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Service design for digital servitization: Facilitating manufacturers' advanced services value proposition design in the context of Industry 4.0

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ABSTRACT

Industry 4.0 provides increasing opportunities for manufacturing companies in servitization, which has led to the emergence of digital servitization. Several single case studies have suggested service design as a means to advanced services value proposition design in digital servitization. However, these case studies are context-constrained, while multicase studies investigating the impact of service design on digital servitization remain sparse. In the present study, we examined, over two and a half years, the application of service design for advanced services value proposition design in a multicase study of 10 manufacturers engaged in digital servitization. By applying a research through design method, we studied the impact of service design on the digital servitization process and identified the types of events that shape the advanced services value proposition design. As a result, this research provides further insights into the impact of service design on digital servitization in the manufacturing context and offers new avenues for further research in the field.

1. Introduction

With Industry 4.0, manufacturing has radically changed because of both technological advances and new and challenging market requirements (Calabrese, Dora, Levialdi Ghiron, & Tiburzi, 2022) that have caused manufacturing companies to design for new value propositions through the extension of services based on product-service systems (PSS; Beuren, Ferreira, & Miguel, 2013). This extension process is called servitization and has been present in manufacturing industries for several decades (Kowalkowski, Gebauer, & Oliva, 2017; Oliva & Kallenberg, 2003). Successful examples of servitization in manufacturing industries are Rolls-Royce engines (Smith, 2013) and Philips lamps (Salwin, Gladysz, & Santarek, 2018). The idea of servitization is to create suitable new value propositions by integrating tangible products with services to enable value co-creation with customers with an eye to complete solutions (Lee, Chen, & Trappey, 2019). These solutions offer not only ownership of a product but also a bundle of products and services associated with its performance (e.g., pay-per-performance) and use (e.g., pay-per-use; Zheng, Wang, Chen, & Khoo, 2019) and are known as advanced services (Baines & Lightfoot, 2013). Advanced services are characterized by focusing on offering capabilities and outcomes (e.g., productivity, performance, availability service contracts) rather than merely offering products (Bigdeli et al., 2018). Thus, advanced services value propositions reflect tangible and intangible benefits co-created and aligned with stakeholders' needs (Lusch & Vargo, 2014).

Industry 4.0 technologies, such as machine learning (Cong et al., 2022), the Internet of Things (IoT), and big data and cloud computing (Gaiardelli et al., 2021), are enablers of advanced services shaped by the alignment among service–product–technology solutions and market development (Chew, 2016). Industry 4.0 technologies allow the full potential of advanced services (Suppatvech, Godsell, & Day, 2019); by leveraging such technologies, manufacturers can increase the pace of change, leading to significant business transformations (Ghezzi & Cavallo, 2020). These business transformations can address deployment and exploitation issues of advanced services (Paschou, Rapaccini, Adrodegari, & Saccani, 2020), such as reducing operating costs or increasing resource utilization by real-time monitoring with virtual or augmented reality in manufacturing (Zheng, Ardolino, Bacchetti, & Perona, 2021). The application of Industry 4.0 technologies to servitization is known as

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digital servitization (Gebauer, Paiola, Saccani, & Rapaccini, 2021). It is the convergence of servitization and digitalization that opens up new growth opportunities for manufacturers through the application of Industry 4.0 (Paschou et al., 2020). Kohtamäki, Rabetino, Einola, Parida, and Patel (2021) emphasize the need to adopt a processual perspective and to conceptualize digital servitization 'as strategic change, continuously constructed and reconstructed at the microlevel when activities are planned, implemented, and adjusted through reconstruction and implementation processes' (p. 137).

The growth of interest in digital servitization is attested in the literature, with recent studies focused on capturing and understanding the interplay between Industry 4.0 technologies and servitization (Kohtamäki, Parida, Oghazi, Gebauer, & Baines, 2019). However, academic research into this interlay is in its infancy when it comes to the role of Industry 4.0 technologies in enabling servitization (Frank, Mendes, Ayala, & Ghezzi, 2019). Specifically, Coreynen, Matthyssens, and Van Bockhaven (2017) point out that the early servitization research downplayed the role of technologies that have always functioned as catalysts for the transition to a service-oriented business (Kowalkowski, Kindström, & Gebauer, 2013). Suppatvech et al. (2019) indicate that technological roles have been underemphasized in servitized business models; they were not sufficiently highlighted in the servitization process for advanced services (Kohtamäki et al., 2021). Hence, Paschou et al. (2020) called for more attention to the integration of Industry 4.0 technologies into advanced services value proposition design as a way to realize digital servitization.

Empirical studies have shown that in practice manufacturers frequently fail to recognize the importance of this integration in various design aspects of advanced services, such as diverse customer characteristics and changes in resources, customer relationships, cost dynamics, and intangible value attributes (Kamalaldin, Linde, Sjödin, & Parida, 2020). This is because digital servitization involves a change in a manufacturer's value propositions (Chen, Visnjic, Parida, & Zhang, 2021; Kohtamäki et al., 2019). However, conventional design frameworks (e.g., design for manufacturability and assembly) focus on managing the production and end of life of products rather than the integration of Industry 4.0 technologies (Benabdellah, Bouhaddou, Benghabrit, & Benghabrit, 2019; Nguyen et al., 2022). Furthermore, Nguyen et al. (2022) revealed the need to integrate design methodologies for advanced services with key design elements: life-cycle service design and the involvement of stakeholders, new service development methods, and design skills. Without the systematic consideration of these key design elements, the implementation of advanced service design could cause confusion in practice, leading to a 'service paradox' (Kwon, Baek, Jeon, Kim, & Jung, 2021; Ping, Liu, Lin, & Liu, 2020) that reflects a situation in which a servitized manufacturer fails to develop profitable advanced services even though it mobilizes resources for that purpose (Gebauer, Fleisch, & Friedli, 2005), which demonstrates the high degree of risk and uncertainty associated with the servitization process.

Thus, the design of advanced services value propositions in digital servitization requires alternative approaches (Sjödin, Parida, Jovanovic, & Visnjic, 2020). A greater focus on digital servitization as a phenomenon and more empirical research into the transformation process towards digital servitization business models are called for (Kohtamäki et al., 2021). Single case studies in manufacturing servitization have suggested service design as a means to advanced services value proposition design; however, they are constrained to their specific research contexts (e.g., Costa, Patrício, Morelli, & Magee, 2018). This limitation leads to a lack of generalizable theories on how service design impacts digital servitization. Moreover, to the best of our knowledge, multicase studies analyzing service design for advanced services value proposition design in digital servitization in the manufacturing context are scarce at best. Additionally, despite the work that has been done to understand the process of digital servitization (e.g., Chen et al., 2021; Rakic, Visnjic, Gaiardelli, Romero, & Marjanovic, 2021; Sjödin et al., 2020), more research is needed to understand the different types of events that facilitate digital servitization (Kohtamäki et al., 2021; Van de Ven, 2013). Furthermore, as Solem, Kohtamäki, Parida, and Brekke (2021) point out there is a need to extend research into service design routines in the digital servitization process to other manufacturing settings and from a processual view, including manufacturers with different characteristics in terms of size, sector, technology development, and the maturity of the servitization process (Iriarte, Hoveskog, Justel, Val, & Halila, 2018). Thus, despite the existence of promising preliminary evidence, research into the impact of service design on digital servitization process, i.e., the particular moments and events when microlevel activities and tasks are performed, in the manufacturing context for facilitating advanced services value proposition design remains underdeveloped.

Thus, the aim of this research is to determine the impact of service design on the digital servitization process by identifying the types of events to surface microlevel practices that facilitate advanced services value proposition design in the manufacturing context. To investigate and answer this question, we applied a research through design qualitative approach. Additionally, our research is inspired by the process mode of thought, which conceptualizes any change process, including digital servitization, as an event-driven process in which observed and recorded events drive change over time (Van de Ven, 2013). Our research also aligns with the practice mode of thought, to capture the doing – namely, the fact that the digital servitization process involves performing microlevel activities and tasks – of how the use of service design visualization tools and practical procedures influences change (Schatzki, 2012). The focus on microlevel, in Felin, Foss, Heimeriks, and Madsen (2012) terms microfoundations, can give important cues for how organizations can purposefully transform themselves and innovate products, services, processes, and business models. With an intense focus on particular moments of the digital servitization process captured in detail to enable understanding of the types of events, we carried out 10 service design projects at 10 different manufacturers engaged in digital servitization. Service design was applied in order to support advanced services value proposition design, which is vital in digital servitization (Tronvoll, Sklyar, Sörhammar, & Kowalkowski, 2020).

This article makes several contributions that advance the discussion on the digital servitization process by taking both processual and practice perspectives. The study unpacks the digital servitization process by investigating the type of events to surface the doings (e.g., particular moments guided by service design) that shape advanced services value proposition design in the digital servitization process. It also demonstrates that knowledge, skills, and use of service design along with the organizational configuration triggered by service design, provide industrial managers with the ability to strategically manage the sociotechnical level of digital servitization (Ciasullo, Polese, Montera, & Carrubbo, 2021). This addresses the calls of Münch, Marx, Benz, Hartmann, and Matzner (2022) and Marcon et al. (2022) for more knowledge on the capabilities a manufacturer needs to advance the digital servitization process. Our study also strengthens Kohtamäki et al,'s (2021) insights that the digital servitization process is driven by the tension between the need for creativity and the identification of new initiatives (i.e., mobilization) and the effective implementation of those new initiatives (i.e., integration). Finally, this work enhances previous research (e.g., Solem et al., 2021) towards generalizable theories on the interplay between digital servitization and service design by carrying out a multicase study revealing microlevel practices of service design in relation to the digital servitization process.

2. Advanced services value proposition design

As Vargo, Akaka, and Vaughan (2017) explain, value is in its essence an experiential, contextual concept. At the core of any business model and its renewal is a value proposition that is able to satisfy customers' needs while simultaneously alleviating their pains (Osterwalder,

Pigneur, Bernarda, & Smith, 2014). As Lusch and Vargo (2014) state, a value proposition can be seen as a hypothesis which a company has formulated about the tangible and intangible benefits that could be co-created and aligned with a stakeholder's needs. It materializes over time as a result of activities, routines, and resource combinations of multiple actors with interlinked business models (Gronroos, 2011). In the context of digital servitization, the role of collaboration in value co-creation for value proposition design is even more prominent, as access to different forms of specialized knowledge is essential to enable advanced services (Marcon et al., 2022). Yet, as Jovanovic, Sjödin, and Parida (2022) emphasize, only recently the literature has started to explore the interplay between the advanced services value proposition design and the associated technological infrastructure (e.g., platforms and their governance).

Manufacturers can use servitized business models to co-create value by enabling a diverse set of actors to use their capabilities to co-create a valuable outcome for the customer (Baines & Lightfoot, 2013; Marcon et al., 2022). Value propositions are the starting point of service innovation from the service provider perspective since they are instrumental in capability use, resource integration, and value creation (Skålén, Gummerus, Von Koskull, & Magnusson, 2015).

