



Ecosystem transformation for digital servitization: A systematic review, integrative framework, and future research agenda

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ABSTRACT

Manufacturing firms are increasingly seeking to capture the potential of digitalization by transforming towards digital servitization. Yet, most manufacturers struggle to realize the value through digital servitization because it requires a sustained focus on forming ecosystem partnerships. Digital servitization research has long recognized the importance of ecosystem transformation but much of the existing discussion on this interlink is fragmented and understudied. Therefore, this study's purpose is to investigate how manufacturing firms engaged in digital servitization transform their ecosystems. To this end, we have examined the triggers, firm-level enablers, ecosystem phases and activities, and effects of ecosystem transformation in digital servitization. We provide a comprehensive review of the phases of ecosystem transformation including ecosystem formation, orchestration, and expansion as well as their associated activities. These findings have been consolidated into an integrative framework for ecosystem transformation and, based on this analysis, suggestions for future research are provided for digital servitization scholars.

1. Introduction

The rapid development of digital technologies is currently promoting significant changes in products, services, innovation processes, business models, and the very nature of business activities in industrial ecosystems (Coreynen et al., 2020; Gebauer et al., 2021; Iansiti & Lakhani, 2020; Naik et al., 2020; Sjödin et al., 2020; Sklyar, Kowalkowski, Tronvoll, et al., 2019). Industrial manufacturers are responding to these opportunities by increasingly engaging in digital servitization: the “*transformation in processes, capabilities, and offerings within industrial firms and their associate 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*” (Sjödin et al., 2020). For instance, industrial manufacturers – such as Scania and John Deere – are increasingly leveraging digital technologies to increase their revenues from digitally-enabled advanced services (Baines et al., 2011; Ziaee Bigdeli et al., 2018), such as fleet management, site optimization, and fuel optimization solutions (Sjödin et al., 2020). However, many digital servitization initiatives fall short of their promise due to lack of ecosystem partnerships to ensure value creation and capture. Thus, prior studies

recognize the importance of ecosystem partnerships to gain access to digital capabilities, resources, and innovations to provide digital servitization (Burström et al., 2021; Kapoor et al., 2021; Markfort et al., 2022; Sun & Zhang, 2021).

However, transforming ecosystems for digital servitization is a very complex undertaking for industrial manufacturers (Coreynen et al., 2020; Gebauer et al., 2021; Jovanovic et al., 2021; Marcon et al., 2019; Qi et al., 2020). Manufacturing companies need to seek out suitable partners who can complement their competence gaps and make up for their shortcomings in the digital servitization process (Grandinetti et al., 2020; Kolagar et al., 2022; Krucken & Meroni, 2006; Marcon et al., 2019; Opresnik & Taisch, 2015). For example, a manufacturer needs to invest in creating and forming an ecosystem of complementary partners, ensuring the participation of necessary roles and capabilities in delivering concrete digital service offerings (Kolagar et al., 2022; Linde et al., 2021; Sjödin et al., 2021). However, manufacturers also need to manage complex ecosystem partnerships over time. Indeed, as the number of interdependent and heterogeneous partners in an ecosystem grows, it becomes increasingly difficult to plan, adapt, synchronize, devise policies, and distribute risks evenly (Breslin et al., 2021; Kamalaldin et al., 2021). Accordingly, a key challenge for manufacturers is to adapt their

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current routines, strategies, and cultures, which may be incompatible with those of their partners and may pose serious risks to the establishment of coherent principles and rules for coordinating various components within the ecosystem (Tsujiimoto et al., 2018). Thus, while the potential for ecosystem collaboration is significant, in practice most manufacturers engaged in digital servitization struggle or even fail to fully reap the rewards (Asplund et al., 2021; Russell & Smorodinskaya, 2018).

The literature on digital servitization has increasingly begun to recognize ecosystem transformation as a major precondition for digital servitization (Coreynen et al., 2020; Gebauer et al., 2021; Kohtamäki et al., 2019; Naik et al., 2020; Sjödin et al., 2020; Sklyar, Kowalkowski, Tronvoll, et al., 2019). In fact, a recent servitization literature review (Khanra et al., 2021) shows that the ecosystem is one of the emergent – and increasingly predominant – themes in the research field. The literature on ecosystem transformation lacks a common conceptualization and terminology. Most of the exiting studies take diverse perspectives on the ecosystem in digital servitization. For example, the literature has discussed ecosystem transformation from the business ecosystem (Gawer & Cusumano, 2014; Huikkola et al., 2020; Humbeck et al., 2019), service ecosystem (Alaimo et al., 2019; Jovanovic et al., 2019; Sklyar, Kowalkowski, Tronvoll, et al., 2019), and innovation ecosystem perspectives (Adner, 2006, 2017; Adner & Kapoor, 2010; Jacobides et al., 2018; Kamalaldin et al., 2021; Kummitha, 2018). In pursuing this theme, an ecosystem refers to “the alignment structure of the multilateral set of partners that need to interact in order for a focal value proposition to materialize” (Adner, 2017). Indeed, despite the relatively extensive research that has been undertaken in the field of digital servitization, there are still many gaps in scholarly understanding of the corresponding ecosystem transformation processes.

First, there is a need for greater understanding of the ecosystem transformation process in digital servitization. While the prior literature contains many vital insights into how better ecosystem collaboration can be facilitated (Kamalaldin et al., 2021; Kolagar et al., 2022; Linde et al., 2021; Sklyar, Kowalkowski, Tronvoll, et al., 2019), there is still a lack of detailed guidance on the transformation process for manufacturing firms. For example, a systematic assessment of key phases, activities, and logics for organizing ecosystem transformation is important to understand. Having such a holistic view of the entire transition process makes ecosystem transformation a more implementable prospect for firms. Indeed, creating a collaborative environment that ensures precise and multifaceted collaborations between actors within an organization, as well as external actors, is critically important for the successful implementation of digital servitization (Chaney et al., 2021; Kohtamäki, Einola, et al., 2020; Kolagar et al., 2022; S. M. Lee & Lee, 2020; Li et al., 2020).

Second, an understanding of the triggers, enablers, and effects of ecosystem transformation in digital servitization is still lacking. Ecosystem transformation processes are contingent on many factors, which can exert an impact on how management should prepare the ground for digital servitization and its subsequent implementation. Accordingly, there is a need to understand the driving factors, levers, and motivations behind firms’ pursuit of ecosystem transformation. This will serve as a micro-foundation for strategic decision making in digital servitization. For example, it is crucial to understand the triggers – what causes this change – so as to ensure the necessary conditions and prerequisites are in place and to remove any obstacles that may stand in the way. Similarly, despite all the research conducted in the area of digital servitization, there is still a dearth of research on the firm-level enablers of ecosystem transformation for digital servitization. In fact, there is still a need for a clear and comprehensive understanding of what firm-level capabilities and enablers a manufacturing company need to build to begin its ecosystem transformation for the purpose of offering digitally-enabled advanced services and solutions. And finally, the last gap in the literature pertains to the effects and outputs of the successful implementation of this ecosystem transformation process. Companies cannot

be persuaded and motivated to start and then go on to implement this transition without having a proper understanding of the pervasive effects of ecosystem transformation in digital servitization.

In an attempt to address these research gaps in the literature, this study seeks to shed light on the concept of ecosystem transformation in digital servitization to clarify the ambiguities existing in its implementation. Accordingly, the purpose of this study is to explore “how the firms engaged in digital servitization are transforming their ecosystem.” In addition, this study investigates the triggers, enablers, and effects of successfully implementing ecosystem transformation in digital servitization. In order to accomplish this purpose, our research method entails an examination of the previous literature on digital servitization and the careful coding of the content using the Gioia methodology (Gioia et al., 2013). In doing so, we make several contributions to the digital servitization and ecosystem literatures. We attempt to conceptualize the triggers, firm-level enablers, phases and activities, and effects of ecosystem transformation in digital servitization. This allows us to uncover the micro-foundations of, and activity-level insights into, the ecosystem transformation process in digital servitization. Specifically, we develop an integrative framework for ecosystem transformation within the field of digital servitization, contributing to both the digital servitization and ecosystem literatures. These insights hold value for researchers and provide an explanation of the complex interplay between digitalization, servitization, and the ecosystem choices faced by manufacturing firms. Finally, based on the literature review, we provide suggestions for future research.

The remainder of the article is organized as follows. Section 2 describes the methodology of conducting the literature review. Section 3 summarizes the descriptive and bibliometric findings from the literature, and Section 4 presents the study findings and coding of previous research. Section 5 discusses the proposed integrative framework for ecosystem transformation in digital servitization. Finally, Section 6 concludes the paper by considering the study’s implications for theory and practice, limitations, and suggesting avenues for further research.

2. Research methodology

In order to ensure rigor, objectivity, and transparency in the research process, we adopted the systematic literature review (SLR) approach to obtain replicable and valid results. The purpose was to evaluate and interpret all available published research studies in relation to a precise question or topic of interest (Kitchenham et al., 2009). Unlike the traditional narrative review method, which has a subjective process and is prone to errors and distortions (Dada, 2018; Tranfield et al., 2003), the systematic review can overcome this type of problem by providing a more objective process and accurately identifying, selecting, and critically synthesizing all relevant studies (Christofi et al., 2017; Tranfield et al., 2003). It summarizes research conducted in a specific field and provides a comprehensive and thorough overview of that research as well as higher quality outcomes and information on a particular topic (Christofi et al., 2017; Danese et al., 2018). In fact, a systematic review establishes an important link between research studies and decision making. In other words, the purpose of conducting a systematic review is to find, evaluate, and combine all high-quality and relevant research evidence to answer a specific question (Crossan & Apaydin, 2010; Kauppi et al., 2018). A systematic review can dispel ambiguity over a topic, identify topics for which there is insufficient evidence, create new perspectives by combining findings from different studies, announce when sufficient evidence is available, and reduce the impact of any defect or error in a particular study (Strech & Sofaer, 2012). By identifying the patterns, themes, and issues, it summarizes the research accomplished and then helps to identify the conceptual content of the phenomenon, playing a role in the development of new frameworks and theories (Kitchenham et al., 2009; Nofal et al., 2017). Therefore, since this article attempts to examine the vital role of ecosystem transformation in digital servitization in a more thoughtful way, we decided

that the systematic literature review was the most appropriate method to achieve our research aim. Inspired by previous research in the field of systematic literature reviews (Christofi et al., 2017; Tranfield et al., 2003), and by making changes, integrating some stages, and localizing them according to our research conditions, we defined a three-phased process to conduct a systematic literature review, in which each phase will be explained in detail.

2.1. Stage one: Question formulation

Clear problem statements and the design of research questions play a guiding role in conducting a successful systematic review (T. Archibald, 2019; Nguyen et al., 2018). It should be noted that the criteria used in selecting or not selecting previous articles for systematic review are determined by careful formulation and clear design of the research question. Hence, defining a research purpose as a fundamental step can determine the accuracy, correctness, and validity of the later stages of the literature review. By holding meetings between the authors as well as consulting academic and industrial experts, the main research purpose was formulated as “*how the firms engaged in digital servitization are transforming their ecosystem.*” In line with the main research question, and in order to answer it as comprehensively as possible, we divided it into the following four sub-questions: *What are the triggers for ecosystem transformation in digital servitization? What are the firm-level enablers for ecosystem transformation in digital servitization? What are the phases and activities of ecosystem transformation in digital servitization?* and, finally, *What are the effects of ecosystem transformation in digital servitization?*

2.2. Stage two: Search and filtration

After defining the main research question and its associated sub-questions, a comprehensive and reproducible search of the literature formed the basis of a systematic review. All articles in this study were reviewed with due regard to the principles of equality, accessibility, transparency, focus, and reproducibility (Thorpe et al., 2005). At this stage, the researcher, using research keywords, systematically searches for materials published in various scientific journals and conferences with the aim of determining valid, credible, and relevant documents in a timely manner. Among these, databases and sources of information that aggregate different works are very important. Compared to the other electronic databases, Scopus has been recognized as a significantly superior database because it covers a wide range of journals and it has the capability to provide various citation analysis tools (Dada, 2018; Endres & Weibler, 2017). By using truncation in the search terms to find different variants of the relevant terms, and also using the Boolean operators OR/AND (Sayers, 2008), we determined the main keywords to be searched in the Scopus database – namely, “*digital servitization*”, “*digitalization + servitization*”, and “*digitalization + product-service-systems (PSS)*”. Moreover, in order to maintain maximum accuracy and relevance to the research topic, we limited our research to a sixteen-year coverage range from 2005 to 2021.

Then, inspired by the research of Tranfield et al. (2003), we defined a number of criteria governing the inclusion or exclusion of selected articles so as to ensure the relevance of articles to the research topic. The filtration process played a decisive role in determining the final sample by applying various inclusion/exclusion criteria that somehow had the task of passing selected research through a funnel. First, to select the document types, we included only publications in peer-reviewed academic journals and high-level conferences, and excluded non-academic articles (such as editorials, extended abstracts, book chapters, and low-level conference papers) (Jones et al., 2011). Second, in terms of document language, we only included articles available in English (Jackson & Kuriyama, 2019; Xiao & Watson, 2017) so as to comply with the majority of scientific journals that choose English as their main language in order to contribute to and generate a common knowledge base (Crossan & Apaydin, 2010; Kauppi et al., 2018; Nguyen et al.,

2018). Furthermore, selection was confined to English articles because only these articles were capable of being analyzed in VOSviewer software (van Eck & Waltman, 2010). Third, in terms of the subject area, we limited our focus only to the “*business and management*” area and excluded any categories unrelated to the subject, which resulted in a total of 457 articles. Fourth, all the titles were checked carefully to prevent any repetition and duplication among the collected sample, which yielded a total of 241 articles after excluding repeats. Fifth, articles obtained up to this point were examined for correspondence between the title and the abstract to ensure they aligned with the research topic (i.e., digital servitization). Sixth, in terms of availability, we had to exclude 12 out of 136 articles due to the lack of access to their full text. And finally, the seventh criterion was related to double-checking the full alignment of articles with the research topic by reading the articles in full and excluding those that sat outside our focus. After validating the inclusion/exclusion procedure, our seven-step filtration stage yielded a total of 112 articles published in peer-reviewed academic journals and one high-rank conference in the field.

