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ORIGINAL ARTICLE

# Exploring the crossroads between digital servitization and sustainability from a business marketing perspective

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**Abstract**
In this study, we explored the contingency effects of digital servitization enabled by Industry 4.0 technologies and sustainability from the perspective of business-to-business marketing relationships. Our in-depth analysis of an Italian company showed the extent to which digital servitization can improve customers' sustainability profiles and could be a lever to address the servitization paradox. However, to capture this sustainability value, companies must transform their supplier–customer relationships. Customer relationship management emerged as a critical element in this sense, especially when highly innovative services were offered.

**Keywords** Industry 4.0 · Artificial intelligence · Internet of things · Servitization · Sustainability · Business relationships

## 1 Introduction

Digital servitization has been widely explored and analyzed over the years, as it has increasingly shaped marketing relationships in business-to-business (B2B) contexts (Gebauer et al., 2021). As a result of the convergence of digital transformation and servitization trends, digital servitization refers to "the use of digital technologies in the processes and offerings related to servitization" (Kowalkowski et al., 2017; Gebauer et al., 2021; Favoretto et al., 2022, p. 105). Digital servitization is a transformational process that can lead to a variety of positive outcomes, but servitization scholars have highlighted the existence of a service paradox, which means that com-

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panies are not always able to capitalize on their investments in servitization (Brax et al., 2021).

Marketing has also shown a growing interest for digitalization impacts on B2B relationships (Taylor et al., 2020), but relatively limited attention has been paid to Industry 4.0 (Nosalska & Mazurek, 2019). In particular, the Industrial Internet of Things, also supported by artificial intelligence-based software and techniques, not only allows customers to access data about the real use of products, but also enables the connection of smart products with other devices or entire systems and platforms (Porter & Heppelmann, 2015). In terms of marketing implications, technologies can favor the cooperation between customers and suppliers, the cocreation of products with customers, and increase the awareness of both customers and suppliers, who can then make better decisions regarding price adjustments (Nosalska & Mazurek, 2019). In this respect, the literature on digital servitization has highlighted that Industry 4.0 technologies can enable companies to offer advanced digital-based services, support the transition towards servitization (Frank et al., 2019), and moderate the impact of servitization on SME performance (Bortoluzzi et al., 2022).

Although still in its infancy, another stream of research has suggested that the adoption and use of Industry 4.0 can positively impact sustainability (e.g., Ardito et al., 2021; Del Río Castro et al., 2021). Scholars focused on digital servitization have started to explore the relationships between servitization and sustainability processes and outcomes (Paiola et al., 2021; Zhang et al., 2022). Parida and Wincent (2019) found positive relationships between servitization and sustainability at corporate, societal, and environmental levels and stressed the relevance of strategic partnerships and, more generally, networks to achieve sustainability goals. Indeed, in sustainability projects, it is "no longer a choice for firms whether to engage with stakeholders or not; the challenge is rather how to engage successfully" (Evans et al., 2017, p. 602). Paiola et al. (2021) acknowledged the relevance of networking and conducted the first analysis on how digital business model innovation and networking in manufacturing servitization can impact sustainability. Zhang et al. (2022) found that servitization is positively related to the social performance of manufacturing firms, whereas the impact on environmental performance is highly influenced by the level of absorptive capacity and human resource slack. Scholars have also underlined the crucial role of relations with strategic stakeholders, such as suppliers and customers, in relation to sustainability (De Martini & Taticchi, 2021). This aspect has further been highlighted in the context of sustainable marketing, which refers to "socially and environmentally responsible marketing that meets the present needs of the consumers and businesses while also preserving or enhancing the ability of future generations to meet their needs" (Armstrong & Kotler, 2012, p. 508).

Despite the increasing interest in the subject (Paiola et al., 2021), servitization scholars have only started to study the interplay between digital servitization and sustainability in relation to Industry 4.0 (e.g., Richardson, 2022; Vollero et al., 2022), and this remains a topic that needs further exploration (Kohtamäki et al., 2019). Moreover, as both digitalization and servitization influence the relationships between customers and suppliers in the B2B sector, it has become urgent to investigate the role of partnerships and networks in the digital servitization process enabled by

Industry 4.0 technologies that also support sustainability achievements (Evans et al., 2017; Gebauer et al., 2021).

In the current study, we aimed to explore the interaction between digital servitization enabled by Industry 4.0 and sustainability from a B2B marketing perspective. The main research questions are twofold: How does digital servitization relate to sustainability? How do B2B relationships affect the relationship between digital servitization and sustainability? To this purpose, we analyzed a small company that, through the adoption of artificial intelligence and other Industry 4.0 technologies, offered its customers innovative products enriched by a range of services. Our analysis highlights the relevance of networking with the actors in a firm's innovation ecosystem, for a small firm that intends to implement a digital servitization strategy to overcome its resource constraints. Moreover, digital servitization requires both an internal organizational change and a transformation in the relationships between the manufacturing firm and its customers to overcome potential service and digitalization paradoxes. Indeed, the value of digital servitization and sustainability can only be captured if there is an overlap in the objectives of the company and the strategic actors, with the value being captured by both these actors.

