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Sustained value creation driven by digital connectivity: A multiple case study in the mechanical components industry

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ABSTRACT

This paper investigates how digital connectivity drives new forms of sustained value creation in traditional industries, where many firms still compete and strategize within a traditional industry structure and supply chain logic. We perform a multiple case study with four companies active in the vehicle component industry and implementing digital connectivity in a business-to-business (B2B) setting. Results show that digital connectivity enables greater transparency, trust, and collaboration with customers and creates new forms of value creation through companies' *strategizing actions* – aimed at developing highly customized solutions – and *critical capabilities* – needed to configure a customer-centric value chain, integrate buyer-supplier digital resources, and improve the coherence between data-driven decision-making, lean management, and employees' skills. We shed light on how manufacturers leveraged digital connectivity to successfully assimilate and scale up their digital-related capabilities across different dimensions, transforming their business models in a sustained way. This should also complement a change in the governance of customer transactions, fostering transparency and trust. Fine-tuning and expanding well-established B2B relationships through digital connectivity become a priority for traditional businesses to change to new and efficiently sustained value co-creation forms that can be complemented to a successful business model innovation or co-creation strictly linked to larger network connections.

1. Introduction

The manufacturing sector has been undergoing a pervasive phenomenon of digital transformation in recent years, where the integration of digital technologies into core business operations, processes, and strategy leaded to fundamental changes in how companies create and deliver value (Kraus et al., 2022).

The feature of digital connectivity, resulting from the innovative use of various digital technologies to facilitate data exchange, visibility, and dynamic interactions with a variety of entities, brings a strategic renewal of the value proposition that combines company resources and capabilities with mutual learning beyond mere technological adoption (Brea, 2023; Pessot et al., 2022; Seetharaman et al., 2019). Indeed, it enables interoperable and collaborative data sharing between heterogeneous products, actors, and conditions by enhancing interdependencies while overcoming physical barriers within value chains and networks (Ismail et al., 2017; Subramaniam et al., 2019). This is true not only in digital-native sectors but also in the traditional ones manufacturing physical products, where the strategic leverage of digital connectivity, when combined with existing capabilities, can lead to new forms of value-creation, able to augment the customer experience, streamline operations, or even create new business models (Sjödin et al., 2020; Warner and Wäger, 2019). In doing so, organizations are challenged in the traditional approach to strategizing and redesigning the way they interact with customers and exchange and exploit new products and services with them, especially in business-to-business (B2B) settings (Jovanovic et al., 2021; Leminen et al., 2020b). Despite the importance of strategically leveraging digital connectivity to achieve a holistic digital transformation, it is still unclear how traditional businesses create value from it in a sustained way, being such companies often forced to deal with conflicts and trade-offs between existing (physical) and new (digital) ways of doing business (Verhoef et al., 2021). Moreover, there is a need to narrow the conceptualization of the multifaceted phenomenon of digital transformation (Kraus et al., 2022; Verhoef et al., 2021) and improve our understanding of the practical and theoretical implications and the strategic relevance of digital connectivity from a value creation perspective (Miehé et al., 2022). Still, many firms are accustomed to competing and strategizing within traditional

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industry and B2B relationship structures, with long-established approaches and interdependencies that require a new quest in the logic connectivity and information sharing that are managed and thus exploited in a sustainable business model (Clarysse et al., 2022; Subramaniam et al., 2019).

This paper aims to gain further insights into the new forms of value creation in B2B relationships driven by an enhanced level of connectivity given by digital technologies and how this value creation is developed and sustained in a long term in traditional industries. Thus, the research question was formulated as follows: *how do companies of traditional industries leverage digital connectivity with their customers for developing new forms of sustained value creation?*

To answer it, we conducted a multiple-case study on four Italian vehicle component suppliers that have been pursuing investments in technologies and the relationship with their customers and are now able to reconfigure the value from such activities enhanced by the digital connectivity with their customers in a sustained way. First, we investigate the impacts of digital connectivity on the new forms of value creation in B2B settings, also focusing on the importance of data sharing for enabling greater transparency and trust in managing the relationship with the customer in the long term. Second, we take a further step in investigating the logic underpinning value creation and how these companies implement strategizing actions and critical capabilities for sustained value creation (Achtenhagen et al., 2013), encompassing customized solutions, co-creation, and higher information transparency with customers.

From a practical viewpoint, establishing consistent digital connectivity and ensuring a transparent real-time data flow in B2B relationships could be a crucial aspect in creating value (Burström et al., 2021; Gilchrist, 2016). This is particularly significant in traditional sectors, where competitiveness is still based on the delivery of physical goods rather than on digitally mediated transactions and where the prevalence of physical infrastructures (rather than digital platforms) and complex supply chains requires a higher level of investment in new technologies (Bresciani et al., 2021; Caputo et al., 2021; DaSilva and Trkman, 2014; Nagle et al., 2020; Warner and Wäger, 2019).

From a theoretical viewpoint, despite the (broad) increasing interest in defining digital transformation and its outcomes in terms of business model innovation (Gong and Ribiere, 2021), we need to narrow the perspective on the critical investments necessary to exploit such a transformation in its constituent elements (Colombari et al., 2022; Verhoef et al., 2021). Consequently, our focus is on digital connectivity, which is argued to affect the strategic responses of companies to redefine value creation paths (Holopainen et al., 2023), but the logic and the mechanisms that sustain them over time have been less studied (Bresciani et al., 2021; Vial, 2019). An in-depth investigation is necessary to understand how value creation, as driven by digital connectivity, can be sustained in the long term, considering that the manufacturing strategies are closely linked to a traditional supply chain logic and industry structure (Achtenhagen et al., 2013; Remane et al., 2017; Subramaniam et al., 2019).

Overall, the results of this study highlight the importance of data and connectivity in enabling greater transparency and trust in managing the relationship with the customer – both at the level of the single firm and the B2B relationship. This, in turn, leads to a better understanding of the capabilities that companies must develop, reducing the information asymmetry in transactions between buyers and suppliers and repositioning themselves both along the value chain and on new markets. The fine-tuning and expansion of the well-established B2B relationships with customers thanks to digital connectivity can thus be a priority for traditional businesses to change to new value co-creation forms that are efficiently sustained in the long term – and that can be complemented to achieving successful business model innovation or co-creation strictly linked to connection to larger networks.

The remainder of the paper is organized as follows. Section 2 presents the theoretical background. The methodological approach adopted in the paper is presented in Section 3. Section 4 describes the results of the case study research, further discussed in Section 5. Finally, the conclusion, limitations, and managerial implications are discussed in Section 6.

2. Theoretical background

2.1. Digital connectivity and new forms of value creation

Digital connectivity enables the horizontal and vertical interconnection of machines, technological systems, products, components, people, and workflows, resulting in a convergence between physical and digital spaces both within companies and between different companies of the supply chain (Guo et al., 2021; F. Li, 2020; Miehé et al., 2022; Thoben et al., 2017). Connectivity may occur in three main ways: the first involves extracting increasing amounts of data from the factory floor; the second involves managing, controlling, and implementing information systems; the third implies an even more intense exchange of data between companies and between such companies and their suppliers and customers, thanks to the availability of innovation and transaction platforms (Brea, 2023; Forrester, 2021). The advancements in connectivity are shown to affect and modify inter-firm relationships, with the fast and shared access and synchronization to large volumes of data needed to convey different forms of knowledge in the supply chain continuously (Miehé et al., 2022; Rajala and Hautala-Kankaanpää, 2023).

The strategic leverage of these connectivity levels can lead to trustworthy, collaborative relationships aimed at promoting information sharing, coordination, and versatile innovations in supply chains as well as at the operational level (Kiel et al., 2017; Li and Li, 2017; Metallo et al., 2018). In this way, companies can design a superior value offer with effective usage of resources at the interface – through wireless communication networks and digital platforms – with their stakeholders, especially customers (Frankenberger et al., 2013; F. Li, 2020; Parida et al., 2019). The decision-making processes necessary for a business model change are redefined at multiple levels, i.e., at the process, activity, and company levels, with business competitiveness being enhanced by new value-creation opportunities (Andersen et al., 2021; Kamalaldin et al., 2020; Schneckenberg et al., 2021). Therefore, digital connectivity drives new strategic choices concerning value creation, new forms of decision-making for the manager as well as more complex relationships with business partners (Porter and Heppelmann, 2014).

Specifically, the impacts of digital connectivity on value creation in B2B settings include (1) the creation of integrated, personalized solutions with a customer-centric approach and (2) the integration of customers as collaborative partners in the co-creation of value (Burström et al., 2021; Kiel et al., 2017; Parida et al., 2019; Schneckenberg et al., 2021).

Firstly, (1) such connectivity can encourage the real-time customizability of solutions according to the customers' individual needs (Amit and Zott, 2001, 2020; Zhou et al., 2015). Manufacturing companies can create an integrated value-creation process designed to optimize the entire product life cycle and offer customers fully customizable products (KPMG International, 2019). New products and services can thus be created from the customer's standpoint, and the actual suppliers' portfolio can be extended (Burström et al., 2021). This trend toward customer-centricity calls for a great ability to understand and assess the operational needs of customers (Burström et al., 2021; Schneckenberg et al., 2021). A customer-centric approach leverages the customers' demands and preferences, which can be gathered from multiple sources using IoT (Burström et al., 2021). To this aim, companies should adopt data-driven decision-making processes with real-time data (and their matching) from customers more extensively to better customize their solutions (Andersen et al., 2021). In this context, digital connectivity allows the traditional trade-off between costs and customization efforts to be overcome and the potentiality of creativity and turning ideas into

real-world solutions to be unleashed (Ehret and Wirtz, 2017). Companies provide not only products but also integrated solutions of personalized and innovative products and services based on data collection, monitoring, and analysis (Kiel et al., 2017). This could imply offering bundles of complementary products and services to leverage the potential complementarities (Amit and Zott, 2001, 2020). Integrated autonomous solutions can also help to reduce the deployment costs associated with customized solutions (Burström et al., 2021).

Secondly, (2) digital connectivity is also concretized through value co-creation with customers, with both the business model and the B2B interaction renewed (Kamalaldin et al., 2020; Lenka et al., 2017; Warner and Wäger, 2019). The logic behind co-creation implies that the supplier becomes the customer's partner by creating an interactive relationship based on increased transparency and mutual exchange (Sjödin et al., 2020). This results in a product whose value – and quality – can be significantly higher than a mass-produced item (Rayna and Striukova, 2016). An interesting research perspective is that concerning the upgrading of technology through the co-creation of value (Caputo et al., 2021). The possible challenges of such an approach include the need to revise roles and responsibilities to overcome ambiguities and match the front-end and back-end function capabilities (Parida et al., 2019). Indeed, manufacturers are struggling to successfully assimilate and scale up their digital-related capabilities, transforming their business models (Colombari et al., 2022; Remane et al., 2017; Sjödin et al., 2020). A change in the digital-related capabilities should also complement a change in the governance of transactions with customers, with the aim to seize the opportunities made available by a large amount of data and digital connectivity, strengthening inter-firm collaboration and evolving value proposition (Miehé et al., 2022; Schneckenberg et al., 2021).

Suppliers and customers need to transform their interchanges to achieve benefits from their interconnection, with dedicated investments to combine the partners' capabilities and unblock data transparency and sharing (Kamalaldin et al., 2020). In this sense, the sharing of a large amount and a large variety of more accurate data and information increases not only the complexity of the transaction but also the relationship (Paolucci et al., 2021). Joint value co-creation can also occur because of independent activities (Kamalaldin et al., 2020). For example, Lenka et al. (2017) showed that service providers should develop different digital-related capabilities to interact and co-create value with their customers, owning simultaneous intelligence, connection, and analytic capabilities (Lenka et al., 2017). Digital connectivity has been shown to create more transparent B2B interactions with less uncertainty and more intensified data availability, collection, and sharing (Leminen et al., 2020a; Zhou et al., 2015). In turn, high internal and external transparency (i.e., along the value chain) is pivotal in improving the innovation and management of business models (Achtenhagen et al., 2013). Digital collaboration is made possible by sharing processes and knowledge, but trust is required to overcome confidentiality issues and build transparency and mutual exchange over time (Sjödin et al., 2020).

