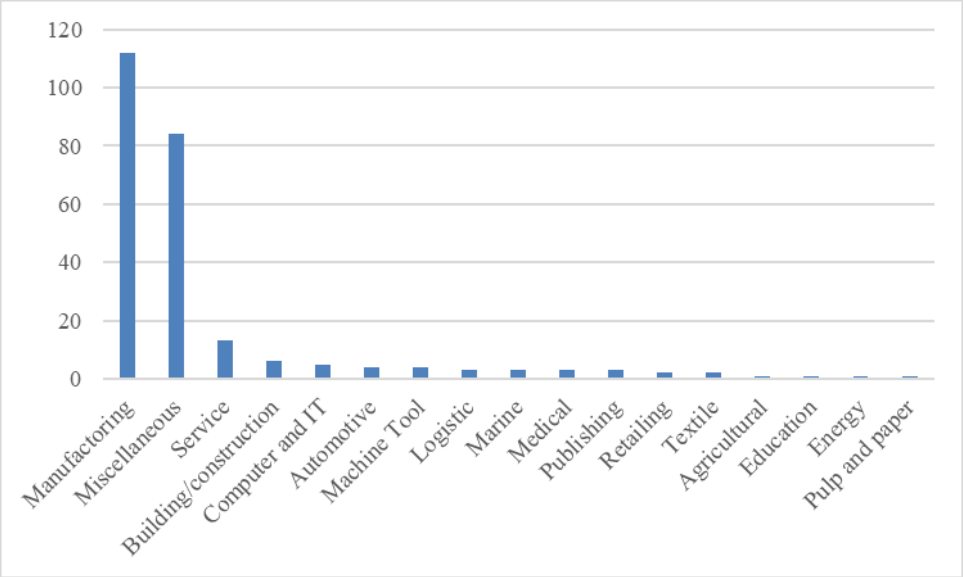
Digital servitization is addressed mainly through empirical and qualitative methods. Particularly, most of the articles were based on case studies and interviews, thus confirming the relative infancy of this research stream, in which confirmation and regulatory work are less then exploratory ones (Table 4).

Table 4. Paper types and methodological approaches

Paper type		**Method**	**No. of works**
Theoretical		Literature review	26
		Concept development	23
		Modelling and computer simulation	49
		Total	**98**
Empirical	Qualitative	Case study	87
		Interviews	13
		Text-mining	1
	Quantitative	Correlation	1
		Regression	16
		Model based analysis	28
		Social Network analysis	1
		Cluster Analysis	1
	Mixed method		3
		Total	**151**

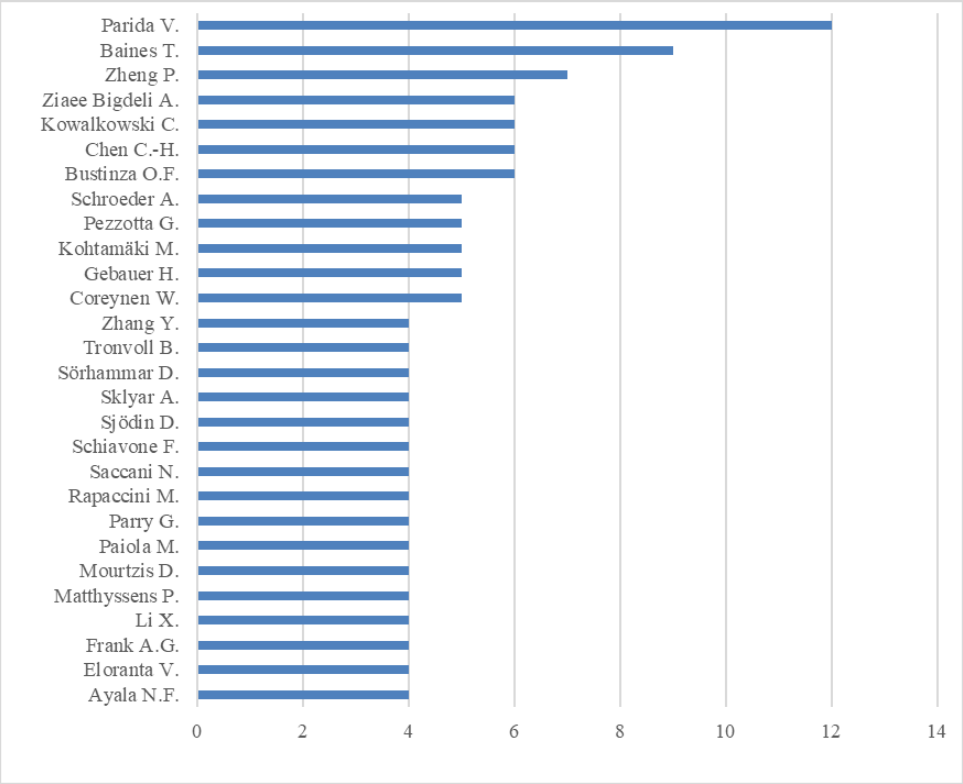
Empirical studies often investigate manufacturing and multiple types of industries at the same time (Figure 5), and the data also shows that research focuses on sectors such as service (Kreye, 2019), building and/or construction (Li et al., 2022), computer and IT (Visnjic et al., 2019), automotive (Goehlich et al., 2020) and machine tool (Andriankaja et al., 2018). Moreover, scholars have mostly paid attention to B2B markets considering digital servitization as a socio-technical process to sustain the relational quality (Grandinetti et al., 2020).