Jovanovic et al. (2022) point out that scholars are very often taking data (e.g., detecting errors in machine-centric data, identifying patterns into larger datasets) as a starting point for advanced services and customer value creation, thus, downplaying the role of co-creation process driven by the focal firm. However, as Kohtamäki and Partanen (2016) emphasize there are positive implications of co-creation in advanced services in relation to profitability. In line with Kindström (2010) and Sjödin et al. (2020), manufacturers that aim to create advanced services value propositions must understand their customers' value creation activities (e.g., processes, competencies, and tangible and intangible requirements) and significantly transform their own value creation processes. This entails that manufacturers must understand customer perceptions, characteristics, and worldviews when conceptualizing advanced services value propositions. As Tuli, Kohli, and Bharadwaj (2007) highlight, the effectiveness of a service value proposition and the customer solution associated with it rests on the fit between service provider and customer characteristics, which enables joint value co-creation. This becomes even more important in the context of Industry 4.0, and the application of digital technologies situates the need to develop skills to enact the co-creation of value among internal and external stakeholders (Kohtamäki et al., 2021; Li, Peng, Xing, Zhang, & Zhang, 2021). Despite the fact that research in industrial markets emphasizes value co-creation in and through customer processes and characteristics (Eichentopf, Kleinaltenkamp, & Van Stiphout, 2011), manufacturers often fail to recognize this (Maglio & Spohrer, 2013) and research is yet to adopt more process perspectives in industrial contexts (Jovanovic et al., 2022).

Kindström, Kowalkowski, and Sandberg (2013) emphasize that one of the most challenging elements in the transition to a service-centric business logic is the need to change behaviours, values, and mental models. Consequently, in designing advanced services value propositions, manufacturers need to be equipped with approaches, tools and a mindset for co-creation and interactions with customers and other stakeholders (Sjödin et al., 2020). These approaches and tools should be applied to mapping, visualization, and materialization of service value with customers and internally within the organization (Kindström, 2010). They can be seen as routines – 'regular, repetitive [...] and behavioural activity patterns in order to accomplish specific organizational tasks' (Huikkola, Rabetino, Kohtamäki, & Gebauer, 2020, p. 3). Routines are important as they might enable or hinder innovation and strategic change processes (Jones & Craven, 2001). Parmigiani and Howard-Grenville (2011) review the literature on routines and suggest two distinct but at the same time complementary perspectives. In the first one, capabilities perspective, routines are viewed as "entities" (whole routines, "black boxes") and their role in accomplishing organizational goals is explored. In the second one, practice perspective, routines are viewed as "parts" with focus on their internal structure (what's inside the "black box") and how they are enacted in the day-to-day activities and with what consequences. Practices are organized 'as a constellation of different peoples' activities [...] in a nexus of doings and sayings' (Schatzki, 2012, pp. 13–14), e.g., use of visualization tools in co-creation workshops. In the present study, we adopt the practice perspective of routines as conceptualized by Parmigiani and Howard-Grenville (2011) and we focus on the doings, such as for example industrial managers adopting a particular set of tools (Seidl & Whittington, 2014). Therefore, in order to meet the practice perspective of routines but at the same time facilitate an easy reading, we will use from this point onwards "service design practices" to refer to the day-to-day microlevel practices of service design observed in the case companies.

3. Service design and visualization tools in digital servitization

3.1. Service design in digital servitization

Service design has profoundly influenced value proposition design in highly digitalized service sectors (e.g., Gallan, Perlow, Shah, & Gravdal, 2021; Patrício et al., 2020; Trischler & Westman Trischler, 2021). However, there is a dearth of research on service design's applications for digital servitization in the manufacturing context (Solem et al., 2021). Designing advanced service value propositions brings with it challenges related to the specificities of servitization in industry (Kimita, McAloone, Ogata, & Pigosso, 2022; Kohtamäki et al., 2019; Zhang & Banerji, 2017). These challenges include a lack of organizational commitment to servitization (Gebauer, Edvardsson, Gustafsson, & Witell, 2010), the absence of technical service expertise, knowledge, and skills (Alghisi & Saccani, 2015; Story, Raddats, Burton, Zolkiewski, & Baines, 2017), a lack of cultural awareness and mindset in customer-centric and service-oriented approaches (Kowalkowski et al., 2017; Tronvoll et al., 2020), potential negative impacts due to changes in the business model (e.g., pricing mechanisms, customer relationships, and operations; Barquet, de Oliveira, Amigo, Cunha, & Rozenfeld, 2013; Kamalaldin et al., 2020; Parida, Sjödin, Wincent, & Kohtamäki, 2014).

A few single case studies examine the impact of service design on manufacturing servitization (e.g., Costa et al., 2018; Iriarte et al., 2018; Solem et al., 2021), but they are limited in their degree of generalizability because they are embedded in a single context. In these case studies, several service design microlevel practices emerge in relation to advanced value proposition design. More specifically, this involves looking into the organized activities and tools of agile co-creation processes for digital servitization (Sjödin et al., 2020): (i) creative customer data collection (design research), (ii) co-creation workshops, (iii) use of visualization tools, and (iv) design prototyping. Such microlevel practices, as outlined in the single case studies, reveal evidence that service design paves the way for advanced services value proposition design—which is crucial for digital servitization—and fosters progressive learning towards the transition to a customer-centric and service-oriented mindset and culture (Costa et al., 2018). Through these practices, manufacturers gain a better understanding of customers' needs through design research and use visualization tools and co-creative workshops with both internal and external stakeholders to ideate, prototype, and communicate advanced services value propositions (Solem et al., 2021). Still, publications measuring the impact of service design in digital servitization through multicase studies remain rare (Costa et al., 2018).

Overall, as Kadir and Broberg (2021) and Raddats, Kowalkowski, Benedettini, Burton, and Gebauer (2019) point out, human-centred design approaches have been significantly underestimated as a research topic in the advanced services and Industry 4.0 literature, despite the fact that human behaviour, human cognition, human emotions, and human needs all play vital roles in control and decision-making in the digital servitization process (Maglio, Kwan, & Spohrer,

2015) and design-led inherent characteristics such as agility and co-creation in the value proposition design process are considered essential for digital servitization (Sjödin et al., 2020).

3.2. Service design visualization tools

There is an explicit call in the digital servitization literature to provide manufacturing companies with new design capabilities to manage the digital servitization process related to advanced services value proposition design (e.g., Baines et al., 2017; Bigdeli, Kapoor, Schroeder, & Omidvar, 2021; Tronvoll et al., 2020). As Sjödin et al. (2020) note, there is a need to develop alternative design approaches to ensure customized and scalable service offers for digital servitization. Examples of this work with a focus on new visualization design tools for advanced services value proposition design in manufacturing are Åkesson, Skålén, Edvardsson, and Stålhammar (2016), Äyväri and Jyrämä (2017), Nguyen et al. (2022), Lievens and Blažević (2021), Chou (2021), and Wu and Liao (2021).

According to Blomkvist and Segelström (2014), visualizations play a central role in service design as co-design tools that designers iteratively use when designing value propositions through co-creative practices to process information, share ideas, and make decisions. Visualizations support the generation, interpretation, and manipulation of information and concepts using spatial images in the design process. These images facilitate problem solving, communication, and team building (Darren, Amitava, & Gerald, 2001). Zhang (2012) emphasizes that visualizations communicate in two or more dimensions using diverse elements that include signs, artwork, drawings, graphic designs, illustrations, models, and colours. Täuscher and Abdelkafi (2017) state that visualizations influence cognition and help establish shared understandings internally and externally. Eppler and Hoffmann (2012) identify the key role played by tools that are used in shaping managers' perceptions and understanding of value propositions. According to Sund, Galavan, and Bogers (2021), those mental images differ between managers on different levels and between and within teams. Naturally, different groups of stakeholders are exposed to different information about the environment, which leads to the establishment of different mental models and the existence of different and even contrasting views of what the service value proposition and business model are and should be (Amit & Zott, 2015; Egfjord & Sund, 2020).

Taking a microlevel practices perspective of routines into service design that focuses on doings, visualizations applied in co-creation allow service designers to synthesize customer data such as personas (Idoughi, Seffah, & Kolski, 2012), facilitate the creation of systemic representations of value ecosystems such as system maps (Morelli, 2006), and chronologically envision the service from both the customer perspective (Rosenbaum, Otalora, & Ramírez, 2017) and at the operational level (Bitner, Ostrom, & Morgan, 2008), such as customer journey maps and service blueprints, respectively. Visualizations such as storyboards and design scenarios also help foresee the way in which the value proposition will be experienced by the customer (Kankainen, Vaajakallio, Kantola, & Mattelmäki, 2012) and prototype interactions using role-playing recreations like desktop walkthroughs that occur in service delivery to predict future situations and prevent failures (Blomkvist & Segelström, 2014).

Research has documented the use of visualizations for value proposition design in manufacturing servitization (e.g., Iriarte et al., 2018; Numata, Hosono, & Shimomura, 2016). In particular, further developments of visualization tools such as service blueprints are found in several studies (e.g., Chuang, Lee, & Yao, 2022; Geum & Park, 2011; Kim, Lee, & Kim, 2015). However, the approach adopted in the majority of the studies in the context of manufacturing servitization related to service design visualization tools focuses on designing service operations (e.g., Chen, Ming, Vareilles, & Battaia, 2020; Ryu, Lim, & Kim, 2020; Sivula, Shasuzzoha, Ndzibah, & Timilsina, 2022; West, Gaiardelli, & Saccani, 2022). However, service design represents an alternative approach to the operational-centred perspective on advanced services value proposition design that is dominant in manufacturing digital servitization (Kuure, Jylkäs, & Miettinen, 2019). In our view, service design core principles and microlevel practices (design research, co-creation, use of visualization tools, and design prototyping) have rarely been identified and analysed in sufficient detail in the servitization literature in general and in the digital servitization literature in particular.

4. Research method

4.1. Research approach and process

This study applies a research through design approach in 10 design projects over a period of two and a half years of service design practice (January 2018 to July 2021) at 10 case companies, including SMEs and large manufacturers. This approach goes beyond theoretical or practice observations-driven treatments to suggest strategies for design that are desirable to pursue in the future (Gaver, 2012). Zimmerman and Forlizzi (2008) define research through design as an 'iterative qualitative research approach that employs methods and processes from design practice' (p. 42). This is seen as particularly appropriate for exploratory studies and, through action and reflection, allows for the stepwise integration and contextualization of knowledge with the help of design artefacts like visualizations, prototypes, and models (McNiff, 2017; Stappers, 2007).