2.3. Stage three: Extraction, analysis, and synthesis

In order to analyze and synthesize our final sample of articles, we conducted two kinds of analysis in this very last stage of the systematic literature review: *i) descriptive and bibliometric analysis*, and *ii) thematic analysis*. The descriptive analysis provided us with the means to identify the distribution of papers based on the journal, year of publication, and geographical analysis of authorship origin. Also, the bibliometric analysis revealed the authors’ co-citation and also the interconnections and relations between the keywords associated with the research topic. In addition, since we were looking for clues of an ecosystem perspective in digital servitization-related papers, the thematic analysis of the final sample of articles, which involved the process of encoding the previous literature, helped us to better answer the research questions. The initial coding process began by analyzing the codes of the collected data, which yielded sixty categories after subsequent re-coding of the data. By identifying the relationships between these codes, twenty-one second-order themes were then identified. Finally, those themes were generalized into eight aggregate themes at a higher level of abstraction (Braun & Clarke, 2006; Gioia et al., 2013). To ensure reliability and credibility of the results derived from the coding process, we conducted an investigator triangulation process among the author/expert team (Adams et al., 2015; M. M. Archibald, 2015). The author team members were asked to review the final samples of papers and also the coding structure to ensure the entire coding process was credible. Then, the proposed research framework was developed based on the obtained themes and dimensions. The whole process is summarized in Fig. 1.

3. Descriptive and bibliometric findings

In order to develop a complete conceptual overview, a descriptive and bibliometric analysis of 112 research articles has been carried out in this section, which offers a comprehensive synthesis of the included literature.

3.1. Journal wise distribution of literature

The final sample consists of a total of 112 articles drawn from forty-seven peer-reviewed journals and one important conference in the field published between 2005 and 2021 and spread over a five-year time interval. The last interval includes six years of publications (2016–2021). The most frequently published papers in this discipline were identified in the following orders: Industrial Marketing Management (12), Procedia CIRP (10), International Journal of Production Economics (6), and Journal of Business Research (5). A list of the eighteen most important journals and one conference that had at least two articles in our final sample, their publication interval, and their total

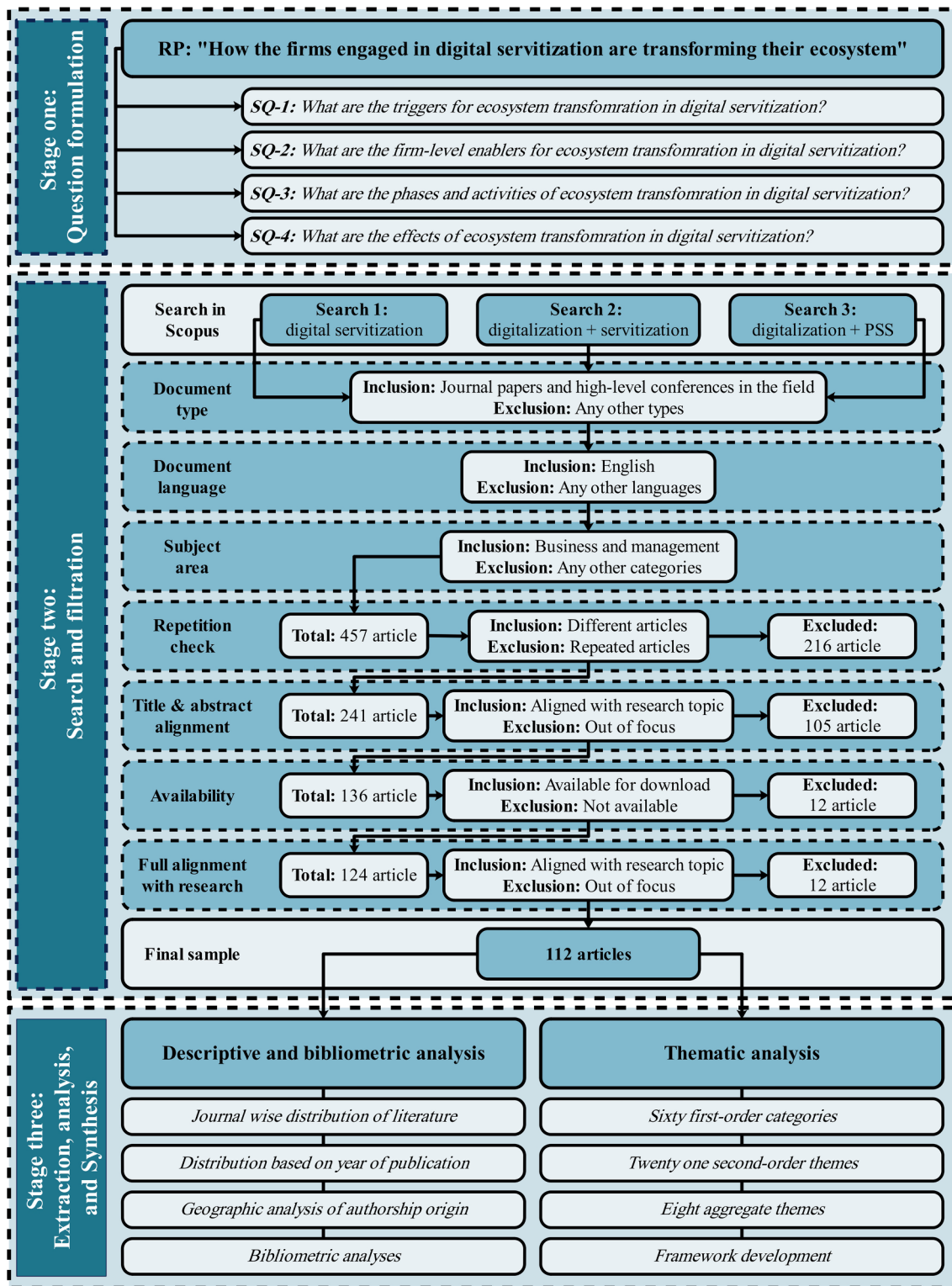


Fig. 1. Research methodology.

number and percentage of articles can be seen in Table 1.

3.2. Distribution based on year of publication

The objective of this section was to categorize the articles according to publication year and know the year-wise trends of published articles. Fig. 2 demonstrates the year-wise publication of papers that found a maximum of 21 papers in the year 2018, and a minimum of 0 articles

was published in 2007. Our analysis of results shows that there was a boost of interest from the scientific community in digital servitization-related publications per year. The number of selected papers by year, especially in the last five years, has a highly skewed distribution. This trend indicates that, in recent years, many more studies have adopted digital servitization, seeing it as an approach to keep up with industry changes.

Table 1
Most important journals/conferences included in the final sample.

Journal/Conference title	2005–2010	2011–2015	2016–2021	Total articles	%
Industrial Marketing Management			12	12	10.71
Procedia CIRP			10	10	8.93
International Journal of Production Economics		1	5	6	5.36
Journal of Business Research			5	5	4.46
Journal of Business and Industrial Marketing		1	4	5	4.46
Technological Forecasting and Social Change			4	4	3.57
Service Business		2	2	4	3.57
International Journal of Production Research		2	2	4	3.57
Journal of Cleaner Production	1	1	2	4	3.57
Journal of Manufacturing Technology Management		3	1	4	3.57
Production Planning and Control			4	4	3.57
Technovation			3	3	2.67
International Journal of Advanced Manufacturing Technology		1	2	3	2.67
International Journal of Operation and Production Management	1	1	1	3	2.67
Sustainability		1	2	3	2.67
Strategic Change			3	3	2.67
Journal of Service Management	1	1		2	1.78
Research Technology Management		2		2	1.78
TQM Journal			2	2	1.78
Other journals (<i>one article per journal</i>)	3	4	22	29	25.97
Total	6	20	86	112	100.0

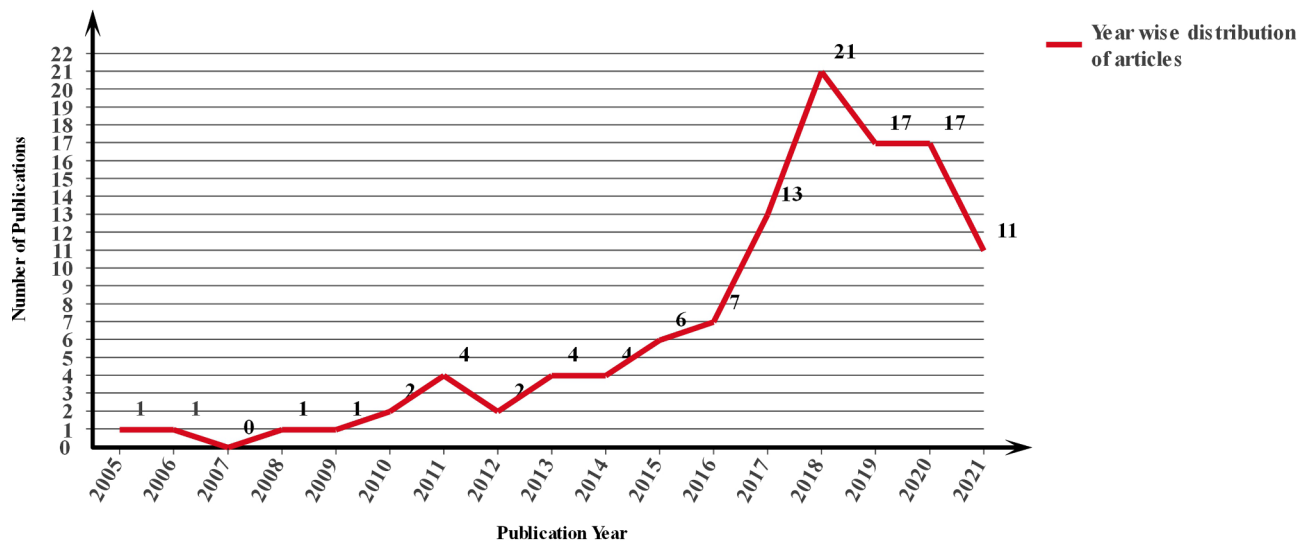


Fig. 2. Annual scientific production (number of papers per year).

Rank	Country	Articles	Percentage	Rank	Country	Articles	Percentage
1	Sweden	18	16.07%	9	South Korea	3	2.68%
2	UK	16	14.28%	9	Switzerland	3	2.68%
3	Finland	12	10.71%	10	Belgium	2	1.78%
4	Italy	11	9.82%	11	Greece	1	0.89%
5	Germany	10	8.93%	11	Hong Kong	1	0.89%
6	Spain	8	7.14%	11	Ireland	1	0.89%
7	China	6	5.36%	11	Lithuania	1	0.89%
7	US	6	5.36%	11	Malaysia	1	0.89%
8	Denmark	4	3.57%	11	Norway	1	0.89%
9	Brazil	3	2.68%	11	Singapore	1	0.89%
9	France	3	2.68%	Total	21 Countries	112	100%

Fig. 3. First author's geographical location.

3.3. Geographic analysis of authorship origin

The purpose of this section was to identify the country that has published the maximum number of articles in digital servitization research. This is based on the affiliation of the first author of each publication. In the case of having several affiliations, only the first-mentioned affiliation has been selected as the main affiliation. According to the results, the authors of our final sample of articles were from 21 different countries, with Sweden (#1), UK (#2), Finland (#3), Italy (#4), Germany (#5), Spain (#6), and both China and US (#7) ranking first to seventh, respectively. As shown in Fig. 3, in global terms, European countries are the leaders in digital servitization research and have addressed this issue in a more focused way.

3.4. Bibliometric analyses

According to our final sample, a total of 112 papers were selected and bibliometric analysis of co-citations and keywords networks was accomplished in Vosviewer software (REF). Concerning the co-citation analysis of authorship (i.e., authors cited in the reference list of the articles included in our dataset), from the 260 cited authors only 24 have been cited more than three times. The five authors with the highest number of citations are Parida, V. (15), Kohtamäki, M. (9), Gebauer, H. (8), Sjödin, D. (7), and Baines, T. (6). Figs. 4 and 5 present the density and network diagrams of the co-citation analysis of authors, highlighting the fact that these authors are not only the most cited but also the most connected according to the co-citation analysis.

In addition, the analysis of co-occurrence of keywords is based on the principle that a research specialty can be identified by the particular associations established between its keywords (Pérez et al., 2016). Given that digital servitization is a contemporary field subject, it was agreed to complement the analysis of citations with an analysis of keyword co-occurrence to identify the main topics and trends investigated. Only keywords that occurred at least twice were kept. This resulted in having only 53 out of 372 keywords to constitute the largest usable set of connected terms. The six most occurring keywords are Servitization (44), Digitalization (16), Digital Servitization (16), Product-service

Systems (14), Industry 4.0 (8), and Internet of Things (7). Figs. 6 and 7 present the density and network diagrams of the co-occurrence analysis of keywords.

4. Results and discussion

Based on coding and analyzing the data collected from the systematic review of the digital servitization literature, this research provides insights into how manufacturing companies can successfully engage in ecosystem transformation for digital servitization. Following the order of aggregate themes in the coding structure (see Figs. 8 and 9), the relevant findings of this research are described below.

4.1. Triggers for ecosystem transformation in digital servitization

Our review of the literature identified three main triggers for ecosystem transformation in digital servitization: *synchronizing with fast-paced market change*, *novel customer demands and readiness*, and *filling technology and resource gaps*. We explain these triggers below.