Figure 5. Industries



Finally, the most prolific authors in the field of digital servitization are Parida with 12 articles, Baines with 9 articles, and Zheng with 7 articles followed by Ziaee Bigdeli, Kowalkowski, Chen and Bustinza (Figure 6).

Figure 6. Articles per authors



The above descriptive analysis suggests that the interplay between servitization and digitalization is a trend that shows a rapid growth, especially in the last 6 years, with articles coming mainly from China and European countries such as the United Kingdom, Italy, and Northern

European countries, neglecting under-developed countries. Moreover, the subjects associated with digital servitization are multiple and concern not only the engineering field but also the management of business processes of manufacturing firms to improve financial performance.

3.1.1 Definition of Digital Servitization (RQ1.1)

Given the recent and diverse development of this research stream, as shown in the previous section, the authors are called in proposing specific definitions of digital servitization. As the table 5 shows, a univocal conceptualisation of the phenomenon is not provided given that digital servitization evolves over time across both contexts of study and perspectives of analysis. Anyway, the various definitions have in common the acknowledgment of ICTs as necessary integrated tools to implement servitization strategies and practises. Indeed, the word 'transformation' tends to be used in a broad sense, as a valuable mechanism to update the companies' value propositions, business model, processes, and capabilities.

Table 5. Definitions of digital servitization: an overview

Authors	*Definition*
Vendrell-Herrero et al. (2017)	The provision of IT services based on digital components embedded in physical products.
Kowalkowski et al. (2017a)	The use of digital tools for transformation processes whereby a company moves from a product-focused business model to a service-focused logic and business model.
Bustinza et al. (2018)	The need for digitally enabled integrated solutions, organizational change and a reconfiguration of business models.
Opazo-Basáez et al. (2018)	The adoption of digital technologies enables more environmentally friendly production processes, communication channels, products, and services, improving economic value.
Kohtamäki et al. (2019)	The transition to intelligent product-service software systems that enable the creation and acquisition of value through monitoring, control, optimization and autonomous function.
Sklyar et al. (2019)	The use of digital tools for servitization purposes
Kohtamäki et al. (2020)	The use of digital technologies to create and appropriate value from product-service offerings; thus, digital servitization is understood as the interplay between digitalization and servitization. Servitization is required to appropriate value from digitalization for higher financial performance of a manufacturing company.
Sjödin et al. (2020)	The transformation of processes, capabilities and offerings within industrial companies and their associated ecosystems to create, deliver and progressively acquire greater service value from a wide range of enabling digital technologies such as the Internet of Things (IoT), big data, artificial intelligence (AI) and cloud computing.

3.1.2 Digital technologies adopted (RQ1.2)

Servitization would not exist without an effective implementation of digital technologies of Industry 4.0: in fact, the latter allow firms collecting data through customer interactions, and adapting the production and internal processes to the emerged insights to deliver value through customized

solutions (Frank et al. 2019; Kohtamäki et al. 2020).

Despite the interplay between digitalization and servitization (Opresnik and Taisch, 2015; Rymaszewska et al., 2017; Martín-Peña et al., 2019), few studies focus on Industry 4.0, limiting generically their discussion to the digital transition. Furthermore, some scholars deal with an unspecified technology when investigating the digital servitization (Lerch and Gotsch, 2015; Lenka et al., 2017; Vendrell-Herrero et al., 2017; Bustinza et al., 2018), while others analyse traditional technologies (i.e., ERP and CRM systems) (Geum et al., 2011; Belvedere et al., 2013).