## 2 Literature review

### 2.1 From servitization to digital servitization

The servitization of manufacturing requires that companies start conceiving their products as means to provide services to customers with the goal of reinforcing the relationship with them over the long term (Vandermerwe & Rada, 1988; (Vargo & Lusch, 2004, 2017); Lusch et al., 2007). Anchored in marketing, servitization generally expresses the transition from a product- to a service-dominant logic (Vargo & Lusch, 2004, 2017). Notwithstanding, scholars have suggested that servitization occurs within a product-service continuum, where manufacturing companies' strategies can range from simply increasing the level of services in their offerings, the so-called "service infusion" (Oliva & Kallenberg, 2003; Kowalkowski et al., 2017), to a "pure servitization" strategy, which results from a transformational process that sees manufacturing companies selling services as their main offering instead of products (Cusumano et al., 2015; Kowalkowski et al., 2017). In the B2B context, both suppliers and subcontractors have gradually abandoned their purely productive roles in favor of proactively offering extra services, such as codesign and total quality assurance services, to their customers.

A relatively recent research stream called digital servitization has increasingly focused on the intersections between digital transformation and servitization (Kohtamäki et al., 2019; Paschou et al., 2020; Gebauer et al., 2021; Kharlamov & Parry, 2021; Solem et al., 2022). Digital servitization refers to the use of digital tools in the transformational processes involved in the move toward servitization (Kowalkowski et al., 2017; Favoretto et al., 2022), where these tools are seen as key drivers in the radical transformation of manufacturers' business models (Kohtamäki et al., 2019; Suppatvech et al., 2019; Tronvoll et al., 2020). However, when imple-

menting a digital servitization strategy, manufacturers may run the risk of focusing too heavily on the technology rather than the overall strategy (Tronvoll et al., 2020) while also being susceptible to change resistance. In fact, digital servitization is a process of change that can generate tensions at the intra- and inter-organizational levels (Galvani & Bocconcelli, 2022). In this sub-field of research, some studies have underlined the potential role of Industry 4.0 technologies in favoring or influencing servitization (e.g., Frank et al., 2019). Industry 4.0 includes technologies such as the Internet of Things, artificial intelligence, cloud-based technologies, and augmented reality, which can be highly integrated with each other and used to offer new or additional services or support servitization strategies (Coreynen et al., 2017; Ardolino et al., 2018; Frank et al., 2019; Paiola et al., 2021). Moreover, some Industry 4.0 technologies may positively moderate the impact of servitization on SME performance (Bortoluzzi et al., 2022).

Despite the multiple potential benefits that can be derived from servitization, researchers have suggested the existence of a "service paradox" (Brax, 2005): firms that make investments to extend their service offerings are not always able to obtain the expected return on investment (called the "financial paradox"), while some companies fail during the organizational transformation process (called the "organizational paradox") (Brax, 2005; Brax et al., 2021). Furthermore, when considering digital servitization, some authors have underlined the existence of the so-called digitalization (digital) paradox, which refers to companies that procure and develop digital assets but cannot pay off this investment (Gebauer et al., 2020). Indeed, Industry 4.0 itself can stimulate resistance to change in organizations and it needs to be aligned with the corporate strategy, to be effective in supporting servitization (Bortoluzzi et al., 2022). All this considered, researchers have suggested that it is necessary to analyze the transformation of digital servitization from a relational perspective (Kamalaldin et al., 2020), complementing past studies that have previously mainly focused on the provider perspective (i.e., on the internal transformation of manufacturing firms) (e.g., Raddats et al., 2019). Kamalaldin et al. (2020 proposed a relational transformation framework for digital servitization, as, to profit from digital servitization, companies require a transformation in the relationships between the providers and their customers.

### 2.2 Digital servitization and sustainability

Servitization strategies include a variety of strategic opportunities, such as diversification, differentiation, and the multiplication of revenue streams, even though the improvement in performance may be context-specific and dependent on several factors, both at an organizational and a strategic level (Baines et al., 2017; Wang et al., 2018). Servitization can lead to financial improvements in terms of profitability and revenue streams, as well as marketing-specific advantages derived from an increase in customers' knowledge, a reduction in customer churn, and an increase in customer loyalty (Wang et al., 2018). More recently, some studies have suggested positive outcomes in terms of sustainability practices (Ghobakhloo, 2020). Despite the existence of multiple definitions (Glavič and Lukman, 2007), sustainability can be generally referred to as a "development that meets the needs of the present without