First, we found that firms engaged in digital servitization are struggling with *synchronizing with fast-paced market change*, which motivates them to transform their ecosystem (Dalenogare et al., 2019; Humbeck et al., 2019; S. M. Lee & Lee, 2020; Li et al., 2020). For example, Lee and Lee (2020) argued that, in order to thrive in today’s rapidly developing digital environment, companies must be agile, resilient, and adaptable in leveraging ecosystem partnerships. They need to do this to gain access to advanced digital technologies for the purpose of enhancing their dynamic service capabilities (S. M. Lee & Lee, 2020). In addition, the prior literature indicated that market change may require reconfiguration of their existing resources through ecosystem partnerships (Linde et al., 2021) and shifting the manufacturing paradigms in accordance with the digital trends of ecosystem collaboration (Jiang et al., 2016). Manufacturers have realized that they require ecosystem partnerships to keep up with the rapid changes (Kamalaldin et al., 2021; Kolagar et al., 2022; Ostrom et al., 2015; Süße et al., 2018) that are taking place in the business environment and to remain competitive (Loonam et al., 2018; Opazo-Basáez et al., 2018). These dramatic disruptions are felt by

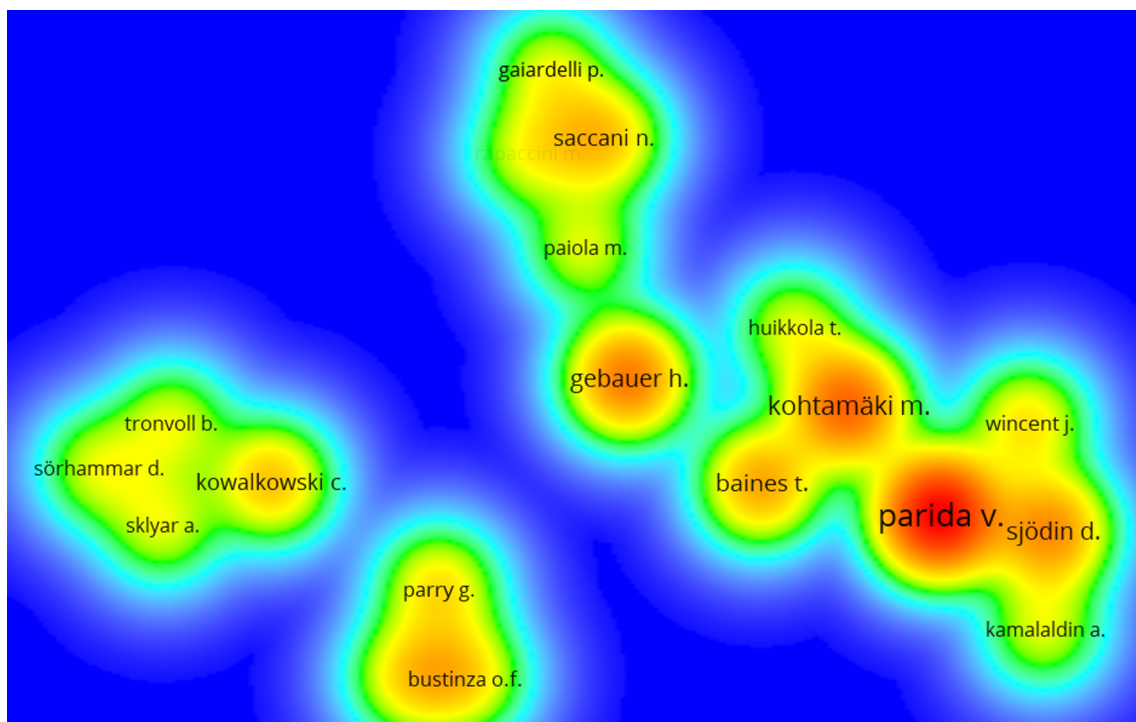


Fig. 4. Density diagram of the largest connected set of cited authors.

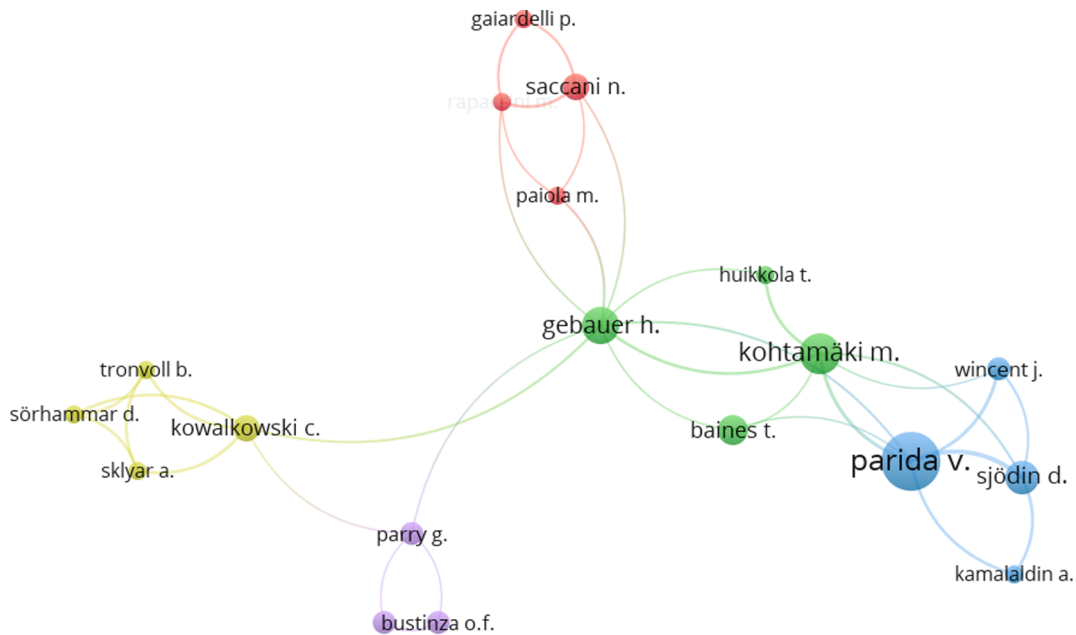


Fig. 5. Network diagram of the largest connected set of cited authors.

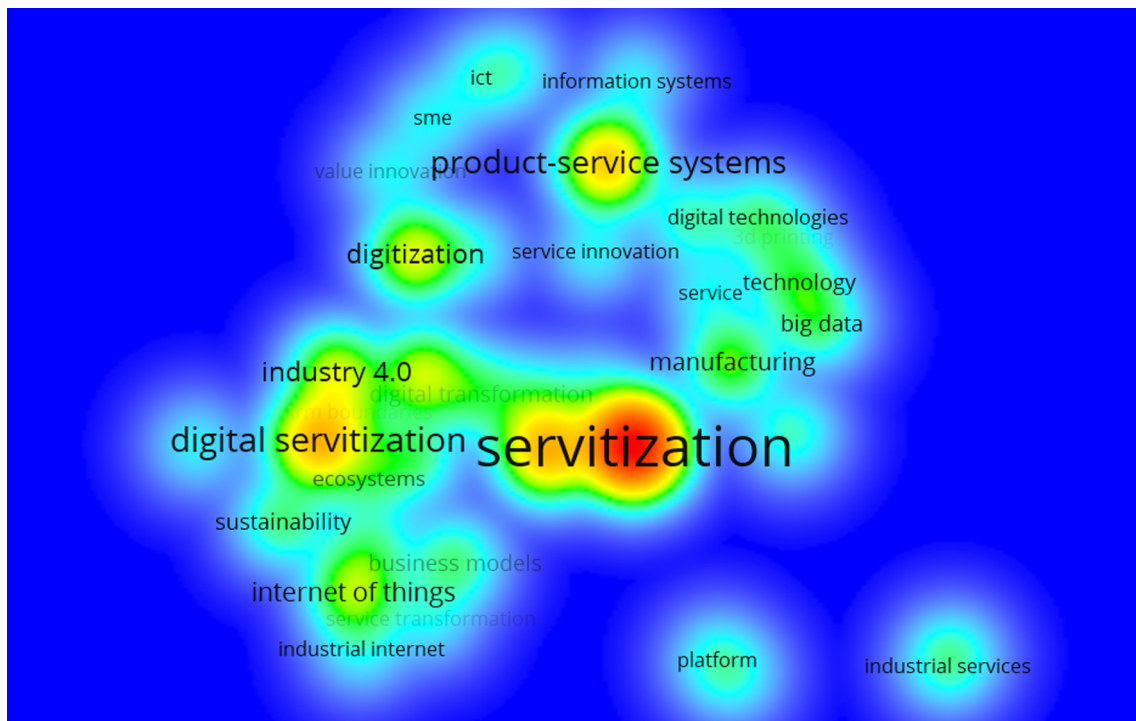


Fig. 6. Density diagram of the co-occurrence of keywords.

companies to the extent that many of them see their survival in danger, and they are looking for ways to transform their ecosystems to maintain competitiveness going forward into this turbulent market (Ardolino et al., 2017; Hofmann & Rüscher, 2017).

Secondly, our review of the literature revealed that *novel customer demands and readiness* are emerging. Indeed, digitalization and the tendency towards servitization have caused customers to make new and different demands requiring manufacturers to meet their emerging digital needs (Charro & Schaefer, 2018; Krucken & Meroni, 2006). For example, customers are increasingly demanding sophisticated digital services, such as site optimization, predictive maintenance, and

outcome-based contracts, that require manufacturers to engage with ecosystem partners to scale novel business models (Sjödin et al., 2021). Moreover, another motivating factor for ecosystem transformation is the need for manufacturing firms to quickly translate customer needs into specific products and services (Paiola & Gebauer, 2020) and to redesign the way offerings are delivered (Charro & Schaefer, 2018; Eloranta & Turunen, 2016; Mourtzis et al., 2017; Naik et al., 2020; Sjödin et al., 2019) so that updated value propositions are provided (Marcon et al., 2019; Paschou et al., 2020). Therefore, it is often necessary for manufacturers to leverage ecosystem partnerships to cope with changing customer needs (Huikkola & Kohtamäki, 2019; Kolagar et al., 2022;

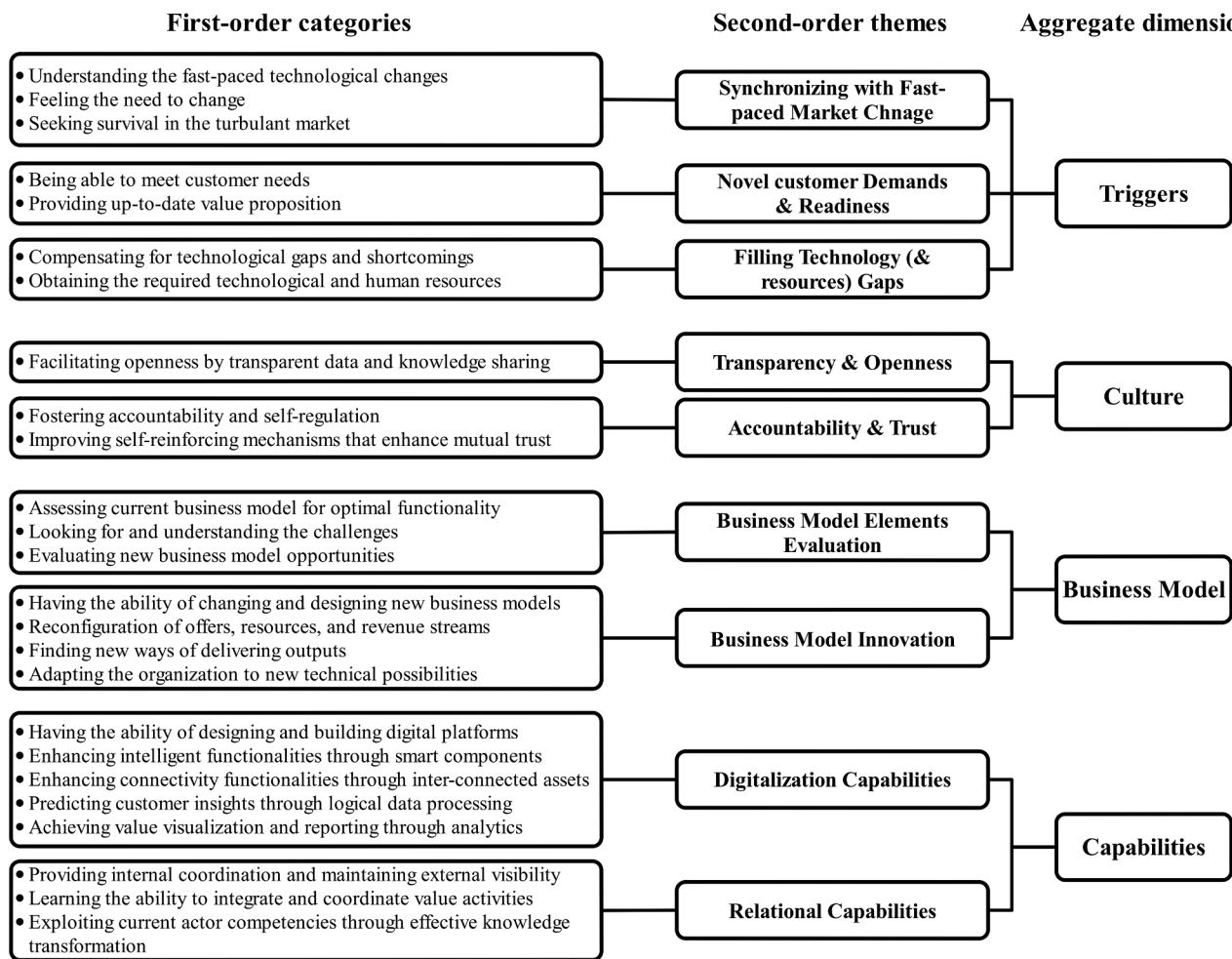


Fig. 8. Review’s data structure and coding process for “triggers” and “firm-level enablers”.

responsibility (Chen et al., 2021; Korkeamäki & Kohtamäki, 2019; Sklyar, Kowalkowski, Tronvoll, et al., 2019).

Secondly, our analysis has revealed that manufacturers need to promote a culture of *accountability and trust* (Boldosova, 2020; Holler et al., 2017; S. M. Lee & Lee, 2020) towards ecosystem partners and implement that culture in those ecosystem partnerships. This is necessary in order to continuously improve the self-reinforcing mechanisms that will enhance trust between the parties (Abou-foul et al., 2020; Lindström et al., 2018; Tian et al., 2021). The previous literature has shown that, by leveraging an open and trust-based culture, it will be much easier to facilitate any proposed transformation and establish new orientations both at the firm level and the ecosystem level (Chaney et al., 2021; Kohtamäki, Parida, et al., 2020; Kowalkowski et al., 2013; Pagoropoulos et al., 2017).

In Table 3, we present a more detailed overview of the first-order categories that emerge from the literature, related to the role of culture as a firm-level enabler of ecosystem transformation.

