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Orchestrating the ecosystem for data-driven digital services and solutions: A multi-level framework for the realization of sustainable industry

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Abstract

The purpose of this study is to investigate how large manufacturing firms can orchestrate their ecosystem for the successful co-creation of data-driven digital services and solutions as a way to achieve sustainable industry benefits. An exploratory single-case study approach has been adopted for this study, which included 23 in-depth interviews conducted with informants from seven Swedish and international companies involved in a transportation ecosystem. Based on the analysis, this study has developed a multi-level framework for ecosystem orchestration that contains three main operational levels: individual, organization, and ecosystem, with an integrated sustainable industry benefits section as the outcome of this process. By providing a detailed account of ecosystem orchestration, this study contributes to the successful co-creation of digital services and solutions. In addition, insights from this research can be used as a continuous evaluation and improvement tool for managers to orchestrate their ecosystem for digital servitization.

KEYWORDS
data-driven digital services and solutions, digital servitization, ecosystem orchestration, sustainable industry

1 | INTRODUCTION

Over the past few decades, there has been considerable discussion regarding the future of the manufacturing industry and the need to explore new ways to align with the sustainability agenda (Schiavone et al., 2022; Yavuz et al., 2023; Zhang et al., 2022). Consequently, manufacturers are required to adopt more sustainable practices and devise innovative ways of providing services and solutions that will allow them to reduce their environmental footprint and improve their social impact while preserving their economic viability (Mukhuty et al., 2022; Paiola et al., 2021). As part of this endeavor, the use of new digital technologies (e.g., artificial intelligence [AI] and machine learning [ML] algorithms, industrial Internet of Things [IIoT], cloud computing, etc.) to transition from manufacturers' conventional product-centric approaches to a more intricate and nuanced service-oriented model, a process known as digital servitization (Barile et al., 2020; Kolagar, Parida, & Sjödin, 2022; Kolagar, Reim, et al., 2022; Naik et al., 2020; Sjödin et al., 2020), has been discussed to assist industrial firms in achieving sustainable benefits (Bähr & Fliaster, 2023; Ghobakhloo et al., 2021). Nevertheless, this transformation requires the orchestration of multiple partners in the ecosystem to co-create a focal value proposition or, in some collective form, come up with a solution that will enhance their competitiveness in the

Abbreviations: AI, artificial intelligence; IIoT, industrial Internet of Things; ML, machine learning; TMSs, transport management systems.

marketplace and enable them to achieve sustainable growth (Hellemans et al., 2022; Kohtamäki et al., 2019; Kolagar, Reim et al., 2022).

However, despite the increasing recognition of ecosystems' role as a major precondition for digital servitization (Adomako & Dong Tran, 2022; Kamalaldin et al., 2020; Parida et al., 2019; Sjödin et al., 2021), research on ecosystem orchestration is not yet theoretically mature, and the digital servitization literature remains underexplored when it comes to this complex process (Kolagar, Parida, & Sjödin, 2022; Linde et al., 2021). In fact, the digital servitization literature has begun to emphasize the importance of ecosystem orchestration (Favoretto et al., 2022; Gebauer et al., 2021; Linde et al., 2021; Martín-Peña et al., 2020); however, it is largely inclined towards firm-specific practices and may not fully capture the underlying processes for managing industrial relations within the broader ecosystem. In addition, a lack of clarity exists in the literature regarding the role of individuals who facilitate ecosystem orchestration in the process of digital servitization (Chirumalla et al., 2023; Simonsson & Agarwal, 2021). These limitations result in critical gaps in our understanding of how to navigate the complexities of ecosystem orchestration for the co-creation of digital services and solutions (Kolagar, Parida, & Sjödin, 2022). Hence, a comprehensive conceptualization of ecosystem orchestration for digital servitization is needed, along with empirical evidence demonstrating the various levels, phases, and activities involved in its successful implementation. Practitioners and academicians have recognized this process as one of the most challenging features of digital servitization (Kolagar et al., 2022), primarily due to the need for orchestration to coordinate diverse ecosystem actors, technologies, structures, and business models by managing complexities adeptly to ensure seamless collaboration and value creation (Autio, 2021; Sjödin et al., 2021). Thus, further scholarly investigation is required regarding the complex processes and activities involved in this multilayered transformation process (Kolagar, Parida, & Sjödin, 2022; Oghazi et al., 2022). Moreover, there is also a fundamental limitation in our current understanding of how digital servitization, as it unfolds within ecosystem orchestration, is intricately intertwined with the pursuit of sustainable industry development through a focus on environmental responsibility, social well-being, and economic viability (Hollos et al., 2012; Paiola et al., 2021; Yavuz et al., 2023). To uncover the intricate links between ecosystem orchestration as a key feature of digital servitization and the valuable benefits that can result from it, empirical studies of real-world cases and industry practices are required (Mäkitie et al., 2023; Paiola et al., 2021).

To address these gaps, this paper examines the different operational levels, phases, and activities necessary for orchestrating the ecosystem for the successful provision of data-driven digital services and solutions. Therefore, the purpose of this study is "to investigate how large manufacturing firms can orchestrate their ecosystem for the successful co-creation of data-driven digital services and solutions as a way to achieve sustainable industry benefits." To achieve this purpose, this paper builds on an exploratory single-case study of a transportation and logistics ecosystem orchestrated by a world-leading manufacturer of trucks and provider of logistics solutions. In addition, the data were collected through conducting 23 in-depth interviews with informants from seven Swedish and international companies engaged in digital servitization and then thematically analyzed using Gioia methodology (Gioia et al., 2013).

There are several theoretical contributions made in this study to the literature on digital servitization (Paschou et al., 2020; Sjödin et al., 2020; Sklyar, Kowalkowski, Sörhammar, & Tronvoll, 2019; Sklyar, Kowalkowski, Tronvoll, & Sörhammar, 2019; Tronvoll et al., 2020), as well as important managerial implications. Indeed, this study offers a significant contribution to the literature by proposing a step-by-step multi-level framework for ecosystem orchestration that encompasses phases and activities at the individual, organizational, and ecosystem levels, allowing for the successful co-creation of digital services and solutions when operationalized. Furthermore, this study contributes by shedding light on the impact of digital servitization on generating environmental and social benefits for industrial firms in addition to economic gains. As a result, managers and practitioners may use the proposed phases and activities at each level as a benchmarking tool for revitalizing their ecosystems in response to ongoing technological and relational challenges and guiding themselves towards a more sustainable industry.

2 | THEORETICAL BACKGROUND

2.1 | Digital servitization based on the development of data-driven innovative solutions

Throughout the past few decades, manufacturing companies have increasingly realized the benefits of shifting their business models to include services rather than just products (Baines et al., 2020; Kohtamäki et al., 2019). Accordingly, the growth of services has driven product companies to take on "servitization" efforts (Adrodegari & Saccani, 2017; Raddats et al., 2019), which signifies the move from a product-centric business model to more of a service-centric business model (Bähr & Fliaster, 2023; Baines et al., 2017). Similarly, there has been much evidence in recent years that digitalization and servitization are interdependent (Frank et al., 2019; Vendrell-Herrero et al., 2017). On the one hand, servitization necessitates the utilization of new digital technologies in order to better understand customers' needs and processes, to collect and exchange data, and to improve their service offerings (Kowalkowski et al., 2022; Tronvoll et al., 2020). On the other hand, digitalization spurs companies to offer smart products, digitally enabled services, and digital solutions (Paschou et al., 2020; Vendrell-Herrero et al., 2017). Indeed, it can be argued that servitization and digitalization are implementable separately in product organizations (Vendrell-Herrero et al., 2017), but they also show great convergence (Frank et al., 2019; Gebauer et al., 2021). This convergence has led to the development of a new stream in servitization literature (Kohtamäki et al., 2020; Kowalkowski et al., 2017) known as "digital servitization," which refers to 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). This concept is therefore more complex than the simple use of digital technologies, and it is necessary to develop a new logic for creating value through designing new services and solutions (Naik et al., 2020). In this context, big data analytics has also been identified as a technology that is capable of powering innovation processes, a concept known as data-driven innovation (Hartmann et al., 2016; Rizk et al., 2018). By leveraging both internal and external data, industrial firms can gain a competitive advantage in transitioning towards digital service-based business models (Kolagar, Reim et al., 2022).

Indeed, in the context of digital servitization, data-driven innovation and optimization refers to innovators applying analytics to machine-readable data to extract useful patterns to create and deliver new or better digital services and solutions (Struyf et al., 2021). Accordingly, the key to creating value propositions through data-driven innovative solutions lies in the application of analytics to customize the outcomes, which is called "innovation through analytics" (George & Lin, 2016; Rapaccini & Adrodegari, 2022). This has resulted in data analytics becoming an integral part of the innovation process (George & Lin, 2016) as well as an essential component of providing data-driven digital services and solutions (Rizk et al., 2018). It is therefore essential to conceptualize data-driven innovative solutions as an integrated phenomenon and to develop conceptualizations that can make sense of these changes through the integration of the potentials available across multiple actors (Kowalkowski et al., 2022). The development of such innovative digital services and solutions by industrial firms is indeed dependent upon collaboration with complementors, technology partners, and other actors within their ecosystem, since one company cannot claim to possess all of the necessary technological resources and capabilities to provide such services (Gebauer et al., 2012; Raddats et al., 2017; Taques et al., 2021).