compromising the ability of future generations to meet their own needs" (Bruntland, 1987). Notwithstanding the rapid evolution of sustainability concepts and literature, a certain consensus exists on the need to integrate environmental, social, and governance factors in both the investment processes and the strategic decision-making phases (De Martini & Taticchi, 2021). Some studies have examined the potential impacts of servitization on sustainability processes and outcomes (Opazo-Basáez et al., 2018; Pham & Vu, 2022; Schiavone et al., 2022). Parida and Wincent (2019) suggested that servitization enables companies to remain competitive and to differentiate themselves from their competitors by generating higher economic, environmental, and social value. Other scholars have investigated the influence of servitization on sustainable development (Chiarini, 2014; Carballo-Penela & Castromàn-Diz, 2015) by assessing the ability of firms to simultaneously consider and balance economic, environmental, and social issues when delivering products or services. Servitization impacts have been demonstrated in different dimensions of the triple bottom line. Studies have shown its positive impacts on the social dimension (e.g., Zhang et al., 2022), particularly in relation to the creation of new job opportunities (Gelbmann & Hammerl, 2015). With respect to the environmental dimension, Abdul-Rashid et al. (2017) showed improved compliance with environmental standards through servitization by analyzing variables such as the reduced use of air and water, decreases in solid waste outputs, and the reduced consumption of energy and hazardous/harmful/toxic materials. Doni et al. (2019) analyzed the environmental performance of servitization using the indicator total energy consumption, while others (e.g., Agrawal & Bellos, 2017) focused on both the economic and environmental performance of servitization. Hao et al. (2021) analyzed the possible synergistic effects of lean production and servitization on economic and environmental sustainability, and Paschou et al. (2020) identified selected social and environmental benefits by considering the following variables: reductions in energy consumption, reductions in the environmental impact, the building of sustainable businesses/production, the impact on social sustainability, and the value delivered to the surrounding society. Moreover, recent studies have demonstrated the impact of servitization on all three dimensions: environmental, economic, and social (Zhang et al., 2022).

Moreover, studies on Industry 4.0 have shown that the adoption of certain technologies can also have a positive impact on firms' sustainability (Beltrami et al., 2021). Bressanelli et al. (2018) showed how some Industry 4.0 technologies (i.e., the Internet of Things, big data, and analytics) can favor the transition toward the circular economy and how these technologies increase resource efficiency, extend products' lifespans, and close the circular economy loop. Romanello and Veglio (2022) found that, by implementing Industry 4.0 technologies, a company had positive implications that can be associated to sustainability aspects both for itself and for its stakeholders, such as reduced environmental impact (environmental), cost reduction and productivity increases (economic), and hiring young and women, upskilling employees and increasing employees' safety (social). Moreover, when analyzing Internet of Things and cloud-based technologies that support manufacturing servitization from a relational perspective, some articles have found positive impacts on the sustainability of both the implementing company on the one hand, and its customers on the other hand (Paiola et al., 2021; Parida & Wincent, 2019). Although two distinctive research

streams have highlighted that both servitization and Industry 4.0 can have distinctively positive impacts on a firm's sustainability-related outcomes, studies explicitly exploring the overlapping effects are only a few to date (Paiola et al., 2021). Given the increasing interest in sustainability, scholars have moved their attention from sustainability-related indicators toward more processual observations of the effects of sustainability at a firm level. Drawing on a service-dominant logic that considers the relational perspective to be highly relevant (Vargo & Lusch, 2004), we aimed to explore the interactions between digital servitization enabled by Industry 4.0 and sustainability by exploring the role of relationships with external actors during this transformational process in the B2B sector (Fig. 1).

## 3 Method

We adopted a case study approach based on a longitudinal, single in-depth case analysis, which is particularly suitable for exploratory purposes (Eisenhardt, 1989). This method has the advantage of providing rich descriptions of the object of study. In this study, we searched for and selected a company with an orientation toward sustainability that had been implementing a project of digital servitization enabled through Industry 4.0. We chose the company used in this case study because it offered a unique perspective: it presented the three pertinent features (i.e., digital servitization, sustainability, and Industry 4.0) and granted us the opportunity to access multisource and in-depth data. This allowed us to develop a highly informative case study (Eisenhardt, 1989). Using a purposive sampling approach, we selected a small Italian manufacturing company operating in the metal sector, which had enriched its offering with solutions for quality control enabled by Industry 4.0 technologies and was moving toward a servitization approach.