4.2.2. Business model

An analysis of the literature has made it apparent that the business model is one of the major factors determining a manufacturing firm’s fate when undergoing an ecosystem transformation (Adrodegari et al., 2017; Peillon & Dubruc, 2019). The business model represents the structure of how a business operates to create, deliver, and capture value for growth and survival in today’s volatile marketplace (Amit & Zott, 2020; Chester Goduscheit & Faullant, 2018; Reim et al., 2019). In this regard, the prior literature has identified *business model elements evaluation* and *business model innovation* as the most important factors shaping

the role of business models in ecosystem transformation. These factors will be discussed in the following section.

First, our literature analysis has revealed that manufacturing firms need to constantly *evaluate their business model elements* in order to identify needs and opportunities for ecosystem transformation. For example, manufacturers may identify the need to support their distributor networks to ensure the value delivery of sophisticated digital offerings (Reim et al., 2019; Sjödin et al., 2021; Sklyar, Kowalkowski, Sörhammar, et al., 2019). Thus, examining the current performance of the business model in terms of value creation, delivery, and capture is often a vital precondition for identifying areas where ecosystem transformation may be required (Charro & Schaefer, 2018; Li et al., 2020; Matthyssens, 2019). Based on the literature, continuous monitoring and evaluation of the business model will allow manufacturers to continuously improve their ecosystem collaboration and afford them the opportunity to evaluate new opportunities that may arise from other business models (Belvedere & Grando, 2016; Martinez et al., 2010; Meier et al., 2010).

A dominant theme in the literature is that manufacturers need to engage in *business model innovation* to enable ecosystem transformation on a larger scale. In the previous research, it was suggested that manufacturers reconfigure the value they create and allocate their resources in a way that aligns with the new value proposition. Moreover, they should assign new revenue streams for their offerings to enable more profitable ecosystem partnerships (Bustinza et al., 2018; Gebauer et al., 2021; Kharlamov & Parry, 2020; Loonam et al., 2018). The literature has also emphasized the need for manufacturers to find innovative ways to deliver the outputs and adapt themselves to the new technical

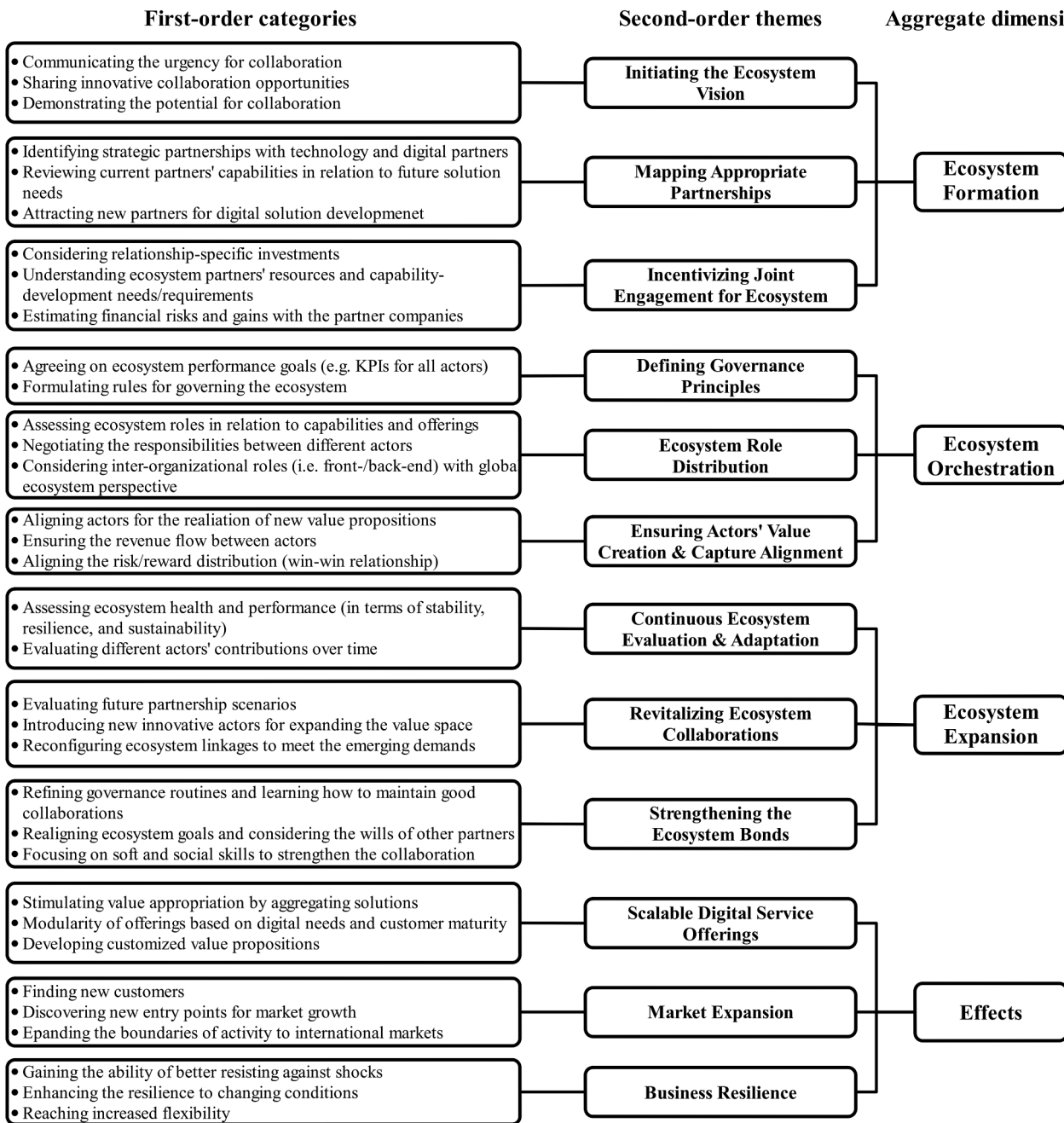


Fig. 9. Review’s data structure and coding process for “ecosystem transformation” and “effects”.

possibilities within ecosystems by continuously focusing on business model innovation (Ardolino et al., 2017; Basirati et al., 2019; Bressanelli et al., 2018; Sjödin et al., 2020).

A more detailed overview of the first-order categories extracted from the literature on the role of business model as an enabler for ecosystem transformation can be found in Table 4.

4.2.3. Capabilities

By coding the data obtained from reviewing the digital servitization literature, it became evident that certain capabilities are needed to enable the ecosystem transformation in digital services. These capabilities can be divided into two main categories: *digitalization capabilities* and *relational capabilities*.

First, our analysis of the literature indicated that manufacturers who wish to implement digital servitization need *digital capabilities* so that

they can cover the technical aspects of the process and address their technology-related gaps (Frank et al., 2019; Gebauer et al., 2021; Grandinetti et al., 2020; Linde et al., 2021). For example, several studies have highlighted the need for manufacturing firms to have different digital capabilities, such as being able to design and build new digital platforms (Cenamor et al., 2017; Sánchez-Montesinos et al., 2018; Tian et al., 2021), enhance their intelligent functions through the development of smart components (Boldsova, 2020; Classen & Friedli, 2021; Peillon & Dubruc, 2019), boost their connectivity functions through inter-connected assets (Hasselblatt et al., 2018; Kamalaldin et al., 2020; Sklyar, Kowalkowski, Tronvoll, et al., 2019; Thomson et al., 2021), predict customer insights through logical data processing (Basirati et al., 2019; Kamp et al., 2016; Mittag et al., 2018), and achieve value visualization and reporting through analytics (Gouvea et al., 2018; Koh-tamäki, Parida, et al., 2020; Sjödin et al., 2021).

Table 2
First-order categories extracted from the literature – (triggers).

First-order categories	Second-order themes	Aggregate dimension
Understanding the fast-paced technological changes (Belvedere et al., 2012; Chester Goduscheit & Faullant, 2018; Dalenogare et al., 2019; Gebauer et al., 2017, 2021; Hernández Pardo et al., 2012; Humbeck et al., 2019; Jovanovic et al., 2021; Kamalaldin et al., 2021; Kolagar et al., 2022; S. M. Lee & Lee, 2020; Li et al., 2020; Linde et al., 2021; Nybacka et al., 2010; Ostrom et al., 2015; Süße et al., 2018; Yeo et al., 2021)	Synchronizing with fast-paced market change	Triggers for ecosystem transformation in digital servitization
Feeling the need to change (Boldosova, 2020; Classen & Friedli, 2021; Coreynen et al., 2020; Dalenogare et al., 2019; Hasselblatt et al., 2018; Huikkola et al., 2020; Huikkola & Kohtamäki, 2019; Jovanovic et al., 2021; Kamalaldin et al., 2020; Kohtamäki, Parida, et al., 2020; Kolagar et al., 2022; Loonam et al., 2018; Pagoropoulos et al., 2017; Peillon & Dubruc, 2019; Sánchez-Montesinos et al., 2018; Struyf et al., 2021; Tian et al., 2021; Tronvoll et al., 2020; Ziaee Bigdeli et al., 2018)		
Seeking survival in the turbulent market (Basirati et al., 2019; Chester Goduscheit & Faullant, 2018; Ciasullo et al., 2021; Kamalaldin et al., 2021; Kolagar et al., 2022; Loonam et al., 2018; Opresnik & Taisch, 2015; Peillon & Dubruc, 2019; Shen et al., 2021; Süße et al., 2018; Tian et al., 2021)		
Being able to meet customer needs (Charro & Schaefer, 2018; Chester Goduscheit & Faullant, 2018; Eloranta & Turunen, 2016; Gaiardelli et al., 2014; Gebauer et al., 2017; Hein et al., 2019; Hernández Pardo et al., 2012; Huikkola & Kohtamäki, 2019; Kamp et al., 2016; Lerch & Gotsch, 2015; Lim et al., 2015; Marcon et al., 2019; Matthyssens & Vandenbempt, 2010; Mourtzis et al., 2017; Parida et al., 2015; Peillon & Dubruc, 2019; Sánchez-Montesinos et al., 2018; Sjödin et al., 2019; Tuli et al., 2018; Ziaee Bigdeli et al., 2018)	Novel customer demands and readiness	
Providing up-to-date value proposition (Coreynen et al., 2017; Goehlich et al., 2020; Grubic & Jennions, 2017; Grubic &		

Table 2 (continued)

First-order categories	Second-order themes	Aggregate dimension
Peppard, 2016; Korkeamäki & Kohtamäki, 2019; Lim et al., 2015; Naik et al., 2020)		
Compensating for technological gaps and shortcomings (Kamalaldin et al., 2021; Kolagar et al., 2022; Matthyssens, 2019; Paluch, 2014; Vendrell-Herrero et al., 2017)	Filling technology (& resources) gaps	
Obtaining the required technological and human resources (Allmendinger & Lombreglia, 2005; Brax & Jonsson, 2009; Bustinza et al., 2018; Cáceres & Guzmán, 2014; Chester Goduscheit & Faullant, 2018; Grandinetti et al., 2020; Grubic & Peppard, 2016; Hein et al., 2019; H. Huang et al., 2021; Kamalaldin et al., 2020; Kharlamov & Parry, 2020; Kohtamäki et al., 2019; Kolagar et al., 2022; Krucken & Meroni, 2006; Marcon et al., 2019; Matthyssens, 2019; Matthyssens & Vandenbempt, 2010; Nybacka et al., 2010; Opresnik & Taisch, 2015; Parida et al., 2019; Thomson et al., 2021; Tian et al., 2021)		

Second, our analysis shows that manufacturing firms need to be able to fill the gaps in their technical capabilities by building their *relational capabilities* and creating a sustainable competitive advantage for themselves and their partners (Kohtamäki, Parida, et al., 2020). Previous studies have emphasized the need for manufacturing firms to have the capability to provide internal coordination and maintain their external visibility (Boldosova, 2020; Coreynen et al., 2017; Paiola & Gebauer, 2020), learn the ability to integrate and coordinate value activities (Harris & Wonglimpiyarat, 2020; Ostrom et al., 2015), and exploit current actor competencies through effective knowledge transformation (H. Huang et al., 2021; Kamalaldin et al., 2020, 2021; Kolagar et al., 2022; Linde et al., 2021). In fact, digitalization and relational capabilities complement each other, and the absence of or weakness in one of them can diminish the other and create challenges for ecosystem transformation in digital servitization.

Furthermore, Table 5 provides a more detailed breakdown of the first-order categories examining firms’ capabilities as enablers of ecosystem transformation.

4.3. Ecosystem transformation

To remain competitive, manufacturing companies intend to develop value propositions that create greater customer value in close collaboration with many ecosystem partners (Kolagar et al., 2022; Linde et al., 2021; Sjödin et al., 2021). In fact, manufacturers need to be open to new forms of collaboration if they want to succeed with their offerings for existing and new customers (Sjödin et al., 2021; Thomson et al., 2021). Moreover, in some cases, industrial firms are mutually granted access to complementary assets and resources in order to boost their digital service levels or reduce costs (Kohtamäki, Parida, et al., 2020; Kolagar et al., 2022). Additionally, industrial customers always request the most up-to-date digital value propositions employing the newest technologies because they naturally want to stay ahead of their competitors

Table 3
First-order categories extracted from the literature – (culture).