2.2. Strategizing actions and critical capabilities for sustained value creation in traditional industries

As digital connectivity is argued to affect the strategic responses of companies to redefine value creation paths (Holopainen et al., 2023) – especially of the manufacturing ones, which are closely linked to a traditional supply chain logic – there is a strong need to understand the logic and the mechanisms that sustain them over time (Achtenhagen et al., 2013; Bresciani et al., 2021; Remane et al., 2017; Vial, 2019).

Sustained value creation, especially in traditional industries, should rely on a successful adaptation and renewal of the underlying business model on a continuous basis (Achtenhagen et al., 2013). The innovation of a business model may be pursued by changing a single part and not necessarily the entire business model (Foss and Saebi, 2017). The reconfigured business models that result from the leverage of the inherent characteristics of digital technologies of interconnectivity and data sharing (Davenport and Westerman, 2018; Holopainen et al., 2023; Matarazzo et al., 2021) are often not radically "new", compared with the ones previously available to the firm (F. Li, 2020).

Firms can innovate their organizational boundaries and the role they play in new or existing value chains because of enhanced connectivity (Giesen et al., 2007). They can follow a network-oriented approach, with changes in their business model toward joint value creation, thanks to continuous B2B interactions (Wirtz et al., 2016). This entails the implementation of different capabilities and the setting up of new kinds of relationships, especially with customers, in a new capability and asset configuration (Achtenhagen et al., 2013; Giesen et al., 2007). Indeed, a transition to new business models is characterized by a high degree of complexity (Caputo et al., 2021). Careful consideration of the elements underlying the transformation includes the activity choices that constitute a competitive advantage and foster a holistic view of an organization (Demil et al., 2015; Schneckenberg et al., 2021). According to Achtenhagen et al. (2013)'s framework on sustained value creation, companies that aim to manage value creation over time - as is the case of the paths enhanced by digital connectivity - should complement strategizing actions and critical capabilities to be translated into specific sets of activities (Achtenhagen et al., 2013). Strategizing actions are those practices through which a company shapes activity in ways that are consequential for strategic outcomes and are needed for adapting and developing business model to achieve sustained value creation; whereas critical capabilities support the strategizing actions and refer to the essential skills, competencies, resources, and capacities that a company needs for fuelling business model change in a sustainable way (Achtenhagen et al., 2013).

When there is both a solid internal fit among the activities and an external fit with the company's ecosystem – and the performed transactions – the configuration of activities that are internally and externally consistent and connected leads to higher interdependencies that create and capture value (Lanzolla and Markides, 2021; Siggelkow, 2011).

Success in dealing with enhanced connectivity is mainly linked to such non-technological factors as strategizing (Volberda et al., 2021). For example, Krammer (2016) showed that firms with a higher diversification in products or markets are more likely to exploit their technological assets and explore and produce new technical knowledge within their networks of suppliers and clients (Krammer, 2016). Such strategies as vertical integration and geographical co-location between the buyers and core suppliers could instead be overcome by digital connectivity, thus lowering massive relationship-specific investments (Ketokivi and Mahoney, 2020; Paolucci et al., 2021).

In this sense, digital connectivity helps firms find new forms of value creation by leveraging the new optimized configuration of their activities and resources (Parida et al., 2019). Firms can then decide on the extension of the digital-driven innovation of the business model in terms of the key components and the supporting design, manufacturing, and distribution activities (Rayna and Striukova, 2016). The innovations that involve several closely coupled elements, as well as the resources and capabilities managed in a company's value chain, have been shown to more likely lead to a sustained competitive advantage (Foss and Saebi, 2017). Thus, companies need to develop strong routines to transform their offerings to customers by building new critical capabilities to complement the strategizing actions (Achtenhagen et al., 2013; Volberda et al., 2021). Such digital-enabled capabilities allow the interaction between the resources and the processes considered in the B2B relationship to be increased to co-create value (Lenka et al., 2017). Beyond the collaborative approach, digital connectivity has been shown to lead also to the strategic renewal of a firm's culture (Warner and Wäger, 2019). The existing mindsets and organizational forms are often to be revised, and new ones to be developed in traditional industries to utilize a company's digital assets and the related improvements in connectivity more efficiently (Krammer, 2016; Volberda et al., 2021). Thus, the critical capabilities complementing the strategizing actions for

sustained value creation should be reconsidered, considering the implications of digital connectivity in B2B relationships.

2.3. Theoretical framework

Research on the topic of connectivity enabled by digital technologies has evolved from determining *what* is needed to be done in terms of implementation (such as investments and emerging value creation opportunities) to understand *how* it should be done in terms of alignment of value creation mechanisms in a sustained way.

Table 1 summarizes the main topics present in the reference literature and highlights the related gaps addressed in this study. Building upon this summary, we aim to take a step further and focus on investigating the ways traditional companies change the logic and implement strategizing actions and critical capabilities for sustained value creation (Achtenhagen et al., 2013).

Unlocking the full potential of the current digital transformation means not only adopting new digital technologies but also leveraging their inherent characteristics of interconnectivity and data sharing. Thus, our starting theme is related to the strategic relevance of *(1a) digital connectivity* from a value creation perspective, especially for the traditional companies operating in B2B settings, often forced to deal with conflicts and trade-offs between existing (physical) and new (digital) ways of doing business (Verhoef et al., 2021). According to previous research, the impacts of digital connectivity on *(1b) value creation* in B2B settings include the creation of integrated, personalized solutions with a customer-centric approach and the integration of customers as collaborative partners in the co-creation of value (Burström et al., 2021; Kiel et al., 2017; Parida et al., 2019; Schneckenberg et al., 2021). However, such impacts need to be further studied from an empirical perspective because traditional sectors are closely linked to a supply chain logic and the delivery of physical goods rather than digitally mediated transactions. In these sectors, connectivity with customers is recognized to be one of the key dimensions (Müller et al., 2018), as different actors at different levels in the supply chain could pursue new forms of collaboration. The value created for customers is based on increased transparency and mutual data exchange (Sjödin et al., 2020). Nevertheless, the empirical evidence on how such settings exploit emerging value creation opportunities, especially in leveraging the *(1c) sharing of information* with their customer, is not complete (Caputo et al., 2021; Rajala and Hautala-Kankaanpää, 2023; Parida et al., 2019).

Accordingly, with our case studies, we first investigate the impact of digital connectivity on the new forms of value creation in B2B settings by focusing on the importance of data sharing in enabling greater transparency and trust in managing the relationship with the customer in the long term.

Then, acknowledging that digital connectivity can bring business model innovation through redefined value creation in B2B settings, we aim to explore further the mechanisms through which companies change their logic and implement strategizing actions and critical capabilities for a *(2) sustained value co-creation* in traditional sectors (Achtenhagen et al., 2013; Volberda et al., 2021).

Fig. 1 summarizes our main contribution to the existing literature.

Table 1
Overview of the main research themes in the literature.

Research theme	References	Literature gaps addressed in this study
1a) Digital connectivity	Brea (2023); Bresciani et al. (2021); Caputo et al. (2021); Gong and Ribiere (2021); Guo et al. (2021); Holopainen et al. (2023); Jovanovic et al. (2021); Kagermann et al. (2013); Leminen et al. (2020a); Leminen et al. (2020b); Miehé et al., 2022; Remane et al. (2017); Sjödin et al. (2020); Thoben et al. (2017); Verhoef et al. (2021); Warner and Wäger (2019)	• The strategic leverage of digital connectivity is mainly studied in digital business models rather than in traditional industries operating in B2B settings, where physical infrastructures rather than digital platforms are prevalent. • Traditional companies struggle to successfully assimilate and scale up their digital-related capabilities into their business models and understand the new innovation logic.
1b) New forms of value creation	Brea (2023); Burström et al. (2021); Caputo et al. (2021); Gilchrist (2016); Kamalaldin et al. (2020); Kiel et al., 2017; Lenka et al. (2017); Li (2020); Parida et al. (2019); Schneckenberg et al. (2021); Rayna and Striukova (2016); Warner and Wäger (2019)	• Empirical evidence on how B2B settings exploit emerging value creation opportunities, especially in leveraging data from customer operations, is scarce. • Also, value co-creation mechanisms and sharing of problems and related solutions in traditional companies need to be further investigated.
1c) Sharing of information	Amit and Zott (2001); Burström et al. (2021); DaSilva and Trkman (2014); Kagermann et al. (2013); Kamalaldin et al. (2020); Lenka et al. (2017); Müller et al. (2018); Nagle et al. (2020); Rajala and Hautala-Kankaanpää (2023); Sjödin et al. (2020); Zhou et al. (2015)	• In traditional sectors, where competitiveness is still based on the delivery of physical goods rather than on digitally-mediated transactions ensuring consistent digital connectivity and an enhanced real-time data flow within the B2B relationships could be critical. • Empirical evidence of the positive effects of digital connectivity on creating new relational forms that favor collaboration while overcoming the issue of sharing confidential information is scarce.
2) Sustained value co-creation	Achtenhagen et al., (2013); Bresciani et al. (2021); Vial (2019)	• Since the strategies in traditional (manufacturing) industries are closely linked to a supply chain logic, there is a need to understand how business model innovation, as driven by digital connectivity, can be sustained in the long-term. • Digital connectivity is argued to affect the strategic responses of companies to redefine value creation paths, but the logic to sustain them over time has been less studied.

3. Methodology

3.1. Research design

This paper adopts a qualitative multiple case study methodology and analyses four different suppliers of mechanical components for the vehicle (automotive, truck, railway, motorcycle) industry in North Italy to explore how companies of traditional industries leverage digital connectivity with their customers for developing new forms of sustained value creation. As a case study is an empirical research process that examines a phenomenon in its natural setting, this methodology is considered appropriate when dealing with situations where there are numerous features of interest and where new phenomena are investigated (Denzin and Lincoln, 2017; Yin, 2016). Moreover, it enables a careful inquiry to be made and an understanding to be achieved of both the complexity and the nature of the phenomenon under analysis (Voss et al., 2002). A multiple case study analysis has here been conducted for several reasons (Gustafsson, 2017). First, it allows the data to be

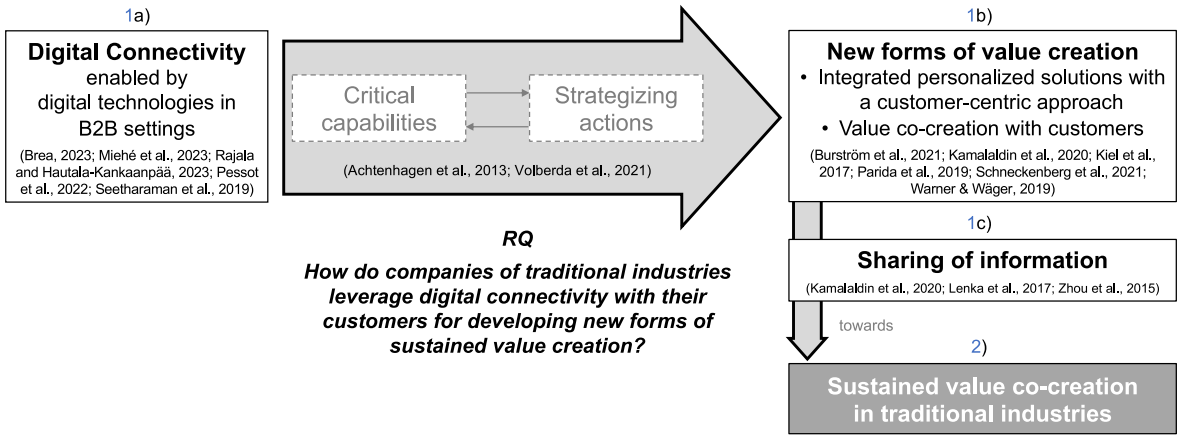

Fig. 1. Contribution of the study on strategizing actions and critical capabilities for sustained value co-creation in traditional industries.

analyzed both within each case to obtain a deeper understanding of the intrinsic aspects of the phenomenon and across cases to identify the emerging patterns of relationships among constructs that lead to important theoretic insights (Eisenhardt and Graebner, 2007; Flynn et al., 1990; Mills et al., 2010) and to recognize the differences and similarities between cases (Baxter and Jack, 2008). Second, a multiple case study allows a wide range of data and evidence to be collected and, thus, results to be achieved that are more valid and general than those of a single case (Eisenhardt, 1989). Suggestions grounded on several different types of empirical evidence create a more convincing theory. Third, this methodology creates a strong empirical foundation to help gain a deeper understanding of how companies of traditional industries leverage digital connectivity in B2B settings for sustained value creation (Miles and Huberman, 1994; Yin, 2016). Fourth, it is useful for qualitative analyses and a theory-testing approach, which facilitates understanding complex phenomena, as in the case of the topic under investigation (Siggelkow, 2007; Yin, 2016). Fifth, the emergent theory based on multiple case research is commonly more generalizable and better grounded than the theory obtained from single case studies, thus making it more suitable for extension and validation with other methods (Davis et al., 2007). Sixth, it permits a replication logic to be attained in which cases are treated as a series of experiments that confirm or negate emerging conceptual insights (Eisenhardt and Graebner, 2007).