The selected firm uses a bundle of Industry 4.0 technologies, including the Internet of Things, the cloud, and artificial intelligence. In Italy, artificial intelligence has low market value, but forecasts suggest double-digit growth rates (Anitec-Assinform, 2022). Moreover, some artificial intelligence-based technologies are expected to help

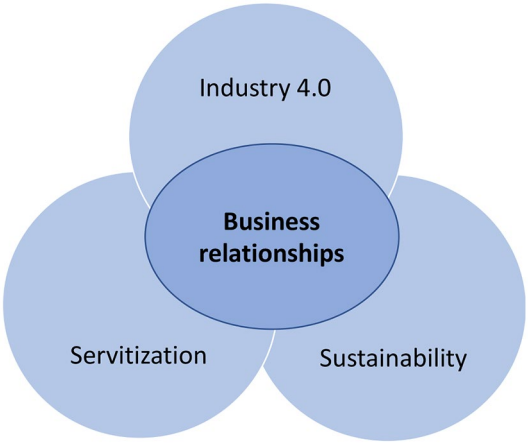


**Fig. 1** Intersections between the areas of research

firms face the sustainability challenge (McKinsey, 2022). Artificial intelligence can have a deep impact on marketing activities (De Mauro et al., 2022). Because artificial intelligence has been adopted by relatively few companies in Italy (Anitec-Assinform, 2022), which are mainly large or medium-sized, we decided to collect evidence from a small company.

We collected data at different points in time (i.e., 2019, 2020, and 2023). Interviews allowed us to follow the process of the digital servitization in its design and implementation phases. We conducted three in-depth interviews with the CEO based on semi-structured questionnaires. Interviews lasted between 30 and 90 min, were taped and transcribed. The semi-structured questionnaires comprehensively covered five topics: historical evolution and current situation of the company (organization, corporate structure, product portfolio, competitors); sustainability path (meaning of sustainability for the company, investments made); investments in technologies, with a focus on Industry 4.0 technologies; servitization (history of the project, services offered and results achieved); connection between industry 4.0, servitization and sustainability. For triangulation purposes and to avoid retrospective bias, we also collected secondary data through the company's website, balance sheets, and used additional material (e.g. articles about the company written by third parties). The case transcript was also submitted to the CEO for reading and verification.

We used qualitative techniques to analyze the data (Miles et al., 2014) by applying the following steps: (1) data reduction to remove redundant and unnecessary data (Miles et al., 2014), (2) a synthesis of the complete transcripts drawn from interviews and notes from secondary data (Eisenhardt, 1989), and (3) data coding using open thematic content analysis (Corbin & Strauss, 2014) supported by tables (Miles et al., 2014). We coded each phrase or statement that referred to digital servitization, Industry 4.0 technologies, and sustainability by using respective keywords, such as "service level," "service offering," "Internet of Things," "artificial intelligence," "digital technologies," "sustainable," and "sustainability," which were identified through the literature on each specific topic (Suppatvech et al., 2019; Culot et al., 2020; Paschou et al., 2020). After organizing the facts, we wrote the entire case story (Eisenhardt & Graebner, 2007).

### 3.1 Case description

Founded in 1993, Systems4Quality is a small, family-owned Italian firm with 21 employees and a turnover of 1.5 million euros. The second generation is now managing the firm. It offers artificial vision and intelligence solutions to maximize production quality and efficiency. Its core business is oriented to the B2B market (about 90% of its turnover). Its customers are mainly large and medium-sized firms that operate in three sectors: hollow glass, iron and steel, and industrial automation. The firm's product portfolio includes three product lines dedicated to B2B, one for each sector, and another line is dedicated to the business-to-consumer market. The firm typically sells directly to its customers, which are mostly based in Italy (only 20% of sales stem from international clients). Direct exports are complemented by indirect exports, which account for over half the company's sales.

All the company's activities are internalized in Italy, from research and development (R&D) to product design, from software development to the production of sensors and machines. Its differentiation strategy is based on the ability to offer customized high-tech solutions. The firm's solutions comprise artificial intelligence applications and the most advanced vision and data processing technologies. For instance, it produces a range of advanced systems for in-line quality control in the production of hollow glass (e.g., bottles, jars) and flat glass products. These systems operate through wireless technologies, which have been developed to ensure every type of defect is detected and false rejects are minimized. Moreover, the embedded artificial intelligence technologies in these solutions allow each machine to self-learn and consequently improve its inspection performance over time. The company also produces a line of sensors, cameras, measurement systems, and advanced artificial intelligence systems specifically designed and manufactured for use in the hot rolling process so that they can withstand the harsh conditions of the steelmaking environment. This line offers not only basic sensors that meet almost all the control requirements of the rolling mill production line, but also advanced applications that represent the best optimal artificial intelligence solutions for advanced quality and process control.

Given the high technological content of its offering, the company has invested about 20% of its annual turnover in R&D over the last decade. In 2023, 70% of the firm's staff were employed in the R&D department. Innovation has been a consistent priority for the company since it was founded. For this reason, in 1993, it had already created an in-house design group for the electronic and software parts of its products, which allowed the gradual development of the internal capability to design innovative, customized solutions based on customers' needs. Indeed, nowadays the firm's products are particularly appreciated when a ready-to-use solution is not available in the market.