First-order categories	Second-order themes	Aggregate dimension
Facilitating openness by transparent data and knowledge sharing (Basirati et al., 2019; Belvedere & Grando, 2016; Gebauer et al., 2017; Grandinetti et al., 2020; Kamalaldin et al., 2020, 2021; Linde et al., 2021; Marcon et al., 2019; Naik et al., 2020; Sánchez-Montesinos et al., 2018; Thomson et al., 2021; Tian et al., 2021; Tronvoll et al., 2020)	Transparency & Openness	Culture
Fostering accountability and self-regulation (Chen et al., 2021; Korkeamäki & Kohtamäki, 2019; Shen et al., 2021; Sklyar, Kowalkowski, Tronvoll, et al., 2019; Tronvoll et al., 2020)	Accountability & Trust	
Improving self-reinforcing mechanisms that enhance mutual trust (Abou-foul et al., 2020; Baines et al., 2013; Baines & Lightfoot, 2014; Boldosova, 2020; Bonfanti et al., 2015; Brax & Jonsson, 2009; Bressanelli et al., 2018; Cao et al., 2015; Chaney et al., 2021; Classen & Friedli, 2021; Durugbo, 2013; Eloranta & Turunen, 2016; Frank et al., 2019; Grandinetti et al., 2020; Grubic & Peppard, 2016; Holler et al., 2017; Holmström et al., 2014; Huikkola et al., 2020; Kamalaldin et al., 2020; Kamp et al., 2016; Kohtamäki et al., 2019; Kohtamäki, Parida, et al., 2020; Kolagar et al., 2022; Kowalkowski et al., 2013; S. M. Lee & Lee, 2020; Lindhult et al., 2018; Lindström et al., 2018; Marcon et al., 2019; Matthyssens, 2019; Nybacka et al., 2010; Opresnik & Taisch, 2015; Ostrom et al., 2015; Pagoropoulos et al., 2017; Reim et al., 2019; Sjödin et al., 2020; Sklyar, Kowalkowski, Tronvoll, et al., 2019; Thomson et al., 2021; Tian et al., 2021; Tronvoll et al., 2020; Vendrell-Herrero et al., 2017; Wallin et al., 2015)		

(Coreynen et al., 2017; Goehlich et al., 2020; Kolagar et al., 2022; Naik et al., 2020). Furthermore, industrial customers want digital services and solutions to work with their existing infrastructure. They want different solutions and equipment from different suppliers to be compatible, versatile, and capable of being integrated with other solutions that emerge in the future (Liu et al., 2020; Pan et al., 2021; Tchoffa et al., 2021).

In this regard, ecosystem transformation goes hand in hand with advanced digital service offerings (Kolagar et al., 2022; Thomson et al., 2021). Although numerous studies mention ecosystem transformation (Linde et al., 2021; Sklyar, Kowalkowski, Sörhammar, et al., 2019), none of them provides a clear definition of the concept. To clarify the emerging dialogue on the concept, we define ecosystem transformation as “the process of initiating a cooperative collaboration amongst diverse actors to facilitate the ecosystem formation, orchestration, and expansion, leading to successful provision of digitally-enabled advanced services and solutions”. Accordingly, ecosystem transformation represents the efforts in creating partnerships with complementary capabilities, resources, technologies, and knowledge to create and deliver complex digital services to their customers. The above definition recognizes three phases of ecosystem transformation, which we use to organize the findings from our literature review. First, the *ecosystem formation* phase focuses on activities related to initiating new ecosystem partnerships, creating a concept for digital servitization offering, and engaging with the partners to agree on that concept. Second, the *ecosystem orchestration* phase

Table 4
First-order categories extracted from the literature – (business model).

First-order categories	Second-order themes	Aggregate dimension
Assessing current business model for optimal functionality (Chester Goduscheit & Faullant, 2018; Goehlich et al., 2020; Kohtamäki et al., 2019; Linde et al., 2021; Parida et al., 2019; Peillon & Dubruc, 2019)	Business model elements evaluation	Business model
Looking for and understanding the challenges (Charro & Schaefer, 2018; Li et al., 2020; Martinez et al., 2010; Matthyssens, 2019; Neely, 2009)		
Evaluating new business model opportunities (Adrodegari & Saccani, 2017; Allmendinger & Lombreglia, 2005; Baines et al., 2011; Basirati et al., 2019; Belvedere & Grando, 2016; Eloranta & Turunen, 2016; Hasselblatt et al., 2018; Kohtamäki, Parida, et al., 2020; S. M. Lee & Lee, 2020; Linde et al., 2021; Meier et al., 2010; Nybacka et al., 2010; Parida et al., 2019; Peillon & Dubruc, 2019; Sjödin et al., 2020)		
Having the ability of changing and designing new business models (Chaney et al., 2021; Gaiardelli et al., 2014; Goehlich et al., 2020; Kamalaldin et al., 2020; Kamp et al., 2016; Kharlamov & Parry, 2020; Kohtamäki, Parida, et al., 2020; S. M. Lee & Lee, 2020; Lenkenhoff et al., 2018; Linde et al., 2021; Marcon et al., 2019; Ostrom et al., 2015; Sjödin et al., 2020; Thomson et al., 2021; Tronvoll et al., 2020)	Business model innovation	
Reconfiguration of offers, resources, and revenue streams (Bustanza et al., 2018; Dalenogare et al., 2019; Gebauer et al., 2017, 2021; Grandinetti et al., 2020; Kharlamov & Parry, 2020; Loonam et al., 2018; Matthyssens, 2019; Mittag et al., 2018; Opresnik & Taisch, 2015; Paiola & Gebauer, 2020; Tronvoll et al., 2020)		
Finding new ways of delivering outputs (Abou-foul et al., 2020; Basirati et al., 2019; Bressanelli et al., 2018; Frank et al., 2019; Holler et al., 2017; Huikkola et al., 2020; Kharlamov & Parry, 2020; Kohtamäki et al., 2019; Paluch, 2014; Sjödin et al., 2020; Tian et al., 2021; Vendrell-Herrero et al., 2017)		
Adapting the organization to new technical possibilities (Ardolino et al., 2017; Charro & Schaefer, 2018; Frank et al., 2019; Kharlamov & Parry, 2020; Kowalkowski et al., 2017; Tian et al., 2021)		

focuses on managing the complex collaborations with diverse actors to advance the digital service offering towards customers. Finally, the *ecosystem expansion* phase focuses on extending the ecosystem by increasing the number of partners with which the manufacturer interacts over time.

In our analysis, we also recognize that each phase includes three kinds of activities with distinct logics, which we categorize as: *activation*, *navigation*, and *consolidation*. The *activation activities* cover all the activities that are performed by the manufacturer in order to trigger the functioning of that particular phase. Then, there are the *navigation activities*, which capture the manufacturers’ efforts to organize the roles and different ecosystem elements during this specific phase of the ecosystem transformation process. Lastly, the *consolidation activities*

Table 5
First-order categories extracted from the literature – (capabilities).

First-order categories	Second-order themes	Aggregate dimension
Having the ability of designing and building digital platforms (Cenamor et al., 2017; Gebauer et al., 2021; Grandinetti et al., 2020; H. Huang et al., 2021; Jovanovic et al., 2021; Linde et al., 2021; Loonam et al., 2018; Parida et al., 2015; Sánchez-Montesinos et al., 2018; Tian et al., 2021)	Digitalization capabilities	Capabilities
Enhancing intelligent functionalities through smart components (Allmendinger & Lombreglia, 2005; Boldosova, 2020; Classen & Friedli, 2021; Mittag et al., 2018; Ostrom et al., 2015; Parida et al., 2015; Peillon & Dubruc, 2019; Tian et al., 2021)		
Enhancing connectivity functionalities through inter-connected assets (Allmendinger & Lombreglia, 2005; Ardolino et al., 2017; Basirati et al., 2019; Díaz-Garrido et al., 2018; Frank et al., 2019; Gebauer et al., 2021; Grandinetti et al., 2020; Grubic & Jennions, 2017; Hasselblatt et al., 2018; Jovanovic et al., 2021; Kamalaldin et al., 2020; Lafuente et al., 2017; S. W. Lee & Lee, 2016; Li et al., 2020; Linde et al., 2021; Martín-Peña et al., 2020; Naik et al., 2020; Sjödin et al., 2020; Sklyar, Kowalkowski, Sörhammar, et al., 2019; Sklyar, Kowalkowski, Tronvoll, et al., 2019; Thomson et al., 2021; Yeo et al., 2021; Zheng et al., 2018)		
Predicting customer insights through logical data processing (Allmendinger & Lombreglia, 2005; Basirati et al., 2019; Boldosova, 2020; Holler et al., 2017; Huikkola et al., 2020; Kamp et al., 2016; Kohtamäki et al., 2019; S. M. Lee & Lee, 2020; Mittag et al., 2018; Pagoropoulos et al., 2017; Paiola & Gebauer, 2020)		
Achieving value visualization and reporting through analytics (Ardolino et al., 2017; Boldosova, 2020; Coreynen et al., 2017; Gouvea et al., 2018; Kohtamäki, Parida, et al., 2020; Paiola & Gebauer, 2020)		
Providing internal coordination and maintaining external visibility (Boldosova, 2020; Coreynen et al., 2017; Kohtamäki, Parida, et al., 2020; Paiola & Gebauer, 2020)	Relational capabilities	
Learning the ability to integrate and coordinate value activities (Chester Goduscheit & Faullant, 2018; Grandinetti et al., 2020; Harris & Wonglimpiyarat, 2020; Kamalaldin et al., 2021; Kolagar et al., 2022; Ostrom et al., 2015)		
Exploiting current actor competencies through effective knowledge transformation (H. Huang et al., 2021; Kamalaldin et al., 2020, 2021; Kolagar et al., 2022; Linde et al., 2021)		

include all the efforts that facilitate the manufacturing firm’s ability to stabilize and strengthen that particular phase.

4.3.1. Ecosystem formation

Ecosystem formation is the first phase of the ecosystem transformation process, and it includes activities related to creating a concept

for digital servitization offering and engaging with the partners to agree on the concept. Prior literature has highlighted the need for manufacturers engaged in digital servitization to form novel ecosystems and to jointly define the value proposition with their ecosystem partners. In this regard, ecosystem formation is focused on the process of developing an integrative and collaborative business ecosystem, with the aim of enabling digital transformation so that higher value can be created for customers and partners alike. Based on the literature, we have identified three core activities in this phase, which consist of *initiating the ecosystem vision*, *mapping appropriate partnerships*, and *incentivizing joint engagement in the ecosystem*.

According to our analysis of the literature, the first activity in ecosystem formation centers on *initiating the ecosystem vision*. A commonly agreed vision allows ecosystem actors to align their efforts with each other based on their declared interests. This creates a sense of urgency in the process of ecosystem formation. Indeed, a critical issue in an ecosystem formation phase is establishing the right balance between a shared vision and the self-interest of the actors involved so that their actions are suitably influenced, facilitated, and stimulated (Kamalaldin et al., 2021; Laczko et al., 2019). In the same vein, the findings of Tronvoll et al. (2020) confirmed that developing and advancing a shared, convincing, and clear vision for both the firm and the entire network of partners is a vital factor in initiating digital servitization. Based on our analysis, several studies have reported that digitalization-led manufacturers are more externally oriented and are able to communicate an increased urgency in transforming their ecosystem (Paiola & Gebauer, 2020; Paluch, 2014; von Krogh et al., 2012) and in exploring the creation of digital innovation opportunities with novel ecosystem partners (Hsuan et al., 2021; Tian et al., 2021; Ziaee Bigdeli et al., 2018). For example, Linde et al. (2021) have described the importance of manufacturers sensing novel digital opportunities and evaluating new ecosystem partnerships to transform their ecosystem through targeted scouting activities. Besides, previous research has recognized that the demonstrating potential of innovation opportunities is a pivotal factor in motivating ecosystem actors to collaborate. Creating an ecosystem vision is thus vital for demonstrating the potential for collaboration (Ardolino et al., 2017; Kamalaldin et al., 2021). Thus, an ecosystem vision enables actors’ efforts to be synchronized. It activates ecosystem collaboration so that the combined skills, capabilities, and resources they possess can be utilized, allowing them to advance towards realizing the digital value proposition they desire.

Then, the second activity of the phase is focused on navigation collaboration by *mapping appropriate partnerships* to shape the ecosystem. Based on the previous studies, manufacturers engaging in digital servitization often identify strategic partnerships with technology and digital partners (Bustinza et al., 2018; Kamalaldin et al., 2021). This type of collaboration allows manufacturing firms to understand what is technically feasible and to figure out the digital value space (Jovanovic et al., 2021). In so doing, manufacturers can accurately identify their needs, capabilities, strengths, and weaknesses and determine what kinds of capability they are seeking in their partners. In addition, companies need to review their current value partners’ capabilities in relation to future solution needs. For example, Linde et al. (2021) argue that identifying the structured process of assessing capability requirements and complementarities is a critical factor in shaping collaboration on digital servitization. Moreover, Kamalaldin et al. (2020) stated that, if ecosystem collaboration on digital servitization is to be initiated, manufacturers should assess the potential that exists to combine the capabilities of their partners. Based on current partner assessment, manufacturers can make conscious efforts to attract new partners for digital solution development (Durugbo, 2013; Kamalaldin et al., 2021; Tian et al., 2021). For example, it would make sense to attract the most suitable and reliable technology partners who can complement existing capabilities and fill the gaps in the technology needed for digital servitization (Jovanovic et al., 2021; Kolagar et al., 2022). Furthermore, previous research has shown that manufacturers

need to have adequate knowledge of the current and future preferences of ecosystem partners (Abou-foul et al., 2020; Brax & Jonsson, 2009; Vilkas et al., 2019) so that the ecosystem can be organized appropriately in the interests of digital solution development.

Finally, as the last and consolidating activity of the formation phase, manufacturers engage in *incentivizing joint engagement in the ecosystem*. The key is finding ways to motivate ecosystem partners to participate in new and close collaboration with various actors and to pursue the shared goal of providing digital service offerings (Sjödin et al., 2021). Based on our review, to form the ecosystem, manufacturing firms need to incentivize complementary relationships in order to share specific investments among ecosystem partners (Grandinetti et al., 2020; Kohtamäki, Einola, et al., 2020). For example, Kamalaldin et al. (2020) stated that the provision of advanced digital services naturally involves investing in relationship-specific investments and co-specialized assets. And partners must set up the knowledge-sharing processes and routines that are essential for digital servitization. In addition, our analysis has revealed that manufacturers need to understand the resource and capability requirements of their ecosystem partners (Ardolino et al., 2017; Cenamor et al., 2017; Tronvoll et al., 2020). Moreover, due to the manufacturing firm's role as the "keystone player", manufacturers will most likely need to support the development of ecosystem partner capabilities. For example, many manufacturing firms are investing in innovative start-ups and SMEs because they are needed to realize the desired digital value proposition and compensate for missing competencies in the ecosystem (Kolagar et al., 2022; Sjödin et al., 2021). Moreover, manufacturers often go further towards strengthening partner relations so that they can estimate the financial risks and gains from their ecosystem partnerships (Brax & Jonsson, 2009; Huikkola et al., 2020; Linde et al., 2021). Of course, no partnership is without risk, but having a clear view of the level of risk and the revenue potential for manufacturer and ecosystem partners forges an anchor for ecosystem formation and provides necessary incentives for future digital servitization activities (Sjödin et al., 2021; Wallin et al., 2015).