To explore the ways companies of traditional industries leverage digital connectivity with their customers, we deductively investigate and describe the impact of digital connectivity in the four companies with reference to the literature and gaps of the themes 1a), 1b), and 1c) of Table 1. Then, we inductively explore how such digital connectivity has been leveraged by traditional industries in B2B settings for developing new forms of sustained value creation, drawing from the framework of Achtenhagen et al. (2013) (Achtenhagen et al., 2013).

3.2. Case selection

The companies considered for the multiple-case study were selected from a larger sample of 25 companies that were studied in a large research project (in 2019) funded by the Italian Ministry of Labour and Social Policies. From such a larger sample, among the 25 companies that have adopted various strategic behaviors and strategies, we have chosen four paradigmatic cases of different dimensions to explore how companies of traditional industries leverage digital connectivity in B2B settings for sustained value creation. We had ex-ante an in-depth knowledge of their digital transformation process, which began fifteen years ago thanks to a strong technological base and customer relationships and accelerated in recent years with the "Industry 4.0" paradigm. They are significant and representative cases that other companies can follow as an example of best in class, as their 2022 performance results also demonstrate.

Since sample sizes in case studies are typically small, in a multiple case study, having three to four distinct cases for comparison is considered the appropriate number of cases that one can realistically handle to explore information-rich cases from which one learns a great deal about issues of central importance to the research (Patton, 2014).

The case selection process followed the principles of theoretical sampling: the four cases selected are particularly appropriate to highlight and extend the relationships and logic among constructs and to ensure external validity (Eisenhardt and Graebner, 2007; Stuart et al., 2002).

In case study research, it is common practice to select cases using criteria instead of selecting a random or stratified sample (Eisenhardt, 1989). In the present study, companies were selected by considering: (i) their homogeneity from the point of view of the industry in which they operate (vehicle component industry); (ii) the possibility of transparently observing the phenomenon of interest: the presence of a digital transformation process over several years, a process which is currently being accelerated thanks to investments, despite the ongoing crisis (Pettigrew, 1990); (iii) their successful relationship with their buyers, in order to prove the efficacy of their implementation of digital technologies and strategic-organizational mechanisms and therefore to gain better insights from the cases selected (Patton, 2014); (iv) their strategic positioning as leading companies, in terms of both the exploitation of digital connectivity and transparent data sharing with customers and of an EBITDA well above the industry average.

The vehicle component manufacturing industry is a particularly interesting setting to analyze the effects of digitalization from the viewpoint of digital connectivity in B2B settings since such an industry represents one of the most complex and dynamic manufacturing supply chains, as it delivers complex products that must conform to high levels of international standards and it is extremely competitive, hence inclined to adopt new digital technologies at the supply chain level (Liao et al., 2020; Paolucci et al., 2021; Qamar et al., 2018). Italian vehicle component suppliers, in fact, constitute one of the most important supply bases for Original Equipment Manufacturers (OEMs) worldwide and have been encouraged to invest in digital technologies related to Industry 4.0 through the incentives that have been offered by the "Piano Nazionale Impresa 4.0" (National Plan Enterprise 4.0) since 2017 (Corò and Volpe, 2020).

As a result, the following four Italian vehicle component suppliers (see Table 2 and Appendix A), who have their headquarters in Northern Italy, were selected. Such companies are included in a list of around 40 companies selected by the Italian Ministry of Labour and Social Policies as leaders in the "Industry 4.0" framework program. The sample size aligns with the recommendation for well-grounded qualitative research to obtain rich empirical data from a limited number of cases (Eisenhardt,

Table 2
Overview of the considered cases.

Company	Manufactured components	Revenue (2022)	Employees (2022)	Main activity sectors
Benevenuta	Manufacturing of vehicle components made by hot-forged mechanical presses	35.3 M€	160	Automotive vehicles, buses, trucks, tractors, excavators, railways
Bonfiglioli	Designing, production and distribution of gear motors, inverters, and electric motors	1234 M€	4.148	Automotive vehicles, harvesters, merchant vessels, aircraft
Brovedani	Production of precision mechanical components	101.5 M€	1.000	Automotive vehicles, trucks, motorcycles
Giobert	Development and manufacturing of lock sets and mechanical and electromechanical vehicle components	32 M€	350	Automotive vehicles, trucks, motorcycles

1989; Yin, 2016).

3.3. Data collection

Prior to the data collection, a short description of the research project and a privacy statement were sent to the companies, and we thus built trust and acceptance with the companies and ensured that the informants had the necessary knowledge to participate in the study (Stuart et al., 2002). Multiple data sources were used to gain a deeper understanding of the involved dynamics by increasing the information base, diversifying data to reduce biases, and triangulating the data to strengthen the validity of our findings (Patton, 2014; Yin, 2016). The data collection covered a period from January 2019 to December 2022 through several streams and included qualitative and quantitative data from secondary sources, that is, from publicly available information and internal documents (Eisenhardt, 1989; Yin, 2016), as shown in Table 3.

The first round of primary data collection involved semi-structured face-to-face interviews conducted in Italian by at least two researchers, spending two days on-site for each company during February 2019. The top and middle management were interviewed either one-to-or or in groups to ensure a variety of points of view on the same phenomenon under investigation, as well as the granularity necessary for its analysis. The decision to interview top and middle managers was made because they are the ones inside a company with a legitimate right to decide on the implementation of managerial practices for digital transformation and because they have a general vision of the previous managerial and strategic choices and a long-term vision of the future digital path of the company. The number of managers involved in the interviews was sufficient to enhance the credibility, transferability, dependability, and confirmability of all the gathered information (Guba and Lincoln, 2004). The interview method was chosen "to obtain both retrospective and real-time accounts by those people experiencing the phenomenon of theoretical interest" (Gioia et al., 2013). Whenever it was possible, interviews were complemented with shop floor visits.

A predetermined topic list, based on the conceptual model and explaining the purpose of the research, was used during the interviews to increase the reliability and validity of the research. This list covered: the operating model and the description of the supply chain, the characteristics of the market and the level of internationalization of the company, digitalization, and strategic choices, investments in Industry 4.0, as well as the impact of digitalization on the main design processes, on the collaborative logic with customers, on the organizational configuration, and business model innovation. After each meeting, each interviewer edited the field notes and checked them for accuracy.

The second round of primary data collection (2020–2021) was conducted through online meetings due to the Covid-19 pandemic, whereas the third round (2021–2022) consisted of follow-up e-mails and telephone calls to supplement the data and clarify the information. The interviews lasted from 60 to 90 min each, were tape-recorded integrally for an overall total of 54,5 h of interviews, transcribed verbatim, and then translated into English with the help of an independent native speaker, for a total of 340 pages of transcript. An overview of the interviews is shown in Table 4.

Table 3
Data collection: secondary sources.

Description of the data source and year	Evidence (n. of pages)
Publicly available information	
White papers	35
Archival documents	120
Reports of previously funded research projects for Public Bodies: Skillab (Centre for the Valorization of Human Resources) 2019, INAPP (National Institute for Public Policy Analysis) 2021, FGA (Giovanni Agnelli Foundation) 2020	250
Databases	–
Website	–
Internal documents	
Financial statements from 2015 to 2021	140
Companies Audit 2020	11
Other technical documents and material provided by the informants	150
Total number of evidence	*706*

3.4. Data analysis

We assessed secondary data sources to ensure their overall suitability for our research questions and objectives. We paid particular attention to the measurement validity and coverage of the data. Then we evaluated their precise suitability, including reliability for our research (Saunders et al., 2012).

The analysis of secondary data was the starting point for creating a first understanding of the four cases to identify and aggregate an initial cross-case pattern of (successful) digitalization among these case studies. Secondary data was then triangulated with other sources to help us refine and strengthen our emerging interpretations (Yin, 2016). Quantitative secondary data were helpful in tracing the growth path of the companies both in terms of size and turnover, considering the investments made in digitalization. We analyzed our data in four main steps, according to the established recommendations for qualitative data analysis, and we reviewed the intermediate results gained during the analysis to ensure a common understanding (Miles and Huberman, 1994; Strauss and Corbin, 2014). Coding and measurements were implemented to reduce the potential of confirmation bias affecting the results and growing descriptive and theoretical validity (Strauss and

Table 4
Data collection: an overview of the interviews.

Company *Interviewees*	Benevenuta	Bonfiglioli	Brovedani	Giobert
CEO	2	2	2	2
Operations Manager	1	1	1	1
Quality Manager	1	1	1	1
IT Manager	1	1	1	1
Logistics Manager	1	1	1	1
Human Resource Manager	1	1	1	1
Marketing Manager	1	1	1	1
Production Manager	1	1	1	1
Total: 36 interviews				

Corbin, 2014). We used NVivo12 software for the qualitative data analysis to support the coding process.

In the first step, we started with deductively elaborating categories and their focus on the impact of digital connectivity in the four companies with reference to the literature and gaps of themes 1a), 1b), and 1c) of Table 1 (see Appendix B for further details). The coding procedure was performed, line by line, using constructed codes and was assisted by the software (Gioia et al., 2013). The second step consisted of a within-case analysis based on the categories previously elaborated (Eisenhardt, 1989; Miles and Huberman, 1994).

In the third step, we analyzed data from the primary and secondary sources, according to the inductive approach, which allows concepts and relationships to emerge from the data, to identify how companies of traditional industries leverage digital connectivity in B2B settings for sustained value creation. Drawing from the framework of Achtenhagen et al. (2013), the data analysis was conducted through a thematic analysis approach, which provides ways of identifying patterns in a large and complex dataset and a means of effectively and accurately identifying links within analytical themes (Achtenhagen et al., 2013; Braun and Clarke, 2006).

We iterated back and forth between the empirical data and emergent theory through a coding procedure, assisted by the software, to identify themes and overarching dimensions to develop an empirically grounded framework. Data were coded into first-order categories, and these were then clustered into second-order themes, which converged into aggregate dimensions (Gioia et al., 2013).

The emerging critical capabilities and strategizing actions have been classified based on the theoretical discussion provided in Section 2.2 (Achtenhagen et al., 2013).

We constantly updated and refined our emerging framework based on evidence gathered in subsequent interviews (Burawoy et al., 1991). The results of the coding procedure are presented in Fig. 2, section 4.2.

In the final step of our analysis, we used cross-case analysis to make case comparisons to identify, corroborate, and compare the differences and similarities, as well as emerging patterns and relationships regarding the research question. The multiple-case study research activities are summarized in Table 5.