### 3.2 Open innovation model supporting the firm's innovative offering

Given the CEO's interest in cutting-edge technologies, the company has been integrating artificial intelligence applications into its offering while simultaneously exploiting external public financial support since the early 2000s. Thanks to the participation in its first European Horizon Project in 2014, the firm had the opportunity to build an international network comprising other manufacturing firms and international research labs and consulting agencies. The in-house research projects financed via Italian and international public funding and the linkages with a network of innovative firms (e.g., some lead customers) and external sources of scientific information (e.g., Italian and international universities) have contributed to the increased internal knowledge of and competences in artificial intelligence and other cutting-edge technologies, which today represent a highly relevant source of competitive advantage for the firm. In addition, the company's technological know-how includes highly specialized yet heterogeneous skills ranging from artificial intelligence to optics, artificial vision sensors, physics, photonics, robotics, the industrial Internet of Things, big data, data mining, applied electronics, computer science, and advanced process automation. At the same time, the company is also expanding and strengthening its

network of external relationships to enhance its innovation capabilities, giving life to an open innovation model. One application of this model is represented by investments in artificial intelligence.

At the same time, inputs for innovation came from the long-term relationships established with key clients, which enabled the firm to better understand their needs, to collaborate with them to create tailor-made products using highly innovative technologies, and thus to meet the needs of its most innovative customers. As a result, for instance, the company offers artificial intelligence-based applications that improve the quality and control of industrial production of its customers' manufacturing facilities. Thanks to Industrial Internet of Things, the firm offers solutions that allow its customers to connect machines within their facilities and to optimize production processes based on data collection and analysis. This also allows customers to control the throughput time of industrial production and access precise data related to the quantity of products in process. In addition, through a patented technology combining artificial vision technologies with data-mining systems and artificial intelligence that can temporally correlate field images and data, the company offers a monitoring technology that automatically detects any process malfunction within a production facility and enables predictive maintenance. Through its technological endowment and technology-based services, the firm becomes a partner to its key customers who are embracing the digital transformation.

## 4 Case analysis

### 4.1 Digital servitization enabled by industry 4.0 technologies

In line with other companies in the metal and machinery industry, in the last years the studied company approached servitization by progressively adding services to its physical products to increase customers' loyalty. Therefore, the firm started expanding the range of services offered to its customers (e.g., installing equipment, tailoring products, performing maintenance). Furthermore, in 2018, the CEO had the idea to design and implement a "digital servitization project". Indeed, as suggested by the Funder and CEO, in a fast changing and highly technological environment, though, *"…technological innovation is essential, but it must go hand in hand with business model innovations to take full advantage of opportunities offered by new technologies" (Founder and CEO, interview in 2022).*

In 2019, the company started a collaboration with a local Technology Transfer Center within a European-funded program, which also led to further collaborations with other external actors (e.g., consultants, Italian and international companies). Thanks to this network of relationships, Systems4Quality accessed specific knowledge (e.g., managerial competences) useful to realize that the high technological content of its products well fitted the offering of innovative services on the one hand, but also to understand opportunities and barriers of servitization on the other hand. At the same time, it became clear that digital servitization would require a profound change in many dimensions of its business model: besides innovating the firm's offering, the

company had to adapt its financial model, the pricing method, and to transform its relationships with its customers.

Besides the CEO's strong commitment to the project and the internal competences, the interactions with external actors (e.g., external consultants) proved crucial to overcome the internal barriers to the change met during the implementation process. The collaboration and continuous interaction with the company and other external actors (e.g., a local Knowledge Transfer Center, external consultants, financial institutions) helped the firm to define two innovative services characterized by different increased levels of digital servitization. Moreover, each solution involved a long-term customer. The combination of external and internal knowledge was fundamental to defining and implementing the project. During COVID-19 pandemic's economic slowdown, the company devoted additional resources (e.g., time of internal resources) to this new strategy. These two servitization solutions are described in the Table 1.

Both solutions (and especially the second) required a high level of collaboration and trust between the company and its customers, both in the design and implementation phases. For example, the customer was required to share sensitive data about its production process, which is a prerequisite for the quality control service. There were also differences between the two solutions. In particular, in the second solution, the pure servitization, the ownership of the asset remained with the manufacturing company, and the customer only had the right to use the asset. This difference is relevant to both the manufacturer and the customer. In this case, for example, the manufacturing company has to revise its pricing model and financial structure; the customer, on the other hand, no longer has to acquire ownership of the asset, but has to shift its focus to the use of the asset.

