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Overcoming pandemic challenges through product innovation: The role of digital technologies and servitization

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ABSTRACT

The fast-changing scenario related to the COVID-19 pandemic calls for firms to rapidly redefine and innovate their strategies to sustain their businesses, with research emphasizing the key roles of digital technologies and servitization. We aim to enrich the theoretical debate on this matter by assessing how small and medium-sized enterprises (SMEs) achieve product innovation under time constraints by leveraging two specific technology groups (information and communication technologies [ICT] and Industry 4.0 data-processing technologies) and servitization. The research is based on a mixed-method approach consisting of an original survey completed by 257 Italian SMEs (grounded on a previous qualitative study about such SMEs’ behaviors during the first Italian lockdown), followed by in-depth interviews with the owners and/or managers of the eight SMEs that participated in the survey. The results show a positive relationship between the increased use of digital technologies (ICT and Industry 4.0 data-processing technologies) during the pandemic with servitization and, in turn, with product innovation. Specifically, the increased use of ICT during the pandemic had a direct positive effect on product innovation, while Industry 4.0 data-processing technologies affected product innovation only through the full mediation of servitization. The qualitative study allowed us to highlight how the different kinds of digital technologies supported SMEs’ innovation (servitization and product innovation) during the pandemic. The theoretical and practical contributions of this study are discussed.

1. Introduction

The coronavirus disease 2019 (COVID-19) pandemic has dramatically affected the global economy and threatened the survival of small and medium-sized enterprises (SMEs) because of the increased risk linked to market contraction (diminishing turnover) and financial-resource constraints (Juergensen, Guimón, & Narula, 2020). Nevertheless, it pushes innovation as a tool for overcoming the challenges of an uncertain and fast-changing environment (Chesbrough, 2020; Wenzel et al., 2020), where time pressure may be a great constraint, especially for SMEs (Priyono et al., 2020).

Most response strategies and actions have leveraged the potential of technologies to support business continuity, ensuring connections that help business activities run smoothly (Margherita et al., 2021). In particular, the crisis has forced firms (both large firms and SMEs) to increase their use of digital technologies for innovation purposes (Mention et al., 2020; Papadopoulos et al., 2020). As the relevant literature points out, the fast pace of technological progress in recent decades, moving from the former information and communication technologies (ICT) to the new Industry 4.0 technologies, has created new chances for business growth (Dalenogare et al., 2018; McAfee, 2006), helping firms develop services and products (Kotler et al., 2017) and also improve production flexibility and customization (Alcácer & Cruz-Machado, 2019) through data exploitation for strategic purposes (Davenport, 2018; Frank et al., 2019). However, not all SMEs have invested, adopted, and exploited digital technologies in the same way (Neirotti et al., 2018). This could have a variety of impacts (negatives and/or positives) on SMEs’ responses to the challenges posed by the pandemic, especially within a short time frame.

Servitization may represent a chance for SMEs to sustain their businesses during the COVID-19 pandemic. Many firms have in fact innovated their offerings through servitization to retain their customers...
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and cope with the crisis (Heinonen & Strandvik, 2021; Mele et al., 2021). Especially in the manufacturing industries, servitization is a complex continuum process referring to the transformation from product-centric to service-centric systems (Kindström, 2018; Kohtamäki et al., 2021). In the literature, some scholars have used the terms 'service infusion', 'servitization', 'service transition', and 'product-service systems' to refer to the same concept (Eloranta & Turunen, 2015; Forkmann et al., 2017). Other authors consider servitization 'an overarching concept that includes but goes beyond service infusion' (Kowalkowski et al., 2017, p. 7), stressing the shift from a product-centric business model to a service-centric one. Due to the challenges posed by the current pandemic, where SMEs react vis-à-vis time constraints and limited resources, we adopt the broader definition of servitization, which considers adding basic, intermediate, and/or value-added services to a firm’s core business (Bustinza et al., 2018).

In the new scenario that emerged with the COVID-19 outbreak, in which firms are forced to rapidly innovate their products (Netz et al., 2022) to sustain their businesses (Ding & Li, 2021), innovating through new-product development or customization may enable firms to increase their sales volumes by serving different customer segments, thus addressing their cash flow issue due to the pandemic (Kang et al., 2020). Digital technologies and servitization may represent key drivers within this turbulent scenario (Kowalkowski et al., 2022).

Digital technologies are not only a keystone for manufacturing firms’ introduction of new services but also a catalyst for product innovation (Blichfeldt & Faullant, 2021). Market uncertainty also increases the adoption of advanced technologies in the short term (Praise, 2019), thus improving a firm’s innovation performance (Usai et al., 2021). Such technological investments create opportunities for firms to quickly adapt to the changes that have occurred during the COVID-19 pandemic (Paiola & Gebauer, 2020) and redesign the ways that they deliver their offerings (Seetharaman, 2020). Nevertheless, the different technological options a firm may adopt (ICT and Industry 4.0 technologies) could have different impacts as pandemic response strategies, because they have different maturity levels requiring different firm readiness levels (Garzoni et al., 2020). Therefore, the use of ICT and Industry 4.0 technologies to develop services and innovate products within the new competitive scenario connected with the pandemic must be further investigated. There is a need to assess the innovation strategies activated by SMEs within a short time and with limited available resources (Heinonen & Strandvik, 2021; Von Krogh et al., 2020).

The aim of this article is to determine whether SMEs have been able to increase their technology usage during the pandemic and whether the two specific groups of technologies (ICT and Industry 4.0 technologies) support servitization strategies and have positive impacts on product innovation. By presenting the results of the mixed-method research that was conducted, including an original survey completed by 257 Italian SMEs (grounded on a previous qualitative study about the SMEs’ behaviors during the first Italian lockdown) and in-depth interviews with the owners and/or managers of the eight SMEs that participated in the survey carried out in 2021, this study highlights the role of the increased use of ICT and Industry 4.0 technologies on servitization and product innovation during the current COVID-19 pandemic, showing that digital readiness can help a firm sustain its business during turbulent times.

This research contributes to the literature on the relationship between digital technologies and innovation strategies during turbulent times and between servitization and product innovation, highlighting the different ways in which ICT and Industry 4.0 technologies allow SMEs to respond to the challenges posed by the pandemic under time constraints and uncertainty through servitization and product innovation. Specifically, servitization works as a full mediator between the increased use of Industry 4.0 technologies and product innovation. On the contrary, servitization has the role of a partial mediator where ICT is concerned because of the significant direct relationship between ICT and product innovation.