4. Results

4.1. New forms of value creation with digital connectivity in the case studies

This section describes the empirical evidence from the four cases related to the first three main themes of Table 1: *1a) digital connectivity, 1b) new forms of value creation*, and *1c) sharing of information*.

First, the analysis reveals that traditional companies operating in B2B settings unfold *digital connectivity* for connectivity and data management both at the firm and the B2B relationship level, strategically integrating the existing (physical) and new (digital) ways of doing business. This occurs through implementing digital twins and simulation systems that became a critical part of the design and production phases, internally and in co-creation with customers. The digital twins of the products are constantly updated in real-time based on the production

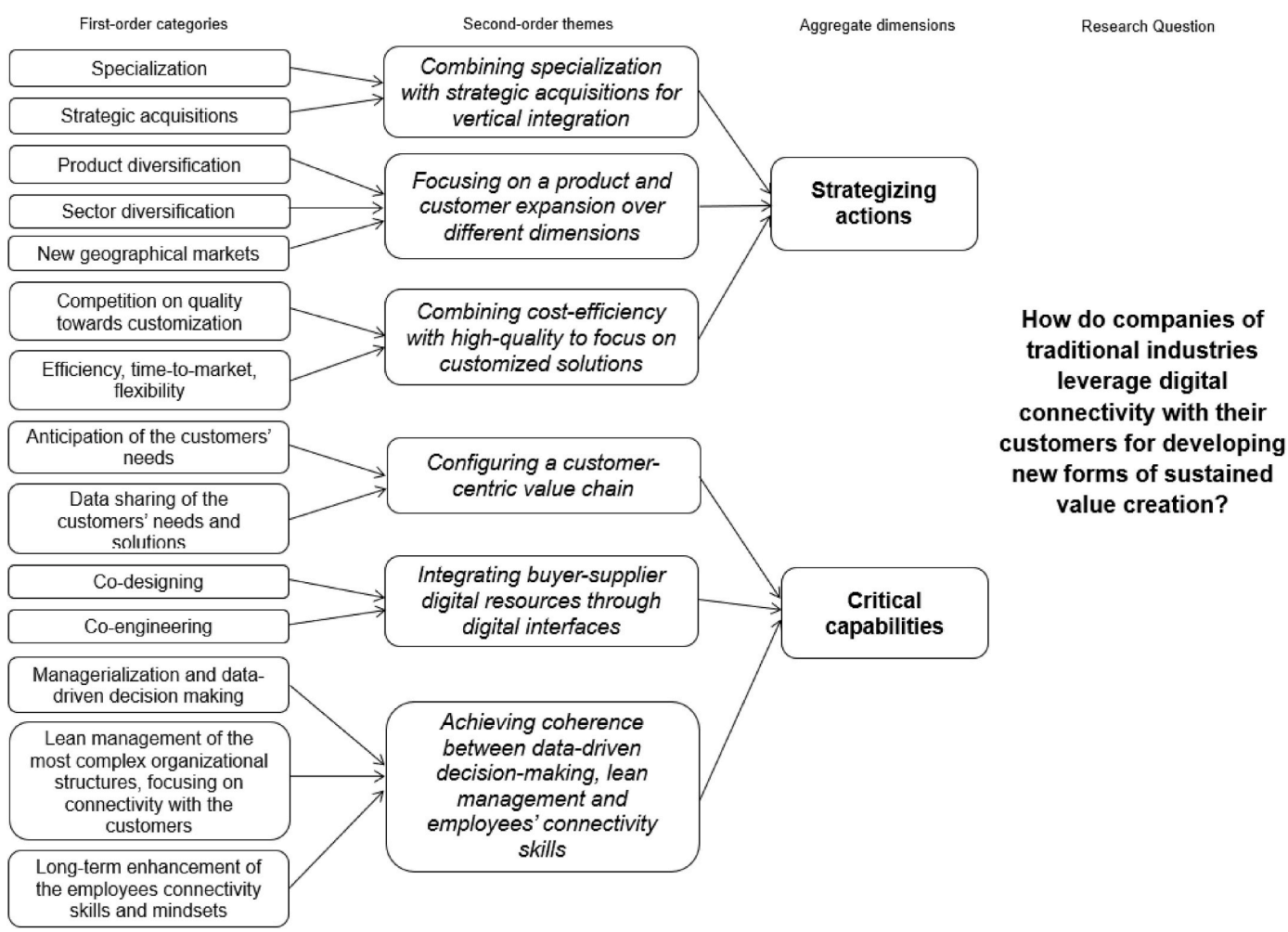

Fig. 2. Results of the coding procedure.

Table 5
The research activities and sub-activities of the multiple case study.

Step	Activity	Sub-activity
1	*Identification and selection of the case studies*	• Definition and analysis of the criteria considered to select the case studies. • Analysis of the relevance of the Manufacturing vehicle industry for this study
2	*Data gathering*	• Collection of secondary data • Establishment of a semi-structured interview protocol with open-ended questions • Identification and selection of the key respondents • Collection of primary data • Conduction of the interviews (recorded and transcribed) • Follow-up e-mails and telephone calls
3	*Data analysis*	• Coding process, within-case and cross-case analyses • Triangulation of the primary data with the secondary data

The results of our multiple case study research are presented in the following section.

data and the customer requirements. These data are collected, managed, compared, and shared by legacy customized MES software that interconnects all the equipment on the shop floor. Moreover, the ERP integrates data for maintenance and product development operations.

Second, the *new forms of value creation* investigated in all the cases include the delivery of integrated solutions of personalized and innovative products/services and the value co-creation with customers, intended as collaborative partners. Thanks to the feature of connectivity of the state-of-the-art design and communication tools, solutions are co-designed, co-engineered, or even customized "end-to-end" with highly specialized engineering services and a flexible approach to production volumes.

Finally, several interviewees highlight that the *sharing of information* with customers is characterized by higher information transparency and real-time data sharing. Data exchange with the customers begins when the ordering process starts; it can take place on an e-procurement portal used by all customers or through a proprietary network continuously updated and functioning as a shared database. It emerges from the analysis that the exploitation of these new tools underpinning the B2B relationship enables more complex transactions with the client based on trust and transparency. Customers have full access to real-time production data (information symmetry), jointly solve problems, and often accept to share part of the investment with their supplier, contributing to the overall value creation.

Table 6 (also building on Appendix B) comprehensively describes these results, showing that the selected companies followed similar patterns in investing in connectivity and data management software. Table 6 also details how the companies created and delivered value to customers and the role that the higher information transparency and real-time data sharing (made possible by digital connectivity) had in this process.

4.2. Sustained value creation mechanisms to leverage digital connectivity in the case studies

This section provides empirical evidence related to theme *2) sustained value co-creation* of Table 1. To present the collected empirical evidence and answer *how companies of traditional industries leverage digital connectivity with their customers for developing new forms of sustained value creation,* the strategizing actions and critical capabilities conceptualized by Achtenhagen et al. (2013) were reinterpreted through a customer relationship perspective. For this reason, Sections 4.2.1 and 4.2.2 re-organize the information gathered in the case studies according to the combination of strategizing actions and critical capabilities implemented by the four suppliers to achieve sustained value co-creation (see Fig. 2).

Given the close relationship between manufacturing strategies, traditional supply chain logic, and industry structure, data and connectivity play a vital role in enabling increased transparency and trust in the relationship with the customer. This, in turn, fosters a better awareness of the capabilities that companies need to cultivate, ultimately reducing information asymmetry in transactions between buyers and suppliers. As a result, companies can reposition themselves along the value chain and explore new market opportunities.

In Fig. 2, the semantics of second-order themes refer to the previous study by Achtenhagen et al. (2013); however, their labels have been revised according to our multiple case studies (see Appendix C). During the interviews, we identified concepts like those of Achtenhagen et al. (2013), and subsequently, we unfolded the underlying new value creation mechanisms. We found that companies had made investments in digital connectivity; however, its strategic leverage through strategizing actions and critical capabilities is a complex and ever-evolving process that this study aims to provide an answer to.

4.2.1. Strategizing actions of the case studies for sustained value creation leveraging digital connectivity

Combining specialization with strategic acquisitions for vertical integration. We found that companies used digital technologies to continuously adopt and integrate new, state-of-the-art production technologies and competencies with their information systems, to increase their value creation processes through an enhanced ability to align manufacturing to their customer's needs and offer them a broader array of technical solutions according to a "one-stop-shopping" logic.

Such a form of vertical integration occurred in two ways. Benevenuta and Giobert internally developed activities and processes that previously were absent by steadily adding new processes to their factory through massive investments in highly specialized machinery and resources. Instead, Bonfiglioli and Brovedani made strategic acquisitions with the vision of producing and providing their customers with a complete "end-to-end" solution and diversifying their product portfolios and target industries. In this way, by using digitalization, they could fully integrate the activities of the acquired companies to provide their customers with a unique and/or broader offer.

Focusing on a product and customer expansion over different dimensions. The expansion occurred over three main dimensions, as all the companies diversified their product portfolios within and outside the automotive sector and opened to new geographical markets.

The product portfolios expanded from one or a limited range of components to several families; the companies also increased the number of components and the heterogeneity of technologies present in each product (including the offer of fully customized products), confirming the "one-stop shopping " logic. This decision implies a growing complexity of the customer relationship, which in turn requires the development of tailored digital twins and a broader sharing of information.

All the companies are also active in non-automotive sectors, where the quality standards and design complexity are higher and where there are severe international codes and standards. Unlike their competitors, who find managing such an additional dimension of product complexity challenging, the companies under study have learned not only to deal with this aspect but also to manage it even better by introducing digital technologies. The decision to work in more complex segments allowed such companies to collect a more significant amount of information regarding technological trends and know-how, which they have exploited to better satisfy their customers' needs. The strategic choice of sector diversification was driven by the willingness of the companies to re-balance their customer portfolios, as they had previously been highly concentrated on a single large client, and to reposition themselves in industries that are traditionally focused on quality and performance, where complexity is a value. Other reasons behind this strategy are

Table 6
Results of the within-case analysis.