The proliferating term "ecosystem" within the context of digital servitization requires an increased investigation in order to fully understand the underlying mechanisms constituting the concept (Kolagar, Parida, & Sjödin, 2022; Oghazi et al., 2022). Indeed, there has been considerable application of this concept across a wide variety of organizational settings; however, it was not until the 2010s that efforts were made to develop its theoretical and conceptual underpinnings (Adner, 2017; Dattée et al., 2018; Shipilov & Gawer, 2020). Therefore, it is essential to scrutinize this concept within different research streams to better understand it and promote its effective use in both academia and industry (Aarikka-Stenroos & Ritala, 2017; Suominen et al., 2019). Accordingly, this study viewed ecosystems as "the alignment structure of the multilateral set of partners that need to interact in order for a focal value proposition to materialize" (Adner, 2017). Specifically, this research focuses primarily upon the concept of "innovation ecosystem," which is among the most relevant of all the various conceptualizations of ecosystems to the context of digital servitization (Kolagar, Parida et al., 2022), with its emphasis on generating a focal value proposition. Drawing on Autio (2021), the innovation ecosystem is defined as "a community of hierarchically independent, yet interdependent heterogeneous participants who collectively generate a coherent, ecosystem-level output and related value offering targeted at a defined user audience." Moreover, in line with the purpose of the research, a comprehensive examination of fundamental changes in business logic resulting from the provision of data-driven digital services is also necessary, along with how the ecosystem should be orchestrated to ensure successful digital servitization.

2.2 | The key role of ecosystem orchestration in digital servitization

Although the literature on the use of ecosystems to create digital services and solutions is rapidly growing (Autio, 2021; Linde et al., 2021; Parida et al., 2019; Sjödin et al., 2021), it is surprising that the detailed activities being carried out for orchestrating this transformational process and the sustainable benefits that it can provide for industrial firms and their customers have remained largely unexplored (de Vasconcelos Gomes et al., 2018; Kolagar, Parida, & Sjödin, 2022; Oghazi et al., 2022). It is, indeed, essential to orchestrate all relevant activities in an environment where each group of actors may typically have different motivations and expectations, thereby avoiding a lack of alignment among parties (Bittencourt et al., 2020). Since its origin in the management literature, orchestration has been regarded as a fundamental concept for understanding the evolution of networks and ecosystems (Gupta et al., 2020). Throughout the literature, orchestration has been defined as a set of activities aimed at configuring multiple actors into a network as well as directing and managing the processes of value creation and value capture (Hurmelinna-Laukkanen & Nätti, 2018; Tabas et al., 2022). This process can be viewed as a means of bringing together expertise from a variety of areas, resulting in a harmonious relationship that is beneficial to the ecosystem as a whole (dos Santos et al., 2022). There has been significant research on this concept within the context of innovation ecosystems (Adner, 2017; Jacobides et al., 2018; Nylund et al., 2021), with a focus on maximizing the use of shared resources and resource complementarities (Kumar et al., 2022; Paquin & Howard-Grenville, 2013). Indeed, orchestrating an ecosystem entails managing complex collaborations among various actors in order to make digital services more accessible to customers (Kolagar, Parida, & Sjödin, 2022). It is also acknowledged in the literature that ecosystem orchestration involves a diverse range of evolving actions aimed at redefining and revising the stakes of actors in realizing and implementing digital services and solutions (Kolagar, Parida, & Sjödin, 2022; Sklyar, Kowalkowski, Sörhammar, & Tronvoll, 2019).

It is also becoming increasingly evident that as advanced digital technologies evolve, the previous models and processes of orchestration have begun to be challenged as more complex and heterarchical sets of relationships emerge (dos Santos et al., 2022; Kolagar, Parida, & Sjödin, 2022; Ofe & Sandberg, 2023). Also, it appears that the entity responsible for orchestration varies with the complexity of the

situation (dos Santos et al., 2022; Kamalaldin et al., 2020). Most often, the orchestration of such initiatives and activities is carried out by a primary actor, called a "hub" or "orchestrator" firm, that possesses a dominant position and authority within the ecosystem (Dhanaraj & Parkhe, 2006; Kolagar et al., 2022; Vangen & Huxham, 2017). Thus, orchestration involves a series of deliberate, purposeful actions implemented by the orchestrating firm to generate value for the enterprise (Dhanaraj & Parkhe, 2006; Nambisan & Sawhney, 2017). There is, indeed, a necessity for a central firm that acts as an "orchestrator" and organizes platforms for communication between participating companies and customers, maintains collaboration, defines the roles and responsibilities of different actors, and facilitates innovation within the ecosystem (Dhanaraj & Parkhe, 2006; Williamson & De Meyer, 2012). It is therefore an essential part of orchestration to enforce the rules of the game and ensure that other partners adhere to them as well (Parida et al., 2019; Wareham et al., 2014).

Hence, manufacturers are urged to manage the orchestrator role effectively to produce more efficient digital services and solutions (Kolagar, Reim et al., 2022; Sjödin et al., 2021). Due to the emergence of new digital technologies, manufacturing firms are now shifting from being solely product sellers to becoming service and solution providers in a variety of industries (Benitez et al., 2020; Kohtamäki et al., 2022). Manufacturing, for example, has also been disrupted by a plethora of innovative technologies within the transportation and logistics ecosystem (Haftor & Climent, 2021). These include advances in autonomous vehicles (Leminen et al., 2022), transportation management systems (Haftor & Climent, 2021), smart logistics platforms (Rachana Harish et al., 2021), and optimization tools (How et al., 2016). In order to enable digital service innovations, it is imperative that data and digital technologies are used in a conscious and collaborative manner among different stakeholders within the ecosystem. There has been little exploration of orchestration in complex multi-actor ecosystems, despite the fact that its practice is fundamentally different in such environments (Jacobides et al., 2018; Kolagar, Parida, & Sjödin, 2022). Indeed, the processes that orchestrate ecosystems have not been fully explained by studies, although some have offered accounts of how ecosystems may be described (Kolagar, Parida, & Sjödin, 2022). Therefore, there is a need for clarity as to how such changes take place and which mechanisms are employed by a focal firm to orchestrate an ecosystem of interdependent actors to develop and commercialize digital services and solutions in order to achieve sustainable industry benefits through this transformational process.

2.3 | Sustainable industry

In accordance with the Brundtland report of 1987 (a document of the World Commission on Environment and Development), sustainable development (sustainability) involves finding a balance between three general areas: social, economic, and environmental (Brundtland, 1987; Gajdzik et al., 2020), often referred to as the triple bottom line (Elkington, 1994, 1998, 2018). In spite of the fact that the concept of sustainable development has been in existence for the past century, its primary objectives have not yet been achieved (Hellemans et al., 2022; Martinez et al., 2022). It is indeed complex to define this oxymoron because of its holistic nature, normative dimension, and multiple facets (Spaiser et al., 2017). Additionally, new cutting-edge technologies have been introduced into industries over the past few decades, which has made modern business increasingly digital and intelligent (Feroz et al., 2021). In fact, the Fourth Industrial Revolution (Industry 4.0) is based on the development of intelligent systems that enable system monitoring and decision-making in real time (Ghobakhloo et al., 2021; Mukhuty et al., 2022; Schwab, 2016). Data-driven digital services and solutions have transformed different industries (Kowalkowski et al., 2022; Rizk et al., 2018; Trischler et al., 2020), especially the transportation sector (Leminen et al., 2022; Meyer et al., 2014). A large range of data is collected and stored within the transportation ecosystem, including GPS tracking, vehicle telematics, customer feedback, and supply chain data. The proper analysis and storage of these data can enable useful applications that can benefit the entire ecosystem, the environment, and society in general (Hartmann et al., 2016; Mehmood et al., 2017; Meyer et al., 2014). Furthermore, large-scale data analysis can be utilized to improve infrastructure planning, enhance energy efficiency and security, and increase traffic capacity, all of which contribute to the sustainable development of industrial firms and their customers (Haftor & Climent, 2021; Mehmood et al., 2017). In fact, through data-driven digital services, industrial firms can gain a greater understanding of their customers' behavior, enabling them to provide even better and more sustainable services to these customers (Kowalkowski et al., 2022; Rizk et al., 2018).

Accordingly, a new paradigm appears here, focused on modern enterprise management based on new technologies enabling integrated optimization of processes (Harikannan et al., 2021), that has the potential to bring about sustainable benefits. This paradigm, known as "Sustainable Industry," results from the combination of intelligent production systems, which on the one hand are vertically connected to the company's business processes and, on the other hand, horizontally connected to other points in the value chain in order to increase efficiency and response time to each request, with the customer being the main target (Culot et al., 2020; Mariani & Borghi, 2019). Also, the scientific literature has increasingly emphasized the concept of sustainable industry since smart technologies became available to businesses (Culot et al., 2020; Harikannan et al., 2021; Mariani & Borghi, 2019; Piccarozzi et al., 2022). Through the integration of digital technologies, data, and services into an ecosystem-based approach, productions are becoming smarter, more efficient, safer, and more sustainable (Harikannan et al., 2021). Using the ubiquitous digital infrastructure, it presents tremendous opportunities for realizing sustainable industry benefits (Luo et al., 2022; Mariani & Borghi, 2019; Pedersen et al., 2023). As a matter of fact, while manufacturing firms should be aware of the short-term and medium-term impacts of the use of digital technologies on organizational performance and operational efficiency, long-term concerns should also be taken into consideration (Martinez et al., 2022). This

study, in accordance with the triple bottom line (Elkington, 2018), also conceptualizes sustainable industry benefits as all the outcomes that can be achieved as a result of orchestrating an ecosystem for digital service delivery, which can result in economic, environmental, and social benefits for industrial firms within an ecosystem as well as their customers. Consequently, the focal firm that plays the role of ecosystem orchestrator needs to exercise greater responsibility in aligning different activities in the ecosystem, taking into account economic, social, and environmental factors. Also, empirical research should analyze in more detail how manufacturing firms implementing a sustainability-oriented digital servitization (George et al., 2020; Guandalini, 2022; Opazo-Basáez et al., 2018; Paiola et al., 2021) frame the orchestration of their ecosystem. Therefore, this research aims to identify the critical activities orchestrators need to consider when orchestrating ecosystems in order to co-create digital services and solutions that can contribute to a more sustainable industry by enhancing environmental and social outcomes, in addition to enhancing economic growth.