Research through design allows for new phenomena to be created by the use in practice of novel artefacts (March & Vogus, 2010). Artefacts may include the following: constructs (ideas), models (representations of realities), instantiations (constructed realities), methods (processes, activities, steps), and improved (grounded) theories (March & Smith, 1995). For instance, in research on servitization, Costa et al. (2018) adopt a research through design approach to outline a design-led approach focusing on service design. Other examples appear in research on value proposition design, where design principles and methods are applied to develop conceptual models and frameworks (e.g., Bocken, Boons, & Baldassarre, 2019; Brown, Baldassarre, Konietzko, Bocken, & Balkenende, 2021). Consistent with that research, in the present study we explore how service design facilitates manufacturers' advanced services value proposition design in digital servitization. Specifically, the paper maps the types of events that facilitate manufacturers' advanced services value proposition design in digital servitization processes.

We combine research through design with a multicase study approach. This is in line with servitization research, which is qualitative, results-oriented, and case-based in nature (Kohtamäki et al., 2021). As Lincoln and Guba (2002) indicate, each 'case study is a construction, a product of interaction between respondents, site and researcher' (p. 207). Research on the link between digital servitization and service design needs more empirical studies and a better theoretical foundation. Additionally, as Chandler, Danatzis, Wernicke, Akaka, and Reynolds (2019) and Henike, Kamprath, and Hölzle (2020) conclude, in spite of the relevance of hands-on approaches for visualizations, more research is needed, especially in an Industry 4.0 context (e.g., Nguyen et al., 2022; Snihur, Lamine, & Wright, 2021). Therefore, the combination of research through design and multiple case studies research approaches fits well with the aim of this study. The companies were selected due to their commitment to digital servitization. They already had some sort of digital servitization strategy, presented Industry 4.0 developments, and were ready to participate in a service design project. All of them faced new challenges from the rise of Industry 4.0 technologies in their respective markets. Hence, upper management had already made the decision to transform the business model with an emphasis on advanced services. Furthermore, there was a variation between the companies in the maturity of the servitization process, the development of enabling Industry 4.0 technologies, and service design expertise. Thus, this group

of companies offered an interesting research setting for this study. Further details about the companies are provided in Section 4.2.

The aim of the intervention at each manufacturer was to design a new advanced services value proposition. This demanded customer value identification, conceptual design of the service, and development of key operations and touchpoints.

Fig. 1 illustrates the research flow of our work, starting with problem identification, towards taking action, and concluding with evaluation. With a focus on problem identification, we made an analysis of the case companies. To do so, we performed 10 group interviews. When taking action, we facilitated 47 co-creation workshops with manufacturers and conducted 10 group interviews. In the evaluation stage, we conducted 10 group interviews.

4.2. Case identification and selection

We approached a total of 18 companies about participating in this research. Our purpose was to set up a group of companies that had already undertaken digital servitization and were engaged in a configuration of advanced services value propositions. We wanted to gather a sample of companies large enough to represent diversity within three criteria: (i) size (large and SMEs); (ii) maturity in the digital servitization process (high, medium, and low); and (iii) service design expertise (high, medium, and low).

Servitization maturity develops along with the capability of the manufacturer to ensure continuous progression on servitization (Kimita et al., 2022). Therefore, to classify the manufacturers in regard of servitization maturity, we adopted Baines and Lightfoot's (2013) categorizations of services: base (installation, documentation, spare parts and product provision, warranty services), intermediate (training, technical assistance, ordinary maintenance, remote monitoring, customer process optimization services), and advanced (customer support agreement, risk-and-reward-sharing contracts, revenue-through-use contract services). We considered high-servitized companies to be manufacturers capable of sustaining advanced services in the market, and made similar judgements regarding medium-servitized (providing intermediate services) and low-servitized (providing only base services) companies. As to service design expertise, we adopted Malmberg's (2017) design capability scale, which is grounded in three parameters: design resources, design structures, and design awareness. We considered a manufacturer to have high service design expertise when it allocates resources to service design, uses service design practices regularly for value proposition design, and has internally legitimized these practices.

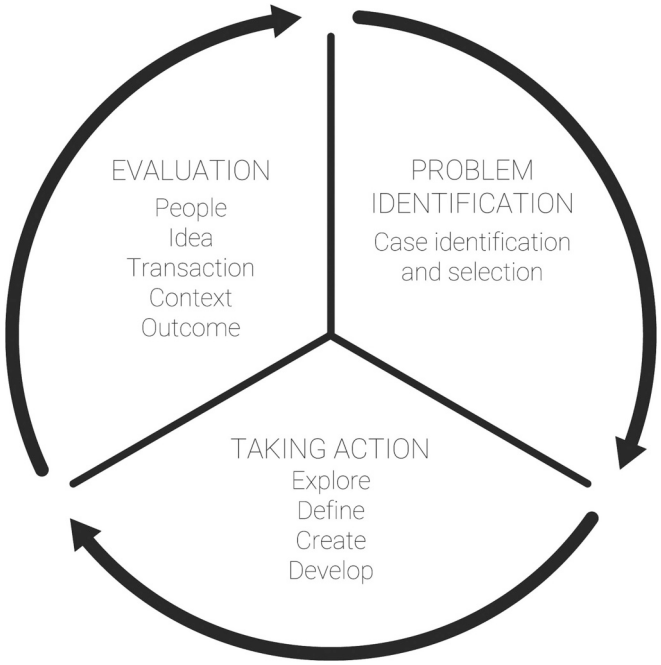

Fig. 1. The research flow.

Based on preliminary discussions with upper-level industrial managers, eight of 18 companies were excluded for not meeting the criteria. The final group of 10 manufacturing companies consisted of five large firms and five SMEs, two high-servitized companies, six medium-servitized companies, and two low-servitized companies. All companies had developed or were developing Industry 4.0 technologies as enablers of new advanced services. Half of the companies were familiar with service design, while for the rest service design was a new approach, with only two having allocated resources to service design. Table 1 summarizes the characteristics of each selected company.

4.3. Data collection

The 10 manufacturers applied service design microlevel practices in experimentation cycles of between four and six months each in order to support advanced services value proposition design. Each stage was followed by group interviews before, just after, and six months after the service design projects ended (February 2022). A total of 30 semi-structured group interviews with upper- and middle-level industrial managers were conducted, divided into the three interviewing cycles.

During the 47 co-creation workshops, 112 design artefacts (visualizations and prototypes) such as customer journey maps, service blueprints, service ecologies, design scenarios, business model canvas, or evidencing prototypes such as prototypes of digital platforms or marketing and training materials were created and treated as data sources. Additionally, we collected 230 pages of notes containing photographs of workshops, hand-drawn visualizations, and sketches of prototypes.

The co-creation workshops lasted between three and five hours; they were all facilitated by two researchers and observed by a third one. The workshops involved upper- and middle-level industrial managers, along with different technicians (e.g., product engineers or R&D engineers) in the companies. A total of 48 people participated in the workshops. Of these 48 people, eight had a design education in design domains (product, service, or UX/UI design). All industrial managers participated in the three interviewing cycles and indicated a commitment to digital servitization. This is consistent with the position of Sund et al. (2021), who argue that managers and members of innovation teams are the natural informants for studies on value propositions and business models since they are the ones who actively work on conceiving standardized visualization tools. Table 2 presents the data sources.

Researchers performed the group interviews at the company's facilities or via online platforms due to the COVID-19 pandemic. All interviews were audio recorded and lasted between 30 and 90 min. Following Jorgensen's (1989) suggestions, we enriched our data from the interviews with handmade notes, sketches of the prototypes, and photographs from the workshops.

In the first interviewing cycle, before we started the design projects, we adapted and combined Dmitrijeva, Schroeder, Ziaee Bigdeli and Baines (2020) work for the interview themes. In the second interviewing cycle, just after the design project, all participants in the co-creation workshops were interviewed, with a focus on service design expertise. Finally, in the third interview cycle, which took place six months after the design project ended (February 2022), we focused the questions on the following themes: (i) the current progress of digital servitization in the company, (ii) the current status of the designed value proposition, and (iii) the contribution of the design project to progress in digital servitization. Further details about the interview themes are available in Appendix A.

Table 3 details the participants in all three interviewing cycles and, in column two, the participants in the co-creation workshops. At each company, one individual (marked in bold) was responsible for the project, was present for the whole design project and participated in all

Table 1
Characterization of the participant manufacturing companies.

No.	Company name (anonymized)	Size	Turnover (million euros)	Sector	Manufactured goods	Service offer when the design project began	Digital servitization maturity	Service design expertise
1	BlowMach	SME	12	Equipment goods	Blow moulding machines	- Spare parts - Maintenance - Training - Machine upgrades and retrofitting - Second-hand machine sales - Engineering services	Medium	Medium
2	ConstrucSys	Large	270	Equipment goods	Formwork and scaffolding systems	- Renting and leasing - Logistics - Pre-assembly, assembly, and execution services - Engineering services - On-site supervision and assistance - Maintenance	High	Medium
3	GearbSys	SME	20	Equipment goods	Special gearboxes and gears	- Spare parts - Maintenance and in-field repairs - Engineering services - Turnkey solutions	Medium	None
4	Food-LaundMach	Large	260	Equipment goods	Equipment for professional foodservice and laundry sectors	- Turnkey solutions - Maintenance - Logistics - Spare parts - Training	Medium	Medium
5	StampMach	Large	230	Equipment goods	Presses and stamping equipment Sheet metal cutting and processing lines	- Spare parts - Assistance and maintenance - Retrofit and equipment upgrades	Medium	None
6	AutomSys	Large	60	Equipment goods	Automated systems for entrances and automatic access control	- Spare parts - Assistance and in-field maintenance	Medium	None
7	ElectParts	SME	5	Components	Electronic and power transmission components	- Engineering services - Spare parts - Maintenance	Medium	None
8	SewMach	SME	6	Consumer goods Equipment goods	Domestic and industrial sewing machines	- Maintenance - Logistics - Spare parts - Training - Sewing academies	High	High
9	HydraSys	SME	5	Equipment Goods	Hydraulic, electro-hydraulic, and servo-hydraulic industrial automation systems	- Maintenance - Spare parts - Training	Low	None
10	AutoParts	Large	70	Components	Automotive parts	- Logistics - Basic engineering services (customized CAD & CAM)	Low	Medium

co-creation workshops and all interview cycles.

4.4. Data analysis

The extensive data gathered for this study and the access to the case companies allowed the opportunity to collect rich, thorough information. To begin the analysis, we began by outlining a detailed description of each company and the service design project carried out. At that point, based on the empirical data and previous theory, we realized that our analysis would benefit by using both process and practice modes of thought. They offer a useful way to capture the key events and micro-level practices related to service design that shape the digital servitization process over time. The process mode of thought sees change processes as driven by events; that is, observed and recorded events drive change over time (Van de Ven, 2013). The practice mode of thought captures the doing; that is, the activities and tasks that influence change (Schatzki, 2012). Schatzki (2012) further states that activities are events, characterized by being intentional and driving change, so studying types of events is well aligned with the aim of the present study.