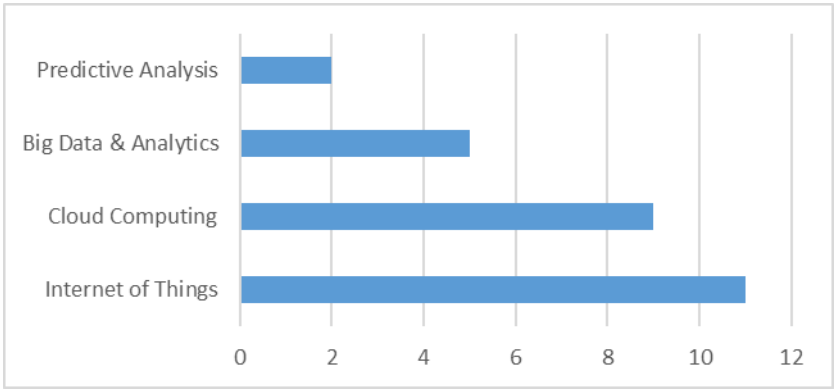
Conversely, Internet of Things (IoT), and particularly Industrial Internet of Things (IIoT), represents the technology that has gained greater popularity, having been discussed in 11 articles (Figure 7). IoT is based on the pervasive presence of a variety of interlinked devices, that enable manufacturers to design service-oriented business models (Rymaszewska et al. 2017), leveraging on the opportunities for capturing and monitoring product usage conditions and related data (Adrodegari et al., 2015; Paiola and Gebauer, 2020).

As Figure 7 shows, 9 papers focused on big data and analytics, which allow to collect a large amount of data, different both for origins and types. At the same time, they imply greater challenges to collect, manage and process them with traditional systems and capabilities (Urbinati et al., 2019).

Cloud Computing (CC) is analysed in 5 articles, always in association with other technologies. It is emphasized its role in terms of convenient and efficient aggregation and processing of a huge amounts of data (Ardolino et al., 2018).

Predictive Analysis (PA), as application of skills, competences, and algorithms on the collected data to estimate the probability that an event will occur (Ardolino et al., 2018), is addressed in 2 studies. Finally, additive manufacturing (Ford et al., 2016), remote monitoring (Grubic, 2014; Grubic and Jennions, 2018) and machine learning (Ardolino et al., 2018) are little studied above all separately from other technologies.

Figure 7. Digital technologies adopted in the reviewed papers



In sum, IoT is recognized as the main enabler of digital servitization. Despite that, it provides greater opportunities for companies when integrated with Big Data, CC and PA (Rymaszewska et al., 2017; Ardolino et al., 2018, Ciasullo et al., 2021). Thus, these technologies should be applied in synergistic rather than a silos way given the combined effects that they produce by working together, calling for integrated and interoperable digital platforms.

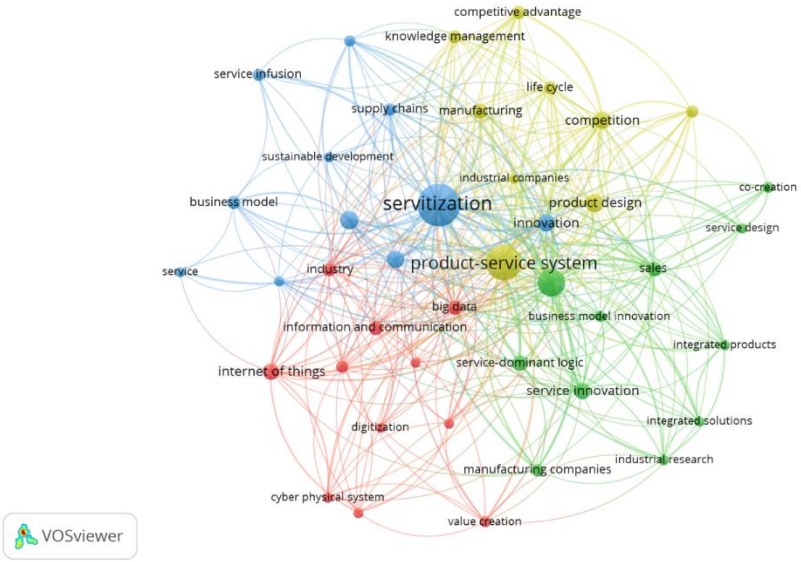
3.2 Major themes and topics in Digital Servitization research (RQ2)

To unpack the major themes or research topics a co-occurrence analysis was performed through VOSviewer analytical functions. Particularly, only keywords that showed an occurrence index of

more than 5 were retained in the analysis; consequently, out of 989 keywords 45 terms were analysed, constituting the largest usable set of related terms. The six most frequently occurring keywords are: Servitization (84), Product-service system (60), Manufacture (36), Product design (16) e Digitalization (16).