3 | METHODOLOGY

3.1 | Research approach and case selection

This research is based on an exploratory single-case study (Nickels et al., 2022; Yin, 2018) of the companies involved in a transportation and logistics ecosystem orchestrated by a world-leading manufacturer of trucks and provider of transportation solutions. The orchestrator company was selected as a result of its participation in a nationally funded academic research project, one of the main goals of which was to examine the orchestration of industrial ecosystems for digitally enabled advanced services and solutions. Aiming to achieve sustainable industry benefits, this study explores how a large manufacturer of transportation vehicles orchestrates the different actors and processes within the ecosystem to ensure the successful provision of data-driven digital services and solutions. The study employs an inductive qualitative approach consistent with the exploratory nature of the study and well suited to answering questions concerning "How" (Mihas, 2023; Yin, 2018). Accordingly, this research follows the theory building from cases (Eisenhardt & Graebner, 2007) by utilizing inductive grounded theory building (Glaser & Strauss, 1967), which is characterized by researchers having a general idea of what they wish to discover, but they are going into the case study with an open mind and without any preconceptions about the constructs and how the phenomenon works (Gehman et al., 2017). Also, choosing real-life case studies allows for the mobilization of multiple observations of complex relational processes and can help identify theoretically novel phenomena (Eisenhardt & Graebner, 2007; Yin, 2018). To align with the research project that this study is part of, the study sought and investigated an ecosystem that was capable of successfully integrating the various actors by implementing connectivity among them. To be more precise, and to be more specific about how we define the term "successful," we were seeking a manufacturing company that has a proven track record of orchestrating its ecosystem to enable the co-creation of data-driven digital services and solutions. As part of the theoretical sampling (Glaser & Strauss, 1967; Suddaby, 2006), the case selection criteria were influenced by the study's purpose: to investigate how large manufacturing firms can orchestrate their ecosystem for successful co-creation of data-driven digital services and solutions as a way to achieve sustainable industry benefits. Based on the purpose, three primary factors were considered when selecting the research case, which was a transportation and logistics ecosystem orchestrated by a manufacturing company: (a) being engaged in digital servitization with a proven track record of successful provision of digital services and solutions; (b) active participation of its actors in ecosystem orchestration processes; and (c) having a separate department or unit dedicated to sustainability.

As a further explanation of the primary selection criteria, it can be stated that it was a deliberate choice to filter the sample cases and include only an ecosystem in which firms have been providing digital services for at least 3 years and have shown success in doing so. Using this approach, the research can focus on more mature and established projects and therefore gain valuable insights from their sustained efforts. Studying firms that have successfully completed the initial experimentation phase may serve both as a valuable contribution to the academic understanding of digital services and as a valuable tool for providing industry managers and practitioners with actionable lessons on implementing digital services and solutions. Additionally, this study has chosen industrial firms that operate within a complex ecosystem, such as the transportation and logistics ecosystem (Haftor & Climent, 2021), which involves multiple actors and can have a significant effect on society and the environment, making them ideal candidates for studying sustainable industry. In addition, as part of our strategic initiative to examine the intersection of digital servitization and sustainable industry, we intentionally selected companies that had dedicated sustainability departments or units. As a result of focusing on firms with specialized sustainability entities, this research provides an in-depth understanding of the strategies, practices, and mechanisms by which industrial firms orchestrate their ecosystems as part of their digital servitization effort to advance a more sustainable industry.

3.2 | Data collection

In keeping with past research on digital servitization (Iriarte et al., 2023; Kolagar, Reim et al., 2022; Paiola & Gebauer, 2020), this study conducted qualitative interviews with managers at respective firms within the selected ecosystem. Accordingly, this research took place over the course of almost 2 years (2020–2022), during which 23 in-depth interviews were conducted with informants from seven Swedish and international companies (one of which acted as the orchestrator, and the other six serving as partners in co-creating digital services based on big data analytics). First, we interviewed key informants within the orchestrator company (a large manufacturer of

transportation equipment) who were actively involved in the orchestration process and were responsible for ensuring that each piece of the puzzle worked smoothly as a whole. Second, additional informants were identified by using the snowballing technique, which involved asking key informants to recommend people from the partner companies who were actively involved in the co-creation of data-driven digital services and were able to describe how the ecosystem collaborations and alignments had progressed. Our analysis incorporated interviews with individuals serving in a variety of roles within the orchestrator and partner companies involved in the co-creation process to capture a multifaceted perspective. An overview of the seven firms studied in the ecosystem is presented in Table 1, along with the positions of those interviewed.

During the interview process, informants were asked open-ended questions in accordance with a semi-structured interview protocol covering a number of themes, including data-driven digital service provision, value co-creation between multiple actors, their approach to sustainability, and the way in which relationships within ecosystems are managed. We solicited multiple opinions on the same questions in order to minimize respondent bias (Eisenhardt & Graebner, 2007). Throughout the interviews, we also collected and analyzed secondary sources such as their websites, podcasts, internal documents, and reports in order to calibrate our findings. A continuous revision of the interview protocol was also carried out as we accumulated new insights from the interviews and secondary data in order to increase relevance and depth of understanding. As a means of minimizing data source biases, such as retrospective sense-making and impression management (Eisenhardt & Graebner, 2007), we triangulated the interview data with the secondary data. To verify our understanding of the secondary data, we followed up with some of our informants and double-checked the interview data with their internal reports and articles. A total of 45–70 min were spent on each interview, and they were all recorded and transcribed; the transcripts were used to analyze the data. With the use of an inductive approach, data were collected and analyzed iteratively until saturation was reached, the point at which further analysis was ineffective to provide new insights (Chase & Murtha, 2019; Hampel et al., 2020). As of the 23rd interview, the study had reached saturation point with regard to data collection, and the findings from those interviews were maintained in the study and used as a basis for data analysis.

3.3 | Data analysis

To ensure that our theoretical perspective is closely aligned with the empirical data, we recursively iterated between the data and theory in

TABLE 1 Companies involved in data collection.

Company	Description	Industry	Role (no. of interviews)
Alpha	World-leading provider of transport solutions with specialties in truck manufacturing, truck leasing and finance, truck sales and services, truck parts and engine manufacturing, and solution provision	Motor vehicle manufacturing	Project manager(s) (3) Business development manager(s) (4) Product manager(s) (4) Head of module design (1) Value manager for connectivity (1) Operations manager (1) General manager (1) Head of data and mobility services (1) Director of strategy and service portfolio (1)
Beta	Digital road freight forwarder who provides mobile apps to drivers, fleet management tools to carrier managers, and logistics management solutions to shippers	Truck transportation	Chief growth officer (1)
Gamma	IT services startup that facilitates the access and use of real-time data by providing transparency, visibility, and integration	IT services and IT consulting	CEO (1)
Delta	Provider of end-to-end visibility platforms that enable tracking and monitoring of movements and loadings	Software development	Director of data partnerships (1)
Epsilon	Provider of logistics solutions, supply chain visibility solutions, and solutions for reducing emissions	Software development	CEO (1)
Zeta	Leading digital transportation company and provider of efficient and low-carbon solutions	Freight and package transportation	Chief operating officer (1)
Eta	Provider of a transportation management platform for facilitating collaboration between parties and optimizing processes	Software development	Business development manager (1)

order to increase the likelihood of accurate and reliable theory generation (Eisenhardt & Graebner, 2007). Following a thematic analysis approach, data were categorized into first-order categories, and these were then clustered into second-order themes, which were then condensed into aggregate dimensions (Braun & Clarke, 2006; Gioia et al., 2013). It focuses on the notion of knowledgeable actors who are actively building their reality, know what they are trying to achieve, and are able to describe their thoughts, intentions, and actions to others (Gioia et al., 2013). During our data analysis, we first focused on an in-depth analysis of raw data (e.g., interview transcripts). As a starting point, we re-read the interviews several times and highlighted the interviewees' phrases, passages, and labels pertaining to ecosystem orchestration activities, thereby establishing 41 first-order categories. During the second step of the analysis, links and patterns within the first-order categories were discovered through further analysis. It was through this iterative process that second-order themes were formed, which represent theoretically distinct concepts derived from the combination of first-order categories. The analysis resulted in the identification of 14 second-order themes, which represented a higher level of abstraction than the first-order categories. The themes were further refined to reflect validity claims in the literature, based on insights from prior literature along with data from interviews and secondary sources (Kumar et al., 2017). Besides, two academic experts (who have no conflicts of interest) have been asked to review the coding process in order to verify that the data have been correctly translated into first-order categories and second-order themes. As a final result of our analysis, we identified four aggregate-level dimensions that tie together orchestration levels and activities and which serve as the basis for our proposed multi-level framework for orchestrating the ecosystem for data-driven digital service provision.