Categories	Digital connectivity	New forms of value creation		Sharing of information
Focus on	*Inter-firm connectivity and data management*	*Delivery of integrated personalized and innovative product/service solutions*	*Value co-creation mechanisms*	*Higher information transparency and real-time data sharing*
Company				
Benevenuta	Digital twins and simulation systems help define and share the product requirements from the design stage to prototyping and manufacturing. These technologies integrate the design and production phases both internally and with customers, to unambiguously define technical and economic details with the customer in "real-time". Legacy MES software make it possible to collect, manage and share (with customers and suppliers) production data, tracking single production lots and their quality parameters. Suppliers are becoming increasingly connected through the MES software.	The company provides customized "end-to-end" products to large companies active in the truck and railways industries. The company continuously expands the number of products in its portfolio (it includes six main lines: suspensions, forks, brake levers, brake brackets, cylinder heads and supports). The production batches vary from a few hundred units up to a maximum of 25–30 thousand units.	Co-designed and customized on-demand products. The company defines the product requirements based on the customer's specifications and shares its technical competencies with its customers to solve problems in a unique and effective way. Its customers only buy the products when they are "satisfied" (they meet or exceed technical requirements). A mix of speed of execution, uniqueness of solutions, cost efficiency and satisfying of the customers' requirements.	Information sharing with the customer begins when the ordering process starts; it takes place on a portal used by all customers. Clients have full access to production data; real-time information sharing and transparency drive customer loyalty and improvements in the relationship, The company is also investing in new production technologies while co-developing new products for a customer, who often accepts to share part of the investment.
Bonfiglioli	Digital twin and advanced virtual simulation techniques help design and optimize products and their performances, satisfying customers' requirements. The digital twins of most of the products are constantly updated based on the production data. The legacy MES software interconnects all the equipment, collects production data and compares them in real-time. The company is introducing an AI-based software used for predictive maintenance. Data analytics measure the production process "end-to-end", from the supplier to the final customer. RFID technology allows suppliers with ready-made material to enter the company's website, print a radio frequency label (to be added to the product packaging) and inform the company two days in advance about the exact date of shipment of the material. Bonfiglioli can plan production using components and material that are not yet in its warehouse.	The company's production ranges from the assembly of both standard and customized solutions to the design, construction and distribution of gear motors, inverters and electric motors made to order for power transmission in all industrial and automation sectors. The production batches vary from a few tens of pieces to a maximum of 4000 pieces/lot	Co-engineering. The company helps customers understand and define their needs, and develops detailed features and production methods, from the development phase to the manufacturing and testing of a prototype.	The automated tracking of materials creates a mechanism that shares detailed data with the customer, creating information symmetry and thus contributing to the value creation. The "Mosaico" legacy supply-chain portal is a complete e-procurement system that can offer customers the product that best suits their needs (choices are made to maximize the customer's benefits, not to reduce the company's costs). Fully integrated with the company's ERP, it gives immediate access to all the necessary technical information, such as 2D and 3D cards and drawings.
Brovedani	Virtual simulation software allows to develop prototypes in real time. Customized MES interconnects all the machinery in the shopfloor and collects their data. The ERP integrates data for the maintenance and product development operations	Brovedani produces high-precision and customized mechanical components for the global vehicle supply chain. The product portfolio is composed of flanges, gears, regulators, bushings, spacers, shafts, rings, fittings, and other components. Through its engineering services, the Group designs and manufactures special custom-made machines, automation, machines for automatic visual and dimensional control and integrated multi-technologies, according to the specific requirements of its customers. It has a total production volume of 200 million pieces/per year.	Co-design. Brovedani manages all the most recent and innovative production technologies and owns the production equipment needed to develop a prototype during the co-design cycle. The company is focused on projects that are highly complex, which include 3–4 thousand components and require hundreds of 2D and 3D tables each.	To enhance the customer relationship, Brovedani developed a proprietary system to control the dimensions and quality of the pieces produced also by local partners, sharing results with them. Advanced engineering services allow the co-development of customized products and/or processes, according to a joint problem-solving approach.
Giobert	Simulation software and injection moulding computer-aided engineering shorten time needed to have high-quality prototypes in place. The company designed software applications to compare engineering data with the measures obtained from the real prototype, and share results with suppliers and customers.	Giobert, due to its flexible approach to production volumes, can supply from large volumes to small specific and premium products.	Co-design. The Product Engineering and Manufacturing Engineering units utilize state-of-the-art design tools to co-design the products with the client.	Data collected by sensors in the production lines are stored through the Giobnet network, which is updated every 2 h and functions as a shared database. The relationship with the client is based on trust, transparency, and information sharing. At the production level, all the machines are equipped with sensors, cameras, force meters and tablets to make data of the process available in real time.

connected to the decision not to start price wars with Asian competitors (Benevenuta), the innovative and competitive entrepreneurial spirit (Bonfiglioli, Brovedani), and the necessity to identify niches where competition against large multinational companies is manageable (Giobert).

Finally, the companies marked attitude toward internationalization drove them to open new offices and plants in new geographical markets and to widen their customer bases to learn and exploit new solutions. In this sense, digital connectivity enables global markets and customers to be explored without being physically present worldwide.

Combining cost-efficiency with high-quality focus on customized solutions. All the companies adopted a "zero defect" approach and are chosen by their customers because of their quality and expertise, making them specialized and highly performing manufacturers. On the one hand, the decision to invest in the acquisition and development of digital and production technologies, as well as in the related competencies, allowed the companies to provide unique solutions to customers. On the other hand, such a decision allowed them to maximize the benefits for their customers in terms of trade-offs between cost-efficiency, high-quality, and performance. The ability to offer highly customized solutions created more value for their customers than just price reduction.

Value creation includes not only the development of novel and customized solutions but also the ability to shorten time-to-market (compared to competitors), thanks to the strategic management of production facilities. In fact, these companies decided to dedicate and specialize each plant in particular activities of value in multiple value chains, thus contributing to the vertical integration and internalization of their competencies.

Detailed findings of the cross-case analysis presented in Section 4.2.1 are shown in Table 7.

4.2.2. Critical capabilities of the case studies for sustained value creation leveraging digital connectivity

The analyzed companies show common traits also in the capabilities developed to introduce new forms of value creation for customers based on superior customer knowledge generated from continuous interaction and co-creation processes.

Configuring a customer-centric value chain. All the companies embraced a strategic approach based on the principle of not only serving the customers and their needs but also anticipating such needs through a priori analysis regarding the implications and issues that had to be managed to transform prototypes into products. These companies have made the strategic choice of working with their customers on emerging problems, and they are trying to develop and share the competencies necessary to solve them through continuous experimentation of new technologies and their mixing.

The need to go back to design for manufacturing emerged as a key point in our analysis since new products already in the pipeline can no longer be exempt from having early equipment engineering to ensure that they are designed according to the technology that will be used in the future. Products are optimized from the initial design stages to identify and anticipate any potential critical conditions and enhance their performances. The implementation of the most advanced virtual simulation techniques to design and optimize the products ensures that the performance and reliability targets are met before the physical prototypes are built, thus reducing the time-to-market and providing clients with the best possible solution.

In this sense, digital technologies are used to anticipate and share issues regarding product requirements, costs, and expected performances. Companies accumulated the competencies needed to perform such activities by sharing data in real-time along complex supply chains to have a much richer understanding of the customers' needs. In doing so, they introduce relevant changes in the company structure and integrated physical and digital processes. For instance, Digital Twins are used today to create and share with the customers experimental prototypes that are not yet in production, sharing any possible issue that could emerge during their life cycle. This strong orientation to the customer is consistent with the decision (started many years ago) to invest in integrating their own information system with the customers' ones.

Integrating buyer-supplier digital resources through digital interfaces. The introduction of digital technologies reflects a balanced use of resources and capabilities in the new collaborative design approach with the client, which is often driven by joint investments in highly specific assets, and implemented through co-design (Benevenuta, Brovedani, Giobert) or co-engineering (Bonfiglioli) processes. Digital collaboration is made possible by sharing processes and knowledge. Still, trust is required to overcome most confidentiality issues and build a continuous and transparent exchange of information over time. It should be emphasized that the companies considered have been able to overcome such confidentiality and intellectual property problems, as they have been guided by a shared vision of the future with the customer, in which skills and work practices are adopted.

Digital technologies are employed with the aim of having immediate control over the progress of both the design and production, controlling all the dimensions of quality and production performances, and sharing such information in real-time with the customer.

The starting point in the co-design process is the product, as designed by the customer, for which 3D drawings and specific product requirements should be considered. The product is often re-engineered to optimize its performance according to customer needs and technical constraints.

Co-engineering activities are based on the identification of customer needs, a process that takes place after an in-depth analysis conducted based on the firm's specific expertise, using dedicated calculation tools, thereby allowing the development time to be reduced. The alignment phase then allows adapting the initial proposal to key performances, expected life cycle, and maintenance issues. Once the prototype is ready, the company tests it again under near real-life operating conditions to verify its performance, robustness, and efficiency.

Such shared processes do not end with the delivery of the products. In many cases, connectivity helps collect product information during their life cycle, allowing engineers to support the customers through the entire life cycle.

Achieving coherence between data-driven decision-making, lean management, and the employees' connectivity skills. The interventions implemented to foster a long-term perspective of digitization have simultaneously taken place in three directions through (i) managerialization and data-driven decision-making, (ii) lean management of the most complex organizational structures, focusing on connectivity with the customers, (iii) long-term enhancement of the employees' connectivity skills and mindsets.

All the companies have transitioned from family business to organizational models where managers have significant responsibility, which has led to a partial decentralization of the decision-making power. The organizational structures are now more complex than they were five years ago, as they have to simultaneously pursue the development of production, product, and customer competencies, with a particular focus on customers driven by digital technologies. This organizational complexity has been managed by introducing lean methodologies, which help identify what data should be collected and stored, what needs to be monitored on the shop floor and identify the definition and sense-making of the KPIs related to plant efficiency, product traceability, etc.

All the companies have created an organizational culture focused on social sustainability, shared values, and attention to the workers; these ingredients were deemed fundamental to obtaining customer satisfaction and sustaining value-creation processes. Using digital transformation, the management of each company has given a great deal of importance to infusing awareness of the change by involving every single human resource, especially in production, in continuous improvement and digitization activities. All companies have recognized

Table 7
Results of the cross-case analysis with reference to strategizing actions presented in Achtenhagen et al. (2013).

Strategizing actions presented in Achtenhagen et al. (2013) used to create sustained value	Results obtained from the case studies			
	Benevenuta	Bonfiglioli	Brovedani	Giobert
Combining specialization with strategic acquisitions for vertical integration	*Vertical Integration*			
	Benevenuta invested both in the internal development of activities and processes that previously did not exist; it also invested in some of its highly specialized suppliers (with minority shareholder positions).	Bonfiglioli Group mechatronics division was created in 2013 with the aim of offering turnkey solutions: gearboxes that reduce the number of revolutions to increase the expressed power, the electric motors that are necessary for the operation of the gearboxes and inverters to activate the engine In 2015 Bonfiglioli acquired O&K Antriebstechnik, which had over 130 years of experience in the design, development and manufacturing of high-performance planetary gearboxes. O&K's expertise has enabled the company to acquire a solid reputation in the mobile and mining (excavator) sectors	In 2018 Brovedani acquired Facert and Fretor, which are specialized in the supply of special machines and the automation of production systems in 2018, mainly to consolidate the already existing partnerships to diversify business and to integrate new key skills	Giobert is managing the entire production process in its own plants, from the design and development to the production and delivery of the finished goods
Focusing on a product and customer expansion over different dimensions	*Product Diversification*			
	Since 2015 Benevenuta constantly increased its product portfolio, focusing its investments on electric vehicle components.	Bonfiglioli today has the widest component assortment in the world of gear motors, inverters, and electric motors for power transmission (industrial gear motors, industrial heavy-duty geared products, travel drives, slew drives, winch drives, transit mixer drives, precision planetary gearboxes & gear motors, specifically geared units, electric motors, inverters & servo drives, motion control and human-machine interfacing, construction equipment transmission).	Brovedani started supplying special machines and automation tools for production lines. The company presents itself as a "one-stop-shop" for customers looking for innovative solutions in the field of high-precision and quality mechanics	Giobert today also manufactures glove box latches, and a broad range of products for car interiors, including glove box latches, internal car door handles and locking systems of various kinds
	Sector diversification			
	Rail, truck, aerospace exploration	Agriculture & forestry, construction, food & beverages, e-mobility, intralogistics, logistics, marine & offshore, mining, packaging, wind power, textile, recycling	Automotive, medical, furniture, eyewear, food and pharmaceutical	Automotive vehicles, trucks, motorcycles
	New geographical markets			
	Benevenuta opened a mechanical manufacturing branch in Cordoba, Argentina to "stay closer" to a large customer, with the aim of replicating its Italian manufacturing model, and not of producing low-cost products.	Bonfiglioli oversees the global market with 14 production plants, 22 commercial branches and over 550 distributors, and boasts its presence in 80 countries around the world. Such a capillarity allows the company to offer dedicated solutions, from co-engineering to after-sales assistance.	Brovedani opened a production site in Slovakia in 2004 and in Mexico in 2008, thereby ensuring know-how and mirror productions on two continents to meet the current requirements of the automotive and non-automotive industries	Giobert opened its first plant abroad in 2007 in Poland to enhance its production, and this was followed by another in Brazil in 2011 and a third in Albania in 2018 to continue and consolidate its multinational and multicultural vocation.
Combining cost-efficiency with high quality to focus on customized solutions	*Competition on quality toward customization*			
	A combination of strong technical skills matched with the adoption of several technological innovations introduced in the plants over the last few years	Quality is part of the brand; any product must guarantee a high level of quality.	Integration of as many as 30 processing technologies, which are supported by increased specialized skills	Development of an internal manufacturing culture focused on satisfying increasingly demanding standards and requirements of customers', thanks to the performance and reliability of products
	Efficiency, time-to-market, flexibility			
	Benevenuta exploits any cost-efficiency opportunity (while keeping the quality high) that results from the digitalization process it has adopted, also to guarantee fast execution (from the first contact with the customer up to the delivery of the finished product).	Bonfiglioli launched EVO (which stands for EVOlution) its largest gear motor plant in Italy, in 2019. It marked the passage of the group into a new phase that is totally digitalized and reorganized according to the Industry 4.0 logic, with a broad diffusion of sensors and IoT needed to simplify and increase data	Brovedani carries out different activities in different factories: the headquarters and main production plant are in Pordenone (Italy), where they develop and produce precision mechanical components, while the secondary production plant focuses on complementary processes and another dedicated	Giobert's headquarters are in the Turin area, where it has two plants that focus on the technical aspects and tooling, as well as on the elementary moulding and shearing processes. The Polish plant in Silesia has been operative since 2007 and its core activity is assembling products for clients in