Table 6 demonstrates a more-detailed overview of the first-order categories drawn from the literature on ecosystem formation.

4.3.2. Ecosystem orchestration

The second phase of the ecosystem transformation process focuses on *ecosystem orchestration*, which consists of managing the complex collaboration with diverse actors to advance the digital service offering for customers. The orchestration phase includes the creation and enforcement of the rules of the game for collaborating partners (Williamson & De Meyer, 2012). Indeed, it is a way for the manufacturer to align the partners to realize the ecosystem vision (Sjödin et al., 2021). Furthermore, the literature acknowledges that ecosystem orchestration involves a dynamic set of evolving actions, which try to redefine and revise the actor's stake in realizing and implementing digital servitization (Linde et al., 2021; Sklyar, Kowalkowski, Sörhammar, et al., 2019; Tian et al., 2021). According to the prior literature, this phase is centered on three key activities that consist of *defining the governance principles*, *distributing ecosystem roles*, and *ensuring value creation and capture alignment of the actors*.

Our analysis of the previous literature indicates that, in order to coordinate partnerships, manufacturers need to *define governance principles* so that there is effective management of relationships within the ecosystem (Jovanovic et al., 2021; Linde et al., 2021; Visnjic et al., 2016). For example, Struyf et al. (2021) have emphasized the importance of designing a governance structure that specifies rules on participation and interaction in the ecosystem for digital servitization. Specifically, there is a need to set certain rules and standards for working jointly and in parallel with partners in a process of co-creation (Chen et al., 2021). A vital prerequisite is that ecosystem actors should come to an agreement on ecosystem performance goals. What qualifies as key performance indicators (KPIs) can vary from one ecosystem to another due to inherent differences in how an ecosystem orchestration is

Table 6

First-order categories extracted from the literature – (ecosystem formation).

First-order categories	Second-order themes	Aggregate dimension
Communicating the urgency for collaboration (Kolagar et al., 2022; Paiola & Gebauer, 2020; Paluch, 2014; von Krogh et al., 2012)	Initiating the ecosystem vision	Ecosystem formation
Sharing innovative collaboration opportunities (Hsuan et al., 2021; Jovanovic et al., 2021; Kamalaldin et al., 2021; Kolagar et al., 2022; Parida et al., 2015; Peillon & Dubruc, 2019; Tian et al., 2021; Ziaee Bigdeli et al., 2018)		
Demonstrating the potential for collaboration (Ardolino et al., 2017; Huikkola et al., 2020; Kamalaldin et al., 2021; Kolagar et al., 2022)		
Identifying strategic partnerships with technology and digital partners (Durgbo, 2013; Jovanovic et al., 2021; Kamalaldin et al., 2021; Kolagar et al., 2022; Tian et al., 2021)	Mapping appropriate partnerships	
Reviewing current partners' capabilities in relation to future solution needs (Abou-foul et al., 2020; Brax & Jonsson, 2009; Cáceres & Guzmán, 2014; Huikkola et al., 2020; Kohtamäki, Einola, et al., 2020; Kolagar et al., 2022; S. M. Lee & Lee, 2020; Reim et al., 2019; Tian et al., 2021; Vilkas et al., 2019)		
Attracting new partners for digital solution development (Jovanovic et al., 2021; Kamalaldin et al., 2021; Kolagar et al., 2022; Tian et al., 2021)		
Considering relationship-specific investments (Grandinetti et al., 2020; Kohtamäki, Einola, et al., 2020)	Incentivizing joint engagement for ecosystem	
Understanding ecosystem partners' resources and capability-development needs/requirements (Adrodegari & Saccani, 2017; Ardolino et al., 2016; Belvedere et al., 2012; Chaney et al., 2021; Grandinetti et al., 2020; Hsuan et al., 2021; G. Q. Huang et al., 2011; H. Huang et al., 2021; Huikkola et al., 2020; Jovanovic et al., 2021; Kharlamov & Parry, 2020; Kohtamäki, Einola, et al., 2020; Kolagar et al., 2022; Kowalkowski et al., 2013; Ostrom et al., 2015; Sjödin et al., 2020; Tronvoll et al., 2020)		
Estimating financial risks and gains with the partner companies (Brax & Jonsson, 2009; Huikkola et al., 2020; Linde et al., 2021; Meier et al., 2010; Sjödin et al., 2020; Thomson et al., 2021)		

intended to be executed (Kolagar et al., 2022; Sjödin et al., 2021). For example, introducing radically new technology applications may focus on ensuring greater acceptance of technology by industrial partners and customers rather than on short-term financial profitability. In such situations, KPIs for ecosystem governance will be directed more to lowering the barriers and incentivizing digital technology acceptance.

Thus, Humbeck et al. (2019) have stressed the need to establish an agreement between different actors to determine a desired target for the ecosystem. In addition, Kolagar et al. (2021) have argued that the actors should formalize their collaboration in pursuit of a common ecosystem goal and work to stabilize their interactions. Similarly, Reim et al. (2018) demonstrated how formal rules and procedures can help manufacturers to more effectively regulate relationships and reduce uncertainty over the outcomes and behaviors in their ecosystem. A market-based governance strategy has been emphasized by Sjödin et al. (2018) to ensure stability and to formulate rules of interaction through contractual agreements between partners, thus maintaining productivity in the ecosystem.

In relation to navigation activity in this phase, manufacturers are concerned with *ecosystem role distribution*. According to previous studies, manufacturers must assess ecosystem roles in relation to existing capabilities and offering requirements. For example, a manufacturer may need to find a partner who can provide designing and manufacturing services so that they can offer a complete solution to trusted customers. In addition, there is a need to negotiate the responsibilities to be assigned to different actors (Kamalaldin et al., 2021; Linde et al., 2021; Parida et al., 2019; Parida & Jovanovic, 2021) in order to identify those who should take responsibility for monitoring operational data from customers (Kamalaldin et al., 2021) and those who should be responsible for customer interactions and solutions delivery (Linde et al., 2021; Loonam et al., 2018; Matthyssens, 2019). As an example, Huikkola et al. (2020) underlined the importance of organizing and balancing the different roles, tasks, and responsibilities of ecosystem actors. Furthermore, the results of previous studies have shown that evaluating inter-organizational roles from a global ecosystem perspective can be an effective means to achieve successful role distribution in the ecosystem (Classen & Friedli, 2021; Tian et al., 2021). Although very few studies have looked at role distribution from a global ecosystem perspective, its importance for manufacturing firms should not be underestimated because they operate in diverse global markets. According to Parida and Jovanovic (2021) and Sklyar et al. (2019), it is essential to assign new roles between the customer-facing front end and headquarters-oriented back end when developing and implementing digital servitization. For example, they found that front-end actors may have increased responsibility for the use of data to conduct preventive or predictive maintenance and establish cooperation with new local digital partners to move towards successful digital servitization (Kolagar et al., 2022; Sjödin et al., 2020).

Lastly, as the final activity and consolidation of this phase, it is apparent that manufacturers need to *ensure value creation and capture alignment of the actors*. The previous literature has demonstrated that it is vital to align actors in order to realize new value propositions because alignment provides the necessary foundation for digital servitization to thrive (Grandinetti et al., 2020; Kowalkowski et al., 2017; Linde et al., 2021; Sjödin et al., 2019, 2021). As an example, Kamalaldin et al. (2021) have highlighted the importance of aligning roles among partners so as to secure the realization of new value propositions in the ecosystem. Moreover, prior studies have highlighted the need to ensure a fair revenue flow between the ecosystem actors (Linde et al., 2021; Sjödin et al., 2021; Sklyar, Kowalkowski, Sörhammar, et al., 2019). However, these studies fail to explain how to define and reach agreement on a fair revenue flow. In essence, the most important recommendation for the orchestrating firm is not to use its power and position to reduce other partners' gains because such opportunistic behavior will, in the long term, result in the loss of revenue and reduce incentives for existing partners to stay committed. Finally, manufacturers must align the risk–reward distribution equally among ecosystem actors and strive for a healthy win–win relationship throughout the ecosystem (Hasselblatt et al., 2018; Kamalaldin et al., 2021; Linde et al., 2021; Thomson et al., 2021).

Table 7 presents a more detailed overview of the first-order categories derived from the literature on the ecosystem orchestration phase.

Table 7
First-order categories extracted from the literature – (ecosystem orchestration).

First-order categories	Second-order themes	Aggregate dimension
Agreeing on ecosystem performance goals (e.g. KPIs for all actors) (Durugbo, 2013; Hein et al., 2019; Hsuan et al., 2021; Opazo-Basáez et al., 2018; Sjödin et al., 2021; Sklyar, Kowalkowski, Tronvoll, et al., 2019)	Defining governance principles	Ecosystem orchestration
Formulating rules governing the ecosystem (Jovanovic et al., 2021; Linde et al., 2021; Sjödin et al., 2021; Tronvoll et al., 2020; Visnjic et al., 2016)		
Assessing ecosystem roles in relation to capabilities and offerings (Abou-foul et al., 2020; Brax & Jonsson, 2009; Cáceres & Guzmán, 2014; Huikkola et al., 2020; Kohtamäki, Einola, et al., 2020; S. M. Lee & Lee, 2020; Reim et al., 2019; Tian et al., 2021; Vilkas et al., 2019)	Ecosystem role distribution	
Negotiating the responsibilities between different actors (H. Huang et al., 2021; Kamalaldin et al., 2021; Kamp et al., 2016; Linde et al., 2021; Sjödin et al., 2021; Sklyar, Kowalkowski, Tronvoll, et al., 2019)		
Considering inter-organizational roles (i.e. front-/back-end) with global ecosystem perspective (Classen & Friedli, 2021; Kamalaldin et al., 2021; Sklyar, Kowalkowski, Tronvoll, et al., 2019; Tian et al., 2021)		
Aligning actors' for the realization of new value propositions (Chester Goduscheit & Faullant, 2018; Gebauer et al., 2017; Goehlich et al., 2020; Grandinetti et al., 2020; Huikkola et al., 2020; Jiang et al., 2016; Jovanovic et al., 2021; Kamalaldin et al., 2020, 2021; Kohtamäki, Einola, et al., 2020; Kolagar et al., 2022; Linde et al., 2021; Marcon et al., 2019; Nybacka et al., 2010; Paiola & Gebauer, 2020; Parida et al., 2015; Sjödin et al., 2020; Sklyar, Kowalkowski, Tronvoll, et al., 2019; Tian et al., 2021; Tronvoll et al., 2020)	Ensuring actors' value creation & capture alignment	
Ensuring the revenue flow between actors (Kamalaldin et al., 2021; Linde et al., 2021; Sjödin et al., 2021; Sklyar, Kowalkowski, Sörhammar, et al., 2019; Tronvoll et al., 2020)		
Aligning the risk/reward distribution (win–win relationship) (Grandinetti et al., 2020; Kamalaldin et al., 2021; Kohtamäki et al., 2019; Kowalkowski et al., 2017; Linde et al., 2021; Parida et al., 2015; Sjödin et al., 2020, 2021)		

4.3.3. Ecosystem expansion

Finally, we come to the third and final phase of the ecosystem transformation process, which focuses on *ecosystem expansion*. Ecosystem expansion can be understood as an extension of the ecosystem by increasing the number of partners with whom the

manufacturer interacts. It is a process of enhancing the ecosystem's physical, social, and economic links with other systems. Indeed, it is a way for ecosystems to engage in expanding their operations beyond the boundaries of the current ecosystem and redefine their current partnerships (Jovanovic et al., 2021). Based on the previous literature, we have found that this phase centers on the three core activities of *continuous ecosystem evaluation and adaptation*, *revitalizing ecosystem collaboration*, and *strengthening ecosystem bonds*.

From our literature analysis, it became clear that, when activating the ecosystem expansion phase, manufacturers need to engage in *continuous ecosystem evaluation and adaptation*. This means that manufacturers must constantly assess the ecosystem's health and performance in terms of criteria such as stability, resilience, and sustainability (Linde et al., 2021). For example, several studies have highlighted the critical role that continuous assessment and adaptation of the ecosystem to changing conditions have on ensuring successful ecosystem collaboration over time (Jiang et al., 2016; Kolagar et al., 2022; Linde et al., 2021; Parida et al., 2015). Specifically, the literature underscores the importance of evaluating the contributions of different actors over time (Sjödin et al., 2021). For example, prior studies have suggested that ecosystem partners can lose clarity on the exact purpose of their collaboration and roles. Hence, manufacturers should be aware of this effect when they evaluate the ecosystem and the contribution of each actor (Huikkola et al., 2020; Sánchez-Montesinos et al., 2018).

The second activity of the ecosystem expansion phase focuses on navigating the ecosystem by *revitalizing ecosystem collaboration*. Previous studies have shown that manufacturers become more demanding of their partners as their expectations rise over time (Huikkola et al., 2020; Sánchez-Montesinos et al., 2018). Consequently, manufacturers need to evaluate their future partnership scenarios, adapt their selection process, and establish suitable criteria to support sustained future performance (Kamalaldin et al., 2020; Opresnik & Taisch, 2015; Paiola & Gebauer, 2020; Thomson et al., 2021; Tronvoll et al., 2020). For example, rapid digital technology development may require manufacturers to evaluate scenarios concerned with changing roles, routines, and agreements. The literature also emphasizes the importance of introducing new innovative actors to expand the value space (Adrodegari & Saccani, 2017; Chaney et al., 2021; Chester Goduscheit & Faullant, 2018; Martín-Peña et al., 2020). For example, Jovanovic et al. (2021) argued that ecosystem expansion can be facilitated by promoting interoperability between different actors and by allowing new partners to deploy value-added digital services. Moreover, there is a need for manufacturers to reconfigure their ecosystem linkages in order to meet emerging demands (Bustinza et al., 2018; Díaz-Garrido et al., 2018; G. Q. Huang et al., 2011; Huikkola et al., 2020; Krucken & Meroni, 2006; Linde et al., 2021; Opresnik & Taisch, 2015). Indeed, when compared to product-focused collaboration, digital-service-based collaboration may lead to an increased number of partners or new types of partner in the ecosystem, requiring manufacturers to redesign their current ecosystem collaboration.