Events are second-order 'coded sets of incidents' (Van de Ven, 2013, p. 217), while incidents are first-order, operational empirical observations: the raw data. Events can occur on various levels, such as actions performed by an actor, interactions between partners, or activities performed by several actors over time (Langley, Smallman, Tsoukas, & Van de Ven, 2013). Being able to outline the events based on the data collected allowed us to elaborate on the main events shaping the digital servitization process to reveal the microlevel activities and tasks related to service design that trigger change. All events were plotted on a table. To help categorize the events, we began our interpretation from theory and followed Poole, Van de Ven, Dooley, and Holmes (2000) classification scheme of organizational change, which uses the event types described in the Minnesota Innovation Research Program (MIRP). Like the research by Olofsson, Hoveskog, and Halila (2018), this approach is relevant for this study due to its focus on a specific innovation and change process – advanced services value proposition for digital servitization. See Table 4 for definitions of each event category and illustrative quotes from the manufacturers. The set of relevant quotes classified by event category can be viewed in Appendix A.

Table 2
The data sources.

Data Type	Focus	Number of pieces of evidence by company									
		BlowMach	ConstrucSys	GearbSys	Food-Laund Mach	StampMach	Autom Sys	ElectParts	SewMach	HydraSys	AutoParts
Co-creation workshops on planning, organization, and execution (47 in total)	Problem identification and taking action stages	7	5	5	4	4	5	4	4	5	4
Artefacts from the workshops (e.g., prototypes, marketing materials, technical reports, and service visualizations such as blueprints, customer journey maps, flowcharts, and personas; 112 in total)	Evaluation stage	16	10	9	8	7	11	14	13	12	12
Notes from the workshops observations (e.g., pictures of the workshops, pictures of the hand-made visualizations, sketches of the prototypes, and notes from the observation of the workshops and from the interviews (230 pages in total)	Evaluation stage	32	21	23	17	22	22	21	24	19	29
Interviews with managers and employees (30 group interviews in total)	Problem identification, taking action, and evaluation stages	3	3	3	3	3	3	3	3	3	3

First, in line with Van de Ven (2013), we coded all incidents (empirical observations), capturing the basic elements of information about a discreet incident that happened at a specific point of time to link it to one of the event types. As recommended by Van de Ven, Angle, and Poole (2000), the incidents were only considered and translated into the relevant event type if they occurred as part of the digital servitization process. As suggested by Robson and McCartan (2016), the overall purpose of the analysis was two-fold: (i) to determine the usefulness of service design for advanced services value proposition design in digital servitization, and (ii) to determine the role of and practical implications for industrial managers.

5. Problem identification: Design projects at the 10 manufacturers

Two of the 10 companies, ConstrucSys and SewMach, were highly servitized firms, with result-oriented renting, leasing, and training services comprising the majority of their incomes (more than 70% in the case of ConstrucSys). However, both were looking for a transition towards 'more advanced services' (General Manager, SewMach), pushed by their customers, who perceived their current service offers as 'too basic' (Marketing Manager, ConstrucSys). BlowMach, Food-LaundMach, StampMach, AutomSys, ElectParts, and GearbSys offered intermediate services such as scheduled maintenance and in-field repairs, retrofitting, or equipment upgrades. Although they did not offer advanced services, these companies presented a digital servitization strategy with developments in Industry 4.0 technologies. Finally, HydraSys and AutoParts offered only base services (i.e., repair and spare parts), but their industrial managers showed a high commitment to digital servitization.

Four companies (SewMach, Food-LaundMach, ConstrucSys, and AutoParts) already had employees trained in service design. In the case of the two highly servitized companies, those were in middle management positions. However, none of the companies had a structured process for the design of new services, and only one company (SewMach) performed service design regularly, aided by external design professionals and had internally legitimized service design. Until the design projects began, all 10 companies had always relied on third parties in the form of external consulting firms to design new services. However, there was a consensus among the companies that they needed to prioritize this aspect, and they all aimed to systematize service design practice in the coming years. BlowMach started to take steps towards systematization and, although still at an early stage, was able to outline a coherent service design process. In addition, half the companies had occasionally experimented with service design practice.

All companies believed they had selected the right Industry 4.0 technologies to enable their new advanced services, and nine of 10 had focused their efforts on developing remote condition monitoring systems via the IoT and cyber-physical systems. At half the companies, some pilot cases were already in place in customer plants. Big data, data mining, and data analytics were also in development since companies considered them to be fundamental for leveraging the IoT. The companies reported that while data capture was straightforward, it was not yet clear to them how to interpret data to draw relevant conclusions or to transform them into valuable advanced services for the market. Manufacturers recognized that the development of those technologies was not clearly aligned with their digital servitization strategy and their intended value propositions. Half the companies had fully developed the

Table 3
Participants in the interviewing cycles and the co-creation workshops.

Company	Participants in the first interviewing cycle (before the design project)	Participants in the workshops and in the second interviewing cycle (just after the design project)	Participants in the third interviewing cycle (six months after the design project)
BlowMach	**R&D Director** Industrial Manager	**R&D Director** Industrial Manager Head of Maintenance R&D Engineer General Manager	**R&D Director** Industrial Manager
ConstrucSys	**Strategic Marketing Manager** Marketing Director	**Strategic Marketing Manager** Marketing Director Marketing Technician Head of ICT Systems Operations Director	**Strategic Marketing Manager** Marketing Director
GearbSys	**R&D Director** General Manager	**R&D Director** General Manager Sales Manager Commercial	**R&D Director** General Manager
Food-LaundMach	**Marketing Director** Marketing Technician	**Marketing Director** Marketing Technician R&D Engineer Chief Digital Officer	**Marketing Director** Chief Digital Officer
StampMach	**R&D Manager** Service Manager Sales Manager	**R&D Manager** Service Manager Sales Manager	**R&D Manager** Service Manager
AutomSys	**Sales Director** R&D Director	**Sales Director** R&D Director Service Manager After Sales Service Director Sales Manager Business Unit Director R&D Technician	**Sales Director** R&D Director
ElectParts	**R&D Engineer 1** General Manager	**R&D Engineer 1** General Manager R&D Engineer 2 Development Engineer 1 Development Engineer 2	**R&D Engineer 1** General Manager
SewMach	**Product Manager** Marketing Director General Manager	**Product Manager** Marketing Director General Manager Product Engineer 1 Product Engineer 2	**Product Manager** Marketing Director
HydraSys	**General Manager** Industrial Director Business Unit 1 Director Business Unit 2 Director	**General Manager** Industrial Director Business Unit 1 Director Business Unit 2 Director	**General Manager** Industrial Director
AutoParts	**Human Resources Manager** Industrial Director	**Human Resources Manager** Industrial Director Continuous Improvement Manager Production Director Chief of staff Human Resources Technician	**Human Resources Manager** Industrial Director

technological solutions without researching the demands of their customers or reflecting on the customer experience with the deployment of the technologies. As the R&D Manager of GearbSys pointed out, 'the speed of our Industry 4.0 technology development has been faster than internal reflections and market demand.'

Table 5 shows the intended advanced services value proposition for each company. Most aimed to design productivity performance, availability, and maintenance or pay-per-use advanced services enabled by remote condition monitoring systems like the IoT and cyber-physical systems. When the design projects began, all companies indicated that they had 'an idea' about their advanced services value proposition by 'sketching it' in an unstructured manner.

In general, all companies claimed to have a positive attitude throughout the organization towards digital servitization. All companies displayed a service-oriented mentality through their high commitment to their customers and their offers of intermediate or basic services. However, the interviewees from ConstrucSys, a highly servitized company, indicated that employees that did not have direct communication with customers tended to lose their sensitivity to customer needs. All companies indicated that the main objectives for digital servitization were to generate differentiation in the market, increase customer loyalty, and establish barriers to entry for competitors. Another important motivation for the development of advanced services was to obtain data about the performance of their products that would enable further product innovation. Only two of the companies, BlowMach and ConstrucSys, saw commitment to advanced services as a way to generate stable and significantly increased revenue flows.

However, despite recognizing the benefits that advanced services would bring, company representatives raised many concerns: 'We don't know how we could monetize these advanced services in a direct way. […] The market is not ready yet,' (Sales Manager, StampMach). 'We are not considering charging per part produced. [...] We don't know our own machines well enough to think about that,' added the R&D Manager from the same company. 'At the moment, we are not thinking of changing our business model, at least not radically; we prefer to avoid risks and not to face unknown scenarios, and we don't want to generate tensions with our distributors,' the Marketing Director from Food-LaundMach said. Additionally, the larger organizations stated that their decentralized structures tended to hinder and slow the digital servitization process. They also felt that significant organizational

Table 4
Classification scheme of organizational change based on event types (adapted from Poole et al., 2000).

Event	Events related to advanced services value proposition design	Illustrative quotes related to each event category
People events	Qualitative and quantitative changes related to staff and responsibility for the advanced services value proposition design.	'Applying the tools requires a design expertise that most of our people don't have yet, but the way of thinking by putting the focus and the centre of the service on the needs and the experience of the clients; that has remained the same' (General Manager, GearbSys).
Idea events	Qualitative and quantitative changes related to ideas (core and related) about the advanced services value proposition design.	'Iterating, checking the ideas with customers; this approach has remained after your intervention. […] Beyond the methodologies and tools, this has permeated the team. […] This way of doing things is growing, and an evolution is positive within the company; we are now opening it up to our customers.' (Strategic Marketing Manager, ConstrucTs).
Transaction events	Changes in legal or social contracts (internal and external) on how the advanced services value proposition design is linked and in its importance to digital servitization.	'With the pay-per-use model we assume a certain financial risk, risks of non-payment [...] but if this happens, the machines are blocked through the IoT. And not only because of non-payments; if the machine is not connected for more than two days, the equipment is also blocked. Technology helps to manage those risks, and this was decided in a collaborative manner in the (service design) workshops' (Chief Digital Officer, Food-LaundMach).
Context events	Occurrence of external incidents related to any aspect of advanced services value proposition design beyond the control of the organization.	'The pandemic has slowed down some plans; for example, the monitoring system indicated impending failures but as we could not travel, we could not provide in-field service and the customer experience was not good' (R&D Director, GearbSys).
Outcome events	Realization of outcomes (positive, negative, or mixed) related to any aspect of advanced services value proposition design.	'We have marketed the new service in some countries in Europe; we'll test it there and see how it goes. Then, the plan is to expand to the rest of the countries afterwards' (Marketing Director, ConstrucTs).

changes were required to deliver advanced services, which slowed the progress of digital servitization.

Companies highlighted the lack of market demand and the perception of customers of advanced services value propositions. 'Customers are used to having services attached to the purchase of the equipment and they simply expect to have them for free,' said the General Manager for GearbSys. In addition, representatives of eight companies indicated that their customers might be unwilling to share their resources and grant access to their data. 'These services require being more transparent about sensitive information of internal processes, both for us and for our customers; […] some of our customers are simply not going to accept this' (R&D Manager, GearbSys). Additionally, half companies experienced internal resistance due to uncertainty about monetization, the establishment of long-term commitments with customers, and new costs that were difficult to calculate. 'We don't want to assume long-term commitments with our customers without knowing what the cost of the service itself might be, or making investments or relocating resources without knowing what the market demand for the service will be,' said the StampMach R&D Manager.