(*continued on next page*)

Table 7 (*continued*)

Strategizing actions presented in Achtenhagen et al. (2013) used to create sustained value	Results obtained from the case studies			
	Benevenuta	Bonfiglioli	Brovedani	Giobert
	Connectivity made it able to flexibly re-configure production activities to satisfy customers requirements.	collection and sharing. Collected data continuously feed the predictive maintenance systems, in order to keep efficiency as high as possible.	plant focuses on logistics, whereas the plant in Modugno (Italy) is specialized in pistons for brake applications. The facility in Slovakia is well equipped to supply both small & medium batches and high-production series through the utilization of CNC. Finally, the facility in Mexico follows the challenging United States-Mexico-Canada Agreement flow with the high-quality requirements that customers are asking for.	Eastern Europe; in 2011, Giobert opened a plant in the state of Saõ Paulo (Brazil), where it produces components and assembles finished products. Finally, the plant in Albania was launched in 2019 and it is dedicated to manufacturing and directly supporting its customers.

the centrality of human resources, as the main factor of success of any business activity, in a relationship of mutual loyalty and trust between employer and employees. Consequently, the companies guarantee conditions of human well-being (safety, health, education) that are distributed equally among the workers to enhance the contribution of each one while ensuring equal growth opportunities based on the evaluation of the results and attributing responsibilities that are consistent with the role and paths of the individuals. All companies aim to establish long-term working relationships and strive to attract, retain and prepare people who demonstrate such characteristics as customer orientation, people-orientation, operating results, leadership, ability to affect, and self-confidence. In return, the companies require their employees to commit to adapting to constantly evolving requirements through professional re-orientation and continuous learning: the goal is to have well-trained and extremely competent human resources.

Some strategies the companies adopt are internal training, individual improvement proposals, team working, and job rotation. Detailed findings of the cross-case analysis presented in Section 4.2.2 are shown in Table 8.

5. Discussion

The findings from our study confirm that in traditional industries, new forms of value creation driven by digital connectivity involve a combination of (i) delivering integrated personalized and innovative product/service solutions, (ii) engaging in value co-creation processes with customers, and (iii) enhancing information transparency and real-time data sharing (Burström et al., 2021; Kagermann et al., 2013; Kiel et al., 2017; Parida et al., 2019; Schneckenberg et al., 2021; Sjödin et al., 2020). More importantly, this study shows that manufacturers are assimilating and scaling up their digital-related capabilities to transform their business models (Colombari et al., 2022; Remane et al., 2017; Sjödin et al., 2020) by aligning critical capabilities and strategizing actions for these new forms. With digital connectivity enabling greater transparency, trust, and collaboration with customers, the cases combine the change in digital-related capabilities with a change in the governance of transactions with customers to make this value creation sustained, and not only successful – thus leveraging digital connectivity both at the firm and B2B relationship level.

Fig. 3 summarizes these key findings in a comprehensive framework of sustained value co-creation driven by digital connectivity in traditional industries, below discussed also in light of the gaps highlighted din Table 1.

First, this research shows that companies of traditional industries strategically leverage digital connectivity for enhanced value creation if they integrate it with existing supply chain logic and 'physical' ways of doing business in B2B settings. The analyzed case studies exhibit similar patterns concerning the role that digital technologies play in creating new ways of connecting suppliers and customers. These encompass the use of virtual simulation and digital twins for real-time prototype development, as well as MES systems designed to connect and integrate all the equipment present on the shop floor and collect, manage, and share any production data. More importantly, our analysis reveals that digitalization and connectivity in a B2B relationship go beyond merely creating the simple availability of information about production activities. Instead, digital connectivity empowers companies to offer new and more complex products that integrate multiple technologies, thus overcoming the struggle in understanding the possible innovation logics and scaling-up their digital-related capabilities, as argued in recent literature (Colombari et al., 2022; Holopainen et al., 2023; Remane et al., 2017; Sjödin et al., 2020). While several works have considered the importance of merging new players in the integration of these technologies for value creation (e.g., Clarysse et al., 2022; Tian et al., 2021) or in the creation of new routines that go beyond the traditional supply chain (Pessot et al., 2022), our results show that these products can be still co-created with the customer, leveraging the well-established relationships while benefitting from the increased transparency and the diffused data sharing, which establish mutual trust and more collaborative governance of the buyer-supplier dyad. Our results support the viewpoint of Bresciani et al. (2021) that the strategic leveraging of digital technologies to enhance connectivity in a firm's survival and value creation in the long term is still based on investments in traditional mechanisms of innovation, learning, and interdependence with strategic partners. We did not find any evidence that the size of the companies could (positively or negatively) affect the ability of the companies to establish such new forms of value creation.

Second, we offer empirical evidence on the value creation mechanisms created by leveraging digital connectivity especially in leveraging data from customer operations (Caputo et al., 2021; Rajala and Hautala-Kankaanpää, 2023; Parida et al., 2019). These mechanisms are oriented toward accepting and increasing the complexity of products and production processes, with data integrated and shared at every level of activity and thus enriching the established B2B relationships – further integrating the 'physical' and 'digital' ways of doing business. Such mechanisms benefit from a more customer-centric value chain and collaborative and transparent governance of the buyer-supplier relationships. These results differ from and complement previous studies arguing that traditional industries need to leverage larger networks enabled by digital connectivity in order to co-create new rich offerings (Tian et al., 2021). Moreover, the integration of digital connectivity in the traditional businesses needs to be done in a way that the new forms of value co-creation and sharing of information are sustained in the long

Table 8
Results of the cross-case analysis with reference to critical capabilities presented in Achtenhagen et al. (2013).

Revised critical capabilities presented in Achtenhagen et al. (2013) for the creation of sustained value	Results obtained from the case studies			
	Benevenuta	Bonfiglioli	Brovedani	Giobert
Configuring a customer-centric value chain	*Anticipation of the customers' needs* Digital technologies allow the customers' needs to be anticipated and satisfied through the advanced introduction of prototypes in the production process *Data sharing of the customers' needs and solutions* Real-time data sharing with the customers to understand their needs and offer the best solution			
Integrating buyer-supplier digital resources through digital interfaces	*A collaborative design approach through co-designing or co-engineering* Co-design	Co-engineering	Co-design	Co-designing
Achieving coherence between data-driven decision-making, lean management and the employees' connectivity skills	*Managerialization and data-driven decision-making* Over the past 5 years, there has been an increase in the number of managers, following the implementation of the WCM methodology and a structured industrialization process that has completely revolutionized the organization of the company. The company hired new managers and has been reorganized in order to respect the structure of the ten technical pillars of WCM and introduced specific responsibilities for the management of each "pillar". By attributing a specific managerial figure to each pillar, the new organization has witnessed a partial decentralization of the decision-making power and a more definitive assignment of delegations to human resources already present in the company, including members of the Benevenuta family, or specifically acquired human resources.	The adopted governance model focuses on the figure of the President, Sonia Bonfiglioli, and the CEO, Fausto Carboni, to whom the general managers of the 3 Business Units, the Cross Business functions and the Country Multi-Bus report directly, unlike the Countries characterized by a single Business, which instead report to the General Manager of reference. Power is centralized since it is a family business, but in some countries, such as the USA, Germany, India and China, which are very important in terms of turnover (exceeding 100 million), the Country Managers have high decision-making powers and a great deal of autonomy, despite having to maintain a direct line with the CEO. The three-year industrial plan is drawn up together with the most relevant Country Managers and some of the first-line managers	The family is in charge of the Board of Directors but the managers are responsible for the strategies and operations. In fact, the level of autonomy of the group's offices has increased in the last 5 years as has the technological specialization. Such organizational model was introduced to satisfy the needs of individual markets and customers: each office has its own board of directors and its own functional areas in the technical offices, sales, human resources, production, and logistics. Its seven companies are integrated at a strategic level and coordinated, by the parent company, at a central level, to deal with strategy, management control and business development.	Over the last decade the number of managers increased, following the digitalization process. In terms of data-driven decision making, data analysts develop analyses based on data collected by sensors in the production lines. Such data are shared with operators in a WCM-style every week so that the problems encountered during the week emerge, determining actions aimed at improving the existing situation and to increase production efficiency. The human resources in the production lines are managed directly by the team leaders, who report to their supervisors. Data analysts work with each team leader.
	Lean management of the most complex organizational structures, focusing on connectivity with the customers Benevenuta formally introduced the FCA World Class Manufacturing (WCM) system in 2015, following a company reorganization that was compliant with its ten technical pillars. According to the WCM philosophy, the company has undertaken a three-phase path of implementation, namely Reactivity (2017–2019), Forecast/Prevention (2020–2023) and Proactivity (2024–2026).	Bonfiglioli implemented a Business Operational Excellence Program, based on eight main pillars that drive all the internal processes, to better serve its customers, including continuous improvement in on-time delivery, lead time, and component quality, as well as production loss reductions.	Brovedani adopted the Lean philosophy in 2006, and it has revolutionized the factory and changed the organization of its workers, starting from several pilot projects. This path was essential to encourage the digitalization of the factory with a corporate culture already clearly oriented toward quality and high precision.	Giobert decided to adopt the "Lean manufacturing" approach, structured according to World Class Manufacturing. However, the complexity and bureaucracy of the philosophy did not combine well with the heterogeneity of the company processes, and for this reason, it has since opted for a "softer" WCM version in which employees are made more proactive by being given more freedom on how to carry out activities.
	Long-term enhancement of the employees' connectivity skills and mindsets Since 2017, Benevenuta has defined a percentage of its turnover that will be allocated to the prize for the best improvement proposal, which is aimed at motivating the employees to propose ergonomic improvements in terms of workstation, safety, quality, logistics and production efficiency. The proposals are periodically analyzed by a management team and classified according to the results that the Company could derive from them, net of the implementation costs. Finally, the classification of non-remunerative incentives (e.g. gadgets, material prizes, shopping vouchers, fuel	In 2017, Bonfiglioli decided to invest €130 million over a period of five years to promote digital skills, from an Industry 4.0 perspective, through a workforce retraining program called: "Bonfiglioli Digital Re-Training". This is a generational program that involves all the human resources, and which, through an innovative approach, aims to create and consolidate a digital mindset in all the workers to support transformation. It is an experimental process that started with the identification of business needs, the choice of new technologies that had to be implemented and, consequently,	Brovedani focuses to a great extent on the improvement of the skills of the human resources in all the group plants. It is necessary to nurture a capacity for resilience and adaptation in the growth path, especially concerning the ongoing digital transformation. This is also enhanced by training and the growth of skills throughout the territory: the parent company is one of the founding members of the Lean Experience Factory 4.0, a centre dedicated to innovation, research and experiential training, which today is also a Digital Innovation Hub at both a national and international level.	In Giobert, several young people have been employed in the last five years, especially in the plastic moulding area. However, internal training is necessary, especially regarding the usability of the data: operators must be able to understand and interpret them correctly to set up and possibly correct the operation of the machinery. Variable production bonus incentives are made available: these are given based on the efficiency of each employee, as measured through the Giobnet system.