Accordingly, four main clusters of interconnected themes have been identified (Figure 8): Knowledge-driven management (Cluster 1 - Yellow), Technology-driven management (Cluster 2 - Red), digital servitization's drivers and barriers (Cluster 3 - Green), and digital servitization consequences (Cluster 4 - Blue) (Table 6).

Figure 8. Results of the co-occurrence analysis



The overlay visualization of keywords shows the temporal distribution of keywords based on a score calculated according to the average year of occurrence of each keyword (Figure 9). The most recently used keywords range from green to yellow colours, while the eldest keywords are in shades of blue.

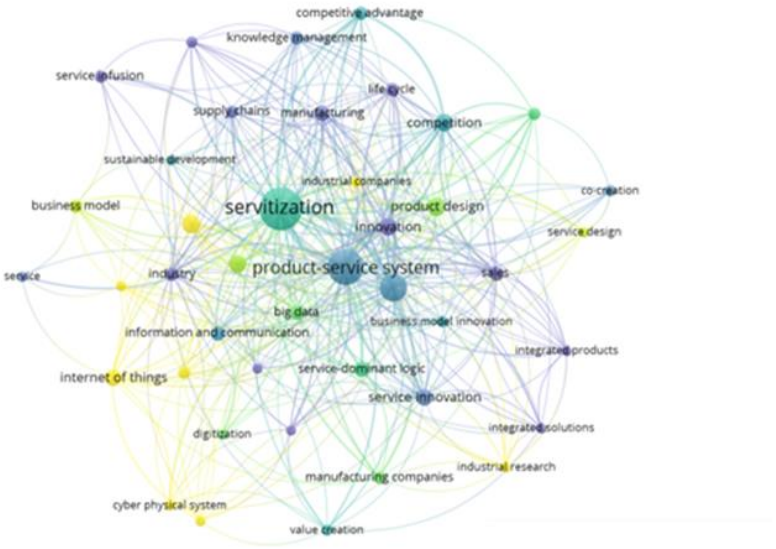
The field of study on digital servitization shows an evolution from a previous focus mainly related to strategy, performance, and application sectors of servitization (e.g., servitization of manufacturing companies) to more specific topics of computer-based nature, regarding newer and integrated technologies (e.g., Internet of Things; cyber-physical systems, and so on).

Table 6. Result of keywords analysis

Cluster 1 Knowledge-driven management			**Cluster 2** Technology-driven management			**Cluster 3** digital servitization's drivers and barriers			**Cluster 4** digital servitization consequences		
Keyword	Occurence	Link Strength	Keyword	Occurence	Link Strength	Keyword	Occurence	Link Strength	Keyword	Occurence	Link Strength
product-service system	60	163	internet of things	13	32	manufacture	36	138	Servitization	84	179
product design	16	58	big data	10	39	service innovation	12	48	Digitalization	16	35
competition	14	64	ICT	10	26	SDL	11	35	Innovation	15	47
manufacturing	11	44	industry	8	32	Sales	10	45	value co-creation	14	41

life cycle	9	35	industry 4.0	7	19	manufactoring companies	7	25	BM	8	16
competitive advantage	9	34	value creation	6	17	BMI	6	23	supply chain	7	28
knowledge management	8	17	Cyber physical system	5	18	co-creation	6	12	service infusion	7	13
product and service	7	28	embedded system	5	18	integrated product	5	21	manufactoring firms	6	24
			service system	5	17	industrial research	5	19	digital technologies	5	15
			manufactoring industry	5	12	integrated solution	5	18	sustainable development	5	12
			digitization	5	11	service design	5	15	Service	5	8

Figure 9. Overlay visualisation of the keywords



Cluster 1 (yellow) collects studies that strategically investigate the opportunities arising from the data produced and analysed by new technologies, which can lead to a competitive advantage. Scholars emphasizes the importance of data in digital servitization strategies, focusing on manufacturing companies. Anyway, they struggle to fully leverage the possibilities of collecting and utilizing data.