The rest of this article is structured as follows. In section 2, we review the literature on digitalization, servitization, and product innovation and present our research hypotheses. In sections 3 and 4, we present the methods used in the empirical study and the study results. In the final section, we discuss the results of the study and conclude the article by outlining its theoretical and managerial contributions, as well as the study limitations and the directions for future research.

2. Theoretical background and research hypotheses

2.1. Digital technologies for servitization during the COVID-19 pandemic

Research has highlighted the relevance of digital technologies in the COVID-19 pandemic scenario in helping SMEs achieve business continuity and overcome the radical challenges posed by the pandemic (Papadopoulos et al., 2020). In the wide technological context, there are multiple digital technologies that SMEs may invest in or leverage, characterized by different levels of adoption maturity (Matt et al., 2021; Pirola et al., 2020) and different degrees of newness (Bettiol et al., 2021a; Calot et al., 2020). In this regard, firms may leverage the use of the more mature digital technologies included in the ICT domain (McAfee, 2006), such as the web-based technologies and/or information systems that can manage customers (e.g., customer relationship management technology – CRM) to promote innovation, and the use of the more recent Industry 4.0 data-processing technologies, such as big data and analytics, cloud, Internet of Things (IoT), and artificial intelligence (AI), to develop new effective marketing strategies (Davenport et al., 2020; Porter & Heppelmann, 2015).

Digitalization can facilitate connections with customers, which can not only enhance product sales but also bring new service opportunities (Chen et al., 2020; Paiola, 2018). Digital technology advancements (e.g., IoT, social network technology, mobile technology, and cloud) enable a proliferation of revolutionary services, with different benefits for customers (Ostrom et al., 2015). By leveraging technology, firms may be able to boost servitization (Coreynen et al., 2017; Mele et al., 2021). Digital technologies (both ICT and Industry 4.0 technologies) offer new opportunities for service-based value creation that accelerate servitization (Belvedere et al., 2013; Frank et al., 2019; Kowalkowski et al., 2022).

According to recent research, the pandemic has pushed firms to diversify their offerings to sustain their businesses (Wenzel et al., 2020), introducing new services and focusing on servitization within a very short time (Rapaccini et al., 2020). The servitization concept was coined by Vandermerwe and Rada (1988, p. 314), who identified firms that were ‘increasingly offering fuller market packages or “bundles” of customer-focused combinations of goods, services, support, self-service, and knowledge’. Although various definitions are provided (see Furrer et al., 2020 for a review), there is agreement among researchers that, especially in the manufacturing context, servitization strategy entails adding services to a firm’s core product offering.

From the aforementioned perspective, which is central to understanding the strategic role of servitization, services can be divided into at least two main groups: basic and advanced (Souza & da Silveira, 2019). Basic services aim to maintain basic product functionality (e.g., pre- and post-sale services). Advanced services, on the other hand, aim to co-create value with customers beyond the product orientation (training, product rental, and consulting), up to a service business model (Kindström, 2010). Moreover, this literature stream shows that firms can develop and offer three main types of servitization: (1) industrial servitization, such as training and consulting; (2) commercial servitization, such as online self-service data management tools for product configuration, purchasing, and adjustments; and (3) value servitization, such as outsourcing of production activities, materials provision and service agreements, including monitoring and/or customization, integration, and reconditioning of digital products in the customer’s process (Coreynen et al., 2017). During the COVID-19 pandemic, however, introducing new services is the only way to sustain customer interactions and

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obtain data from customers targeting production and product innovation (Zambetti et al., 2021).

Research has highlighted the positive relationship between digitalization and servitization (Ardolino et al., 2018). The use of both mature ICT (Belvedere et al., 2013; Kowalkowski et al., 2013) and the newest Industry 4.0 data-processing technologies (Frank et al., 2019) offers firms opportunities to develop new services. For example, in the case of ICT, the increased use of web-based technologies (e.g., website, social media, and e-commerce) during the pandemic has positively affected the firm–customer interactions and collaborations and the firms’ service innovation (Zhang & Zhu, 2021), increasing favorably the firms’ sales through the offering of value-added services to overcome the limitations of the traditional brick-and-mortar retail channels (Kim, 2020). Moreover, CRM solutions may favor after-sales services (Koiler et al., 2017) and may help firms develop individual-level marketing efforts (Rust & Verhoef, 2005). Considering the variety of ICT available and the different ways in which they can affect servitization, the increased use during the pandemic of the well-established ICT utilized to interact with markets and customers could support firms’ servitization strategies. Thus, we formulated hypothesis 1 (H1) as shown below.

H1. SMEs’ increased use of ICT during the COVID-19 pandemic positively affects their servitization strategies.

The second group of technologies consists of Industry 4.0 data-processing technologies, which, as mentioned earlier, include big data and advanced analytics, cloud, AI, and IoT (Bettiol et al., 2021a; Culois et al., 2020). Industry 4.0 data-processing technologies are specifically designed to expand a firm’s knowledge base so that the firm can identify new strategic directions. Nonetheless, such technologies also have strong potential in analyzing dynamic and fast-changing markets, supporting enhanced interaction with customers and advanced product uses. Solutions related to IoT (smart-connected products) (Iansiti & Lakhani, 2014; Porter & Heppelmann, 2015) and advanced data analytics (Davenport, 2018) deeply influence a firm’s strategic and marketing options (Pagani & Pardo, 2017).

The relationship between Industry 4.0 technologies and servitization allows a shift from a traditional product orientation to the provision of bundled solutions (see Zambetti et al., 2020 for a review) that may be crucial during turbulent and crisis times, such as the current COVID-19 pandemic, allowing firms to adapt and innovate their business models to meet the new customers’ needs and face the changing environmental conditions (Tian et al., 2021). This is also true in the context of SMEs. Thus, we formulated hypothesis 2 (H2) as shown below.

H2. SMEs’ increased use of Industry 4.0 data-processing technologies during the COVID-19 pandemic positively affects their servitization strategies.

2.2. Servitization and product innovation

As mentioned earlier, past studies have highlighted the positive effects of the adoption of innovation strategies on a firm’s survival during turbulent or crisis times (Kolk & Pinkse, 2006; Wenzel et al., 2020). Researchers have outlined the benefits and acceleration of product innovation during the current pandemic (Cooper, 2021; Slotegraaf, 2021). In particular, research has emphasized the interplay between servitization and product innovation (Visnjic et al., 2016), showing the positive consequences of such in the long term. Research done after the 2008–2009 world financial crisis (Kwak & Kim, 2016) and about the COVID-19 pandemic (Rapaccini et al., 2020) has shown that servitization can help SMEs to stabilize their businesses and sustain their competitiveness (Kowalkowski et al., 2017).