(*continued on next page*)

Table 8 (*continued*)

Revised critical capabilities presented in Achtenhagen et al. (2013) for the creation of sustained value	Results obtained from the case studies			
	Benevenuta	Bonfiglioli	Brovedani	Giobert
	vouchers) and the operators' award ceremony are formalized quarterly.	the necessary roles that had to be set up. Four key roles were defined: maintenance, conductor, technologist and planner. The "Manufacturing Excellence academy 4.0" was created because of the pilot "Digital Re-Training" project, and it is based on three pillars: Methodology (Bonfiglioli Production System), Digital (technical and cultural Re-Training 4.0) and Roles (focus on specific roles).	In Brovedani, reports are developed and shared for risk analyses and improvement plans at both a group level, as well as at an individual company and a single department level. The company introduced site has a section, accessible to any employee to upload ideas and propose suggestions, which are then processed by managers to assess their potential. In Brovedani's project entitled "From blue collar to blue collar", the same workers who participated in the digital transformation projects (and with a greater aptitude for dissemination) train the other workers, both in technical terms of the actual use of the enabling technologies and in terms of digitalization and human-machine interaction	
	Structured job rotation and a skill matrix allow the companies not to over-specialize the human resources to increase the flexibility and growth of the operators and the plant, thus favouring their multi-functionality.			

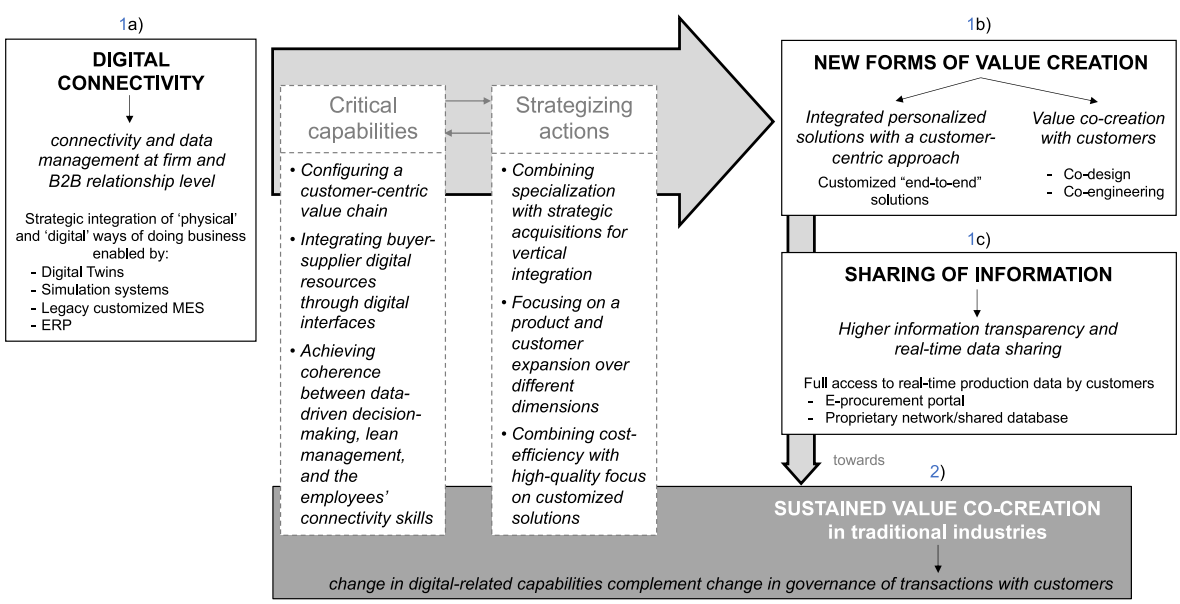

Fig. 3. Sustained value co-creation in traditional industries in traditional industries leveraging digital connectivity at the firm and B2B relationship level.

term. The resulting new business models entail a value creation that takes into account multiple dimensions, making imitation difficult and costly for competitors, since the relational forms established with customers are highly idiosyncratic and time-consuming to create, implying a relational and managerial complexity that is not immediately imitable. This point is fundamental in light of the previous studies that investigate companies' activities in revising business models thanks to the digital connectivity with network stakeholders for successful value creation (e.g., Andersen et al., 2021) while overlooking the importance for this to be sustained.

Third, results from the case studies show the critical importance of aligning the new forms of value creation with new relational forms that favor collaboration in order to do it in a sustained way – at the level of the individual firm as well as the B2B relationship (Burström et al., 2021; Kamalaldin et al., 2020). Our investigation revealed that they are instrumental to new forms of product customization – through data sharing – and more collaborative relationships with the customer, as digital connectivity allows building long-term oriented B2B relationships based on trust and sharing of problems and related solutions (Nagle et al., 2020; Rajala and Hautala-Kankaanpää, 2023; Sjödin et al., 2020). To be sustained in the long-term, the value creation processes go well beyond the design and production stages, and is shown to entail

internal and external transparency.

Fourth, the sustained value co-creation results from the alignment and continuous interaction between critical capabilities and strategizing actions as demonstrated in Achtenhagen et al. (2013), but these should be revisited. This study shows that the strategic leveraging of digital connectivity requires a reinterpretation of the strategizing actions and critical capabilities configured by suppliers in B2B settings, with value co-creation paths redefined to complement digital-related capabilities with governance transactions with customers. In this sense, results contribute with an in-depth understanding on their definition and the logic sustain them in the long term with digital connectivity (Bresciani et al., 2021; Vial, 2019). Concerning strategizing actions, digital technologies are shown to allow advanced technologies and production phases to be integrated, but the greater complexity created due to the integration of multiple activities needs to be managed appropriately (*combining specialization with strategic acquisitions for vertical integration*). The investments in digital technologies made by companies have made it possible to expand their product portfolios by offering more integrated and customized solutions that result in a more complex and complete offer in terms of technologies and competencies (*focusing on a product and customer expansion over different dimensions*). Finally, these companies began to be able to offer customers performances that in the past were considered as "divergent" – such as customized production in small batches at a competitive cost (*combining cost-efficiency with high-quality focus on customized solutions*). Among critical capabilities, companies aim to align information systems and data with customers to create exactly the value they require, with the integration and connectivity offered by digital technologies to tackle these issues and experiment and share new technical solutions (*configuring a customer-centric value chain*). Digital technologies are employed with the aim of having immediate control over the progress of both the design and production processes, controlling all the dimensions of quality and production performances, sharing information in real-time with the customer, determining co-design or co-engineering processes (*integrating buyer-supplier digital resources through digital interfaces)*. Digital technologies allow the continuous tracking of products, with the suppliers' end-to-end digital integration with information systems that are key to supporting and fully integrating operational processes (ranging from smart internal logistics to dynamic shipping schedules). The real-time connection of machines directly to these information systems enables companies to precisely monitor and optimize each step of the production and assembly processes through an interpretation of the available data. Thus, the interventions implemented to foster a long-term perspective of digitization have simultaneously taken place in three directions through (i) data-driven decision-making, (ii) lean management of the most complex organizational structures, focused on connectivity with the customers, (iii) long-term enhancement of the employees' connectivity skills and mindsets (*achieving coherence between data-driven decision--making, lean management, and the employees' connectivity skills)*.

Finally, the efforts in achieving a sustained value co-creation should be concurrent with investments in digital connectivity, enhanced real-time data flow within the B2B relationships and related capabilities. The ability to manage all these transformations contemporaneously is a core aspect that entails rethinking the critical capabilities of companies and properly aligning them toward the new forms of value co-creation identified. The organizational change should not follow the digital connectivity between the supplier and the customer, as argued by Seetharaman et al. (2019), rather the alignment between strategizing actions and critical capabilities represents the fundamental "how" this digital connectivity can be exploited for a value co-creation that is sustained. We confirm that the digitally-enabled ways of connecting with customers call for greater data gathering and analysis capacity, with more informed strategic decision-making (Volberda et al., 2021). The engagement of customers in co-creation should also be defined in terms of opportunity and downside sharing for mutual benefit (Ehret and Wirtz, 2017; Parida et al., 2019), with our results showing that the strategic renewal enhanced by digital connectivity should build further the concept of dynamic capabilities for digital transformation (Warner and Wäger, 2019) to make this renewal sustained in the long-term. Thus, a change in the digital-related capabilities – both at the level of the single firm and the B2B relationship – should also complement a change in the governance of transactions with customers, enabling greater transparency and trust in managing the relationship with the customer. Investments in digital technologies that enable collaborative software applications and represent similar connectivity-based solutions for suppliers have been argued to lower asset specificity investments (Gottge et al., 2020). We found in our analysis the importance of aligning digital investments (on both the supplier and customer side in a B2B relationship) to facilitate the activities required for co-creation and customization, and with the assets not becoming more specialized as the complexity of the transaction increases (Nagle et al., 2020). Governance patterns are also impacted by digital technologies in the codification process, as well as by the evolution of the suppliers' competencies over time (David, 1995; Storper, 1995). The unprecedented access to real-time data should benefit both parties so they can effectively rely on the respective co-creation activities (Müller et al., 2018). The higher frequency of transactions mediated by connectivity, coupled with digital trace information about the transacting parties, mitigates the concerns that arise from asymmetric information, lowering the monitoring costs and making the transactions more efficient (Amit and Zott, 2001). Finally, both parties become better at handling uncertainty downsides, as the related costs can be reduced, thanks to better access to (and availability of) information and higher transparency in negotiating and controlling compliance in the fulfillment of the customization requirements (Ehret and Wirtz, 2017; Paolucci et al., 2021).

6. Conclusions

This study presents the results of multiple case studies to explore how companies of traditional industries leverage digital connectivity with their customers for developing new forms of sustained value creation. Based on the framework of Achtenhagen et al. (2013), our study analyzes and reinterprets the strategizing actions and critical capabilities configured by suppliers to achieve and maintain sustained value creation.

Results contribute to the growing literature on the implications of digital technologies on business model innovations with a focus on "how" companies of traditional industries are able to sustain in the long-term new forms of value creation (Achtenhagen et al., 2013; Remane et al., 2017), as driven by digital connectivity. The novelty of this research consists in studying how the resulting new forms of value creation recognized in current literature – i.e. co-creation and integrated personalized solutions with a customer-centric approach (Burström et al., 2021; Kiel et al., 2017; Parida et al., 2019; Schneckenberg et al., 2021) – can be implemented successfully by companies operating in traditional and "non-digital-native" industries. These are indeed closely linked to a traditional industry structure and supply chain logic, resulting in a lack of competencies in digital technologies and business models focused on a high specialization of production processes and cost competition. Although digital innovation has shown important implications in several sectors, we show that traditional manufacturing companies introduce digital connectivity to fine-tune and expand the well-established B2B relationships, strengthening inter-firm collaboration and evolving value proposition in a way that is sustained as it integrates the traditional 'physical' and the new 'digital' way of doing business – both at the firm and the B2B relationship level. These results deepen the understanding of the implications of digital technologies and enhanced connectivity in B2B relationships from a value creation perspective (Miehé et al., 2022). The multifaceted phenomenon of digital transformation is argued to imply a change in the past practices concerning value creation and capture of companies in different industries (Gong and Ribiere, 2021). Our results seem to suggest that

digital connectivity enables fine-tuning and reinforcing the strategizing actions of traditional businesses while challenging and leading firms to rethink their critical capabilities, both at the firm and the B2B relationship level (see the comparison with the framework by Achtenhagen et al. (2013) in Appendix C). We show the "how" these companies redefine the value co-creation with their customers and the creation of integrated, personalized solutions with a customer-centric approach, to be sustained over time – as business model innovation is quite complex (Bresciani et al., 2021; Vial, 2019). Moreover, digital technologies are exploited not only to co-create value and develop complex solutions with a perfect fit for the customers' needs but also to face relationship governance issues determined by the increasing complexity of products and production activities. Thus, we offer empirical evidence on how companies in traditional industries exploit emerging value creation opportunities, especially in leveraging data from customer operations with increased information sharing (Caputo et al., 2021; Parida et al., 2019). In this sense, we also contribute to the call to better conceptualize digital transformation and its outcomes in terms of business model innovation (Gong and Ribiere, 2021) by narrowing the perspective on the critical investments necessary to exploit such a transformation in its constituent elements (Colombari et al., 2022; Verhoef et al., 2021), such as digital connectivity.