Table 5
Intended advanced services value proposition by company.

Company	Intended advanced service value proposition
BlowMach	Production performance improvement services based on remote condition monitoring technologies.
ConstrucSys	Concrete formwork and scaffolding construction systems improvement services based on remote condition monitoring technologies.
GearbSys	Availability services based on remote condition monitoring technologies.
Food-LaundMach	Pay-per-use services based on remote condition monitoring technologies.
StampMach	Advanced maintenance services based on remote condition monitoring technologies.
AutomSys	Full availability services based on remote condition monitoring technologies.
ElectParts	Production performance improvement services based on remote condition monitoring technologies.
SewMach	On-site and on-line sewing academies based on ICT platforms.
HydraSys	Maintenance services based on remote condition monitoring technologies.
AutoParts	Advanced product co-design and co-engineering services based on ICT platforms.

Overall, while there was a clear commitment to digital servitization, and Industry 4.0 developments were taking place at high speed, there was no clear vision among the manufacturers of how these technologies would enable advanced services value propositions. Additionally, a lack of service design expertise and the absence of a well-structured process for designing services were also evident in the companies.

6. Taking action: The approach to advanced services value propositions

Four design phases were featured when the focus was on taking action of the research flow: explore, define, create, and develop (Fig. 2). Each design phase represents a co-creation workshop cycle (W1 to W4) in which the visualization tools are recurrently applied. Explore (W1) aims to identify customer value and involves collecting customer data to gauge the customer's perspective. Define (W2) aims to visualize, merge, and prioritize customer insights through visualizations. Create (W3) is focused on the conceptual design of the new advanced services value proposition. Finally, develop (W4) defines and prototypes service operations and touchpoints and assesses the impact on the company's business model. These phases capture activities and tasks – that is, doings – that aim to facilitate the emergence of advanced services value propositions. They are in line with the processual definition of digital servitization provided by Kohtamäki et al. (2021).

Appendix A lists the co-creation workshops and details the visualization tools used at each manufacturer. The design stages were iterative, so the visualization tools were used several times in the process, and they were revised and updated multiple times after each workshop. In total, we conducted 47 co-creation workshops organized around the four design phases. In many cases, more than one workshop was necessary to address each design phase; additionally, the visualization tools were reworked by participants between workshops. At on-site workshops, participants co-created the visualizations on paper templates using sticky notes and marker pens (Fig. 3). With online workshops, participants co-created the visualization on Miro boards; Miro is a visual collaboration tool. Fig. 4 presents an example of a work-in-progress Miro board at HydraSys.

Table 6 describes the service design practices that took place at the manufacturers through a microlevel lens. We focus on the description of

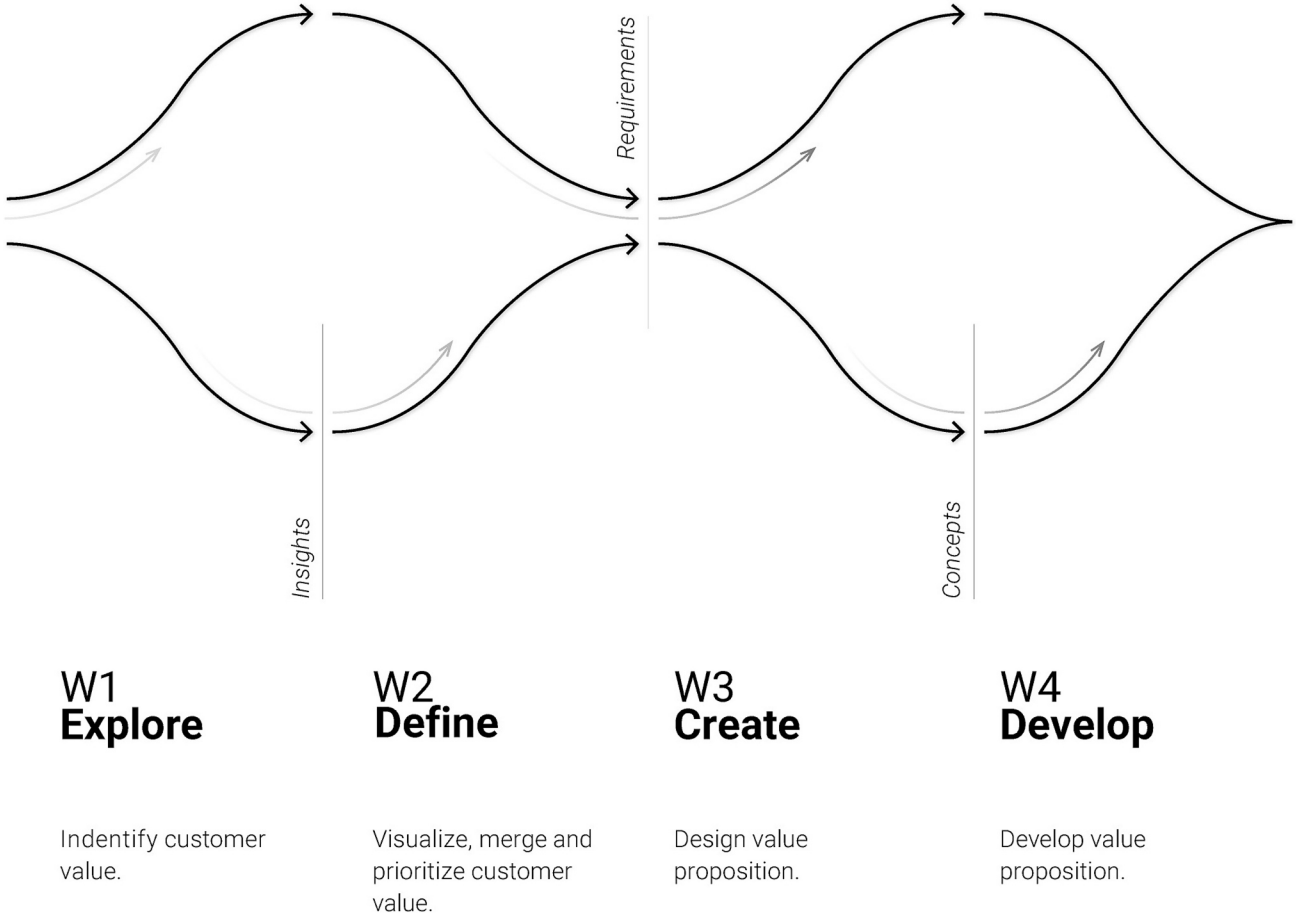

Fig. 2. The design process applied at the 10 manufacturers.

the activities carried out in the co-creation workshops and how participants applied service design visualizations and prototyping tools.

7. Findings: Relevant events to advanced services value propositions design facilitated by service design

To depict the observed and recorded events relevant to advanced services value proposition design and capture the doings that facilitate the digital servitization process over time, we categorize them based on Poole's et al. (2000) categories – people events (P), idea events (I), transaction events (T), context events (C) and outcome events (O) – that emerge from the cases. Appendix A summarizes quotes illustrating the identified events within each category.

7.1. People events

People events refer to the qualitative and quantitative changes specifically relating to staff and responsibility for advanced services value proposition design. Six months after the design projects ended, a large majority of the manufacturers (eight of 10) had allocated human resources to service design practices by hiring service designers, training in-house designers and engineers in service design, or redirecting employees' roles towards service design practices (P1). Industrial managers in these companies decided to allocate human resources to service design practice because as the Chief Digital Officer, Food-LaundMach noted:

> We think their aptitudes – empathy, teamwork facilitation, and visual communication skills – […] can contribute a lot to bridge our servitization and digitalization processes […] to seek shared visions and facilitate decision-making. […] She [the service designer] is now leading customer research and co-creation with customers.

The manufacturers did not create new organizational structures to allocate service designers; rather, they were integrated into existing departments (e.g., R&D, digital transformation, customer service, or marketing). The allocation of human resources to these departments assigns leadership for advanced services value proposition design to these teams and employees (P2): 'Now, we [the Strategic Marketing team] are tasked with leading the digitalization of our services. […] Before, it was an open discussion in the company' (Strategic Marketing Manager, ConstrucTs).

Moreover, at half the manufacturers, after the design project took place, some participating employees were formally entrusted by management to run service design practices (e.g., performing customer research or facilitating co-creation workshops with customers). Additionally, new roles were created inside departments to carry out design practices (e.g., UX/UI designers, design researchers; P3). As the R&D Director from StampMach noted:

> We realized that we needed to create a new role in the company [assistance manager] to better understand customer needs and collect customer requirements in a proactive way, not just reactively. […] I think that design-related knowledge such as how to perform interviews or facilitate focus groups with customers and how to synthesize and visualize information using personas, for example, can be very useful.

Outcomes from service design practices, such as the results of customer data collection and the visualizations built into the co-creation workshops, positively influenced the engagement and empowerment of

Fig. 3. On-site co-creation workshops with the manufacturers.

internal (e.g., software developers, maintenance staff) and external stakeholders (e.g., Industry 4.0 development partners) in advanced services value proposition design. This motivated industrial managers to allocate resources to service design practices:

> Before, they [development engineers] were far away from the customer; the workshops have brought them closer to their [customer] needs. [...] They now go on site visits and participate in customer conversations (General Manager, ElectParts).

Overall, people events show that the design project drove industrial managers to develop service design capabilities among company staff to promote and sustain advanced services value proposition design in digital servitization over time. Industrial managers enhanced the development of service capabilities on the corporate level by hiring, training, or re-allocating in-house designers and engineers to practices that were not previously legitimized within the organization. The incorporation of service design capabilities resulted in intentional practices in the development of more service-oriented, customer-focused, and human-centred skills in specific teams inside their companies: 'The organization is now more convinced (about digital servitization) and what is certain is that the new profiles are drivers of the change' (Chief Digital Officer, Food-LaundMach).

Notably, this also changed attitudes towards service design practice among people not working at the frontline. Allocating resources to service design facilitated shared understandings of the motivations for the various stakeholders internally and externally while speeding up the digital servitization process by assigning clear leadership inside the company to specific teams and employees. Overall, our first insight based on the empirical evidence about people events indicates that by allocating human resources to service design practices, the manufacturers' management internally legitimized digital servitization.

7.2. Idea events

Idea events specify qualitative and quantitative changes related to notions about advanced value proposition design tasks and activities. We found that nine manufacturers were applying service design practices six months after the design project took place (I1). Several service design microlevel practices were established inside those firms. We observed a recurrent use of qualitative design research (e.g., interviews, in-field observations, cultural probes for data collection) with customers and other external stakeholders, the use of co-creation workshops with stakeholders across different departments and externally with customers and partners, the use of visualization tools (customer journeys, service blueprints, service ecologies, and personas) in these co-creation workshops, and the application of design prototyping methods (role playing and UX/UI prototyping) to test new concepts and ideas internally (across departments) and externally (with Industry 4.0 developer partners and customers):

> Since the project began, we have been using them [visualizations] assiduously […] Personas and customer journey mapping are now key for us to iteratively inform our customer research activities (Product Manager, SewMach).