For example, reuse and resale have been considered two main data exploitation strategies with the potential to create new revenue and value (Chen et al., 2021; Baines et al., 2020). Furthermore, Wang et al. (2019), integrating heterogeneous data sources into a holistic database, introduce the product-service system as an emerging value proposition paradigm, capable of generating services as a solution bundle to meet individual customer needs.

Following this line of thought, scholars (Galera-Zarco et al., 2016; Weking et al., 2020; Wang et al., 2020) contend that the information generated by technologies has the potential to drive the development of novel and enhanced services, further strengthening a firm's competitive advantage. In this sense, digital servitization emerges as all-encompassing business process where data creates new business opportunities, thereby adding a third level of value, alongside the existing product and service levels, which is information as a relevant intangible asset (Opresnik and Taisch, 2015).

To facilitate the implementation of a digital servitization strategy in improving a competitive advantage, an effective Knowledge Management (KM) system is necessary (Leoni, 2015), that allows to sustain data management as well as the acquisition of new knowledge to leverage data from digital technologies.

KM becomes a vital system for preparing employees for servitization (Lertsakthanakun et al., 2012), because it can support individual learning, promote knowledge sharing and integration, and create a culture of organizational learning that can enable a company to succeed using the new digital servitization strategy. However, digital servitization as a business strategy requires the integration of a broader range of competencies, posing new challenges to the acquisition and management of knowledge (Chirumalla, 2013).

The attainment and management of knowledge is both internal, when it contributes to expand employees' knowledge within the company and external when it incorporates knowledge about necessary services from other companies (Ayala et al., 2017). In sum, digital servitization strategies require intra and inter managerial practises to be renovated.

Cluster 2 (red) includes studies that focus on strategies based on technology-driven value creation. The technological development has led to the availability of increasingly pervasive and high-performance information and communication technologies (ICTs), which are also being deployed outside the typical industrial environment with a broader range of stakeholders involved. These improvements regarding processing power, miniaturisation, and availability of wireless connectivity led to the generations of smart and connected products that can provide better services and products, paving the way for the development of new value propositions.

Accordingly, scholars contend that companies leverage ICTs to pursue digital servitization strategies, then impacting value creation through the improvement of operational processes. Based on the study by Belvedere et al. (2013), ICTs foster value creation, by redesigning operational processes, thereby improving their responsiveness. Chen et al 2021, by combining process-perspective and business-model lenses, offer insights into how digital servitization unfolds. They highlight the different stages in which new value propositions and value delivery systems are created and enabled with digital technology through both discontinuous and continuous interplay between business models and digital technologies.

By specifically focusing on value proposition, ICTs are deepened to advance smart solutions or service-oriented PSSs (Tao and Qi, 2017; Corradi, et al. 2018; Liu et al., 2019).

In a smart PSS, deep convergence of the physical and cyber worlds is realized through the combination of new information and communication technologies (e.g., IoT, cloud computing, big data, mobile Internet, and cyber-physical systems) and services (Liu et al., 2021). Through the interoperability, integration, and fusion of the physical and cyber worlds of production, companies can aim at smart production where data generated in the physical world can be captured and transferred to the cyber world through IoT and the Internet and be processed and analysed by cloud computing and big data technologies. From a value chain perspective, this merger impacts firms' understanding and relationships with their customers and other actors. To successfully offer smart solutions or smart PSSs, manufacturer companies require an ecosystem value delivery composed of a net of suppliers, distributors, partners, and customers. Once the ecosystem relationships are well aligned, manufacturer companies gain value with multiple value-capture mechanisms (i.e., efficiency, accountability, shared customer value, and novelty) (Chen et al., 2021).

Moreover, smart connectivity gives information on how users manage products, thus giving a firm the chance to anticipate problems and transform the customer experience, reshaping the conventional idea of products as autonomous concepts (Frank et al., 2019). The enrichment of products through value-added services based on the adoption of ICT, therefore, leads firms and their associated ecosystems to develop new value propositions, effectively overturning the concept of ICT-derived value traditionally based on productivity. Indeed, strategies based on technology-driven value creation allow firms to directly interact with ecosystems' actors. Accordingly, technology-based interactions are faster and more effective, by improving the relational quality among actors involved (Grandinetti et al., 2020). Anyway, to grasp and exploit the full potential of digital technologies, allowing a high interconnectivity and scalability, a fit alignment among the actors is required.