In a fast-changing competitive environment requiring rapid market responses, investing in new services for new value propositions may be a key strategic behavior for survival (Zhang et al., 2019). Market pressure forces firms to provide more comprehensive and customized value offerings, such as increasing their service orientation (Eloranta & Turunen, 2015). Servitized firms can obtain greater knowledge about the market and customer needs, which will allow them to come up with a feasible value proposition and exploit more product innovation opportunities (Wang et al., 2021). Especially in manufacturing firms, servitization affects the formation, evolution, and performance of product innovation (Bustinza et al., 2018; Cusumano et al., 2015). During the COVID-19 pandemic, product innovation can be the consequence of changing customer needs (Das et al., 2021). In this view, investing in servitization can expand the value of a product through different nuances and features with different levels of technological and organizational complexity (Cusumano et al., 2008; Raddats et al., 2019). This will enable firms to attract new customers and markets, thereby improving their new-product development performance (Chen et al., 2016). The need to rapidly cope with the external challenges related to the pandemic (i.e., reduced physical interaction with customers, emerging demand for new products that needs to be quickly met) can push SMEs to adopt servitization as a response to the market. Servitization can be implemented by offering new services complementing physical goods to facilitate sales and product usage and by coming up with a process-oriented offering that can retain customers (Mathieu, 2001). Past research stressing the relationship between servitization and product innovation showed that manufacturing firms increasingly innovate products through value-added services (Visnjic et al., 2016). Specifically, consistent with the predictions of the business model literature (Chesbrough, 2011), servitization may lead to open service innovation, where the insights collected from the interactions between the (firm) service provider and the customers are used to innovate products. Thus, we formulated hypothesis 3 (H3) as shown below.

H3. The servitization strategies adopted by SMEs during the COVID-19 pandemic are positively related to SMEs’ product innovation.

Despite the attention given to the key role of digitalization in helping firms, especially SMEs, face the COVID-19 pandemic and better position themselves thereafter, there has been very limited research on how the two different groups of technologies, specifically ICT and Industry 4.0 data-processing technologies, could contribute to product innovation (and firm performance) via servitization. Research on information systems has shown that servitization may depend on the use of technologies, from the former digital technologies (Kowalkowski et al., 2013) to the new Industry 4.0 technologies (Ardolino et al., 2018; Frank et al., 2019). The initial research showed that firms have been relying on digitalization to react to the crisis brought about by the pandemic, and that this can further sustain servitization (Kohtamäki et al., 2020). By developing servitization strategies closely linked to digitalization – SMEs may be able to exploit new business opportunities (Rachinger et al., 2019) that can also be achieved through product innovation. This service transition can improve firm competitiveness within turbulent industries and in cases of environmental uncertainty and demand volatility (Fang et al., 2008).

Firms may use the former digital technologies (ICT) and the new Industry 4.0 data-processing technologies to improve their servitization and, consequently, their product innovation in terms of both industrial processes (backend digitalization) and commercial processes (frontend digitalization) (Coreynen et al., 2017). Thus, we formulated the fourth set of hypotheses as shown below.

H4a. SMEs’ servitization strategies during the COVID-19 pandemic mediate the relationship between SMEs’ increased use of ICT and product innovation.

H4b. SMEs’ servitization strategies during the COVID-19 pandemic mediate the relationship between SMEs’ increased use of Industry 4.0 data-processing technologies and product innovation. Fig. 1 summarizes the hypotheses developed into a conceptual framework.
3. Method

To achieve our research aims, we used a mixed-method research approach, which is particularly helpful in providing insights into a new complex phenomenon by integrating the existing knowledge about it (Van Dun et al., 2017). We particularly adopted a sequential mixed-method multi-study design (Venkatesh et al., 2013) with a quantitative study followed by a qualitative one to obtain a more profound understanding of the initial results and explore other interesting findings through interviews. This approach allowed us to refine our study results by interviewing SME owners and/or managers (Johnson et al., 2007). The design of the quantitative study benefited from a previous qualitative study carried out during the first Italian lockdown (2020) that showed the relevance of digital technologies for business survival, especially for enabling a firm to maintain its relationships with both its suppliers and customers and design new marketing responses to the challenges posed by the pandemic (Bettiol et al., 2021b).

Both the quantitative and qualitative studies in the present study focused on assessing the use of digital technologies during the pandemic and the implementation of servitization and product innovation strategies to overcome the crisis. Specifically, the quantitative study aimed to assess the relationships between the different variables in the developed conceptual framework. For the qualitative study, due to the peculiar circumstances of the pandemic, we aimed to obtain an in-depth understanding of how firms have used different digital technologies for servitization and product innovation purposes during the pandemic.

3.1. The quantitative study

A computer-assisted web interviewing-based (CAWI) survey was carried out from October to November 2020 through a questionnaire sent to a stratified sample of 4811 Italian SMEs across different sectors. Stratification was performed using the random search method (Rozak, 2004). We were able to collect 257 useful accomplished questionnaires. The sample was composed of firms operating mainly in the business-to-business (B2B) sectors (87.2%), with only 12.8% operating in the business-to-consumer (B2C) sectors. In particular, the firms were in leading Italian industries, such as fashion, chemicals, food, furniture, and mechanics. They were grouped into the low/medium-low (48.2%) and medium-high/high (51.8%) groups, taking into consideration the Organisation for Economic Co-operation and Development (OECD) classification of industry technological levels. Moreover, the sample consisted of two different groups of SMEs as follows: top performers (31.9%) and average performers (68.1%). The former group had higher levels of the economic and financial indicators used by financial institutions to rate companies (average turnover 2016–2018, average turnover growth 2016–2018, and average return on equity 2016–2018).

The aforementioned quantitative study benefited from the first qualitative study carried out during the first Italian lockdown (Authors, 2021), which allowed us to have a first impression of how Italian SMEs were responding to the unforeseen pandemic and thus which variables could be analyzed through a survey. Apart from the directions captured in the recent literature on COVID-19 responses (Cooper, 2021; Papadopoulou et al., 2020; Rapaccini et al., 2020; Wenzel et al., 2020), variables were identified for the purposes of the present research. Such variables mainly refer to the increased use of digital technologies and the activation of both servitization and product innovation strategies, in addition to some descriptive and contextual variables.