4 | RESULTS AND DISCUSSION

Upon analysis of the collected data, it has been determined that orchestrating the ecosystem for the co-creation of data-driven digital services and solutions involves three distinct but interdependent operational levels, each building upon the previous levels. These levels include the *individual*, the *organizational*, and the *ecosystem* levels. The results also suggest that firms may benefit from numerous environmental, economic, and social benefits by orchestrating the ecosystem for digital servitization, thereby contributing to the development of a more sustainable industry. In accordance with the order of aggregate themes in the coding structure (see Figure 1), the relevant findings of this research are outlined below.

4.1 | Individual level

During the course of this research, it was found that the individual level lies at the core of both the organizational and ecosystem levels and that if this level is weak, the consequences will affect all operational levels as well. Indeed, in order to successfully engage in ecosystem orchestration for the co-creation of data-driven digital services and solutions, individuals involved in this process (e.g., top managers, employees, etc.) are likely to benefit from possessing certain morals, mindsets, capabilities, and skills. The analysis indicates that the individual level consists of two phases, which are primarily aimed at the enhancement of the necessary personal traits, mindsets, and competencies to undergo the orchestration process. The following sub-sections will elaborate on each of these phases.

4.1.1 | Having the required mindsets and personal traits

As part of this operational level, the first phase focuses on having the required mindsets and personal characteristics. Therefore, we assume that the organization's top managers and employees are responsible for the delivery of digital services, as they are in charge of securing the organization's digital future. As a result of this research, individuals are more likely to accept and not resist positive changes if they can *demonstrate an ambition to improve their personal performance*. For individuals to potentially achieve success, it appears crucial that they feel motivated, interested, and confident about enhancing their performance. It was found that individuals who are part of the responsible team for orchestration may also *demonstrate a passion for digital innovations* emerging within the industry as the next step of this phase. Providing such solutions effectively requires individuals to be more enthusiastic about digital services and solutions than they are with their current products and services. A passion for the organization can inspire creativity in employees, and further fostering this trend can facilitate the increase of innovation within the organization. As they approach their future, individuals may benefit from cultivating optimism, confidence in the potential growth of digital services in the coming years, and motivation to explore new opportunities for developing their personal characteristics.

It has also been underscored by the findings of our study that it is critical for both management and employees to have an understanding of digital servitization that is well aligned with their responsibilities and roles. This can help them make better decisions that are consistent with designing orchestration activities as part of the digital servitization process. We concluded that successful implementation of ecosystem orchestration within digital servitization may be facilitated by *possessing an open mentality towards experimentation and digital servitization* among top management, employees, and other individuals involved in this process. They require to be able to use tools that enable efficient utilization of data, thereby facilitating the making of appropriate and informed decisions in a timely manner. Also, the results indicate that it is individuals who *have the ability to communicate with other people*. Indeed, it appears that individuals may need to adapt to new ways of working and be open to changing established habits in order to achieve success. It has been observed that it is usually the individuals responsible for organizational structures who resist organizational transformation, rather than the organizations

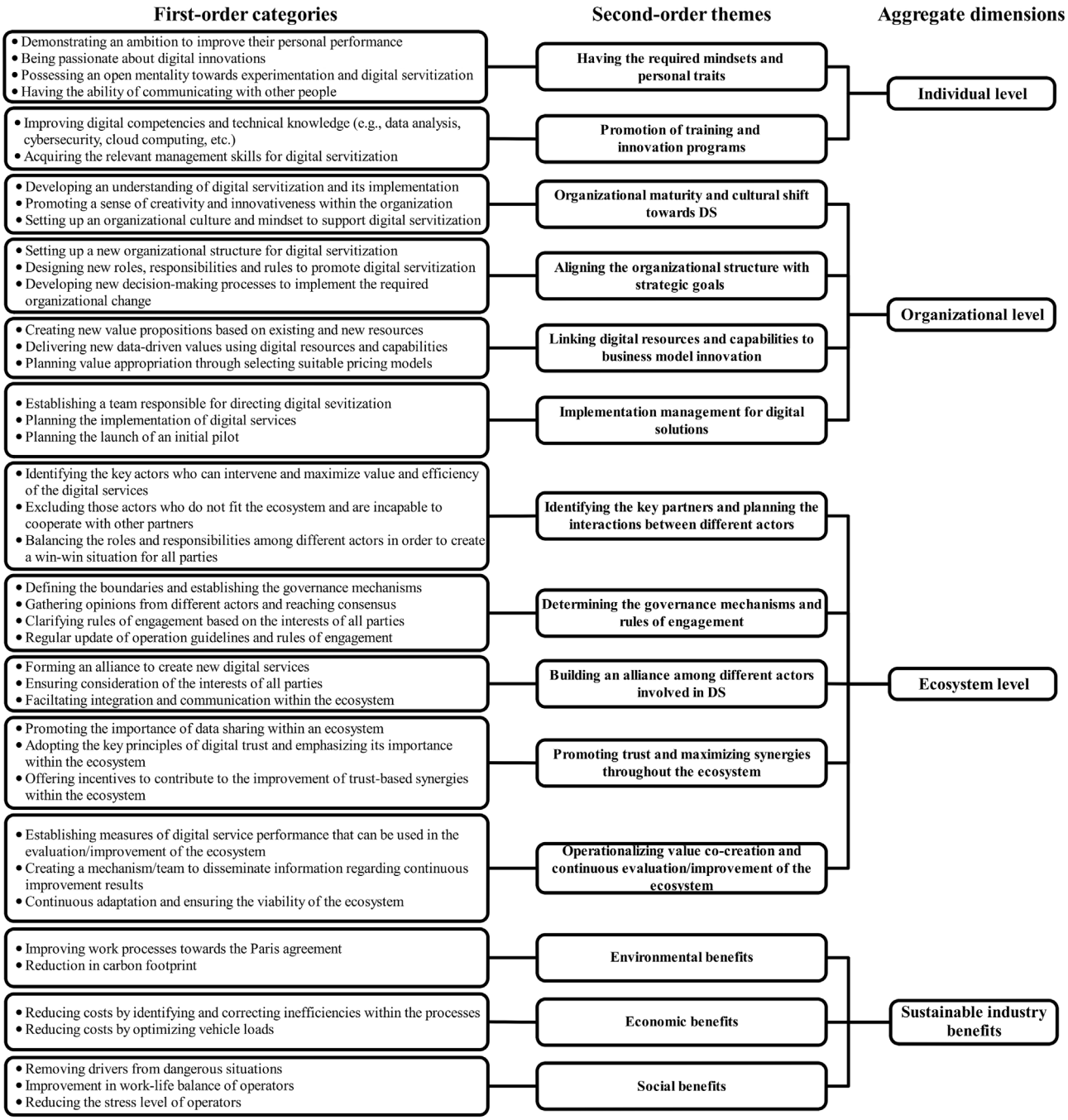

FIGURE 1 Data structure and coding process. DS, digital servitization.

themselves. The same principle can be applied to most issues within an organization, such as building trust between diverse organizations for the development of digital services and solutions. In the same vein, a director of strategy and service portfolio management at company Alpha stated:

> .... At the end of the day, trust is not built between organizations, but between individuals. It always comes down to specific people. I think, I think it's very difficult to build trust between organizations ....

4.1.2 | Promotion of training and innovation programs

During the second phase of the individual level, a focus is placed on the promotion of training and innovation programs. The problem is especially acute in large firms with a variety of employees with varying degrees of digital and organizational maturity. Despite the fact that it is primarily applied to large manufacturers who have traditionally been used to sell products, it is also applicable to companies with a digital-savvy culture and technology partners whose individuals are

more familiar with the digital and relational skills necessary to implement digital services. As a result of these training and innovative programs, our results revealed that individuals were able to *improve their digital competencies and technical knowledge* (e.g., *data analysis*, *cybersecurity*, *and cloud computing)*. As an example, employees learned how to use data analytics tools and digital interfaces that are useful for data-driven operations in the transportation industry. Additionally, our analysis suggests that individuals (e.g., top management, employees, etc.) may benefit from *acquiring relevant management skills* to effectively fulfill their roles in digital servitization. It appears important that they possess core managerial skills, including the ability to recognize information and data patterns, present findings and solutions concisely, and effectively utilize their relational and communication skills. By cultivating this trait in individuals, they will be able to communicate effectively with customers and establish a strong relationship with them. According to a business development manager at company Eta, managing people has become increasingly important with digitalization:

> …. The more you digitalize, the more you need your management to handle people, rather than processes, because people will be able to do things faster, and those are the repetitive tasks. But what management needs to know is how do we pick the best out of our people, which is actually inside their brain, it's not on their keyboards ….

4.2 | Organizational level

In the second operational level, the emphasis is placed on the organizational level, which is built upon the individual level. In our analysis, it was revealed that the main functions of this level are to align internal factors with strategic goals and to utilize business model innovation in order to orchestrate and implement a digital service. It is generally recognized that orchestration at this level refers to guiding internal initiatives towards achieving collaboration with partners at a higher level in order to develop a focal digital solution. Based on our analysis, we identified four phases in this level, which we explain in more detail below.