Industrial managers highlighted the agility, ease of use, and transversality of service design as the key to the adoption of new routines for value proposition design:

> We wanted to bring our [service] ideas down to earth. We have discovered an agile methodology to order, visualize, and land our ideas in an orderly way, following a process that we did not know before and that is easy and fast to apply in order to make our ideas tangible. […] We did not know how to design services; it marks a before and after (Business Unit 1 Director, HydraSys).

Fig. 4. The work-in-progress Miro board at HydraSys.

Moreover, six manufacturers started to frame these practices in a new structured service design methodology that was communicated and shared within the organization: 'I think that we can say that now we have a clear step-by-step process to design new services,' noted the R&D Director of BlowMach.

The departments responsible for leading the design of advanced services (see P2) created and shared across the organization the(ir) new service design process (I2) for reinforcing their leadership in new value proposition design inside the company. Service design practices gained legitimacy at each manufacturer under the leadership of a specific team as they were successful at achieving alignment and fostering collaboration between stakeholders inside and outside the company:

> Service design activities have produced a symbiosis between business and technology developers, as well as introducing new roles and agile methodologies in the company as the new way of working (Chief Digital Officer, Food-LaundMach).

Overall, our second insight based on the empirical observations about idea events shows that the application of service design microlevel practices allowed service design to gain legitimacy inside the manufacturers for digital servitization by fostering collaboration between external and internal stakeholders through co-creation and visualization tools.

7.3. Transaction events

Transaction (T) events reflect the changes in legal or social contracts (internal and external) on how the advanced value proposition design activities and tasks are linked and their importance to digital servitization. Three companies created a new business unit to provide the advanced services value propositions from the service design project, while two others restructured and reinforced an existing unit to enable it to deliver the designed advanced service (T1). The reasons for the establishment of separate business units mentioned by the industrial managers were as follows: (i) to better communicate to the market the new value proposition (notably, all 10 companies created new brands for the new service unit); (ii) to achieve a more efficient match of internal resources to meet market needs; (iii) to avoid tensions in the value chain (e.g., avoiding conflicts with distributors); and (iv) to minimize financial and pricing uncertainties linked to the new advanced services value proposition. Industrial managers participating in the service design projects indicated that the decision-making process to create a new business unit was influenced and sped up by the co-creation workshops and the tools used in the workshops: 'The experimentation served as a reflection and was the trigger for the launch of the new business unit and new service development projects,' said the Marketing Director of Food-LaundMach.

Visualizations contributed to generate convergence and a common understanding among industrial managers on the innovativeness and

Table 6
Viewing service design practices at the companies through a microlevel lens.

Service design co-creation workshop cycle	Description of the workshops
Explore (W1): Identify customer value.	To collect valuable insights from customers and other external stakeholders through co-creation workshops, design research was applied. As a result, each of 10 manufacturers performed several interviews with stakeholders; two ran a focus group with customers, two conducted observations in customers' plants, and one launched a customer survey.
Define (W2): Visualize, merge, and prioritize customer value.	To analyze customer value propositions based on the outcomes of the first workshop cycle, participants were first asked to build personas representing the key people involved in purchasing decisions inside the customer firm (e.g., production managers, quality managers, maintenance managers, operators). Customer journey maps were also applied to identify customers' pain points in existing service offerings. Due to the network of stakeholders and their interactions in the companies' value ecosystems, service ecologies were also used to analyze the nature of the interactions among stakeholders. Furthermore, in some cases, business model canvases were created (or revised) in parallel to analyze the current value propositions and business models.
Create (W3): Design value proposition.	To ideate advanced services value propositions, brainstorming and dot-voting techniques were iteratively used with different visualizations combining divergence and convergence thinking. In some company cases, design scenarios were also generated to explore possible futures by creating speculative narratives; these scenarios were used as a base to build the customer journey maps from scratch later. Participants generated ideas on the customer journey maps with several layers that capture the journey of all of the customer's key personas and stakeholder interactions (e.g., sales activities, product transactions) identified by the explore and define workshops. Participants also built or rebuilt service ecologies by analyzing the relationships among stakeholders to envision possible changes in the ecosystem.
Develop (W4): Develop value proposition.	To develop value propositions, different design stages were executed to build the service operations, measure the impact of the business models, develop and prototype service touchpoints. First, changes in service operations were defined; participants used service blueprints and flowcharts for this aim. Based on the customer journey maps, blueprints were created to create make the link between the intended customer experience, the backstage processes, and the support processes. Second, flowcharts were used, modified, and updated to go further in the specific details of the key service operations. In parallel, business model canvases were again used to analyze the impact of the new value propositions. Third, participants built rapid prototypes simulating service touchpoints by applying evidencing prototyping that would enable the service to render tangible value to the customers. This includes a very diverse set of prototypes for envisioning the outcomes of the service during the entire customer journey (e.g., marketing and training material, drafts of offers and contracts models, technical reports, user interfaces). Finally, these prototypes were tested by half of the companies who asked for the involvement of external stakeholders like customers and partners.

appropriateness of the service ideas, monetization models, infrastructures, the establishment of new relationships with stakeholders in the value network, and the need for new human resources, organizational structures, and new enabling technologies:

> We have established a new business unit to deliver the services. […] The key from the workshops was the reflection we did on the partners needed to offer a more inclusive productivity service that also included aspects of quality and people management. Thanks to that, we have been able to reach customers from different sectors, and I believe the project was one the keys (General Manager, ElectParts).

In particular, service design microlevel practices in the form of co-creation and visualization tools helped generate convergence and a common understanding among industrial managers about the decisions to be made on the investments needed to deliver advanced services value propositions. Half the manufacturers activated plans for further investments to develop enabling Industry 4.0 technologies or realigned existing development projects to better fit customer needs after the design projects took place (T2). The R&D Director at AutomSys stated, 'the project helped us to understand that servitization and connectivity developments and digitalization go hand in hand. […] A large part of the company's new technology strategy is grounded in the work we did in the workshops.' The General Manager at HydraSys confirmed this view: 'In the workshops we realized that to provide the new services, we needed to develop new technologies (VR and AR) that we didn't consider valuable before.'

Significantly, we also observed that manufacturers were adapting visualization tools to consider Industry 4.0 performance. For example, we noticed changes in the customer journey maps and service blueprints, where new levels were added after the co-creation workshops so that developing engineers across departments and in external Industry 4.0 technology partners could use the visualizations to discuss the outcomes generated by the technological systems in the different phases of the customer's life cycle. The R&D Director of BlowMach put it this way:

> It was interesting to see how blueprints led to further Industry 4.0 developments. […] What purpose do we pursue with big data? […] Which outputs should be generated for the customer? […] When in the [customer] relationship? […] Working on the technical dimension but with a tool [the blueprint] that goes beyond technology was valuable for our engineers to add new functionalities to the new smart system.

Furthermore, service design practices assisted industrial managers in decision-making for developing Industry 4.0 technologies to minimize risk in the intended advance service value proposition. For example, the Chief Digital Officer at Food-LaundMach indicated that:

> With the pay-per-use model we assume a certain financial risk, risks of non-payment […] but if this happens, the machines are blocked through the IoT. And not only because of non-payments; if the machine is not connected for more than two days, the equipment is also blocked. Technology helps to manage those risks, and this was decided in a collaborative manner in the workshops.

Finally, nine companies were awarded with regional, national, or European public funding or with awards, recognition, and establishment of partnerships with clients and other stakeholders to further develop the enabling Industry 4.0 technologies (T3):

> We have secured funding to develop the new service from several regional innovation calls because the idea that came out of the workshops has been considered very innovative (General Manager, HydraSys).

Overall, the empirical evidence about the transaction events indicates that the co-creation process and the use of visualization tools helped industrial managers with decision-making about novel organizational configurations and new Industry 4.0 developments. This leads

us to our third insight, which shows that service design triggered organizational reconfiguration to deliver advanced services value propositions while leveraging Industry 4.0 development aligned with customer and other relevant stakeholder needs. This resulted in the establishment of new value ecosystems to support the development of advanced services.

7.4. Context events

Context (C) events are external incidents related to any aspect of advanced services value proposition design activities beyond the organization's control. The one context event that universally affected the advanced services value position design process in digital servitization beyond the manufacturers' control was the economic crisis generated by the COVID-19 pandemic (C1). For manufacturers linked to sectors like automotive or aerospace (e.g., StampMach and AutoParts), the pandemic significantly slowed their advanced services value proposition design process due to a significant drop in market demand that led to radical changes in the priorities of both the manufacturers and their customers. However, other companies (e.g., ElectParts and Food-LaundMach) indicated that even though there was no increase in advanced services demand, they found that their customers became more perceptive about Industry 4.0-enabled value propositions. The General Manager of ElectParts stated, 'I think that the current context does not help sell the new services. […] In any case, I believe that there is a change of perspective; COVID has accelerated digital technology acceptance, and this is going to be reflected sooner rather than later.' The Marketing Director at Food-LaundMach explained the situation as follows:

> We were the first in our sector to offer pay-per-use and total-care solutions in the national market. […] Maybe the market demand is still incipient, but when demand grows, we'll be prepared. […] Definitely, the project accelerated our digital servitization progress.

On the contrary, companies in the retail and consumer goods sectors (e.g., BlowMach and SewMach) viewed their digital servitization process as notably accelerated since market demand for services (mainly base and intermediate) grew exponentially due to the effects of the COVID-19 pandemic. In that sense, service design prepared the companies better than their competitors for unexpected events such as the pandemic. For example, the sewing machine producer (SewMach) doubled its revenue from product sales and increased its service revenues by more than 11 times. The SewMach Product Manager indicated that 'we have had several stock-outs. […] The service we designed has been one of the keys because thanks to it we have been able to build loyalty and retain our customers and win new ones; we were more prepared than our competitors'.

Overall, our fourth insight based on the empirical evidence about context events indicates that service design better prepares manufacturers for exposure to external factors that might put the digital servitization process at risk.

7.5. Outcome events

Outcome (O) events reflect the results of the application of the design projects at the manufacturers. Six months after the design project took place, six companies had progressively marketed the advanced services involved in the service design project (O1): 'We have marketed the new service in some countries in Europe. We'll test it there and see how it goes; then the plan is to expand to the rest of the countries afterwards' (Marketing Director, ConstrucTs). For the rest, advanced services were still under development. Companies that did not bring their advanced services to market reported contextual factors described in the previous section (C1) as the main reason for the slower pace of their advanced services value proposition progress.