3.1.1. Variables and measures

As far as digitalization strategies are concerned, we asked the respondents if, during the current COVID-19 pandemic, their respective firms had increased their use of the identified digital technologies. We measured the responses through a 7-point Likert scale where 1 = ‘completely disagree’ and 7 = ‘completely agree’ (the option ‘not used’ was also included to take into consideration any case where an identified technology was not available within the firm). Specifically, we assessed the increased use of two main groups of technologies. The first group of technologies consisted of the more mature digital technologies (ICT), such as websites, social media, e-commerce, and CRM, which firms use to interact with customers and/or manage their relationships with them (Kumar & Pandey, 2018; Kim, 2020). The second group of technologies consisted of Industry 4.0 data-processing technologies as follows: big data, cloud, IoT, and AI (Bettiol et al., 2021a; Culot et al., 2020). Then, following the recent literature (Agostini & Nosella, 2019), we proceeded with the ‘dummification’ of these items by assigning a value of 0 to ‘not used’ and ‘lower use’ (values 1–4 on the Likert scale) and a value of 1 to ‘higher use’ (values 5–7 on the Likert scale) for each technology. Finally, we calculated the scores of the four technologies in each group (ICT and Industry 4.0 data-processing technologies) to create the two independent variables used for the analyses.

The mediator variable was the servitization strategy used by a firm during the pandemic. Specifically, the development and offering of five different services were assessed through a 7-point Likert scale where 1 = ‘completely disagree’ and 7 = ‘completely agree’: (1) pre- and post-sales services; (2) complementary product-related services; (3) consulting and training services; (4) pay-per-use services; and (5) introduction of apps for integrated solutions. We calculated a ‘servitization index’ as the mean of the five items.

Regarding product innovation and on the basis of the literature (Eggert et al., 2011; Visnjic et al., 2016), we used a 7-point Likert scale where 1 = ‘completely disagree’ and 7 = ‘completely agree’ to assess if a firm, during the pandemic, had (a) innovated its existing products, (b) developed new products, and (c) increased its product customization. We calculated a ‘product innovation index’ as the mean of the three items.

Finally, as already shown in the recent literature on the relevance of some contextual variables for firms’ innovation strategies during the current COVID-19 pandemic (Penco et al., 2022), we considered different control variables. We controlled for each firm’s business performance, creating a binary variable with a value of 1 for top performers and a value of 0 for average performers. Moreover, we controlled each firm’s industry specialization through a binary variable with a value of 0 for ‘low and medium-low technological sectors’ and a value of 1 for ‘medium-high and high technological sectors’. Another control variable considered the type of market: B2B (coded 1) and B2C (coded 0). The other control variables were the percentage of employees, research and development (R&D) expenditure on turnover in 2019. In addition, we considered the firms’ turnover variation during the COVID-19 pandemic, creating a binary variable with a value of 0 for ‘decreased turnover’ and a value of 1 for ‘stable/increased turnover’.

Table 1 shows all the variables used in the analysis. To assess the effects of both ICT and Industry 4.0 data-processing technologies on servitization and product innovation, we performed regression analysis using a mediation model.

![Fig. 1. Conceptual framework.](image)
owners and/or managers of the SMEs that had given positive answers in (Eisenhardt, 2021). We set out to interview, in December 2020, the ‘survey’ (gelkow, 2007; Yin, 2014).

Toward this end, all the items in the present study were subjected to unrotated principal component analysis, with the fixed number of factors to be extracted set at 1. The test results showed that a single factor explained 51.4% of the total variance, which was lower than the 60% threshold for identifying a common method bias. Thus, common method bias was not a significant concern in the present study through interviews of the owners and/or managers of eight SMEs during the pandemic (from 0 to 4) during the pandemic (from 0 to 4) among manufacturing firms that participated in the quantitative study to explore these relationships. A strong positive relationship between servitization and product innovation was shown, confirming their key roles as SMEs’ responses to the challenges posed by the COVID-19 pandemic. Moreover, both servitization and product innovation were found to be positively correlated with the two groups of digital technologies analyzed (ICT and Industry 4.0 data-processing technologies). However, all the correlation values were lower than the multicollinearity risk threshold of 0.6 (Ghauri & Gronhaug, 2005).

Concerning the regression analyses with mediation, collectively, hypotheses H1, H2, and H3 test the direct effects of digital technologies (ICT and Industry 4.0 data-processing technologies) and servitization on product innovation. Instead, the hypotheses H4ab tested the mediation effect using the Sobel test as a formal significance approach to verify the indirect effects, because it is more powerful than the stepwise procedure addressing mediation directly (Preacher & Hayes, 2004). However, the Sobel test has a limitation: it rests on the assumption that the indirect effects are normally distributed. Bootstrapping is thus recommended. Therefore, in the present study, the mediation hypotheses (H4a and H4b) were tested using the SPSS Process Macro developed by Hayes (2013), which includes both a normal theory approach (i.e., the Sobel test) and a bootstrap approach to obtain confidence intervals (CIs), which facilitated the estimation of the indirect effects.

The results shown in Tables 4 and 5 confirm all the hypotheses developed. Hypotheses H1 and H2 were supported, showing that the increased use of digital technologies (both ICT and Industry 4.0 data-processing technologies) during the pandemic is positively associated with SMEs’ servitization strategies, as indicated by the significant unstandardized regression coefficients (ICT: $B = 0.302, t = 4.079, p = .000$; Industry 4.0 technologies: $B = 0.331, t = 2.472, p = .014$). Hypothesis H3 was also supported, showing that the servitization strategies implemented by SMEs during the pandemic are positively associated with product innovation, as indicated by the significant unstandardized regression coefficients (ICT: $B = 0.562, t = 10.232, p = .000$; Industry 4.0 technologies: $B = 0.603, t = 10.947, p = .000$). Finally, these hypotheses H4a and H4b were supported, showing that the increased use of both ICT and Industry 4.0 data-processing technologies during the pandemic facilitated the estimation of the indirect effects.

### 3.1.2. Common method bias

Common method bias typically occurs when the data were collected from only a single survey, and the measurement technique that was used introduces systematic variance into the measures. According to the literature, common method bias can be prevented or minimized by varying the formats of the scales used to measure the variables investigated (in our case, binary and Likert scales) by creating clearly delineated sections (Malhotra et al., 2006).

Furthermore, business researchers typically perform Harman’s single-factor test to determine whether common method bias exists (Fuller et al., 2016). Toward this end, all the items in the present study were subjected to unrotated principal component analysis, with the fixed number of factors to be extracted set at 1. The test results showed that a single factor explained 51.4% of the total variance, which was lower than the 60% threshold for identifying a common method bias. Thus, common method bias was not a significant concern in the present study.

### 3.2. The qualitative study

In the second part of the present study, we conducted a qualitative study through interviews of the owners and/or managers of eight manufacturing firms that participated in the quantitative study to deepen our understanding of the use of different digital technologies during the pandemic and how firms have used digital technologies to implement servitization and product innovation strategies. Moreover, we aimed to understand whether technologies could be considered strategically essential for a firm’s competitiveness after the COVID-19 pandemic. The use of multiple case studies is considered particularly helpful in investigating contemporary and complex phenomena (Sig-gelkow, 2007; Yin, 2014).