The servitization projects have been active for nearly two years, but contrary to the CEO's initial expectations, the market for these services has not widened. Many potential customers consider them too innovative and often do not understand the benefits of buying services instead of purchasing technological solutions. Further-

**Table 1** The digital servitization project: two solutions

| | First solution | Second solution |
|---|---|---|
| Description of the solution | Systems4Quality maintains its focus on selling a physical product but increases the service content offered to the customer. After purchasing the product, the customer pays for additional services that provide: (a) the use of a software to operate the device; (b) the software updates, which are highly relevant for artificial intelligence-based services, and (c) remote support, for example, to analyze data collected during quality control. | The customer pays a monthly pay-for-use service fee instead of buying the product. The service includes the installation and use of physical devices and related software, software upgrades, maintenance of the physical device at the expense of the manufacturer, and a remote support service provided by the manufacturing company. Remote support includes continuous monitoring of reliability and productivity of devices; software upgrades; and data collection and analysis at the customer's facility, which is then also shared with and analyzed by Systems4Quality. |
| Position in the product-service continuum | Service infusion (Kowalkowski et al., 2017) | Pure servitization (Cusumano et al., 2015; Kowalkowski et al., 2017), |

more, tax credits are available in Italy for companies that buy (and possess) a product that is certified Industry 4.0, but tax incentives are granted only for the purchase (and not the use) of such technologies, which turned out to be a barrier to Industry 4.0-based servitization. In addition, according to the CEO, a culture of servitization is frequently lacking in many potential customers. Customers do not want to face the challenge of changing their existing businesses: they prefer to possess the physical product and are frequently reluctant to share the data related to their production processes, particularly when a remote connection between the company and customer is required. According to the CEO, this is another barrier to the diffusion of services related to data analysis.

### 4.2 Digital servitization and sustainability

The CEO considers sustainability a relevant dimension for the future of its business and pays attention to the economic, environmental, and social dimensions of sustainability. As far as the environmental dimension is concerned, the internal management considers sustainability as a relevant criterion for the selection of raw materials, components, and suppliers. Indeed, to manufacture machines and control systems, the firm chooses solutions and materials with a low environmental impact, which are as most recyclable as possible. Moreover, in suppliers' selection, the company considers their ability to guarantee products, materials, and processes that comply with current regulations related to environmental sustainability.

In terms of the social dimension of sustainability, the firm pays strong attention to internal human resources, as required for SA8000 certification. Systems4Quality has consistently invested on this certification over the years (i.e., ISO 9001 in 2006, SA8000 certification for ethical and social business in 2010, ISO 27,001 certification for data security in 2012).

> We have always believed that the quality of service and production must include work ethics and the quality of life of employees. More generally, we believe that production activities must be at the service of the community and of man. (Website statement)

The company's traditional focus on environmental impact (e.g. choice of materials, components, and suppliers) and social impact (e.g. SA8000 certification) makes it a potential partner for sustainability-conscious customers. Moreover, the CEO believes that a high sustainability profile can also have a positive impact on customers sustainability through its innovative offerings. Indeed, digital service-related solutions provide several sustainability-related benefits to its customers as well and some technology-based services might help customers in improving their sustainable performance indicators. First, the solutions for quality control ensure the secure identification of scrap in-line, thus reducing material waste and emissions. In addition, all the systems are designed to minimize energy consumption. These products' features allow customers to improve their economic performance (e.g., less material waste means fewer costs) and offer benefits in terms of eco-sustainability (e.g., less material waste means a lower environmental impact). In this respect, the economic and

environmental benefits are connected. The quality control solutions also provide the company's customers with social benefits. They can enable people with specific disabilities to carry out quality control activities that would otherwise not be available to them. Furthermore, these solutions favor the upgrading from human operator's repetitive, wearisome, and dangerous towards coordination and supervisory roles, thus reducing the risk of workplace accidents. As quality control tasks are carried out in a safer way, it is expected that the well-being and working conditions of employees will increasingly improve indirectly.

Besides these purely digital technology-driven benefits, the CEO highlighted that digital servitization can offer the servitizing company's customers benefits from a sustainability perspective. Remote services reduce operator mobility, thereby reducing $CO_2$ emissions. Moreover, since the servitizing company provides a guarantee to maintain the product, it is encouraged to create a product with a longer life cycle, which in turn reduces the environmental impact associated with the decommissioning of a non-functioning product. Further, continuous remote monitoring of production processes improves and speeds up maintenance times and the associated costs, also favoring a longer life cycle of products in the Table 2.

However, based on the company's experience, environmental and social benefits are not appreciated by customers as much as economic benefits.