4.2.1 | Organizational maturity and cultural shift towards digital servitization

As part of the organizational level, the first phase involves strategically setting up an internal environment for digital servitization. In this regard, our analysis suggests that organizations may benefit from *developing a clear understanding of digital servitization and its implementation* before attempting to implement it effectively. Therefore, this level of orchestrating the ecosystem places great emphasis on the development of organizational mindfulness and maturity towards driving the change as part of digital servitization. Indeed, industrial firms can increase the likelihood that they will make digital-service-oriented decisions and effectively deploy their organizational resources by being mindful. This will help them to play a more productive and mature role in implementing data-driven digital services and solutions that will bring them and their customers sustainable benefits. During an interview with the head of module design at company Alpha, he discussed the importance of organizational maturity for driving the shift towards digital servitization:

> …. One thing could be how mature they are in driving organizational change. That is needed to become more digital if you should adopt any other new technology ….

Furthermore, our results indicate that businesses can benefit from *promoting a sense of creativity and innovativeness within their organizations*. Consequently, it may be beneficial for companies to consider providing their employees with a working environment conducive to creative thinking and innovation. In the same vein, our findings suggest the importance of *setting up an organizational culture and mindset that supports digital servitization*. It requires the establishment of a culture that encourages experimentation and risk-taking and the eradication of departmental barriers so that ideas can flow freely across all areas of the organization. Indeed, it was found that individuals play a pivotal role in creating a culture and mindset conducive to the management, orchestration, and operationalization of digital service delivery. Accordingly, the chief growth officer of company Beta has highlighted the critical role that individuals can play in setting the cultural and relational foundations for orchestrating digital services beyond their technical aspects:

> …. Logistics is about relations, about trusting the people you deal with, …, actually you need people to understand the cultures and relationships! ….

4.2.2 | Aligning the organizational structure with strategic goals

As a result of our analysis, the second phase of the organizational level involves the alignment of the structure of the organization with digital servitization. By tuning the organizational structure, the goal of this phase is to maximize the organization's responsiveness to market changes and challenges. In fact, our results revealed that *setting up a new organizational structure that is aligned with the goals of digital servitization* requires integrating digital capabilities into the mission of an organization as well as aligning organizational management with technology. According to a product manager at company Alpha, the right organizational structure is fundamental to supporting the provision of digital services:

> …. We also address digitalization by having departments such as where I belong right now working solely

> on digital services. I would say that's also a way to manage it. Having the supporting structure in the line organization is also very important. This is also reflected in the processes where we work for service development ….

The results of our analysis also suggest that organizations may need to consider *designing new roles, responsibilities, and rules to promote digital servitization*. In fact, our findings suggest that the implementation of a new organizational structure can effectively promote digital servitization, as long as the roles and responsibilities of individuals, which are crucial to this process, are clearly defined. As a final step in this phase, our results suggested that organizations may also need to consider *developing new decision-making processes to implement the required organizational change* in alignment with digital servitization. To promote digital services, organizations can consider adjusting their traditional decision-making processes to adopt more timely and efficient approaches. Thus, industrial firms will be able to anticipate changes in the turbulent business environment and address their customers' needs by synchronizing themselves for the development of digital solutions that take environmental and social concerns into account in addition to economic goals.

4.2.3 | Linking digital resources and capabilities to business model innovation

Our analysis indicates that linking digital resources and capabilities to business model innovation is the third phase at the organizational level. As a result of our analysis, the first step in this phase focuses on *creating new value propositions based on existing and new resources*. Indeed, many transportation and logistics companies have already started to provide value-added services with digital technologies. The use of telematics solutions, for example, provides real-time information to the driver and vehicle, while traffic management solutions are used to optimize the transportation system by using data collected by telematics and real-time monitoring systems. Accordingly, industrial companies may need to consider capitalizing on the opportunities presented by new technologies to potentially change their business models in a way that could create new customer value. A head of data and mobility services at company Alpha has emphasized the importance of business models and stated as follows:

> …. It's not always about technology and technical prowess to achieve some value, it's also about identifying the business model ….

Moreover, our results suggest that the second step of this phase focuses on *delivering new data-driven value through the use of digital resources and capabilities*. As a result of using digital technologies, industrial firms will be able to utilize data in a variety of ways. By monitoring traffic patterns and other data, they can provide real-time updates to drivers, adjust their schedules accordingly, and optimize fleet utilization. By optimizing industrial processes, industrial firms and their customers can achieve several environmental, social, and economic benefits, resulting in a more sustainable industry. As an example, the chief operating officer of company Zeta has highlighted the potential of using digital technologies to deliver data-driven services and solutions and how it has helped them achieve two major benefits:

> … that allows to do two things: first of all is that the agents, they don't need to look at everything, they can just look at where the system says: ok, there might be a problem, that's what they focus on. And then secondly, usually the system allows them to try to act proactively, so, uh, something might happen there, keep an eye, and it means that usually they can solve the problem more ahead of time ….

Also, the third and last step in this phase is for companies to *plan their value appropriation through the selection of suitable pricing models* for their digitally enabled services and solutions. Several factors contribute to the development of an appropriate pricing model, including the customer's needs, the offerings of competitors, the cost of suppliers, and regulatory requirements. Based on our analysis, most firms in the transportation ecosystem have difficulty determining a pricing strategy, and this has been a major barrier to their digital servitization. According to a general manager at company Alpha, selecting the right pricing model for solutions is extremely important:

> …. You got to be smart. They've got to be commercially right in the pricing. It's no good having a [solution's name] on a drive that cost a million dollars. You've got to have a [solution's name] on the truck that's commercially available ….

4.2.4 | Implementation management for digital solutions

According to our analysis, implementation management and piloting digital solutions is the last phase of the organizational level. As with the previous phases of the organizational level, implementation management relies heavily on judgments about how much time and resources are required to align internal factors with strategic goals and to leverage business model innovation for the purpose of planning and implementing digital services. Our results indicate that organizations may need to consider *establishing a team responsible for directing their digital servitization*. As a result, an organization can utilize many resources and capabilities at its disposal by having different types of multidisciplinary roles within this team. Moreover, this team may be assigned to assist organizations in *planning the implementation of digital services*. The organization requires to consider many variables when planning for the development of a digital service, such as the customers' acceptance of the service, its potential profitability, and so forth. In this regard, the CEO of company Gamma has highlighted the

critical importance of managing in a way to provide services and solutions that are consistent with the customer's needs:

> … you become a more attractive partner to your customers by being able to solve their needs! ….

Furthermore, organizations may need to consider *planning the launch of an initial pilot of the digital service*. As part of the pilot planning stage, the organization can consider making arrangements for their forthcoming collaboration with partners and customers to develop a working model of the digital service. In addition, the organization may need to allocate a sufficient testing period to understand the acceptance of the service and its potential profitability. In discussing the importance of incremental testing of the functionality of solutions and planning for the various stages of the process, a project manager at company Alpha stated:

> …. We're doing in a way more agile while releasing small packages, small bits of functionality, testing them together with the customer, and growing with them. It's more like we do increments, we do a little bit more functionality, a little bit more, a little bit more, and we expand our functionality as we go. Project it's very difficult to just plan. This is the beginning, this is the end, and we're going to get there, and this is the exact times when things are happening ….

4.3 | Ecosystem level

The third operational level is built upon the organizational and individual levels. At this level, orchestration refers to managing and coordinating a variety of organizations, individuals, and actors within a particular ecosystem in order to facilitate digital servitization and improve the efficiency of the entire ecosystem in an effort to establish an industry that is environmentally friendly, socially responsible, and economically viable. We identified five phases for the ecosystem level, which we describe in more detail below.

4.3.1 | Identifying the key partners and planning the interactions between different actors

In the first phase of the ecosystem level, the main focus is on the development of a web of interactions between the different actors within the ecosystem. As a general observation, a web of interactions between different actors could potentially be based on the incentives and capabilities of those actors to maximize the value and efficiency of digital services and solutions. According to our analysis, the first step of this phase is to *identify the key actors who can intervene and enhance the value and efficiency of digital services*. Without the existence of these actors, digital servitization cannot be fully demonstrated and made operational. A product manager at the company Alpha explained the importance of creating partnerships with new actors to develop digital services and solutions:

> …. All of a sudden, we have to deal with service providers that are data aggregators selling data to our customers on mass, selling from not only us, but from the Volvos and the Mercedes and everybody. Then we have to enter into partnerships with these kind of new partners and also to develop together with them ….

We also found that, as a second step, the orchestrator is required to filter the actors and *exclude those who do not fit the ecosystem and are incapable of cooperating with other partners*. According to this filtration process, an actor's capabilities and attitude determine whether or not it will cooperate with other players in the ecosystem. Furthermore, our analysis has shown that the orchestrator can aim to *balance the roles and responsibilities among different actors to potentially create a win–win situation for all parties* involved in digital servitization. Differentiating between the values of cooperation and competition, known as coopetition, is an important component of establishing mutual win–win relationships among ecosystem actors. As part of the orchestration process, the roles and responsibilities of each actor may need to be balanced in a manner that can meet the ecosystem's performance goals.

4.3.2 | Determining the governance mechanisms and rules of engagement

The second phase of the ecosystem level involves defining the ecosystem boundaries and rules of engagement in order to facilitate the orchestration of digital services. Our results indicate that the orchestrator can consider *defining the boundaries of the ecosystem and establishing governance mechanisms*. A series of interactions as well as the development, architecture, and management of digital applications define the boundaries of digital service ecosystems. A business development manager at company Alpha highlighted the importance of having the right governance structures within the ecosystem:

> …. One of the biggest issues will always be not be just having the right tools and equipment and competences but really about the governance. Today, we are very much measured upon delivering a core product. Everyone is very interested and wanting to contribute into whenever we meet clients or whatever, but when it comes down to the bottom line, it's all about, "What am I being measured upon? Will I get my bonus as a CEO in the business unit somewhere?" That whole, not just having the right tools and the right mindset, but really having the right governance structure all the way from headquarters down to people doing the job on a specific site ….