The selection of the interviewees, which took place soon after the survey’s completion, was based on the variables investigated in the quantitative study and followed a careful case-selection approach (Eisenhardt, 2021). We set out to interview, in December 2020, the owners and/or managers of the SMEs that had given positive answers in the quantitative study (values 5–7 on the 7-point Likert scale) about the topics that were investigated: increased use of digital technologies, implementation of servitization and product innovation strategies, and implementation of other innovation strategies (captured through the SMEs’ R&D expenditure). Forty Italian SMEs were selected for the qualitative study. We contacted all of them via email and/or telephone, and eight SMEs agreed to participate in this qualitative study (Table 2).

Each interview was based on a set of open-ended questions that followed guidelines to keep the conversation structured and on point and was accompanied by documentation from the prior study. All the interviews were recorded and transcribed, and each lasted for 30 min on average. Specifically, the questions aimed at understanding how firms used the different identified digital technologies to face the COVID-19 pandemic (to interact with customers, support their sales, reach new markets, etc.), whether and how they increased or improved their servitization and product innovation during the pandemic and what their post-COVID-19 strategy is.

### 4. Results

#### 4.1. Results of the quantitative study

#### 4.1.1. Results of mediation model regression

Table 3 shows the descriptive statistics and the correlations between the variables included in the regression analyses. As far as the main variables of the mediation regression model are concerned, the descriptive statistics show that the SMEs during the pandemic had good levels of servitization and product innovation. Moreover, the SMEs showed a higher increased use of the mature ICT than of the new Industry 4.0 data-processing technologies, which, as expected, have a lower adoption rate. Correlation analysis provided a starting point for exploring these relationships. A strong positive relationship between servitization and product innovation was shown, confirming their key roles as SMEs’ responses to the challenges posed by the COVID-19 pandemic. Moreover, both servitization and product innovation were found to be positively correlated with the two groups of digital technologies analyzed (ICT and Industry 4.0 data-processing technologies). However, all the correlation values were lower than the multicollinearity risk threshold of 0.6 (Ghauri & Gronhaug, 2005).

Concerning the regression analyses with mediation, collectively, hypotheses H1, H2, and H3 test the direct effects of digital technologies (ICT and Industry 4.0 data-processing technologies) and servitization on product innovation. Instead, the hypotheses H4ab tested the mediation effect using the Sobel test as a formal significance approach to verify the indirect effects, because it is more powerful than the stepwise procedure addressing mediation directly (Preacher & Hayes, 2004). However, the Sobel test has a limitation: it rests on the assumption that the indirect effects are normally distributed. Bootstrapping is thus recommended. Therefore, in the present study, the mediation hypotheses (H4a and H4b) were tested using the SPSS Process Macro developed by Hayes (2013), which includes both a normal theory approach (i.e., the Sobel test) and a bootstrap approach to obtain confidence intervals (CIs), which facilitated the estimation of the indirect effects.

The results shown in Tables 4 and 5 confirm all the hypotheses developed. Hypotheses H1 and H2 were supported, showing that the increased use of digital technologies (both ICT and Industry 4.0 data-processing technologies) during the pandemic is positively associated with SMEs’ servitization strategies, as indicated by the significant unstandardized regression coefficients (ICT: $B = 0.302, t = 4.079, p = .000$; Industry 4.0 technologies: $B = 0.331, t = 2.472, p = .014$). Hypothesis H3 was also supported, showing that the servitization strategies implemented by SMEs during the pandemic are positively associated with product innovation, as indicated by the significant unstandardized regression coefficients (ICT: $B = 0.562, t = 10.232, p = .000$; Industry 4.0 technologies: $B = 0.603, t = 10.947, p = .000$). Finally, these hypotheses H4a and H4b were supported, showing that the increased use of both ICT and Industry 4.0 data-processing technologies during the pandemic facilitated the estimation of the indirect effects.

### Table 1

| Variable                  | Description                                                                 | Type              |
|---------------------------|-----------------------------------------------------------------------------|-------------------|
| ICT                       | Increased use of website, social media, e-commerce, and CRM during the pandemic from 0 to 4 | Counting          |
| Industry 4.0 data-processing techs Servitization | Increased use of big data, cloud, IoT, and AI during the pandemic (from 0 to 4) | Counting          |
| Performance               | 1 for top-performing firms, 0 otherwise                                      | Dichotomous       |
| Industry                  | 1 if the firm specializes in “medium-high/high technological industry”, 0 for “low/medium-low technological industry” | Dichotomous       |
| Market segment            | 1 for firms operating in the B2B market, 0 for firms operating in the B2C market | Dichotomous       |
| Turnover variation (during pandemic) | 1 for firms experienced stable/increased turnover, 0 for firms experienced decreased turnover | Dichotomous       |
| Export                    | % Export on turnover 2019                                                   | Continuous        |
| R&D expenditure           | % R&D on turnover 2019                                                      | Continuous        |

![Table 1](image-url)
Table 2
Profile of SMEs interviewed.

| Company | Industry sector | Employees 2019 | Turnover 2019* | Length of interview | Interviewee |
|---------|----------------|----------------|---------------|---------------------|-------------|
| Company 1 | Food | 30 | 5.7 | 27 min | Administration and HR manager |
| Company 2 | Engineering | 51 | 24 | 36 min | Trade manager |
| Company 3 | Engineering | 48 | 15 | 32 min | Co-owner |
| Company 4 | Certification services | 29 | 2.6 | 30 min | Owner |
| Company 5 | Packaging | 47 | 13.5 | 30 min | General manager |
| Company 6 | Engineering | 15 | 10.3 | 30 min | Founder & CEO |
| Company 7 | Engineering | 5 | 1.6 | 42 min | CEO |
| Company 8 | Fashion | 76 | 19.8 | 25 min | Sales manager |

Note. * Millions of euros. Companies are listed by the interview date.