> Our solutions for quality control offer economic, social, and environmental benefits. Even in companies where the top management considers sustainability to be an important value, during the purchase process, we sometimes negotiate with operators who decide whether or not to buy our solutions by almost exclusively examining the product's ability to reduce costs in terms of the working hours of employees; they do not fully recognize or appreciate the social and environmental benefits as relevant criteria in their decision-making process. (Founder and CEO, interview in 2022)

**Table 2** Some sustainability implications for the digital servitization project

| Sustainability dimension | Evidence |
|---|---|
| Environmental benefits | • Reduction of material waste<br>• Reduction of $CO_2$ emissions (e.g., generated by the reduction of operator mobility or by the reduction of material waste)<br>• Minimization of energy consumption<br>• Longer product life cycle |
| Economic benefits | • Reduction of material costs<br>• Reduction of $CO_2$ emissions' costs<br>• Reduction of energy costs<br>• Reduction of mobility costs<br>• Higher productivity<br>• Proper and on time maintenance |
| Social benefits | • Reduction of repetitive, wearisome, and dangerous tasks<br>• Reduction of risk of workplace accidents<br>• Superior commitment of employees<br>• Higher inclusion of people with disabilities |

The CEO stressed that customers do not fully appreciate the sustainability implications of Industry 4.0-enabled servitization solutions. Whereas the economic benefits are intuitive and certainly aligned with intent of customers, social and environmental benefits must be properly emphasized to be understood. Notwithstanding, customers are not exploiting these benefits to improve their sustainability profiles. For instance, they do not appreciate that an increased sustainability performance could generate a superior commitment of employees that are sensitive to issues related to sustainability.

## 5 Discussion

In this study, we conducted an in-depth analysis of a small manufacturing firm that implemented a digital servitization strategy through Industry 4.0 technologies with the aim of exploring the interrelationships between digital servitization, Industry 4.0, and sustainability from a relational perspective.

Our evidence consolidates the importance of networking for a small firm when designing and implementing a digital servitization strategy (Kowalkowski et al., 2017), also exploring its potential when considering sustainability aspects. In the analyzed small firm, the complex system of innovation combining both internal and external sources of innovation explains the firm's ability to overcome its resource constraints, also contributing to explain both innovation and business model innovation. As shown in other studies, the COVID-19 pandemic impacted the firm's commitment to explore and implement digital servitization (Rapaccini et al., 2020; Di Maria et al., 2021), and networking with external actors (e.g., local Knowledge Transfer Center, external consultants, financial institutions) has been fundamental in enhancing technological and managerial competencies that have been critical in the design and implementation of servitization strategy. Among external actors, the collaboration with customers during the design phase was crucial to understand how the company's services could help meet its customers' needs through innovative technologies. Close collaboration with its customers was also crucial in the implementation phase to capture the value of digital servitization, especially when a pure servitization strategy has been implemented. This collaboration reduced the risk of a service paradox. The current study confirms that capturing the value of a digital servitization strategy enabled by Industry 4.0 is neither trivial nor always easy (Gebauer et al., 2021), suggesting the need to properly communicate and valorize the benefits of a digital servitization strategy to customers, especially when a "pure servitization" strategy is implemented (Oliva & Kallenberg, 2003; Kowalkowski et al., 2017). In line with Kamalaldin et al. (2020), our case study suggests that the relationship between the manufacturing firm and the customer is particularly important. Overcoming the service and digital paradox may require a dramatic shift in the relationship between the provider (e.g., the manufacturing company) and the customer, particularly in the case of artificial intelligence, which shows its true potential when strategic data is shared and analyzed.

Previous analysis highlighted that, when implementing a digital servitization strategy, manufacturers may run the risk of focusing too heavily on the technology rather

than the overall strategy (Tronvoll et al., 2020). This case study highlighted the need to consider the importance of relationship management. In the analyzed case, digital servitization based on Industry 4.0 was made possible and accepted by the customers, as it allowed them to co-create value with the company, to reduce costs, solve production problems, or reduce environmental impacts. The company was able to sell innovative services to long-standing customers with whom already had relationships based on trust and shared knowledge. In contrast, the company met strong resistance when proposing these services to other potential customers. According to the CEO, this resistance was due to several factors: some related to the external environment (i.e., the presence of fiscal incentives) and others on customers' preferences and perceptions. For instance, since 2016, the Italian government released the Industry 4.0 initiative spreading the ultrawideband infrastructure and introducing a bundle of fiscal and venture capital incentives for companies buying Industry 4.0 technologies and supporting the related training and education activities (Romanello & Chiarvesio, 2021). This plan, however, had a negative effect on servitization, because companies were incentivized only to buy technologies rather than simply using or developing them. Still, customer resistance could be overcome through the creation of a servitization culture among potential customers while emphasizing the sustainability-related benefits. This aspect should be considered both at the Nevertheless, other aspects, such as customers' resistance to sharing proprietary data with an external firm, may continue to hinder servitization.

Our study contributes to the stream of literature that aims to explore the intersection between digital servitization, Industry 4.0, and sustainability. Many authors have highlighted that servitization is a strategy that product companies can implement to achieve growth and gain a competitive advantage (Baines et al., 2017). In line with recent studies, our case study suggests that digital servitization, when paired with Industry 4.0 technologies, could represent a means to address the sustainability challenge.