However, in all cases, the manufacturers indicated that service design practices contributed to materializing digital servitization strategies into value propositions and helped them better communicate with customers: 'For us, service design was useful to streamline our servitization strategy, prototype the digital platforms and other service touchpoints, and bring the service ideas to the market' (R&D Director, BlowMach).

This indicates how the companies witnessed an alignment between customer requirements and characteristics that led to ideas for new advanced service value propositions (external fit) and the service operations necessary to offer these new value propositions to customers in digital servitization (internal fit; O2). This was made possible by the conscientious design of all the touchpoints (digital and physical) facilitated by the service designers. All those touchpoints were carefully planned and designed to demonstrate the potential for value co-creation to customers over time. This facilitated presenting and communicating value-in-use step by step both internally and externally. The process was entirely focused on customer value co-creation mapped in the visualization tools created in the workshops:

> We are using service design to detect the key performance indicators of the different users in the value chain, to develop co-creation activities with these users, and to design excellent user experiences for the new value propositions. […] I believe that service design is one of the catalysts of the process (Chief Digital Officer, Food-LaundMach).

Overall, our fifth insight based on the empirical evidence about the outcome events indicates that service design provided manufacturers with a way to achieve a progressive materialization of advanced services value propositions in the digital manufacturing context from the overall concept level to the detailing of single service operations and touchpoints.

8. Discussion: The impact of service design on digital servitization

We set out to understand the impact of service design in the digital servitization process by identifying the types of events and surfacing microlevel practices that facilitate advanced services value proposition design in the manufacturing context. Based on the overview of the different types of events, five main insights were formulated. In this section, we discuss each in light of the relevant literature. Fig. 5 integrates the five insights (the impact of service design in the digital servitization process) in relation to the events and the microlevel practices of service design into a single figure to show the interplay between those.

8.1. By allocating human resources to service design, industrial managers internally legitimized digital servitization

Industrial managers play a central role in building a service culture around digital servitization inside the company (Favoretto, Mendes, Oliveira, Cauchick-Miguel, & Coreynen, 2022; Huikkola et al., 2020). Alghisi and Saccani (2015) note that top management must demonstrate a visible commitment to servitization in order to legitimize the change processes required. Our findings show that by intentionally allocating human resources to service design practices (P1), industrial managers internally legitimized digital servitization. By assigning clear leadership to specific teams and employees (P2) and entrusting them with running service design practices for advanced services value proposition design (P3), industrial managers generated trust among employees across departments in regard to the company's digital servitization strategy, which is vital for that strategy to succeed (Tronvoll et al., 2020).

Trust creation across an organization has been noted as important for the consolidation of digital servitization by researchers like Dmitrijeva et al. (2020) and Sjödin et al. (2020). We demonstrate that service designers serve as catalysts in this regard because they contribute to overcoming intraorganizational tensions (Tóth et al., 2022) by

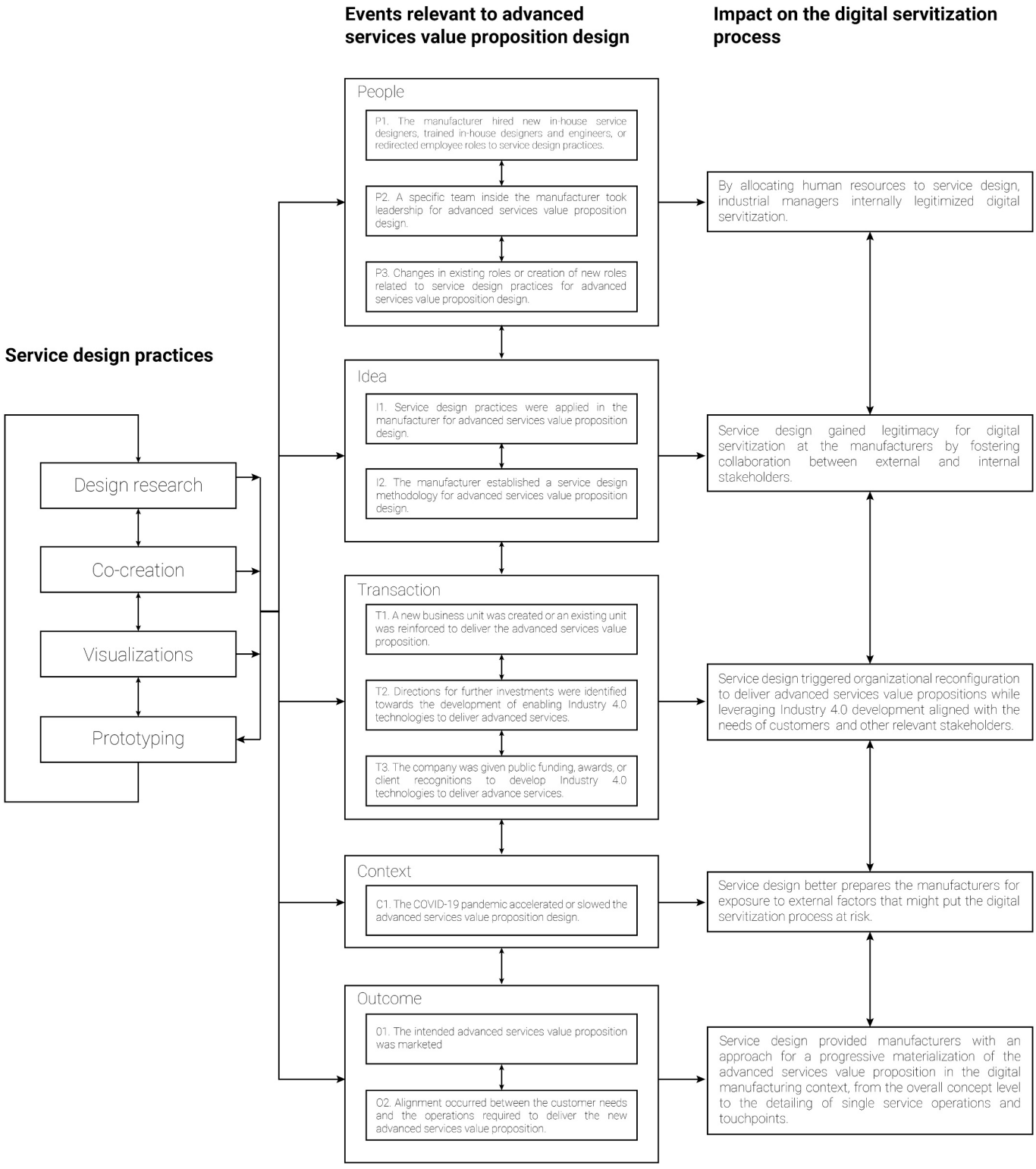

Fig. 5. The interrelationships between service design practices, the key events relevant to advanced services value proposition design, and the impact on the progress of digital servitization.

facilitating co-creation and collaboration among departments. This is aligned with the findings of Coreynen et al. (2017) and Favoretto et al. (2022), who explain that manufacturers need to develop or acquire new knowledge and competencies to make progress in digital servitization, and with the findings of Tronvoll et al. (2020) and Cimini, Adrodegari, Paschou, Rondini, and Pezzotta (2021), who highlight the necessity of hiring employees with soft skills (e.g., facilitation skills for negotiation and cooperation) to break silo mentalities by facilitating collaborative work internally and externally.

8.2. Service design gained legitimacy for digital servitization by fostering collaboration and co-creation between external and internal stakeholders

The lack of service expertise and knowledge is a notable barrier for

digital servitization progress in manufacturing (Paiola & Gebauer, 2020; Story et al., 2017; Tronvoll et al., 2020). In particular, the digital servitization literature indicates that limits on organizational capacity to collect customer feedback slows digital servitization progress (Bigdeli et al., 2021; Gebauer & Friedli, 2005). Therefore, the development of the manufacturer's capability to co-create and learn from and with customers and other external stakeholders is crucial in digital servitization (Dmitrijeva et al., 2020; Favoretto et al., 2022). Through the 10 studied manufacturers, we revealed that the recurrent application of service design microlevel practices (I1) and the establishment of a service design methodology (I2) foster manufacturers' ability to co-create and learn from customers and other stakeholders. Our findings thus show that service design gained legitimacy within the manufacturers because the staff participating in service design practices saw how successful collaborations emerged even as the intensity of cooperation between external and internal stakeholders increased as a result of service design. That means that service design practices not only serve to open up internal departmental silos (Kohtamäki et al., 2021; Li et al., 2021; Solem et al., 2021; Tronvoll et al., 2020) but also help foster co-creation and overcome resistance externally among customers and other stakeholders (e.g., Industry 4.0 technology developer partners). Moreover, our findings show that service design promotes the necessary change in the roles, mindsets, and skills of people not working on the frontline with customers (Tronvoll et al., 2020) in order to guide and facilitate advanced services value proposition design process in digital servitization. Service design was useful to clear up employee misconceptions about the new service concepts, which is a relevant internal challenge in servitization (Bigdeli et al., 2021).

8.3. Service design triggered organizational reconfiguration and leveraged Industry 4.0 development to deliver advanced services in digital servitization

Our findings show that service design also empowers and speeds up industrial managers' decision-making for the materialization of digital servitization. New business units were formed and/or existing ones were reinforced to deliver the advanced services (T1) derived from the design projects. The observation of organizational changes in the manufacturers aligns with recent research in digital servitization (e.g., Favoretto et al., 2022), which emphasizes the need for changes in organizational design as one prerequisite for successful digital servitization.

Advanced services value propositions increase complexity and require the adoption of an ecosystem perspective (Bigdeli et al., 2021; Kolagar, Reim, Parida, & Sjödin, 2021), which translates into more complex environments and the challenging orchestration of the actors involved (Beverungen, Kundisch, & Wünderlich, 2020; Favoretto et al., 2022; Paiola & Gebauer, 2020; Sklyar, Kowalkowski, Tronvoll, & Sörhammar, 2019), such as the need for new partnerships (Chen et al., 2020). Our findings indicate that service design helps in mobilization; that is, manufacturers plan suitable directions for investment that leverages Industry 4.0 development (T2) to design and deliver advanced services that can be supported and rewarded by public organizations and customers (T3). Service design also contributed to integration in the form of generating convergence and a common understanding among industrial managers and engineers (Favoretto et al., 2022) on the investments needed to develop the enabling Industry 4.0 technologies that will deliver value to customers. Service design helped manufacturers to reflect on the use of Industry 4.0 technologies for risk management, pricing policies, and delivery of risk–reward contracts (Story et al., 2017) and customer relationships (Paiola, Schiavone, Grandinetti, & Chen, 2021). Therefore, service design demonstrated the capacity to leverage IoT technological developments (Patrício, Gustafsson, & Fisk, 2018) in manufacturing digital servitization contexts by fostering discussions of complex value creation ecosystems (Paiola et al., 2021), such as facilitating support for the transition from ownership-based business models to non-ownership-based approaches (see the Food-LaundMach case; Ehret & Wirtz, 2017; Paiola & Gebauer, 2020).