Table 3
Descriptive statistics.

| | Min | Max | Mean | SD | 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. |
|---|-----|-----|------|----|----|----|----|----|----|----|----|----|----|----|
| 1. ICT | 0 | 4 | 1.195 | 1.206 | 1 | – | – | – | – | – | – | – | – | – |
| 2. Industry 4.0 data-processing techs | 0 | 1 | 0.260 | 0.667 | 2.67** | 1 | – | – | – | – | – | – | – | – |
| 3. Servitization | 1 | 7 | 3.276 | 1.391 | 2.76*** | 1.83** | 1 | – | – | – | – | – | – | – |
| 4. Product innovation | 1 | 7 | 3.868 | 1.482 | 3.66*** | 1.66** | .586*** | 1 | – | – | – | – | – | – |
| 5. Performance | 0 | 1 | 0.319 | 0.467 | 1.67** | 1.01 | .159* | .150* | 1 | – | – | – | – | – |
| 6. Low/medium-low vs medium-high/ high tech industry | 0 | 1 | 0.518 | 0.501 | .998 | .137* | .102 | .065 | .110 | 1 | – | – | – | – |
| 7. B2B vs B2C | 0 | 1 | 0.872 | 0.335 | .064 | .039 | .006 | .015 | .013 | .281*** | 1 | – | – | – |
| 8. Turnover variation | 0 | 1 | 0.409 | 0.493 | .037 | .138* | .048 | .010 | .042 | .010 | .036 | 1 | – | – |
| 9. % Export on turnover 2019 | 0 | 1 | 10.20.610 | 28.155 | .157* | .033 | .024 | .121 | .048 | .169* | .006 | .115 | 1 | – |
| 10. % R&D on turnover 2019 | 0 | 1 | 3.795 | 6.751 | .277*** | .194* | .054 | .172** | .014 | .151* | .219** | .025 | .198** | 1 |

Note. N = 257; *** p < .001; ** p < .01; * p < .05.

Table 4
Regression with mediation results for ICT.

| | β | SE | t | p | LLCI | ULCI |
|---|----|----|---|---|-----|-----|
| Direct and total effects | | | | | | |
| Servitization regressed on ICT | .302 | .074 | 4.079 | .000 | .156 | .447 |
| Product innovation regressed on Servitization | .562 | .055 | 10.232 | .000 | .454 | .670 |
| Product innovation regressed on ICT | .232 | .066 | 3.504 | .001 | .102 | .362 |
| Product innovation regressed on ICT, controlling for servitization | .401 | .076 | 5.263 | .000 | .251 | .552 |
| Indirect effects and significance using normal distribution | | | | | | |
| Sobel | .169 | .045 | 3.773 | .000 | | |
| Bootstrap results for indirect effects | | | | | | |
| Effect | .169 | .046 | .082 | .260 | | |

Note. N = 257. Unstandardized regression coefficients are reported. Bootstrap sample size = 5000. LLCI = lower limit of 95% confidence interval; ULCI = upper limit of 95% confidence interval.

Table 5
Regression with mediation results for Industry 4.0 data-processing technologies.

| | β | SE | t | p | LLCI | ULCI |
|---|----|----|---|---|-----|-----|
| Direct and total effects | | | | | | |
| Servitization regressed on I4.0 | .331 | .134 | 2.472 | .014 | .067 | .595 |
| Product innovation regressed on servitization | .603 | .055 | 10.947 | .000 | .494 | .711 |
| Product innovation regressed on I4.0 | .103 | .118 | .874 | .383 | .282 | .333 |
| Product innovation regressed on I4.0, controlling for servitization | .302 | .141 | 2.139 | .033 | .024 | .581 |
| Indirect effects and significance using normal distribution | | | | | | |
| Sobel | .199 | .083 | 2.402 | .016 | | |
| Bootstrap results for indirect effects | | | | | | |
| Effect | .199 | .088 | .055 | .396 | | |

Note. N = 257, I4.0 = Industry 4.0 data-processing technologies. Unstandardized regression coefficients are reported. Bootstrap sample size = 5000. LLCI = lower limit of 95% confidence interval; ULCI = upper limit of 95% confidence interval.

The pandemic has a positive indirect effect on product innovation by mean of servitization (ICT’s indirect effect is 0.169; Industry 4.0 technologies’ indirect effect is 0.199). The formal two-tailed significance test (assuming a normal distribution) demonstrated that both indirect effects were significant (ICT: Sobel z = 3.773, p = .000; Industry 4.0 technologies: Sobel z = 2.402, p = .016). The bootstrap results confirmed the Sobel test results (see Tables 4 and 5), with a bootstrapped 95% CI interval around the indirect effect not containing zero. Thus, hypotheses H4a and H4b were supported. Moreover, it is interesting to note that ICT had a direct effect on a firm’s product innovation strategy; thus, servitization works as an improver of this existing relationship (partial mediation). For increased use of Industry 4.0 data-processing technologies, the results of the mediation analysis show a full mediation by servitization as increased use of Industry 4.0 data-processing technologies was shown not to have a significant direct effect on product innovation.
Finally, from the viewpoint of the control variables, only business performance was found to be marginally significant in some steps of the mediation analyses (see Tables 4 and 5). None of the other variables were found to be significant, including the turnover variation during the pandemic. This latter case means that the economic situation brought forth by the pandemic has not negatively influenced companies to decide to invest in servitization and product innovation strategies as a reaction to the challenges posed by the pandemic.

4.1.2. Endogeneity test

The present study could have suffered from endogeneity problems arising as a result of autoregression with autocorrelated errors, simultaneity, or omitted variables. To address this issue, we firstly performed the Durbin–Watson’s test (Cegarra-Navarro et al., 2016), a statistic with values ranging from 0 to 4, where a value near 2 means that there is no autocorrelation in the sample. In this study, the Durbin–Watson statistic for ICT was 1.953, and that for Industry 4.0 was 1.995; thus, there were no signs of autocorrelation or model specification error. Moreover, because of the significant direct relationship between ‘increased use of ICT’ and ‘product innovation’ (Antonakis et al., 2012), we used the mediation approach (Kenny, 2012) to identify the instrumental variable (IV) that was the theoretical cause of increased use of ICT but was not directly related to product innovation (Souza & da Silveira, 2019). The respondents were asked to indicate on a 5-point Likert scale whether, during the pandemic, they encountered a need to link with the other employees through digital technologies (the variable was named digital job continuity). This variable was a plausible factor for increased use of ICT, but it could hardly be associated with product innovation.

To address endogeneity with the IV regression, we used the EndoS macro of SPSS and the procedure shown by Daryanto (2020). The common form of IV regression is two-stage least squares. Hausman’s specification test showed an F-value of 2.820 (p = .094), which is marginally significant. The 10% critical value of the maximal IV size was 16.38. The Cragg-Donald F-statistic from the two instruments (F = 19.540) was higher than the critical value of 10% maximal bias (p = .05). These results indicate that endogeneity was likely not influential in the relationship between increased use of ICT and product innovation.