Cluster 3 (green) comprises studies that investigate the main drivers and challenges of digital servitization. Different elements such as service offerings, prices, the need for service fulfillment, and service integration processes can influence the success or failure of digital servitization implementation, highlighting the importance of service capabilities for both firms and business partners to ensure effective service infusion (Eloranta and Turunen, 2015, 2016; Ostrom et al., 2015; Kowalkowski et al., 2017b).

Moreover, by linking digital servitization to service innovation (Chester and Faullant, 2018; Bustinza et al., 2021), critical success factors emerged, such as: actor value networks, resource integration, and the right set of ICTs. At the same time, converting digital servitization into value poses managerial challenges, because it must be combined with efficient and effective mobilisation of the internal and external resources. Many scholars (Kamalaldin et al., 2020; Kolagar et al., 2022) have emphasized the need to develop both close collaborations and strong partnerships to support integrated value propositions, as well as the inclusion of new technological resources implies changes along the overall value chain, calling for new collaborations. Therefore, identifying relevant partners and establishing effective relationships are central challenges for managers in their efforts in achieving service innovation. On the other hand, inter-firm collaboration creates challenges, such as: 1) shared and complementary goals, 2) the joint design of a new business model aimed at both value creation and appropriation, 3) collaborative project management, and 4) the fruitful combination of multiple agile approaches (Simonsson and Magnusson, 2020).

Another challenge is represented by the digitalization paradox, which could occur because digitalization requires large investments in not only digital material assets, but also digital skills and technological competences. Such investments may not earn the expected returns, according to the digitalization paradox (Kohtamäki et al., 2020; Gebauer et al., 2020). Moreover, the so-called paradox of service entails increasing revenues from services, but subsequently reducing profits, leading companies to deservitize or even fail (Gebauer and Kowalkowski, 2012; Kowalkowski et al., 2015). Overcoming the service paradox, cultural challenges could be met because the product-oriented mindsets of manufacturers should shift towards a culture of service (Kowalkowski et al., 2017b).

Cluster 4 (blue) collects studies that emphasize the consequences of digital servitization. From this perspective, where new technologies are essential levers to respond accurately and quickly to market dynamics, scholars analyse the business opportunities arising from both customer and supplier perspectives. From a customer perspective, digital technology-enabled services empower the end-user (Hernández et al., 2012), who obtains increased flexibility and higher customization (Wünderlich et al., 2013; Kowalkowski et al., 2013; Paluch and Wünderlich, 2016; Wan et al., 2017), improved performance in service usage (Weinmann et al., 2016), thereby transferring risks to the firm (Grubic, 2014, 2018).

From a supplier's perspective, digital servitization brings new business opportunities (Vendrell-Herrero et al., 2017; Bigdeli et al., 2018; Bressanelli et al., 2018) and allows the configuration of service-based business models. Cao et al., 2022 analyse the servitization transformation performance of manufacturing, providing some insights into servitization transformation activities by merging business model innovation and technological innovation. Other scholars (Eloranta and Turunen, 2016; Cenamor et al., 2017; Bustinza et al., 2018; Lindström et al., 2018) contend that digital servitization allows the configuration of service-based business models enabled by platforms in which relationships between customers and supplies are fostered. Kohtamäki et al., (2019; 2021) conceptualise different configurations of the digital servitization business model. To achieve a more competitive, socially, economically, and environmentally sustainable industry, digitization is certainly a key enabling factor, but it is insufficient and becomes necessary to merge technology and business model innovation by organizing and leveraging appropriate resources and developing strong partnerships to support new and advanced value propositions. The analysis shows that any digital-based change must be managed from an ecosystem perspective, aligning players to improve coordination and collaboration by promoting new services and opportunities, strengthening

established relationships, and facilitating new ones. This perspective amplifies the possibility of identifying new forms of competitiveness, thereby opening up new markets.

At the operational level, other consequences derived from digital servitization concern the improvement of maintenance by leveraging remote monitoring and the use of predictive analysis to provide fast and smart solutions to issues concerning offerings (Rakyta et al., 2016; Wan et al., 2017; Grubic et al., 2018). In this direction, Kamp et al. (2017) highlight that digital servitization impacts quality control, increasing the possibility of rapid detection of anomalies in manufactured products used by customers, and on production efficiency, providing a clearer definition of supply chains' needs and capabilities. Moreover, digital technology-enabled services generate positive financial performance (Kohtamäki et al., 2020) as well as additional profits through increased sales, reduced internal production and engineering costs, and increased productivity and flexibility (Frank et al., 2019).