8.4. Service design better prepared manufacturers for exposure to external factors that put digital servitization at risk

Successful progress in digital servitization depends not only on the capabilities of the manufacturer but also on its ability to navigate its contextual environment (Dmitrijeva et al., 2020; Parida et al., 2014; Turunen & Finne, 2014). Our findings show that service design practices resulted in better positioning manufacturers for unexpected external contextual factors (e.g., increased market demand because of COVID-19 pandemic) that could put digital servitization at risk (C1; Dmitrijeva et al., 2020; Favoretto et al., 2022). This ability is acquired by thinking holistically about the nature of the relationship among the different stakeholders (Story et al., 2017) and putting the emphasis on the customer's perspective (e.g., operations, capabilities, processes; Baines & Lightfoot, 2013; Eichentopf et al., 2011; Kindström, 2010).

8.5. Service design provided progressive materialization of the advanced service value proposition in digital servitization

The present study has shown that service design facilitated manufacturers in the progressive definition of advanced services from the conceptual level to the details of single service touchpoints and processes in the market delivery of advanced services (O1; Favoretto et al., 2022; Solem et al., 2021). Service design was useful to manufacturers to better communicate and demonstrate value to customers and other external stakeholders. This addresses the issues related to ineffective communication in the delivery of advanced services. Sjödin et al. (2020) state that embracing agile co-creation practices in digital servitization contributes to understanding how customers combine resources, processes, and outcomes. Service design practices demonstrated their utility not only for understanding the co-creation of value with the customer by involving numerous cross-functional actors but also in materializing co-creation outcomes into specific service touchpoints and processes to better communicate and demonstrate value to customers.

In addition, as previous single case research has suggested (Iriarte et al., 2018; Solem et al., 2021), the present study indicates that service design generates the necessary alignment between external (customer needs, wants, and processes) and internal (resources, processes) factors during advanced services value proposition design (Kindström et al., 2013; Münch et al., 2022). This alignment enables manufacturers to overcome the 'service paradox' in digital servitization (Favoretto et al., 2022) by better understanding customer needs and characteristics and accelerating the definition of the new service offer. Our study has demonstrated that this alignment is independent of both manufacturer characteristics and external context.

Fig. 5 depicts the interrelationships between service design practices and the key event categories during the design of advanced services value propositions and their impact on the progress of digital servitization. In service design, the microlevel practices or doings are interrelated and used in an iterative fashion. For example, visualization tools are used in co-creation workshops, design research informs visualizations, and visualizations help identify new touchpoints to prototype; the cycle continues beyond that point. The events also present interrelationships among each other. For example, valuable outcomes from service design practices lead industrial managers to allocate human resources to service design which themselves reinforce specific service design practices and legitimize service design in general. The same phenomenon was observed in the impacts on digital servitization. For example, successful materialization of the advanced services value proposition through co-creation between external and internal stakeholders leads to service design legitimacy, with digital servitization progressing at the same time.

This is in line with the processual definition of digital servitization offered by Kohtamäki et al. (2021), for a constant construction and

reconstruction at the microlevel when planning, implementing, and readjusting tasks and activities which, in our case, are guided by service design. Additionally, it strengthens those authors' finding about the digital servitization change process taking place through mobilization and integration, meaning that creativity leads to new initiatives which, if accessed as valuable, need to be integrated into the organization. As the authors explain, the tension between mobilization and integration drives the change process, something we also observed in our study.

9. Conclusions

9.1. Theoretical contributions

This paper sheds light on the digital servitization change process by adopting both processual and practice perspective on routines to map in detail the types of events and reveal managerial doings in relation to service design that shape advanced services value proposition design. The paper has advanced the discussion on how service design practices facilitate manufacturers' advanced services value proposition design in digital servitization through a multi-case study of 10 manufacturers undertaking digital servitization that we followed for more than two and a half years. More specifically, this study contributes to digital servitization literature by empirically investigating advanced services value proposition design as a starting point of the digital servitization process, as opposed to other data insights and thus offers another possible approach. We revealed how the use of microlevel practices of service design (e.g., visualization tools in co-creation), and not only pure data insights (e.g., detecting errors in machine-centric data, identifying patterns into larger datasets), helps manufacturers in their digital servitization process by envisioning the ecosystem needed (e.g., the necessary partners) to deliver advanced services and reducing uncertainty by iteratively discovering which possible advanced services value propositions to explore further (Dattée, Alexy, & Autio, 2018). This is relevant because it means that service design microlevel practices directly impact the ecosystem orchestration for digital servitization (Kolagar et al., 2021; Makkonen, Nordberg-Davies, Saarni, & Huikkola, 2022) by reflecting on the need for collaboration, demonstrating the benefits of collaboration, and considering reviewing current relations or the goals of the collaboration.

Although Industry 4.0 facilitates servitization by improving the delivery of advanced services and enabling data insights (Paschou et al., 2020; Rust & Huang, 2014; Thoben, Wiesner, & Wuest, 2017), it alone does not automatically lead to new and increased value creation (Gaiardelli et al., 2021; Kohtamäki et al., 2019; Kristensson, 2019) and co-creation is needed with partners and customers to develop advanced services value proposition (Jovanovic et al., 2022). Our study shows that when service design is applied in digital servitization for advanced services value proposition design by cross-functional groups, it opens the way to organizational reconfiguration and leverages Industry 4.0 by encouraging co-creation both internally and externally (i.e., integration). Co-creative microlevel practices of service design foster individual actors to reshape and align their mental models (Vink, Edvardsson, Wetter-Edman, & Tronvoll, 2019) about advanced services value proposition design. Moreover, successful outcomes endorse the general judgement of service design as a desirable and pragmatically useful capability to drive digital servitization. This triggers new routines to come into life in the organizations characterized by a more service- and customer-oriented culture internally and externally by increasing collaboration with customers and other stakeholders, which in turn supports the legitimacy of digital servitization. Thus, our work grounded in empirical data from the digital servitization process, enriches, previous research developed in non-manufacturing sectors (e.g., Kurtmollaiev, Fjuk, Pedersen, Clatworthy, & Kvale, 2018), which endorsed the capacity of service design to facilitate the legitimation of new organizational configurations through stakeholder participation in digitalization.

As Parmigiani and Howard-Grenville (2011) emphasize the role of artefacts in routines is still understudied and more empirical studies from the practice perspective are needed, given that previous work is mostly theoretical. The present study adds to that conversation by empirically demonstrating how tools and artefacts (e.g., visualizations) are part of the new routines and positively enhance their performance. Service design enrolls artefacts to a large extend in its microlevel practices which also nudges companies adopting service design for advanced services value proposition design. This, however, might differ in other instances of digital servitization. Our study presents service design as a useful capability to analyze the interrelationships between social, technical, and environmental aspects (Marcon et al., 2022; Münch et al., 2022) that manufacturers can consider for successfully steering progress in the digital servitization process and materializing the advanced services value propositions (i.e., mobilization). This strengthens Kohtamäki et al.'s (2021) finding that digital servitization is driven by the tension between mobilization and integration which, in our study, was facilitated by service design practices.

In brief, the present study bridges and enhances the research on the interplay between digital servitization and service design (Solem et al., 2021) by carrying out a multicase study on the management of the digital servitization process when shaped by the use of service design practices for advanced services value proposition design. This is relevant because as Bigdeli et al. (2021) indicate, even if the focus of servitization research starts to shift more towards the 'progress' perspective and related capabilities (e.g., Chen et al., 2020; Jovanovic, Raja, Visnjic, & Wiengarten, 2019) rather than studying and evaluating the 'end result' of the servitization process, we still need a better understanding of how to manage the process from the managerial point of view (Münch et al., 2022). In particular, our work contributes to respond to the calls of Nguyen et al. (2022) and Sjödin et al. (2020) who ask for a need to enhance design frameworks with more holistic, flexible, iterative, artifact enhanced and co-creative practices that have a clear focus on customer value creation processes (Raddats, Naik, & Bigdeli, 2022) and can manage the exposure to external factors that put digital servitization at risk (Dmitrijeva et al., 2020).

9.2. Managerial contributions

From the managerial perspective, by adopting a processual view and focusing on microlevel activities and tasks, the present study offers valuable guidance for industrial managers who seek to design new advanced services value propositions in digital servitization (e.g., Huikkola et al., 2020; Solem et al., 2021; Tronvoll et al., 2020), along with a better understanding of the specific capabilities and organizational adaptations that are required (Favoretto et al., 2022; Münch et al., 2022; Tronvoll et al., 2020). This offers industrial managers insights into how a manufacturer's transformation towards digital servitization is facilitated by the application of service design. In particular, industrial managers can exploit the opportunities that service design opens for organizational reconfiguration and co-creation with internal and external partners to legitimize digital servitization and make progress in achieving it. In particular, service design visualization tools are powerful but underutilized tools for shaping digital servitization, and we strongly recommend that industrial managers use service design to embrace complexity through an ecosystem approach beyond the boundaries of their company, seek to better understand their customers' processes, and leverage Industry 4.0. Our study presents service design as a way to address uncertainty related to digital servitization capability that industrial managers can use to better address the digital servitization process in a co-creative manner, rather than solely focusing on insights from data as a starting point for designing new advanced services value propositions.

9.3. Limitations and future research

Despite the long time frame and diversity of the companies studied in this paper, which together provide a good base for generalizable insights related to advanced services value proposition design in digital servitization in manufacturing contexts, further research is needed. First, the applied research through design approach is highly context-dependent and thus impacts the generalizability of our findings (Horvath, 2008). Adopting a wider array of qualitative and quantitative methodological approaches is needed. Second, all manufacturers selected for this research already had made a clear commitment to digital servitization and were already immersed in Industry 4.0 developments for advanced services. Therefore, longitudinal case studies with varying degrees of digital servitization and Industry 4.0 development maturity are needed to enrich the discussion and enhance the generalization of the design capabilities required (Münch et al., 2022; Sjödin et al., 2020). Third, the exceptional occurrence of the COVID-19 pandemic and its effects during our study time frame shaped the progress of advanced services value proposition design in the manufacturers and is thus reflected in our results. As a result, developing longitudinal multi-case studies to understand how manufacturers developed service design capability and its impact during digital servitization, how this process unfolds over time, what microlevel practices of service design are adopted, and what is the impact of internal and external factors requires more attention.

CRediT authorship contribution statement

Ion Iriarte: Conceptualization, Methodology, Formal analysis, Writing – original draft. **Maya Hoveskog:** Conceptualization, Methodology, Formal analysis, Writing – original draft. **Hien Nguyen Ngoc:** Investigation, Visualization. **Iker Legarda:** Formal analysis, Investigation. **Maitane Uranga:** Investigation, Visualization. **Maite Nazabal:** Investigation, Visualization. **Ariane Atxa:** Investigation, Visualization.

Declaration of Competing Interest

None.

Data availability

Data will be made available on request.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.indmarman.2023.02.015.

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