Also, the orchestrator requires to *take into consideration the opinions of different actors in order to reach a consensus*. As a matter of fact, understanding the concerns and preferences of the various participants in an ecosystem is an important aspect of orchestrating. By doing so, it will be possible to ensure that the ecosystem partnership that is forming considers the mutual benefits of the different actors within the ecosystem. Similarly, a head of module design at company Alpha has highlighted the importance of considering what is expected from ecosystem collaboration:

> …. It's always important to have a kickoff meeting and sit down face-to-face and talk about intentions and expectations. That's when you get more of a feel for the people and the trustworthiness on the people. Of course, people can be very good actors ….

In the same vein, the findings suggest that it appears important for the orchestrator to *clarify the rules of engagement based on the interests of all parties involved*. As the term implies, rules of engagement refer to a set of principles and guidelines that define the relationships among the various actors in an ecosystem. These guidelines can take the form of official written documents and contracts or unwritten rules, which mostly focus on relational aspects of the collaboration. Besides, there is no one-size-fits-all approach to setting these rules of engagement, and they can differ based on the context. In the same vein, the business development manager at company Eta has stated:

> … let me just start by saying there's as many ways to do this as there are people doing it. So, it's a very personal style, but I think in general, most of the time you try to find the common ground where this is something that we can actually help you with, …, how do we make the information secure, can we actually share that with you, you won't share it with anyone else, you won't use it for illegal purposes, …, we have contractual work that covers basically what we are allowed to do and we are not allowed to do with the data, ….

In addition, our results indicated that the next and final step of this phase focuses on *regularly updating operation guidelines and rules of engagement* in order to facilitate digital service delivery within the ecosystem. The need for this updatability is due to the rapidly changing economic, social, and technological conditions in the transportation industry, which can have a significant impact on various parties involved in the ecosystem.

4.3.3 | Building an alliance among different actors involved in digital servitization

The third phase of the ecosystem level focuses on the importance of building alliances among the different actors engaged in the provision of digital services and solutions. This is aimed at facilitating the sharing of information, knowledge, and experience between various parties. Based on our analysis, it appears that an orchestrator can potentially assist ecosystem actors in *forming an alliance to create digital services*. In this way, the various actors are able to share more information and knowledge, as well as lessons learned and best practices. The analysis also indicated that the orchestrator requires to *ensure consideration of the interests of all parties* in the formed alliance. In order to achieve this goal, it is imperative that all parties be given incentives to contribute to the alliance and cooperative efforts in such a way that it does not stifle innovation in the transportation ecosystem. In addition, it seems critical for the orchestrator to *facilitate integration and communication within the ecosystem* to enable digital service delivery. To be more precise, it appears important for the orchestrator to ensure that all enterprises within the ecosystem are able to interact with each other and also with customers, adding value to each other. Furthermore, it is important for all parties to be able to effectively utilize and integrate their own systems with those of the customer and other partners in order to facilitate interoperability and create synergy. In regard to the importance of being able to integrate into the customer's systems, a business development manager at company Alpha stated:

> …. All of a sudden, we will take a lot more responsibility and will be much more integrated with the customer base. We will be integrated in your logistics systems. If our part of the IT system, if our API screws up, everything stops ….

4.3.4 | Promoting trust throughout the ecosystem and maximizing synergies among actors

Based on the analysis, the fourth phase of the ecosystem level focuses on the promotion of trust throughout the ecosystem as well as the maximization of synergies between actors. In fact, we realized that *promoting the importance of data sharing within an ecosystem* requires being encouraged by the orchestrator. Participants may benefit from orchestrator assistance to overcome any resistance towards sharing such information. Regarding the importance of data sharing, the CEO of company Gamma has stated:

> … a big bottleneck is the [ecosystem actor] themselves, and the insecurities they have around sharing their data. It's about actually set up the data sharing, because sometimes they need to do a lot of the work themselves. It's also about the incentives, why should they share their data in first place, because it can be a quite scary thing, and typically they do not get paid for it by their customers ….

In addition, our analysis revealed that the orchestrator can potentially motivate ecosystem actors to *adopt the key principles of digital trust and emphasize its importance within the ecosystem*. Digital trust can be

defined as the ability to rely on digital information and services, especially those provided by new entrants into the ecosystem. In fact, digital trust is more than just a technical mechanism; rather, it is deeply related to how people perceive each other and how they interact with each other. Trust is, therefore, a social mechanism essential for a digital ecosystem to function at its optimum. Furthermore, our analysis revealed that the orchestrator may require to *offer incentives in order to improve trust-based synergies within the ecosystem*. It is imperative that all actors work together as a team, combining their individual talents and leveraging one another's resources and technologies. A key aspect of promoting trust-based synergies is to ensure that ecosystem members understand the short-term and long-term benefits of collaborative efforts. The director of strategy and service portfolio management at company Alpha has highlighted the importance of trust among ecosystem partners:

> …. At the end of the day, trust is about that I know that when my ecosystem partners says something, they say what they mean and they mean what they say. No hidden agendas, no other kind of foul play going on behind the curtains ….

4.3.5 | Operationalizing value co-creation and continuous evaluation/improvement of the ecosystem

In the last phase of the ecosystem level, value co-creation is implemented as well as continuous evaluation and improvement of the ecosystem. The completion of this phase is an essential step in maintaining the symbiotic relationship among the actors and organizations involved in the digital servitization process. For this purpose, our results indicate that the orchestrator, in conjunction with other key actors, may need to *establish measures of digital service performance that can be used to evaluate and improve the ecosystem*. It is recommended that these measures include quantifiable information concerning the efficiency of transportation, the performance of technological systems, and the social acceptance of digital services. As well, the chief operating officer of company Zeta has supplied an example of how a business plan is developed for measuring the performance of each digital solution project in order to continuously evaluate and improve the ecosystem:

> … you do a business case together and say, what are you expecting to gain from this, how much revenue you are expecting to get, how much savings you are expecting to get, so, we almost construct a business plan together for this area of the business and say ok, that's what I expect for the next twelve months, in some cases we've done four, three years, so that you can go back to that at least three months, six months' time, and at the key moments in time, and say: how are we doing in compare to our expectations? ….

Aside from that, our results indicate that the orchestrator may need to provide the prerequisites for *creating a mechanism or team to disseminate information regarding continuous improvement*. As part of the dissemination mechanisms, performance indicators, measurement systems, and ongoing value creation can be disseminated. This mechanism can be used to establish benchmarks for continuous improvement and evaluation, as well as provide a feedback loop for the ecosystem orchestrator to identify potential problems and take measures to prevent them. A project manager at company Alpha emphasized the importance of continuous improvements based on customer feedback:

> …. All the time; continuous improvements, continuous improvements, continuous improvements. I think if we're going to do development in a field that we haven't been working with, it's not been our core business for the past 100 years, then it's important that we get up. We are working in an agile way of working, and customer feedback is really important when you are developing in an agile way, in an incremental way, getting continuous feedback from them ….

Furthermore, the last step of the last phase of the ecosystem level involves *continuous adaptation and ensuring the viability of the ecosystem*. Our analysis suggests that the orchestrator can consider maintaining and strengthening its symbiotic relationship with actors who are likely to positively impact the digital servitization process. This can be accomplished through active collaboration and communication.

4.4 | Sustainable industry benefits

Based on the results of our analysis, orchestrating the ecosystem as part of digital servitization has the potential to provide several sustainable benefits to industrial firms and their customers. In line with the triple bottom line, these benefits can be divided into three categories, including environmental, economic, and social benefits, which we explain in more detail below, and all together can contribute to achieving a more sustainable industry.

4.4.1 | Environmental benefits

The first aspect of these sustainable outcomes is focusing on the environmental benefits of orchestrating the ecosystem as part of digital servitization. The findings of this research showed that digital services and solutions co-created by orchestrating the ecosystem have the potential to *improve work processes towards the Paris Agreement* and drive the shift towards more sustainable ecosystems. Indeed, by using the potential of technologies such as AI, big data analytics, and the IIoT and orchestrating formal and informal relationships within the ecosystem, industrial firms may jointly develop data-driven digital services and solutions. With the help of these solutions, they are able

to optimize their own operations as well as those of their customers, thereby reducing the consumption of materials, reducing waste generated, and eliminating inefficient processes that are detrimental to the environment. Furthermore, the findings demonstrated that these digital solutions that emerged from the orchestration of multiple actors can contribute to the *reduction of carbon footprints*. It can be accomplished by analyzing large volumes of data to help industrial firms make better decisions in order to optimize their transportation operations, which results in fewer empty vehicles on the road. It is through such an approach, which is a result of orchestrating the processes within the ecosystem for digital servitization, that firms can reduce their environmental footprints as well as position themselves as the pioneers of a sustainable approach to business. Similarly, a director of data partnerships at company Delta stated the following regarding the leveraging of data collected within an ecosystem to be analyzed for environmental purposes:

> …. We are working with [company Alpha] already to start surfacing what we call advanced data streams. This is like fuel, euro type of the engine, aggressive breaking, driver acceleration stuff like that. That feeds into CO_2 models, which we have data vendors who help us calculate CO_2 through the standard. That helps from a carbon accounting perspective ….