Finally, the consolidating activity of the ecosystem expansion phase is concerned with *strengthening the ecosystem bonds* between the actors. Based on previous studies, a key focus is to refine governance routines (Sjödin et al., 2021) by learning from the experience of managing ecosystem collaboration. For example, as the ecosystem matures, prior studies highlight the need to make ecosystem governance more trust-based, inclusive, flexible, and relationally beneficial, with a focus on achieving high levels of involvement in the delivery of digital solutions by ecosystem partners (Chaney et al., 2021; Charro & Schaefer, 2018; H. Huang et al., 2021; Kamalaldin et al., 2020; Kohtamäki et al., 2019; Lafuente et al., 2017; Linde et al., 2021; Marcon et al., 2019; Naik et al., 2020). Similarly, Tian et al. (2021) have pointed out the importance of manufacturers not only innovating their new offerings but also learning to maintain good collaboration and co-create value with other actors. As a result, manufacturers must focus on re-aligning their ecosystem goals and consider the wishes of other partners (Abou-foul et al., 2020; Brax &

Jonsson, 2009; Cáceres & Guzmán, 2014; Huikkola et al., 2020; Kohtamäki, Einola, et al., 2020; S. W. Lee & Lee, 2016; Reim et al., 2019; Tian et al., 2021; Vilkas et al., 2019). For example, there may be a need to re-assess leadership–follower roles in certain situations depending on the customer context and ecosystem partner preferences (Kamalaldin et al., 2021). In order to fulfill this purpose, manufacturers must focus on their soft and social skills (Paiola & Gebauer, 2020; Tian et al., 2021; Tronvoll et al., 2020) to strengthen their collaboration efforts. Hence, the research literature encourages manufacturing companies to develop their soft and social competencies, such as intercultural skills, language skills, communication skills, networking skills, teamwork abilities, ability to compromise and cooperative, ability to transfer knowledge, and leadership skills, to offer better digital services and solutions (Baines & Lightfoot, 2014; Cimini et al., 2021; Tronvoll et al., 2020).

Table 8 demonstrates a more-detailed overview of the first-order categories drawn from the literature on ecosystem expansion.

4.4. Effects of ecosystem transformation in digital servitization

As noted earlier, we recognized that the philosophy behind ecosystem transformation is to smooth the path to digital servitization for manufacturers and their ecosystem partners. From our systematic literature review, we found that ecosystem transformation can lead to different effects and outcomes related to digital servitization – namely, *scalable digital service offerings*, *market expansion*, and *business resilience*.

First, our analysis of the literature revealed that, by leveraging the complementarity abilities of ecosystem transformation, manufacturers are able to provide *scalable digital service offerings*. Accordingly, and in line with prior research, manufacturing firms must be able to augment value appropriation by aggregating solutions (Díaz-Garrido et al., 2018; Jovanovic et al., 2021; Marcon et al., 2019), improve the modularity of their offerings based on the digital needs and maturity of their customers (Hein et al., 2019; Hsuan et al., 2021; Sjödin et al., 2020; Tronvoll et al., 2020), and develop their customized value propositions (Chaney et al., 2021; Coreynen et al., 2020; Eloranta & Turunen, 2016).

Our literature analysis also revealed that the second effect of ecosystem transformation is that it can help manufacturers and their partners with *market expansion*. For example, prior studies have shown that ecosystem actors can find new customers (S. W. Lee & Lee, 2016; Tian et al., 2021; Ziaee Bigdeli et al., 2018), discover new entry points for market growth (Hernández Pardo et al., 2012; Huikkola et al., 2020; Peillon & Dubruc, 2019) and, thus, expand the boundaries of their activities to international markets (Cenamor et al., 2017; Chester Goduscheit & Faullant, 2018; Grubic, 2018; Yeo et al., 2021). In fact, our analysis shows that ecosystem transformation can give rise to economic growth in the international market.

And finally, the results of our review show that this transformation can enhance *business resilience* and improve actors' capacity to predict crises and learn how to respond appropriately to the obstacles and challenges in digital servitization. For instance, the prior literature has argued that manufacturing firms can develop the ability to better resist shocks and disruptions (Martín-Peña et al., 2020; Paiola & Gebauer, 2020; Vendrell-Herrero et al., 2017), enhance their resilience to changing market and customer conditions (Baines & Lightfoot, 2014; Kamalaldin et al., 2021; Lafuente et al., 2017; Linde et al., 2021), and achieve increased flexibility in their businesses (Frank et al., 2019; Hsuan et al., 2021; Tian et al., 2021).

A more detailed overview of the first-order categories drawn from the literature on the effects of ecosystem transformation in digital servitization can be viewed in Table 9.

5. A framework for ecosystem transformation in digital servitization

We synthesize our findings in a framework for ecosystem transformation in digital servitization (see Fig. 10). The framework includes

Table 8
First-order categories extracted from the literature – (ecosystem expansion).

First-order categories	Second-order themes	Aggregate dimension
Assessing ecosystem health and performance in terms of stability, resilience, and sustainability (Jiang et al., 2016; Linde et al., 2021; Parida et al., 2015)	Continuous ecosystem evaluation & adaptation	Ecosystem expansion
Evaluating different actors' contributions over time (Jiang et al., 2016; Linde et al., 2021; Lindhult et al., 2018)	Revitalizing ecosystem collaborations	Ecosystem expansion
Evaluating future partnership scenarios (Kamalaldin et al., 2020; Opresnik & Taisch, 2015; Paiola & Gebauer, 2020; Thomson et al., 2021; Tronvoll et al., 2020)		
Introducing new innovative actors for expanding the value space (Adrodegari & Sacconi, 2017; Chaney et al., 2021; Chester Goduscheit & Faullant, 2018; Díaz-Garrido et al., 2018; Eloranta & Turunen, 2016; Grandinetti et al., 2020; Grubic, 2018; Grubic & Peppard, 2016; Hein et al., 2019; H. Huang et al., 2021; Kamalaldin et al., 2020, 2021; Kohtamäki et al., 2019; Kohtamäki, Einola, et al., 2020; Kolagar et al., 2022; Kowalkowski et al., 2017; S. M. Lee & Lee, 2020; Li et al., 2020; Linde et al., 2021; Lindhult et al., 2018; Martín-Peña et al., 2020; Matthysens & Vandenbempt, 2010; Opazo-Basáez et al., 2018; Pagoropoulos et al., 2017; Reim et al., 2019; Sjödin et al., 2019, 2020, 2021; Sklyar, Kowalkowski, Sörhammar, et al., 2019; Süße et al., 2018; Tian et al., 2021; Tronvoll et al., 2020; Wallin et al., 2015)		
Reconfiguring ecosystem linkages to meet the emerging demands (Bustinza et al., 2018; Díaz-Garrido et al., 2018; G. Q. Huang et al., 2011; Huikkola et al., 2020; Kolagar et al., 2022; Krucken & Meroni, 2006; Linde et al., 2021; Opresnik & Taisch, 2015; Sjödin et al., 2021)	Strengthening the ecosystem bonds	Ecosystem expansion
Refining governance routines and learning how to maintain good collaborations (Cáceres & Guzmán, 2014; Chaney et al., 2021; Charro & Schaefer, 2018; Gaiardelli et al., 2014; H. Huang et al., 2021; Kamalaldin et al., 2020; Kohtamäki et al., 2019; Lafuente et al., 2017; Linde et al., 2021; Marcon et al., 2019; Naik et al., 2020; Pagoropoulos et al., 2017; Paiola & Gebauer, 2020; Parida et al., 2015; Sánchez-Montesinos et al., 2018; Sjödin et al., 2019; Sklyar, Kowalkowski, Tronvoll, et al., 2019; Thomson et al., 2021; Tian et al., 2021; Tronvoll et al., 2020)		
Realigning ecosystem goals and considering the wills of other partners (Abou-foul et al., 2020; Brax & Jonsson, 2009; Cáceres & Guzmán, 2014; Huikkola et al., 2020; Kohtamäki, Einola, et al., 2020; S. M.		

Table 8 (continued)

First-order categories	Second-order themes	Aggregate dimension
Lee & Lee, 2020; Reim et al., 2019; Tian et al., 2021; Vilkas et al., 2019)	Focusing on soft and social skills to strengthen the collaboration (Paiola & Gebauer, 2020; Tian et al., 2021; Tronvoll et al., 2020)	Ecosystem expansion

four interdependent parts: i) *triggers* (RQ1), ii) *firm-level enablers* (RQ2), iii) *ecosystem phases and activities* (RQ3), and iv) *effects* (RQ4), relating to ecosystem transformation in digital servitization.

First, we identify the triggers of ecosystem transformation in digital servitization based on reviewing and coding the literature. Triggers include *synchronizing with fast-paced market change, customer demands and readiness, and filling technology (and resources) gaps*. These triggers provide an explanation why manufacturing companies engage in creating organizational and ecosystem transformation. The triggers are also perceived by manufacturing firms as urgency signals to expedite ecosystem transformation because an inability to do so could lose a competitive advantage.

Second, our review clearly shows that companies need to have in place firm-level enablers that will facilitate ecosystem transformation. Successful ecosystem transformation requires manufacturing companies to have the necessary internal prerequisites, which then need to be strengthened. Based on our analysis, we have divided these firm-level enablers into three main categories – *culture, business model, and capabilities*. Accordingly, companies must first cultivate a culture of transparency and openness and accountability and trust to effectively manage ecosystem collaboration. In addition, the literature shows a clear link between the business model and ecosystem collaboration (Chen et al., 2021; Sjödin et al., 2021; Thomson et al., 2021). The literature refers to the need for manufacturers to constantly evaluate their business models and find solutions to the challenges and opportunities they are currently facing. In doing so, they can determine how best to align the transformation of their business models and ecosystems to facilitate digital servitization. Finally, our review indicates that ecosystem transformation for digital servitization requires companies to have developed digitalization and relational capabilities. Otherwise, there will be no willingness on the part of other ecosystem actors to partner with them, and there may be struggles to capitalize emerging digital technologies from ecosystem partners.

Third, the focal part of the proposed framework explains different phases of ecosystem transformation in digital servitization. In this regard, we divided ecosystem transformation studies into three phases – *ecosystem formation, ecosystem orchestration, and ecosystem expansion*. Each of these phases includes three activities – *activation, navigation, and consolidation*. Activation includes all the activities concerned with conducting initial assessments to accurately understand the challenges and opportunities in ecosystem development. Navigation addresses role clarification throughout the entire ecosystem transformation process. And finally, the consolidation step encapsulates all the necessary measures to achieve cohesion and to stabilize this phase. The *ecosystem formation phase* highlights the need to define the vision of the ecosystem in the first place, and then to attract partners and promote joint investments. The *ecosystem orchestration phase* defines the orchestration principles, distributes different roles among ecosystem actors, and ensures their alignment. Finally, the last phase focuses on *ecosystem expansion*, which embraces continuous evaluation and adaptation to revitalize the collaborations, seize the opportunities of ecosystem development, and strengthen the bonds between ecosystem actors.

Finally, the last part of our framework is related to the outcomes of successful ecosystem transformation in digital servitization. A common theme in the literature is that the ecosystem transformation process will enable manufacturing companies to gain competitiveness by sharing

Table 9
First-order categories extracted from the literature – (effects).

First-order categories	Second-order themes	Aggregate dimension
Stimulating value appropriation by aggregating solutions (Bustinza et al., 2018; Díaz-Garrido et al., 2018; Gebauer et al., 2021; Geum et al., 2011; Huikkola et al., 2020; Jovanovic et al., 2021; Kohtamäki, Einola, et al., 2020; Kolagar et al., 2022; Marcon et al., 2019; Matthyssens & Vandenbempt, 2010; Sánchez-Montesinos et al., 2018; Thomson et al., 2021)	Scalable digital service offerings	Effects of ecosystem transformation in digital servitization
Modularity of offerings based on digital needs and customer maturity (Ardolino et al., 2017; Coreynen et al., 2020; Eloranta & Turunen, 2016; Gebauer et al., 2017; Hein et al., 2019; Hsuan et al., 2021; G. Q. Huang et al., 2011; Huikkola et al., 2020; Jovanovic et al., 2021; Kohtamäki et al., 2019; Kolagar et al., 2022; Kruken & Meroni, 2006; Li et al., 2020; Meier et al., 2010; Ostrom et al., 2015; Paiola & Gebauer, 2020; Sjödin et al., 2020; Tronvoll et al., 2020; Zheng et al., 2018)		
Developing customized value propositions (Chaney et al., 2021; Coreynen et al., 2020; Eloranta & Turunen, 2016; Hsuan et al., 2021; Kohtamäki, Einola, et al., 2020; Kolagar et al., 2022; Tian et al., 2021)		
Finding new customers (Kolagar et al., 2022; S. M. Lee & Lee, 2020; Tian et al., 2021; Ziaee Bigdeli et al., 2018)	Market expansion	
Discovering new entry points for market growth (Allmendinger & Lombreglia, 2005; Hernández Pardo et al., 2012; Huikkola et al., 2020; Kolagar et al., 2022; Linde et al., 2021; Parida et al., 2015; Peillon & Dubruc, 2019)		
Expanding the boundaries of activity to international markets (Chester Goduscheit & Faullant, 2018; Grubic, 2018; Kamalaldin et al., 2021; Kolagar et al., 2022; Parida et al., 2015; Reim et al., 2019; Yeo et al., 2021)		
Gaining the ability of better resisting against shocks (Martín-Peña et al., 2020; Paiola & Gebauer, 2020; Vendrell-Herrero et al., 2017)	Business resilience	
Enhancing the resilience to changing conditions (Baines & Lightfoot, 2014; Kamalaldin et al., 2021; Lafuente et al., 2017; Linde et al., 2021)		
Reaching increased flexibility (Frank et al., 2019; Hsuan et al., 2021; Kamalaldin et al., 2020; Loonam et al., 2018; Matthyssens, 2019; Meier et al., 2010; Reim et al., 2019; Sjödin et al., 2020; Tian et al., 2021; Vilkas et al., 2019)		

knowledge, resources, and capabilities in a synergistic way and aggregating their solutions to provide scalable digitally-enabled advanced service offerings. Furthermore, the literature review shows that manufacturers can benefit from the opportunities that arise during this transformation process to expand their market position. This is measured by establishing new customer segments, securing entry into new markets, and expanding the boundaries of their international markets. Indeed, the ecosystem transformation process provides incentives for ecosystem actors to engage in a continuous learning process. A vital aspect is taking the opportunity to gain experience and learn from different partners to further the firm's internal digital servitization transformation. In this way, firms can determine how to appropriately respond to the obstacles, challenges, and crises they may face. Companies can learn how to increase their resilience, how to resist shocks, and how to be more flexible when facing discrete challenges.