Finally, few scholars investigated the contribution of digital servitization to environmental and social sustainability. The main consequences discussed are related to the reduction of the environmental impact of manufacturing activity, mainly in terms of energy consumption (Mourtzis et al., 2017; Holler et al., 2017; Opazo-Basáez et al., 2018), and to the shift to a circular economy (Bressanelli et al., 2018; Lindström et al., 2018).

3.2.1 Perspective of analysis (RQ2.1)

Digital servitization has been investigated as a valuable business strategy, by merging two main perspectives: internal managerial and external relational. These two perspectives allow to draw and pursue different approaches for the achievement of a competitive advantage.

The internal managerial perspective focuses on stressing the internal capabilities, resources, and skills that the firm needs to own and train to address digital servitization effectively, ensuring a seamless integration of technology-driven services into their existing product offerings and maximizing customer value. From this perspective, two main theories arose:

- Resource Based View (Barney, 1991, 1995), which outlines that to reap the potential benefits of digital servitization for gaining competitive advantage, operational skills, such as software capabilities and strategic capabilities (technology development, mergers and acquisitions, value quantification, supplier network management, etc.) are required (Hasselblatt et al., 2018). Moreover, the ability to connect and analyse data is highly relevant, because the generation of information represents a resource and a valuable strategic asset that encompasses the features required for sustainable competitive advantage in a manufacturing company (Huikkola and Kohtamäki, 2017);
- Dynamic Capabilities (Teece et al., 1997; Teece, 2007), which are linked to the ongoing assimilation, transformation and exploitation in organizational routines of accumulated resources and capabilities in the context of digitally enabled servitization. Thus, higher order dynamic capabilities – that enable to extend, modify, and improve ordinary capabilities – are necessary to create a sustained competitive advantage (Coreynen et al., 2017).

These theories clearly call for the management of data and the need to sustain both resources acquisition and resources integration. At this regard, Knowledge Management systems emerge as the means through which the creation of new knowledge and abilities is supported.

The external relational perspective, instead, is deeply related to the way in which a firm manages its external relationships to handle and improve the use of digital technologies for embracing servitization. Also from this perspective, two main theories arose:

- Relational view (Dyer and Singh, 1998; Lavie, 2006; Dyer et al., 2018), which stresses the need to develop complementary digitalization capabilities, relation-specific digital assets, digitally enabled knowledge-sharing routines, and partnership governance to shape and nurture provider-customer relationships, so that digital servitization is successfully implemented (Kamalaldin et al., 2020);
- Service-Dominant Logic (SDL) (Vargo and Lusch, 2008), which outlines the role of close

interactions among actors. Indeed, SDL opens to actors' network, by stressing the relevance to establish partnerships and collaborations, also technological enabled, to co-create and co-deliver new digital services (Sjödin et al., 2019, 2020).

By developing this line of thought, the ecosystem approach appears to maximize the possibility to co-create value among actors. Indeed, value co-creation is enabled when close collaborations are established. Digital technologies allow to accelerate the efficacy and the promptness of interactions, paving the way to increase interconnectivity and to exploit scalability, allowing a continuous resource exchange and recombination. The potential of digital technologies for servitization is fully exploited when synergistic alignment among actors is achieved.

3.3 Future directions for digital servitization research (RQ3)

Given the observed trajectory of the research and the discussion of its key themes and topics, there are a number of noteworthy reflections and promising directions that can guide future research in expanding the body of knowledge on digital servitization.

Firstly, the research on digital servitization is still highly debated, then it requires further focus on two key aspects. On the one hand, there is a need for more attention to theoretical studies that aim to develop the fundamental concepts and theories underlying this emerging research area. On the other hand, future research should employ quantitative research methods to establish the reliability and validity of the qualitative research approaches used thus far. Moreover, combining mixed approaches of analysis could effectively address both theoretical and empirical gaps present in this field of research.

Secondly, since B2B arose as the most investigated markets (Grandinetti et al., 2020), future research could focus on analysing digital servitization in new industries, also conducting cross-industry comparisons and considering B2C markets as intriguing research setting. Then, it would be appropriate to investigate case studies that relate to B2C industries, for example through surveys and user accessions.

Thirdly, because of industrialized countries have been more investigated than under-developed countries, future research could analyse how digital servitization can be implemented in these under-developed countries, and, more importantly, explore how it can enhance and accelerate their economic growth and development.