4.4.2 | Economic benefits

As a result of the analysis, economic benefits are the next aspect of sustainable industry benefits. A further benefit of orchestrating the ecosystem for co-creating digital services and solutions is the ability to *reduce costs by identifying and correcting inefficiencies within the processes*. Indeed, ecosystem orchestration is an integral part of digital servitization and can enable the co-creation of digital solutions that have proven to be capable of identifying and resolving flaws in transport management systems (TMSs) with the goal of optimizing logistical operations. Therefore, firms can reduce the costs associated with transportation and logistics, thereby enhancing their economic performance. As well, the CEO of company Epsilon has stated the following regarding the importance of optimizing logistics and how it impacts cost reduction:

> …. The second thing is that if we can optimize logistics, then we can lower cost on logistics. Most of the things that get thrown out today, that we throw it is because the logistic is expensive, it's cheaper to actually throw a pallet of tomato than to move it ….

Moreover, another advantage of developing data-driven digital solutions co-created by orchestrating collaboration among multiple actors within the ecosystem is *reducing costs by optimizing vehicle loads*. Through the combination of big data analytics and different pricing models, companies will be able to adjust their choices, determine the optimal amount of load, and, by having fewer empty vehicles on the road, reduce their fuel consumption and operating costs. Additionally, companies will also be able to identify how much to charge their customers accordingly. Achieving this level of optimization, which allows organizations to adjust their decisions and plan their processes, comes from going through multiple layers of orchestration within the ecosystem.

4.4.3 | Social benefits

This section focuses on the social benefits that can be derived from orchestrating the ecosystem for digital services and solutions in terms of sustainable benefits for the industry. In addition to their environmental and economic benefits, the co-created digital solutions can also contribute to social sustainability by *removing drivers from dangerous situations*. In fact, safety is a major concern when traveling on roads that are considered dangerous or long enough to cause the driver to fall asleep. Using route optimization solutions, this problem can be solved by optimizing how many trips each driver receives and scheduling their trips so that they receive sufficient sleep, thereby preventing drivers from being in dangerous situations. In this way, real-time data analytics can be leveraged to orchestrate different activities within the ecosystem towards the creation of a focal digital solution capable of optimizing operations to keep people safe and facilitate lifesaving decisions. Moreover, digital solutions can be used to *improve the work–life balance of operators*, both within industrial firms and among their customers. The optimization of transportation and logistics operations allows firms to manage their operators to be closer to their homes in order to provide them with a better quality of life. The use of optimization solutions generated by orchestrating ecosystem partnerships is likely to allow operators and drivers to feel better about their work environment, thereby contributing to their psychological and social well-being. In this regard, the chief growth officer of the company Beta commented on the impact of optimizing operations on individuals' work–life balance:

> …. You keep people operating more regionally, but if you take the bigger sustainable topic where people's work–life expectations and all those things means not only can you make the working environment much nicer for the individuals, because they stay more regional, but you can also take out capacity because it's more optimized ….

As a further benefit, digital solutions have been proven to be effective in *reducing operators' stress levels*. Management of operations, especially in the transportation and logistics sector, is a very challenging job due to the need to keep an eye on all aspects of the operation at all times. As an example, consider a shipper contacting the operator and complaining about an expected truck that has not yet arrived. As opposed to having to call multiple times to determine the exact nature of the problem, the digital solution co-created by orchestrating a

number of actors within an ecosystem can filter the data in real time, pinpoint the problem, and provide suggestions for resolution. As a result, the operator does not have to search everywhere and can focus only on what the digital solution suggests, thus causing them to feel less stressed.

In general, these environmental, economic, and social benefits were achieved by orchestrating multiple levels, phases, and activities, which together led to the co-creation of focal digital solutions that could potentially facilitate sustainable benefits for the industry. Ecosystem orchestration is indeed an integral and inseparable part of the digital servitization process and is concerned with facilitating interactions among people, technologies, organizational structures, business models and processes, and ecosystem relationships that are intertwined throughout the process.

5 | A MULTI-LEVEL FRAMEWORK FOR ORCHESTRATING THE ECOSYSTEM IN DIGITAL SERVITIZATION

Based on our findings, we have developed a framework to illustrate how large manufacturing firms can orchestrate their ecosystem for successful co-creation of data-driven digital services and solutions as a way to achieve sustainable industry benefits. In order to clarify the paths, phases, and relationships between different operational levels in the ecosystem orchestration process, we present our model as a multi-level framework in conjunction with a flowchart. The operational levels in this framework are intricately interconnected, which is why our analysis concluded that all these levels need to co-evolve in order for ecosystem orchestration to be successful and generate sustainable benefits for the industry. Using Figure 2 as a guide, we will provide a step-by-step description of the different operational levels and phases of the proposed framework.

The proposed framework begins with examining the individual level, which is concerned with the qualities, characteristics, and skills essential for participation in the co-creation of digital services and solutions. The findings at this level are consistent with the call to better understand servitization in relation to individual perceptions and behaviors (Rabetino et al., 2017), as well as some overlap with the literature on entrepreneurial orientation that can foster innovation, proactiveness, and risk-taking in organizations (Simonsson & Agarwal, 2021). There is a possibility that these individuals hold different roles, ranks, and responsibilities, for example, members of the top management team, middle managers, operational managers, operators, employees, and so forth. Furthermore, the study found that the top management team of the orchestrator organization should possess specific characteristics when it comes to establishing the overall vision for digital service transformation (Sklyar, Kowalkowski, Tronvoll, & Sörhammar, 2019) in order to enable a successful process of co-creation. A top management team without these qualities is unable to transfer the necessary concepts and mindsets to their employees (Taglialatela et al., 2023; Todaro et al., 2021) as well as to other partners throughout the ecosystem. In this regard, it has been noted that once members of the orchestrator company align with the initiatives relating to digital service transformation and sustainable industry initiatives, the next step is ensuring that the other partners and ecosystem actors are also on board. Our proposed flowchart also attempts to emphasize this fact through the order in which it is presented. As a result of the establishment of these traits, capabilities, and mindsets, organizations would be able to reduce their resistance to change (Minaya et al., 2023; Tronvoll et al., 2020), which is one of the most significant challenges that they face when undertaking major transformations.

Additionally, the findings suggest that a lack of the appropriate organizational structure (Kohtamäki et al., 2021) and procedures to make the required alignment between internal people, processes, and activities with the external actors within the ecosystem will result in a failure of orchestration for the digital servitization process. Likewise, we concluded that it is critical for orchestrators to assess their own organizational alignment and business model innovation before attempting to deploy digital services and solutions. Moreover, it is necessary to determine whether the other actors possess a compatible structure and setting that match the other actors' settings (Kohtamäki et al., 2019). Indeed, it has been revealed that without such efforts, the co-creation of digital services will be challenged (Carloni & Galvani, 2023; Sjödin et al., 2019), and organizations will not be able to align their internal sectors in a way that will allow them to provide digital services and solutions that will enable them and their customers to become closer to achieving a more sustainable industry. As an operational method to align the ecosystem actors on the organizational level, this study proposes a four-phased process in order to better equip industrial firms for making the necessary changes in their business models, cultures, and structures.

Furthermore, the third operational level, which focuses on ecosystems, illustrates the orchestrators' abilities to align different actors within an ecosystem and manage the processes of value creation and value capture collectively (Hurmelinna-Laukkanen & Nätti, 2018; Kolagar, Parida, & Sjödin, 2022). By involving and coordinating other key players in the ecosystem, the orchestrator needs to determine how to put together the pieces of this puzzle in order to maximize the efficiency and productivity of the whole ecosystem (Chen et al., 2023; Kohtamäki et al., 2019). Ultimately, this will result in the co-creation of digital services and solutions that will optimize business processes within all industrial firms and their customers in order to generate sustainable benefits for all parties (Kolagar et al., 2024; Sjödin et al., 2023). Aside from that, as it can be seen within the framework, the flowchart does not have an "end" point, suggesting that the fifth phase encompasses a continuous evaluation process. Accordingly, the orchestrator must continue to undergo this process so as to ensure that all the elements are in place for a successful co-creation of digital services. Also, based on the findings of this research, it became apparent that the development of data-driven digital services and solutions would benefit firms and their customers in several meaningful ways. In accordance with the triple bottom line approach (Elkington, 1994, 1998, 2018), the benefits identified within the context of this research have been classified into three main categories:

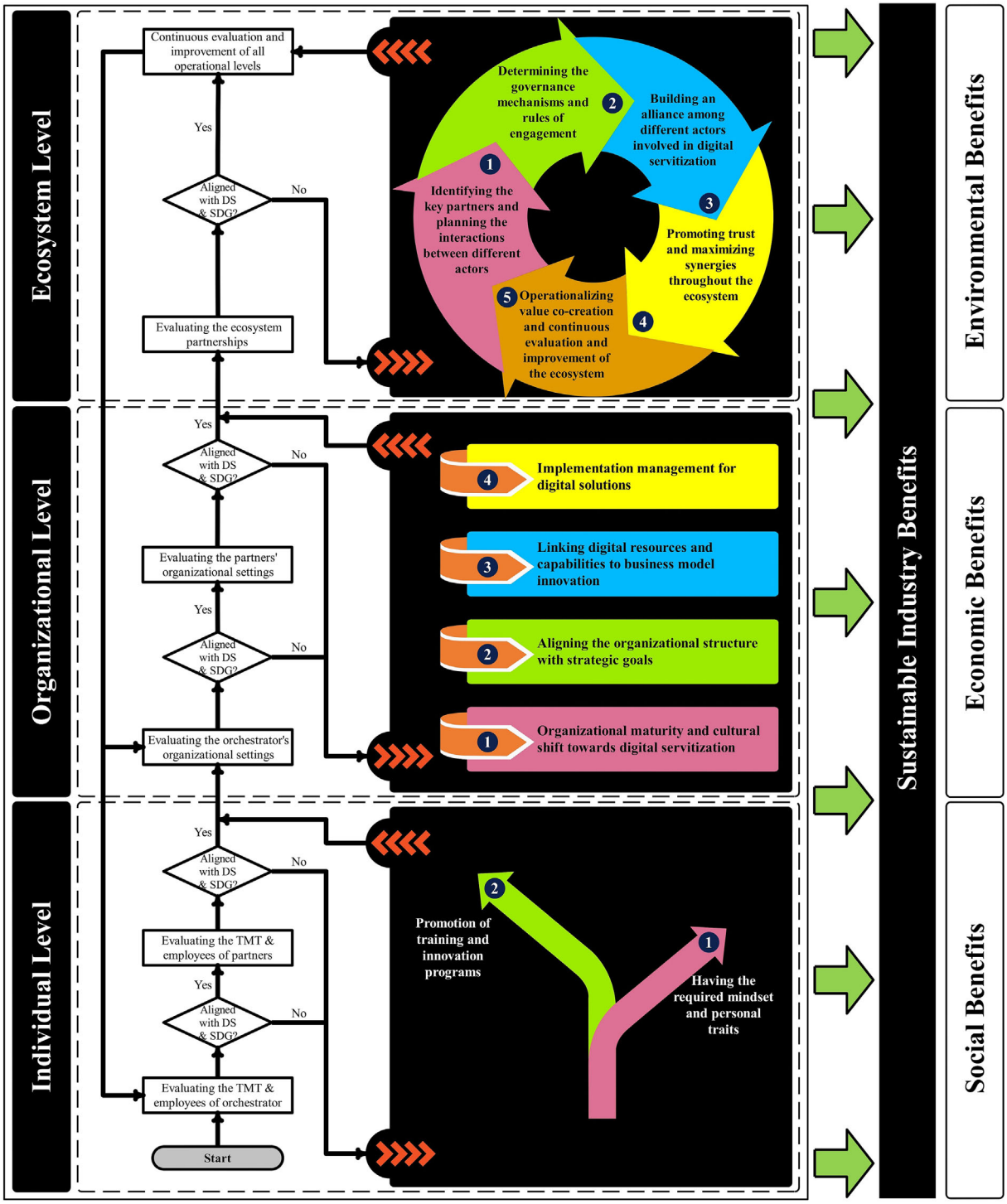

FIGURE 2 A multi-level framework for orchestrating the ecosystem in digital servitization (DS). SDG, Sustainable Development Goals; TMT, Top Management Team.

environmental, economic, and social, all of which contribute to the realization of a more sustainable industry (Kolagar et al., 2024; Paiola et al., 2021).

For sustainable industry benefits to materialize, all these operational levels need to work together and co-evolve. As such, all three levels of orchestration, namely, individual, organizational, and ecosystem, play an essential role in realizing these benefits over the long term. According to the findings of this study, all levels contribute to the realization of the three categories of sustainable benefits, but some of these specific benefits may reflect broader aspects of specific operational levels. Putting it in a more comprehensive manner, it can be said that the orchestration activities start at the individual level but

then extend to a broader level as they serve as the foundation for the organizational and ecosystem levels. Thus, it can be stated that this process begins at the individual level, and then, following the realization of ecosystem orchestration for digital servitization, it can have the potential to make the lives of a larger group of individuals more convenient and less stressful. In addition, it can also benefit those who are close to these individuals' social circle, such as their family and friends, thus contributing to a more fulfilling life for them. Hence, the individual level reflects, in a broader sense, in the form of social benefits. Likewise, it has been revealed that the organizational level has a significant impact on the overall economic condition of firms and their customers. As a result, the proposed framework chose to place it in front of the organizational level in order to illustrate its impact on a broader range of firms and economies. Also, the evidence presented in this study reveals that to realize sustainable industry benefits, all actors within an ecosystem will need to become involved, since environmental improvement cannot be achieved without forming a collective will at the ecosystem level. Thus, the proposed framework positioned the environmental benefits in front of the ecosystem level based on the same logic. Nonetheless, it is imperative to emphasize that all levels are crucial in achieving each specific sustainable benefit and that all operational levels need to function together to orchestrate an ecosystem that facilitates the development of digital solutions that benefit society, the economy, and the environment.

6 | CONCLUSION

6.1 | Theoretical and managerial contributions

Based on the findings of this study, a number of theoretical implications can be drawn in various directions. This study contributes primarily and significantly to the literature on digital servitization (Kolagar, Reim et al., 2022; Paschou et al., 2020) by emphasizing ecosystem orchestration as a critical component for the successful co-creation of data-driven digital services as a way to reach a more sustainable industry. In addition, this study presents a multi-level framework consisting of all the crucial phases and activities and conceptualizes the individual, organizational, and ecosystem levels to operationalize a successful orchestration process for co-creating digital services and solutions within the ecosystem. It is important to understand that successful orchestration refers to a process that has demonstrated consistently valid results and outcomes in regard to the economic, environmental, and social benefits for industrial firms over time, which, in the case of the present study, has been realized and confirmed. In this regard, our conclusion is that it is not enough for ecosystem orchestrators to only focus on creating alignment at the ecosystem level (Kolagar, Parida, & Sjödin, 2022; Sjödin et al., 2021). As a matter of fact, they should also take a closer look at their own organizations to determine whether they are capable of taking on the role of orchestrator. They should also examine their chosen partners' organizational settings to determine whether they are worthy and capable of becoming a part of the ecosystem and whether they will be able to contribute to the collaborative effort (Kolagar, Parida, & Sjödin, 2022; Tabas et al., 2022). It should also be noted that, at the end of the day, it is the individuals who make the decisions, and it is the human brain that is capable of managing organizations and orchestrating ecosystems. As a result of our research, we have highlighted the critical role of individuals who play a central role in the decision-making process regarding ecosystem orchestration. Moreover, the proposed framework highlights the link between digital servitization and sustainability (Kolagar et al., 2024; Paiola et al., 2021) and illustrates the sustainable benefits that firms can realize by orchestrating the ecosystem for co-creating data-driven services and solutions. Furthermore, it has been revealed that the resulting social, economic, and environmental benefits can be viewed as a broader manifestation and reflection of the various orchestration levels.

As well as contributing to theory, our research has practical implications for large manufacturing companies that are currently orchestrating their ecosystems to create the right collaborative environment for offering digital services and solutions or who intend to do so in the future. In this regard, manufacturing firms can employ the proposed framework as a continuous evaluation and improvement tool for implementing and operationalizing ecosystem orchestration processes. Through the use of the flowchart provided in the framework, industrial companies can identify potential flaws and problems at each operational level and use this model as a road map for designing their orchestration strategy within the context of digital servitization, thereby playing an important role in creating a more environmentally friendly, socially responsible, and economically viable industry. Managers also need to communicate a compelling vision to their organization regarding how each individual can contribute constructively to the ecosystem. It is essential that they realize that it is the people who are using different technological and relational tools in order to assist their organization and the entire ecosystem to go through these transformational changes. In addition, they need to pay more attention to customer centricity and work towards meeting the needs of their customers when offering digital services and solutions. Furthermore, managers and practitioners need to assign a high priority to achieving sustainable industry benefits in terms of their strategic goals.

6.2 | Limitations and future research

While this study contributes several novel insights to the emerging literature on digital servitization (Kolagar, Reim, et al., 2022; Paschou et al., 2020), some limitations should be considered before interpreting the empirical findings of the study for future research. The first limitation stems from the fact that we have only examined successful ecosystem collaboration within the transportation sector, whereas the orchestrator company was a large manufacturer whose partners included software developers, IT service providers, and transportation and logistics companies. Thus, we only examined one case study of an ecosystem that included firms with a proven track record of digital servitization initiatives that have already resulted in environmental,

economic, and social benefits for the industrial firms. It is therefore possible to design future studies that facilitate the comparison of successful and unsuccessful cases in order to gain a deeper understanding of the differences between them, thereby assisting managers in making the best decision possible regarding their digital servitization. Further, all the companies we studied were based in European and North American countries. It would therefore be advantageous to select and review companies that are operating in different regions or industries, which may result in different findings for future research. Additionally, a comparative study focusing on different company sizes (micro, small, medium, and large) operating in emerging economies could yield valuable insights into the orchestration processes and phases at each level. Second, we acknowledge that certain aspects of the thematic analysis were subjective and that it is ultimately the author(s)' responsibility to interpret the data gathered from the interviews. We have attempted to address this limitation as much as possible by utilizing experts in the field and researchers' triangulation and explicit coding rules. This will enable future studies to focus on conducting quantitative studies using various methodologies (e.g., structural equation modeling-partial least squares method, multiple criteria decision-making techniques, etc.) (Kolagar et al., 2021; Sarstedt et al., 2022), which may help validate the results of qualitative studies by identifying correlations between different phases and their specific outcomes. Furthermore, the proposed framework has attempted to demonstrate the fact that sustainable industry benefits are broader reflections of the three main levels for orchestrating an ecosystem for digital service delivery. Further research may focus on the relationship between specific levels of orchestration and different aspects of sustainable benefits and try to determine how they interact and what role they play in the realization of these benefits.

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