6. Conclusions

6.1. Theoretical and practical contributions

This study investigates how firms engaged in digital servitization transform their ecosystems. More specifically, we draw on a systematic literature review of prior literature in digital servitization to detail the triggers, enablers, phases, and activities involved in ecosystem transformation, as well as the effects of such a transformation. Accordingly, this research makes several theoretical contributions to the existing body of knowledge on digital servitization and ecosystems, including the sub-streams on business ecosystems (Gawer & Cusumano, 2014; Huikkola et al., 2020; Humbeck et al., 2019), service ecosystems (Alaimo et al., 2019; Jovanovic et al., 2019; Sklyar, Kowalkowski, Tronvoll, et al., 2019), and innovation ecosystem (Adner, 2006, 2017; Adner & Kapoor, 2010; Jacobides et al., 2018; Kamalaldin et al., 2021; Kummitha, 2018) literature.

Our core contribution is recognition of the value of an ecosystem perspective on digital servitization. In particular, through our literature review, we highlighted those studies that have been influential in combining digital servitization and the ecosystem literature (Gebauer et al., 2021; Linde et al., 2021; Sjödin et al., 2021; Sklyar, Kowalkowski, Tronvoll, et al., 2019). Those manufacturing firms that can realize the value of ecosystem transformation are in a position to ensure the successful provision of digitally-enabled advanced services and solutions (Kohtamäki, Parida, et al., 2020; Paiola & Gebauer, 2020). Indeed, an enhanced ability to integrate with ecosystem partners leads to co-innovation and greater value for customers (Berthet et al., 2018; Rukanova et al., 2021). Furthermore, we synthesize these emerging research insights into an integrative framework consisting of key phases and activities, and we conceptualize the triggers, firm-level enablers, and effects of ecosystem transformation in digital servitization. Thus, we provide an organizing framework for structuring the research on digital servitization and ecosystem transformation and for advancing the research agenda (Kohtamäki et al., 2019). The framework conceptualizes different phases of ecosystem transformation, including ecosystem formation, ecosystem orchestration, and ecosystem expansion, which previous studies had tended to overlook. In addition, we provide details on three activities associated with each phase – activation, navigation, and consolidation. Our review of the literature clearly shows ecosystem as a critical component of digital servitization research, and a key avenue for further research in order to gain additional insights into the provision of digitally-enabled advanced services and solutions. In doing so, we place existing scholarship in its proper context and provide directions for cumulative research going forward. We hope that our review provides a clear framework for future research on ecosystem transformation in digital servitization, and that it will inspire scholars to continue investigating this important construct.

Our study is of benefit to senior managers who are driving digitalization and ecosystem partnership initiatives in manufacturing firms. We

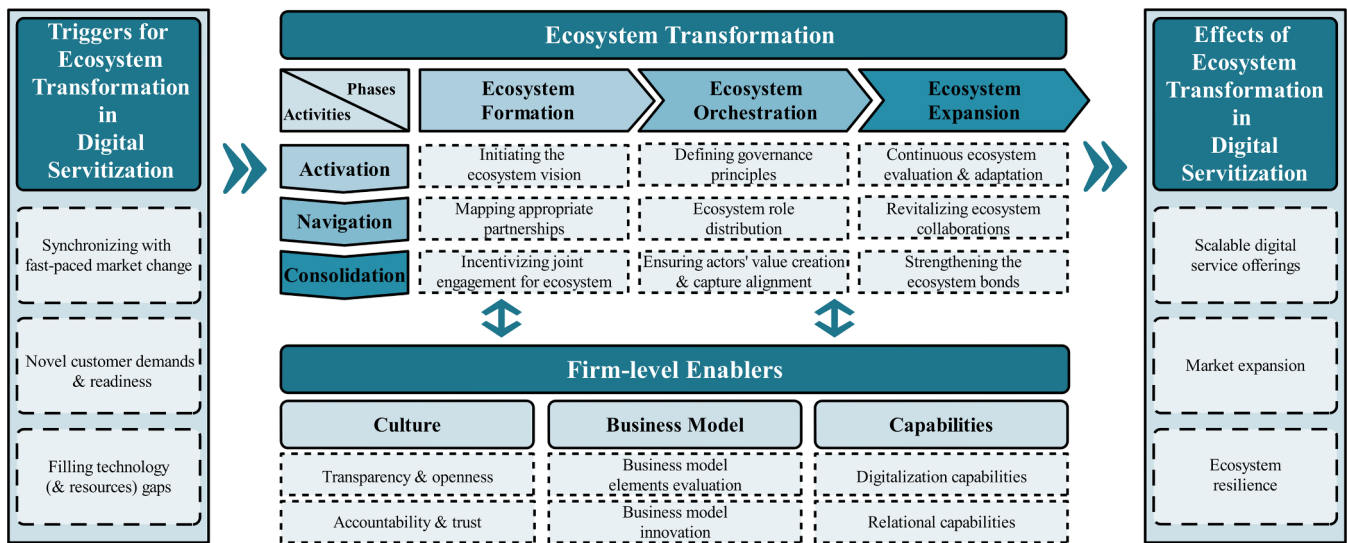


Fig. 10. An integrative framework for ecosystem transformation in digital servitization.

encourage these managers to place emphasis on firm-level enablers, such as culture change, business model, and capabilities development programs, as a way to create the foundations for ecosystem transformation. For example, getting ecosystem partners involved in pilot projects and seeking feedback from progressive customers are useful means to test innovative digital service business models. We also encourage ecosystem managers to search for partnerships outside their existing value chain. For example, cooperation with innovative SMEs and digital infrastructure providers has been critical for manufacturing firms in successfully delivering digital services to customers (Kolagar et al., 2019). We would also highlight the importance of distinguishing between partnering strategies across different phases of ecosystem transformation. This provides a temporal perspective on ecosystem transformation and underlines the need to devise appropriate activities for each specific phase. Finally, the proposed integrative framework can act as a step-by-step roadmap for manufacturers to maximize their gains from digital servitization by transforming their ecosystems. With the help of our framework, managers can facilitate their ecosystem transformation, thereby enabling them to develop the capabilities they need to offer digitally-enabled advanced services and solutions.

6.2. Research limitations

The authors acknowledge that their paper suffers from several limitations, such as those that are evident in any systematic literature review. First, as a result of the diversity and multi-disciplinary nature of the digital servitization topic, this study has sometimes had to operate on a more general level, favoring breadth over depth in the analysis. Second, the use of a specific database and our keyword formula may have resulted in the exclusion of potentially relevant literature. It is our belief, however, that the publications identified are, by and large, representative of the current literature on the digital servitization subject. Indeed, it is probably not feasible or may not even be necessary to include every published work (Bakker, 2010). Third, we acknowledge that the content analysis of the relevant articles was subjective in certain aspects, and that the responsibility for interpreting that content lies with the authors of the current study. Researchers' triangulation and explicit coding rules, on the other hand, have contributed to the reliability of the

results. Despite these limitations, we believe that our study provides researchers and managers with a more thorough understanding of ecosystem transformation in digital servitization research.

6.3. An agenda for future research on ecosystem transformation in digital servitization

This section presents an agenda for future research on ecosystem transformation in digital servitization. Through our systematic literature review, we identified several research gaps during the descriptive and thematic analyses of the review findings and during the synthesis part of our study, which provides an opportunity for researchers in digital servitization and ecosystem transformation to conduct further research. Our analysis revealed that future research can benefit from focusing on different elements of the proposed integrative framework including the triggers, firm-level enablers, different phases of ecosystem transformation, and its effects. By highlighting and categorizing these gaps, Table 10 lays out a potential research pathway, which can assist scholars in conducting their own studies.

Additionally, a key insight from our review is that most research on digital servitization and ecosystem transformation is still qualitative in nature. This is natural for emerging areas of inquiry. Yet, the application of quantitative research methods is important to establish the reliability and validity of qualitative research approaches so that the validated knowledge on ecosystem transformation in digital servitization can be maximized. We encourage researchers to leverage other sources of data (e.g., surveys and panel data) and methods of analysis. For example, the structural equations modeling or partial least squares methods (Kolagar & Hosseini, 2019; Ratzmann et al., 2016; Sarstedt et al., 2022) can be used to examine the relationships between different constructs and investigate the existence of a significant correlation between different variables. Furthermore, the design of research approaches using multi-criteria decision-making techniques (Kolagar, 2019; Yasmin et al., 2020) based on crisp, fuzzy, and hesitant fuzzy logic (Kolagar et al., 2019, 2021) will support the use of configurational logic (Sjödin et al., 2019) and enable examination of different constructs in ecosystem transformation to advance digital servitization studies.

Table 10
Theme-based gaps and potential questions for future research.

Main theme	Gaps/underexplored areas	Potential questions for future research
Triggers for ecosystem transformation in digital servitization	<ol style="list-style-type: none"> 1. Understanding the influence of new entrants in digital servitization. 2. Understanding the role of policy in ecosystem transformation. 3. Investigating the impact of new digital technologies on different industries (e.g., manufacturing, construction, energy) and on the ecosystem transformation process. 4. Understanding the changing and emerging digital and sustainability needs of progressive customers. 	<p>RQ1: How can digitally oriented new entrants (e.g., start-ups) collaborate and compete with established firms in shaping the ecosystem for digital transformation?</p> <p>RQ2: How can national and international policies (e.g., data regulations, antitrust) trigger or obstruct ecosystem transformation in digital servitization?</p> <p>RQ3: How can the emergence of AI, IoT, blockchain, and big data analytics impact the process of ecosystem transformation for digital servitization in different industries (e.g., manufacturing, energy, construction)?</p> <p>RQ4: How does customer need for digital transformation trigger ecosystem formation and orchestration of digital servitization?</p>
Enablers of ecosystem transformation in digital servitization	<ol style="list-style-type: none"> 1. Promoting organizational change for ecosystem cooperation. 2. Understanding the impact of BMI on current ecosystem relationships. 3. Understanding the required capabilities and routines needed for ecosystem orchestration. 4. Considering the trade-offs of leading or following ecosystem. 	<p>RQ1: How can senior managers drive organizational change and create a collaborative culture to gain from digital servitization?</p> <p>RQ2: How can activities related to value creation, value capture, and value delivery be revised to realize benefits from ecosystem cooperation?</p> <p>RQ3: How can capabilities and routines that are required to managing early phases of ecosystem formation be conceptualized?</p> <p>RQ4: How can a decision framework be developed to assess the roles needed for profitable digital servitization?</p>
Ecosystem Transformation Phases	<p><i>Ecosystem formation:</i></p> <ol style="list-style-type: none"> 1. Understanding the requirements for forming new partnerships. 2. Understanding the relationship between and differences for socio-economic characteristics for ecosystem formation. 3. Understanding digital technologies impact on the formation of ecosystems towards broader international markets. 	<p>RQ1: How can manufacturers use tactics to attract new types of actors and partnerships to their ecosystems with the aim of offering digitally enabled services and solutions?</p> <p>RQ2: How does the socio-economic characteristic of a region/country impact the potential of ecosystem formation?</p> <p>RQ3: How can digital capabilities for ecosystem formation be used for employing an international market perspective?</p>

Table 10 (continued)

Main theme	Gaps/underexplored areas	Potential questions for future research
	<p><i>Ecosystem orchestration:</i></p> <ol style="list-style-type: none"> 1. Understanding the governance mechanisms for ecosystem orchestration. 2. Coordinating actors within an ecosystem. 3. Understanding governance mechanisms to protect the intellectual property in the ecosystem. 4. Understanding the orchestration of data sharing in ecosystems. 	<p>RQ1: How can governance mechanisms be configured to orchestrate ecosystems in different contexts?</p> <p>RQ2: How can manufacturing firms develop routines to coordinate their activities with other actors in an ecosystem for digital servitization?</p> <p>RQ3: How can governance mechanisms be designed to protect intellectual property in digital servitization ecosystems?</p> <p>RQ4: How can manufacturers balance data sharing and data protection in emerging ecosystems for digital servitization?</p>
	<p><i>Ecosystem expansion:</i></p> <ol style="list-style-type: none"> 1. Developing market entrance strategies for ecosystem expansion. 2. Developing criteria for ecosystem evaluation. 3. Managing the customer experience during ecosystem expansion. 	<p>RQ1: How can manufacturing firms use the potential of different market entry strategies (e.g., piggybacking, licensing, joint ventures) to develop new adaptable strategies for ecosystem expansion in digital servitization?</p> <p>RQ2: How can manufacturers monitor the health of their ecosystem collaboration in digital servitization?</p> <p>RQ3: How can manufacturing firms manage customer experiences during ecosystem expansion?</p>
Effects of ecosystem transformation in digital servitization	<ol style="list-style-type: none"> 1. Understanding market expansion by ecosystem transformation. 2. Understanding the means of ecosystem resiliency enhancement. 3. Understanding the impact of ecosystem transformation on learning and innovation. 4. Understanding the sustainability implications of ecosystem transformation. 	<p>RQ1: How does ecosystem transformation impact the sales growth of digital services for manufacturers?</p> <p>RQ2: How does ecosystem transformation affect resilience and the long-term competitive advantage of manufacturers?</p> <p>RQ3: How does ecosystem transformation during the learning and innovation of manufacturing firms?</p> <p>RQ4: What are the social, economic, and environmental implications of ecosystem transformation in digital servitization (e.g., the carbon footprint of digital services and solutions).</p>

CRedit authorship contribution statement

Milad Kolagar: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Vinit Parida:** Writing – review & editing, Visualization, Validation, Supervision, Project administration, Funding acquisition, Formal analysis, Data

curation, Conceptualization. **David Sjödin:** Writing – review & editing, Validation, Supervision, Project administration, Funding acquisition, Formal analysis, Data curation, Conceptualization.

Declaration of Competing Interest

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

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