Fourthly, introducing digital servitization requires for manufacturing firms to adapt and innovate their current routines, skills, and capabilities to be able to handle new digital technologies (Kapoor et al., 2021). Then, it is relevant to identify strategies and practices to overcome technological gaps and to train employees' digital readiness and ability to recognize, analyse and interpret data towards an organizational data-driven culture shift able to embrace digital servitization.

Fifthly, from the analysis it is clearly emerged the relevance of partnerships and collaboration among different stakeholders, calling for an ecosystem approach (Ciasullo et al., 2021). But, transforming ecosystems for digital servitization is a very complex undertaking for industrial manufacturers (Coreynen et al., 2020). In fact, there is a need for greater understanding of the ecosystem transformation process in digital servitization (Kolagar et al., 2022). The research could start focusing on analysing how different actors can contribute to co-create value, what type of relationships should be established.

Sixthly, in recent times, both sustainability and business models have gained academic interest. On the one hand, the need for sustainability is linked to the urgency to move towards this topic; on

the other hand, the implementation of digital technologies brings to innovate business models for servitization. Nevertheless, the explanation of how servitized business models can lead to sustainability is still poorly investigated (Gebauer et al., 2020). Indeed, there is a need for further research to discuss the link between digital servitization and sustainability (Kohtamäki et al., 2020).

Seventhly, the role of digital technologies in the development of services and servitization strategies has been addressed (usually) in isolation. It would be useful to study the joint role of each digital technologies in relation to the others, by focusing on their integration. Then, it would be possible to highlight how interconnectivity and scalability are achieved, when digital technologies are integrated, by shaping ecosystem digital platforms. Future research should deepen the study of technologies still little explored such as, additive production, blockchain, cyber security, remote monitoring, to generate value moving towards a service-oriented perspective and it should investigate how digital platforms can contribute to embrace digital servitization.

4. Conclusion and limitations

This paper describes the current state of art and offers a research agenda for future research. Particularly, this review explains the phenomenon of digital servitization by combining the most recent conceptual and empirical material.

The article finds an exponential academic interest in digital servitization from 2015 with a consistent contribution from China and Western European countries. The study reveals four major themes of digital servitization research, such as: knowledge-driven management, technology-driven management, digital servitization's drivers and barriers, digital servitization consequences. Seven research directions have been identified for future research.

Theoretically, this study, first, by combining descriptive and bibliometric analysis contributes to systemize the body of knowledge about digital servitization. Accordingly, the research contribution in terms of time, geography, and publication outlets, the methodological approaches adopted, the features of digital servitization, the benefits that can be achieved and challenges to consider, the specific technologies addressed, the perspectives of analysis regarding digital servitization are highlighted. Second, main research areas and themes have been identified, paving the way to focus and discuss research gaps that can guide following studies in advancing this topic. Third, it emerged that digital servitization implies changes in business processes and it calls for new resources and capabilities to handle digital technologies and new collaborations to co-create value. Then, it becomes relevant to identify new ways to exchange and combine resources and knowledge among actors, adopting an ecosystem perspective.

Moreover, managerial implications are highlighted. Indeed, this literature review can assist managers in better understanding the concepts associated with digital servitization. Particularly, several managerial takeaways are outlined. First, the development of competencies, skills, and capabilities to support digital servitization strategies is necessary. In fact, the firm needs to be able to handle digital technologies and to collect and interpret data for developing an effective servitization strategy. Second, a servitized firm needs to reshape its business model to embrace digital servitization, readapting the processes and related mechanisms of value creation, value delivery and value capture. In this direction, managers should consider involving relevant socio-economic actors as co-creators of value. Third, adopting an ecosystem perspective allow firms to open-up to actors' network, gaining the possibility to exchange resources and information by establishing close collaborations and partnerships.

Finally, the paper has different limitations, some of which are common to all systematic literature reviews. First, it is possible that some potentially pertinent material was excluded because of using a particular database looking for academic journals in English. However, in our opinion, the publications listed are largely indicative of the literature that is currently available on the topic of

digital servitization. Nevertheless, future reviews may wish to engage in alternative databases (e.g., Web of Science). Second, different review methods (e.g., content analysis using frameworks and meta-analysis) could be considered and applied in the future (Kraus et al., 2022; Lim et al., 2022). In the end, the expertise and training of the reviewers have a significant impact on the results of a literature review.

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