The managerial implications of this work are relevant since our findings show both (a) the pervasiveness of the effects of digital connectivity in B2B settings and (b) the importance of having a long-term strategic view in traditional industries, linked to a supply chain logic with physical transactions, where the ability to manage complexity and organizational changes are key aspects. On the one hand, companies are fine-tuning their strategizing actions to create and capture value from digital connectivity. The exploitation of technologies to accelerate their evolution processes was already inherent to their business strategies. Now the integration of digital connectivity with their existing technology and process expertise have allowed them to move even closer to their customers, confirming their role as suppliers of integrated and customized solutions, as well as holders of unique know-how. To further make this new value creation sustained, they need to extend further their ongoing diversification initiatives concerning their products and/or markets to deliver customized solutions and exploit their technological assets to explore and produce new technical knowledge with their customers (Krammer, 2016). This has key implications on the governance mechanisms and the role of suppliers along traditional supply chains. On the other hand, the adoption of digital technologies and enhanced connectivity can unleash a (new or revised) bundle of critical capabilities that can be used to foster sustained value co-creation effectively. The existing mindsets and organizational forms should be revised, and new ones should be developed to utilize the digital assets and the related improvements in connectivity more efficiently (Volberda et al., 2021). Investments in both human resources to achieve enhanced data-driven decision-making and higher connectivity skills and in managing all the relationships along the supply chain should be prioritized to build long-term sustained value co-creation. In this sense, our results offer an indication for companies – especially traditional businesses – that aim to identify a priority in fine-tuning and expanding well-established B2B relationships with customers thanks to digital connectivity. The strategizing actions and critical capabilities analyzed in the cases call for reasoning on the importance of changing to new value co-creation forms that are efficiently sustained in the long-term – and that can be complemented to achieving a successful business model innovation or co-creation strictly linked to connection to larger networks.

Although interesting findings have emerged from this research, the paper has some limitations. Firstly, we acknowledge that the case selection limits the study's external validity. However, we rigorously sampled the case studies based on multiple-purpose sampling criteria and conducted a cross-case comparative analysis. This was designed to improve the study's external validity and enable more generalizable conclusions to be drawn from our findings (Eisenhardt, 1989). Moreover, the selected companies refer to the same territorial context and position as a supplier in the supply chain, thus allowing comparability and replicability. The case studies have different dimensions, thus guaranteeing a certain level of variety that is propaedeutic to the emergence of diverse themes and issues. Secondly, the qualitative nature of the selected methodology may suffer from researcher bias; to mitigate this risk, we adopted specific methods, including theory-based coding and researcher triangulation (Yin, 2016).

Widening the sample of projects and considering cases belonging to other regions/nations represents a possible future development avenue of this research. Adding new cases to the analysis and interviewing other organizational actors could support the validation of the analysis conducted in this research, particularly concerning the strategizing actions and critical capabilities required for sustained value creation emerging from such a complex B2B relationship. The discussion could be further deepened in terms of transaction cost economics and other theories supporting the study of digital technologies and enhanced connectivity in B2B settings from the relational perspective. Nevertheless, quantitative research, based on a broader and stratified sample of companies, is needed to test the presented results and further develop the concepts outlined in this article.

Declaration of interest

None.

Data availability

The data that has been used is confidential.

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Appendix A. Detailed description of each company

Benevenuta (www.benevenuta.it)

Benevenuta is a medium-sized family business with years of tradition located close to Turin. In 2015, the company started to accelerate its customer-driven orientation, and it decided to first invest in digitalization and then to make dedicated co-investments with its customers in both physical and digital technologies, especially the ones needed to create shared digital twins and a legacy Manufacturing Execution System (MES). In doing so, the company took a significant step forward in its strategy (already underway) aimed at providing complex, brand-new technical solutions with a perfect fit for the customers' needs. These technologies allowed the company to improve its production processes efficiently and to provide integrated and complex solutions in small batches in a very short time (30–40% less time than its competitors), thereby contributing to an ever-increasing and sustained value creation for its customers.

Benevenuta carries out a complex, high-added-value co-design phase for several major international customers (automotive vehicles, buses, trucks,

tractors, excavators, railways), which need tailored solutions with a short time-to-market, but they do not have adequate competencies to develop such solutions. The following are examples of its clients: Brembo, CNH, FCA, Eaton, Knorr Bremse, Magneti Marelli, Dana-Oerklion Graziano, Wabco, Mercedes, and Man.

The strategic choice of sharing information with their customers in each stage of the product design and manufacturing has led to increased customer loyalty and improved customer/client relationship because of real-time information transparency.

Bonfiglioli (www.bonfiglioli.com)

Bonfiglioli Riduttori S. p.a was founded in 1956 in Calderara di Reno (Bologna) and is still a family-run company that operates globally. Around 80% of its turnover comes from the international market, thus confirming it is one of the world's leaders in the power transmission and control market.

The strategic choice of investing in digital technologies for multidirectional connectivity (especially in simulation and digital twin-related technologies) allowed the company to meet its performance and reliability targets before building physical prototypes, thus reducing the time-to-market and providing clients with the best possible solutions. The relationship with its customers is a central point in Bonfiglioli's modus operandi, as testified by the co-investments that have been made with its customers (in fact, although it has standardized products, co-engineering remains of fundamental importance for the company as well as its ability to create value).

Other long-term investments in digital technologies, such as a legacy MES (Mosaico, a complete e-procurement system, fully integrated with the company Enterprise Resource Planning (ERP), which offers flexibility and control over data sharing, and offering customers immediate access to technical information about its products), Artificial Intelligence applications, Data Analytics and Radio-Frequency Identification (RFID) technologies, altogether increased information sharing and transparency with its customers (about both the design and production), thus contributing to the process of value creation, based on enhanced information symmetry.

Brovedani (www.brovedanigroup.com)

Brovedani was founded in 1947 in the province of Pordenone in the North-East of Italy as a subcontractor specializing in the construction of screws and small pins, and it has evolved to produce large volumes of precision mechanical components for the B2B market. In 1972, the company first specialized in producing components for the household appliance sector and then later for the automotive sector. The core business of the Brovedani Group is the production of high-precision and customized mechanical components for the global vehicle supply chain, which are co-designed with the customers according to their specific requirements and simulated through the development of digital prototypes. To enhance the customer/company relationship through connectivity and data sharing, Brovedani developed a proprietary system to control the dimensions and quality of the pieces produced with local partners. On the one hand, this software interfaces with plant automation, thanks to the provision of sensors and data collection tools in a man-machine interface system and, on the other hand, with the existing MES and ERP systems.

The following are some of its main clients: Bosch, Borg Warner, Continental, Denso, Eaton, Hidria, Hitachi, Marelli, Mahle, Sanden, Thyssenkrupp, and Vitesco.

Giobert (www.giobert.com)

Giobert was founded in Turin in 1953, and it develops and manufactures lock sets and mechanical and electromechanical components for cars, commercial vehicles, and motorcycles. The company is both a Tier 1 supplier and a customer partner, and due to its short time-to-market and flexible approach, it can supply both large volumes and small, specific, and premium products.

The Product Engineering and Manufacturing Engineering divisions utilize state-of-the-art design tools to co-design components with their clients, and they can develop unique and tailor-made solutions in part thanks to their unique mix of technical skills and capabilities. The company has always managed the entire process itself, from the design and development to the production to the delivery of the finished goods. The co-investments of the company's customers have facilitated investments in highly specific technologies.

The company's relationship with its clients is based on trust, transparency, and information sharing. All the machines at the production level are connected and equipped with sensors, cameras, force meters, and tablets to obtain data on the processes, which are made available in real-time.

Among its main clients: Abarth, Alfa Romeo, Aprilia, BMW Motorrad, Chrysler, Continental, Derbi, Dodge, Ferrari, Fiat, Fiat Professional, Ford, Gilera, Gruppo Antolin, Iveco, Jeep, Lancia, Lamborghini, Magneti Marelli, Maserati, Piaggio, and Webasto.

Appendix B. step of the data analysis

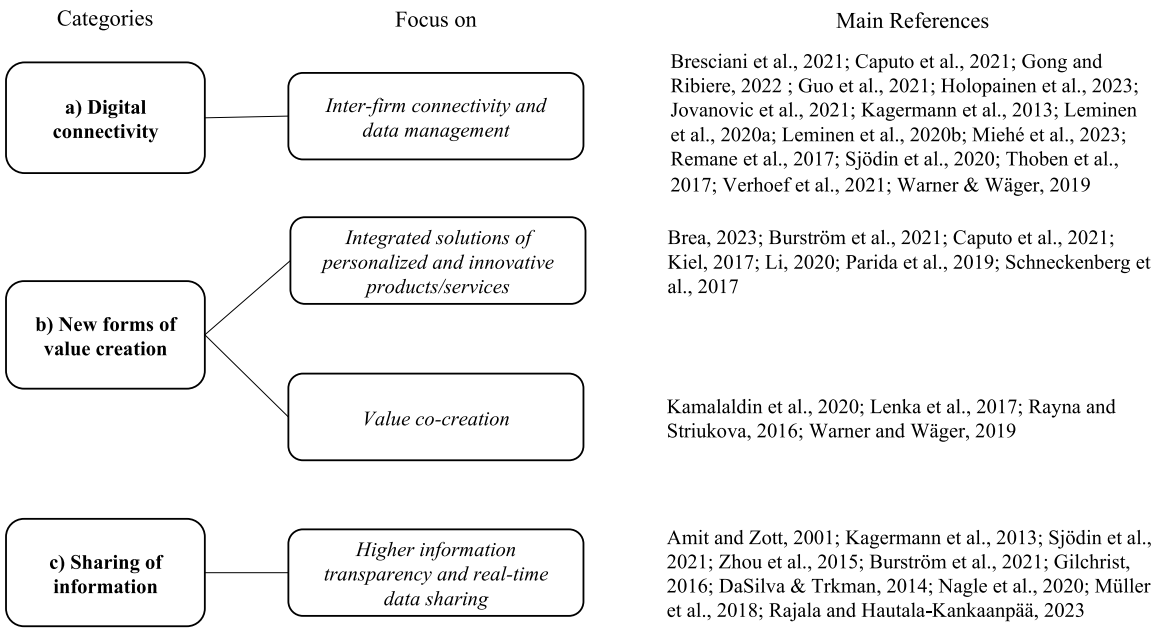

Fig. B1. The impact of digital connectivity on the four companies.

Appendix C. step of the data analysis

Table C1
Comparison between strategizing actions and critical capabilities in Achtenhagen et al. (2013) and in this study

	Achtenhagen et al. (2013)	This study
Strategizing actions	Combining organic growth with strategic acquisitions	*Combining specialization with strategic acquisitions for vertical integration*
	Focusing on simultaneous expansion along different dimensions	*Focusing on a product and customer expansion over different dimensions*
	Combining cost-efficiency with a high-quality focus	*Combining cost-efficiency with high-quality focus on customized solutions*
Critical capabilities	Identifying, experimenting with and exploiting business opportunities	*Configuring a customer-centric value chain*
	Using resources in a balanced way	*Integrating buyer-supplier digital resources through digital interfaces*
	Achieving coherence between active and clear leadership, a strong organizational culture and employee commitment	*Achieving coherence between data-driven decision-making, lean management, and the employees' connectivity skills*

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