4.2. Results of the qualitative study

All the SME owners and managers interviewed in the present study pointed out that after the first lockdown owing to the pandemic, their priority was to reconnect with their clients by investing specifically in ICT to support their communications. The interviewed SME owners and managers indicated that before the pandemic, their SMEs’ client relationships were managed mostly offline; hence, ICT became the only tool at hand for them to talk to their clients when the pandemic broke out. As the founder and chief executive officer (CEO) of Company 6 said, ‘The pandemic has led the company to manage relationships with clients and suppliers digitally, through the videoconferencing technologies of their choice. This allowed the company to implement the technologies that it already had but that were not being used and that will be used in the future’.

For SMEs, client relationships are instrumental in defining new products. As the general manager of Company 5 said, ‘We don’t sell commodities. Each of our projects is customized on the basis of the customer’s needs and therefore requires strong interaction between our technical department and the customer himself. Videoconferencing has allowed us to manage this process largely online, making it more fluid and rapid. We could have used these technologies in the past, but both the client and we had sort of “mental barriers” that prevented us from doing so’. This increased use of communication was not limited to videoconferencing; it also pushed firms to improve the way they interacted with their clients and to adopt more advanced technologies, such as CRM. From interactions that were limited in time and space (physical) thanks to digital technologies, SMEs started to dialogue with their clients almost continuously (every week, at least) and collect better information from them for offering new services and designing new products. In this regard, the owner of Company 4 said, ‘For pre-sales activities right up to the commercial stage, we have increased the use of CRM. All customer data are stored, allowing us to identify the customer’s exact commercial development status. CRM helps us reduce quote times and pre-sales and understand where the market is going’.

We found that four of the eight firms in the present study achieved product innovation using digital technologies (mainly ICT). There were two main areas of investment: e-commerce and product customization. For e-commerce, it was used not just as a new way of selling products to clients but also as a form of differentiation by offering value-added online services. The co-owner of Company 3 maintained, ‘In the after-sales phase, the customer has the ability to purchase spare parts online using an e-commerce service that is easily accessible from the website. We have noted that this mode of support has increasingly been used during the pandemic’. New services were also offered through the virtualization of physical spaces and products. As the sales manager of Company 8 said, ‘We have a large physical archive (a vault of ideas) that we are digitalizing to promote new services to our international clients. Luxury companies are always looking for new ideas, and we believe that with this service, we can offer our clients a value proposition’. Firms seem to have increased their capacity for in-product customization, which is becoming an important competitive advantage, especially during the pandemic. The CEO of Company 7 told us, ‘One of my French clients called me to say that he was impressed by the fact that we were able to completely customize our packing to his needs in a couple of weeks by interacting only online with him. He was very happy to have an ad hoc pack only for his company’.

In the area of product customization, an interesting new line of investment deals with client participation in the early phase of product development, especially in B2B. The trade manager of Company 2 told us, ‘Digital is changing its sales process by putting the customer in contact with the technical department at an early stage to begin to create customized solutions: product innovation by providing not only machines but also systems for water treatment to design all phases that are upstream of the water treatment itself’.

When ICT and Industry 4.0 technologies are combined, firms have opportunities to redesign their internal processes and increase their product innovation through servitization. The chief financial officer (CFO) and human resource (HR) manager of Company 1 said, ‘During the lockdown, for the group companies, we enhanced the website and e-commerce area with new functions, developing greater integration with the production area and ERP [Enterprise Resource Planning]’. This decision was essential for managing the extraordinary increase in orders, especially of products that from the average pre-pandemic 50 online orders per week reached 150 orders per day. The production runs 24h, 7 days a week, to keep up with the demand. This was possible thanks to an innovative group of machines based on Industry 4.0 technologies that were way more flexible and, most importantly, were directly connected to the ERP. Data exchange between the e-commerce site, ERP, and Industry 4.0 machines was instrumental for the management of the increased volume of orders. The machines were bought before the pandemic but were underused. The company understood the machines’ potential during the lockdown, and henceforth, this allowed for a more varied production mix and improved the services offered to the clients. Servitization can also be achieved in the aftersales. During the pandemic, Company 2 decided to adopt ‘… solutions that would allow remote maintenance with augmented-reality devices, so our operator remotely guides another operator located in a different part of the world in the maintenance of the machine’. This new service was the result of an attempt to solve a practical problem related to the need to guarantee the remote maintenance of complex machines. In the past, a team of technicians would have flown out to the client. Through virtual reality, however, the company not only solved the problem of guaranteeing its service but also learned how to provide a new service to its clients for more timely and cost-effective maintenance. The use of augmented/virtual reality was possible thanks to the digitalization of the design phase. The 3D file of each new machine is stored in
the company’s cloud, which allows technicians to provide augmented/virtual-reality services. All the respondents asserted that the pandemic has given them an opportunity to innovate their business activities/processes, and that the innovative solutions they experienced during the pandemic would be integrated into their respective firms’ daily activities even after the pandemic. Moreover, all the respondents said that in the ‘new normal’ era after the pandemic, they will continue to invest in digitalizing their businesses, as that is the only way to ensure business continuity.

5. Discussion and conclusions

The present study provided empirical findings regarding how digital technologies have allowed SMEs to overcome the challenges that have emerged with the COVID-19 pandemic. The core result of our quantitative analysis is the finding that the increased use of both ICT and Industry 4.0 data-processing technologies during the COVID-19 pandemic has helped SMEs improve their servitization and, indirectly, their product innovation.

The mediation analyses showed that servitization has a relevant role as a mediator of product innovation, especially for Industry 4.0 data-processing technologies, because no direct link was found between this group of technologies and product innovation (full mediation). Instead, for ICT, servitization allows to improve the existing direct relationship with product innovation (partial mediation). This result could be explained by several factors. Historically, ICT has played a key role in marketing, especially in promoting new products or entering new markets through e-commerce and social media (Roccocelli et al., 2017; Zhang & Zhu, 2021). ICT has also always played an important role in promoting customer interactions and business success in terms of creating and capturing value (Drnevich & Croson, 2013). This latter aspect could be the real strategic element of ICT because of the key value of the customer-centric approach that emerged from the pandemic. The COVID-19 pandemic has forced people to spend more time on the Internet and increase their use of digital channels to interact with companies (Baig et al., 2020); therefore, companies should be ready to exploit the rise of digital channels (Kim, 2020) and the benefits of the company’s increased interactions with its customers, such as in the form of collaborative relationships with them, in terms of innovation (Patrucco et al., 2021). In addition, recent advances in ICT and database marketing could facilitate customer-centric processes, allowing effective management of increased interactions with customers and information collected (Kumar & Ayedee, 2018; Rust et al., 2010). However, this may depend on the different adoption rates and maturity levels of ICT and Industry 4.0 technologies (Matt et al., 2021; Pirola et al., 2020). Firms could have a better understanding of a ‘relatively old’ technology, such as ICT, than of a ‘relatively new’ one, such as Industry 4.0 technologies (Bettiol et al., 2021a).