The interaction between servitization and Industry 4.0 can also lead to positive outcomes for firms (Coreynen et al., 2017; Kowalkowski et al., 2017; Frank et al., 2019; Paschou et al., 2020; Paiola et al., 2021; Bortoluzzi et al., 2022) in terms of sustainability indicators. Our study helps to create a bridge between Industry 4.0 and sustainability from a relational perspective in B2B contexts by highlighting the role of business marketing as a tool to identify (and exploit) new opportunities and enhance innovation in the customer base.

In line with Parida and Wincent (2019), our empirical study confirms that new digital services provided by manufacturers could have positive impacts on the sustainability of their customers' businesses. The manufacturing enterprise that offers innovative products and evolved services can help other companies achieve their economic efficiency goals as well as their goals of greater environmental and social sustainability. For instance, the analyzed firm proposes artificial intelligence-based solutions to help customers reaching efficiency and reducing waste e.g. through predictive maintenance. This approach thus allows customers to obtain both economic and environmental benefits. The use of the firm's solutions could also have positive impacts on social sustainability, as they can increase workers' safety and/or create

new employment opportunities for people with disabilities such as in quality control activities.

The case also suggests that, besides service and digital paradoxes, the service provider could face a "sustainability paradox". In fact, even though digital servitization could have a sustainability impact by extending the lifetime of products and favoring the alignment between supply and demand, most customers do not appreciate this potential sustainability value. Our study thus reveals a misalignment between the service provider and the customers in terms of sustainability goals and sustainability-related motivations to provide or purchase advanced services. Our case clearly highlights that customers appreciate social and environmental benefits when associated with economic benefits. Thus, even though the economic element should be strongly considered when developing a company's marketing campaign, providers should emphasize other sustainability-related benefits that could result from a digital servitization strategy, particularly the potential value that could be derived for customers in terms of sustainability communication towards their clients or final customers.

## 6 Conclusions, implications, and further research

From a theoretical perspective, this study confirms the positive relationship between digital servitization and sustainability, but also suggests that the combination of digital servitization, enabled by Industry 4.0 technologies, and sustainability shows its benefits only when the purposes are clearly aligned. Customers understand the investment in terms of finance, resources, and organizational change only when the digital servitization based on such technologies allows both the manufacturer and its customers to cocreate and capture the value. From the servitizing company's perspective, the value derived from digital servitization relates to the fact that, compared to its main competitors, the company can become more competitive by presenting advanced product-offering solutions. From the customer's point of view, the derived value relates to the increased sustainability levels achieved through the use of these services. These two aspects are contextual and must be valorized to capture the value from a relational perspective (Taylor et al., 2020) and ultimately to overcome the paradoxes (Galvani & Bocconcelli, 2022). Furthermore, this study suggests the need to adopt a relational view to understand how digital servitization relates to sustainability. Networking could be fundamental not only for designing and sustaining a digital servitization strategy that generates sustainability benefits, but also for overcoming the potential "sustainability paradox" caused by the misalignment between service provider and customers in terms of sustainability goals and sustainability-related motivations to deliver or buy advanced services.

From a practitioner's perspective, this study provides insights into the extent to which servitization can help manufacturing firms derive value from Industry 4.0 investments through not only the economic but also the social and environmental dimensions. Our empirical analysis describes how some cutting-edge technologies, such as artificial intelligence and the Industrial Internet of Things, can support the innovative services created by a small firm. The case study further suggests that supportive public programs can help SMEs increase both their technological endow-

ments and their capacity to use cutting-edge technologies to capture new business opportunities, for example, by implementing new strategies for digital servitization. In the analyzed case, the servitization project was supported by the strong commitment of the CEO and the entire organization. This commitment was fundamental to creating the company's innovative services. At the same time, the case foregrounds that supportive public programs and partnerships with external actors could be fundamental in helping firms understand how digital technologies could be exploited to create innovative business models such as digital servitization.

Our study highlights that service and digitalization paradoxes can prevent companies from profiting from digital servitization. In line with recent research, our study suggests that the success of digital servitization is strongly influenced by both internal and external forces (Baines et al., 2017). In particular, the transformation of the relationships between the service provider and its customers could be particularly relevant for them for the former to profit from digital servitization when advanced services are proposed.

From a practical perspective, our study underscores the need for firms to work on the relational dimension to be able to implement a purely digital servitization strategy. The relationship between a firm and its business customers could be a key to profiting from digital servitization. Customer relationship management could help overcome the potential service and digitalization paradoxes.

The results of this study should be interpreted with due consideration of its limitations. First, this was a single case study, and the results can thus not be generalized. It was exploratory in nature, as the purpose was to explore the overlaps between the different phenomena that were the object of analysis. This was also a case study of a small company, which is highly relevant when interpreting the dynamics that emerged during the analysis. Finally, this case study reflects—and must be interpreted in relation to—the Italian metals and machinery sector.

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## Declarations

**Conflict of interest** On behalf of all authors, the corresponding author declares that there are no conflicts of interest.

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