Another possible explanation of the different results obtained regarding the direct relationship of ICT (existing) and Industry 4.0 technologies (missing) with product innovation is the greater availability and ease of use of ICT compared with Industry 4.0 technologies. Product innovation requires firms to have technological competences and knowledge of their customers (Danneels, 2002). Although Industry 4.0 data-processing technologies have demonstrated their relevance for sustaining business activities in turbulent times with time and resource constraints, particularly during the COVID-19 pandemic (Papadopoulos et al., 2020), they require higher levels of digital knowledge and capabilities on the part of those who will operate them (Wamba et al., 2017), which could limit the successful exploitation of such technologies in terms of product innovation in the short term, especially in the case of SMEs. In other words, the learning curve for ICT is lower than that for Industry 4.0 technologies, and especially in unexpected and unpredictable times, such as a pandemic, to innovate their products, firms using Industry 4.0 data-processing technologies must improve their servitization, a core part of the new technological revolution (Frank et al., 2019).

However, despite the different degrees of relevance of ICT and Industry 4.0 technologies as enablers for servitization (Tian et al., 2021), from a relationship marketing perspective, the COVID-19 pandemic has unleashed the power of the digital environment in fostering personalized solutions that can help SMEs develop effective strategies in a short time. As revealed by our in-depth interviews, digital technologies have been able to support communication and interaction with markets and customers (Fraccastoro et al., 2021; Matt et al., 2021), allowing firms to understand the changes occurring in terms of demand and response and capture value to innovate their offerings.

From this study, a clear strategic direction emerges for firms: by investing in digitalization upstream and, above all, downstream and through an effective data management strategy (Rachinger et al., 2019), firms may be able to transform their competitive behavior not only to react to the new market conditions but also to proactively define their new offerings (Poss & Saebi, 2017). Investing in digitalization is a key strategic decision for firms to achieve growth and innovation, allowing them to overcome a pure efficiency-seeking strategy (Björkdahl, 2020) to deepen their relationships with customers and sustain their businesses in turbulent times, and for firms to expand the space of service and product offerings in which they operate (Nambissan et al., 2019).

5.1. Theoretical contributions

The present study was one of the first attempts to assess whether two different groups of digital technologies, the more mature ICT and the newest Industry 4.0 technologies, enable firms’ innovation (servitization and product innovation) as a response to the challenges posed by the COVID-19 pandemic. Theoretically, this article contributes to the literature on the relationship between digital technologies and servitization, a relationship that is still underexplored (Baines et al., 2017). Because time and resource constraints during the COVID-19 pandemic may be obstacles for SMEs, this research highlights the positive relationship between digital technologies and servitization, both identified as critical variables for sustaining business due to the imposed restrictions (Rapaccini et al., 2020). The costs of servitization do not tend to lead to immediate returns, and its linkage with product innovation may sometimes result in a short-term performance decline (Gebauer et al., 2005; Visnjic et al., 2016). On the contrary, however, the present study showed that during the COVID-19 pandemic, servitization and product innovation have paid off within a short time and under uncertain conditions. Product innovation during the pandemic allows companies to improve the customers’ perceptions of products’ safety and quality, adding social value by coevolving together (companies and customers) and reorienting the business activities (Netz et al., 2022) to satisfy new market needs (Wang et al., 2020).

This article also shows that in the controversial debate about the relationship between servitization and product innovation (Qi et al., 2020; Wang et al., 2021), during the pandemic, the offering of new services from the viewpoint of servitization has allowed firms to innovate their products to cope with the changed market conditions. In this regard, our research emphasized how the readjustment of a firm’s strategy in the event of a crisis (i.e., the COVID-19 pandemic) is linked to digitalization, but that digital technologies play different roles (Luz Martín-Peña et al., 2018; Paschou et al., 2020) with regard to product innovation. Digitalization and servitization have a mutual influence and a joint effect that facilitate the emergence of ‘new’ products finding new value in digital technologies and services. Firms have to provide digital tools and services to capture value from the market and facilitate the tailoring of their products to customer-specific needs. In this regard, using more mature ICT has allowed SMEs to have direct contact with their customers, which enables product innovation, increased by servitization. The use of Industry 4.0 data-processing technologies during the pandemic is needed, however, to improve servitization for product innovation purposes.
Regarding new products and services that may have a long-lasting impact beyond the pandemic, the question of how digital technologies will influence recovery after the pandemic is highly salient for strategy and management researchers. There is evidence in the literature that the appropriate and strategic use of digital technologies can enhance a firm’s competitiveness and performance (De Luca et al., 2020). The COVID-19 pandemic has stressed the need for firms to digitalize to identify alternative business opportunities by innovating their services and products.

5.2. Managerial contributions

As far as managerial implications are concerned, the findings of the study suggest entrepreneurs and managers to focus their attention on digitalization as an effective response to short-term environmental changes and new market demands, as it allows to develop new services and innovate products. Specifically, our findings highlight the direct effect of the use of ICT on SMEs’ product innovation strategy, while Industry 4.0 data-processing technologies need to be mediated by services (Xu et al., 2018). This finding may help managers and entrepreneurs make more informed decisions on which technologies to invest in and implement and how to extract the highest value from their use. Choosing the right set of technologies to achieve servitization and product innovation can capture additional value from the market and is a viable way of coping with turbulent times.

Moreover, our research findings suggest that managers and entrepreneurs should pay greater attention to opportunities for customizing services as a way to develop fruitful interactions with customers, which will have positive effects on their firms’ performance. Therefore, to effectively compete during the COVID-19 pandemic and in the ‘new normal’ era, managers and entrepreneurs should devote much attention to the development of new services and the design of new products by considering the potential of customer insight.

5.3. Limitations and future research

This study had some limitations that could be considered prompts for future research. The analysis was carried out considering SMEs. Additional research is required to explore single technologies and the relationship between firm’s size and technological strategy. Future research should also be industry-specific to better analyze the impact of different digital technologies on diversification and servitization, should focus on other digital services, and should evaluate how relationships with suppliers and other business partners could support diversification, and thus competitiveness. Future research should also identify specific capabilities and consider a firm’s resources that may affect the firm’s innovation strategies, especially with respect to Industry 4.0 data-processing technologies. Finally, future studies could use panel data to better address endogeneity and improve the rigor of the results of the present study while also considering other organizational factors.

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