



Research article

How companies navigate circular economy paradoxes: An organizational perspective

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ABSTRACT

The consideration and implementation by companies of only those circular economy (CE) practices involving economic returns (win-win solutions) is the result of a utopian and reductionist view of the circular transition. A more realistic and holistic perspective toward circular economy (CE) should recognize and embrace the complexities it entails and not be limited to only instrumental solutions. By drawing on the paradox theory, we delve into the conflicting issues that companies encounter in adopting circular initiatives and analyze the role of organizational attributes in the recognition and navigation of CE tensions. We tested our conceptual framework by using survey data from 303 manufacturing and construction companies in Italy. This study shows that cognitive diversity of internal managerial figures and supply chain collaboration foster the recognition of CE tensions at corporate level. In addition, the results reveal that companies with flexible organizational design, which collaborate with other supply chain actors, and recognize CE tensions are more likely to navigate CE paradoxes. Finally, the study indicates that establishing an experimentation and dialogue space increases the effect of flexible organizational design on navigating CE paradoxes. The research findings are relevant not only to managers and companies, but also to policy makers who can implement industrial policies that incentivize companies' development of organizational attributes likely to stimulate a paradoxical approach toward CE.

Compliance with Ethical standards

We have no known conflicts of interest to disclose.

This research did not involve human participants or animals in any phase of the study. We conducted information-gathering questionnaire with individuals, focusing on organizational capabilities, practices and procedures.

All individuals provided informed consent to answer the survey questions, to include their anonymous responses in the study, and to have guaranteed complete anonymity of their names and organizations.

1. Introduction

Sustainable transition is proving to be a complex challenge for companies. Circular economy (CE) is an approach conceptually capable of contributing to the achievement of sustainable development, being aimed at meeting the production and consumption needs of the socio-economic system while minimizing waste generation and exploitation of natural resources (Ghisellini et al., 2016). However, the CE not only

aims to replace linear production models with cyclical (or circular) models “for slowing, closing and narrowing loops of material and energy flows regeneratively” (Tura et al., 2019, p. 90) but strives for the development of a regenerative economy where business models are able to regenerate natural capital (Morsetto, 2020). As such, the CE, unlike linear production models, acts within ecological boundaries, since anthropogenic activity is conceived as an integral part of the whole social-ecological system (Desing et al., 2020). Therefore, it is necessary to rethink operational and organizational dynamics in a holistic systemic manner (Tura et al., 2019; Eikelenboom and de Jong, 2022). Relevant and multi-level actions and changes concerning business operations and phases of the value chain and involving a wide variety of stakeholders are required (Figge et al., 2023). These characteristics and needs make the CE a multidimensional concept, thus requiring a systems approach (*system-thinking*) by companies to embrace its complexity and virtuously integrate its principles (Kirchherr et al., 2023; Iacovidou et al., 2021).

Over the past two decades, scholars have mainly focused on describing the peculiarities of the circular economy (Kirchherr et al.,

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2023), categorizing a plethora of CE business models (Lüdeke-Freund et al., 2019) or highlighting the benefits of CE actions for value creation and capture (Bocken et al., 2016), while further research needs to explore the organizational transformations required to implement a true circular transition. As CE adopters are primarily driven by economic reasons (Gusmerotti et al., 2019), organizations tend to pay attention and efforts only to win-win solutions leaving, in fact, the circular transition only a utopia.

The complexity that connotes the CE is reflected in tensions in the adoption of circular practices by companies, as they have to concurrently face conflicting but desirable and interrelated objectives and demands (De Angelis, 2021). For instance, companies' implementation of circular practices may simultaneously assume the reduction of environmental impact through long-lasting design and the pursuit of commercial performance (sales), or the need to integrate their resources and skills with other value chain actors and retain their own individual identity (Brown et al., 2020; Geissdoerfer et al., 2018). In essence, tensions are inherent in CE, as a systemic and multifaceted concept, and are persistent and interrelated. Therefore, given the inevitability and persistence of tensions, the challenge for companies adopting circular practices is not to choose one alternative over another, but to recognize and accept the competing elements and develop innovative responses to dynamically address and manage them.

However, very few studies examined company level tensions with specific reference to the CE. Among them, De Angelis (2021) conducted conceptual research aimed at identifying, from a business model perspective, the typology of organizational tensions in CE implementation. Another example is the multiple case study conducted by Daddi et al. (2019) who investigated the paradoxes related to circular practices that paper, textile, and leather firms may encounter in the performance of their activities and analyzed the strategies adopted to cope with them.

Although CE has been recognized as a multifaceted concept, steeped in complexities and ambiguities (Iacovidou et al., 2021; Ghisellini et al., 2016), no study has examined how companies adopting circular practices can develop proper capabilities for recognizing and navigating the inherent tensions. In particular, research has never focused on what organizational factors companies can leverage to recognize CE tensions and adopt creative solutions "to ensure simultaneous attention to the alternatives over time" (Smith and Lewis, 2011, p. 392). Previous studies that have analyzed organizational factors in CE have considered only those that favor or hinder the adoption of circular practices (Chowdhury et al., 2022; Tura et al., 2019), overlooking the inconsistencies these may generate. In order to fill this gap, we use the lens of the paradox theory, which have already inspired managerial literature on sustainability (i.e. Hahn et al., 2014; Van der Byl and Slawinski, 2015; Slawinski and Bansal, 2015; Bianchi and Testa, 2022), with the objective of analyzing organizational capabilities and practices that help companies recognize and navigate CE tensions. Starting from Ivory and Brooks' (2018) framework on business processes and practices likely to foster a paradoxical approach to sustainability, we identified organizational factors potentially contributing to the management of CE tensions through a paradoxical lens. Consequently, we developed the hypotheses, which we tested deductively by a unique dataset on a sample of Italian manufacturing firms, in order to go beyond theory and collect empirical evidence (Creswell and Creswell, 2017). In detail, with the present research we investigate whether: i) cognitive diversity of management figures, flexible organizational design, and supply chain collaboration stimulate the recognition of CE tensions; ii) flexible organizational design, supply chain collaboration and recognition of CE tensions positively influences the navigation of CE paradoxes. In addition, we tested the moderating role of: iii) an input-focused reward and incentive structure on the relation between supply chain collaboration and navigation of CE paradoxes; iv) an organizational context characterized by experimentation and dialogue on the relation between flexible organizational design and navigation of CE paradoxes.

This study, by relying on paradox theory, contributes to highlight the

complexities of circular transition in organizations (De Angelis, 2021), and to empirically test the organizational factors which can stimulate a system thinking into the organizations, embracing complexity and avoiding an oversimplification of the CE implementation. Thus, the outcomes of the study enable the development of new insights into how companies can simultaneously address and manage over time the tensions inherent in a complex phenomenon such as the CE (Iacovidou et al., 2021). In particular, an opportunity is offered to understand the organizational capabilities and practices that companies should have to assume a CE paradoxical mindset that enables them to integrate CE consistently with its systemic and multidimensional nature (Kirchherr et al., 2023). Such an approach by companies adopting (or intending to adopt) circular practices makes it possible to reduce the activation of only instrumental logic (win-win or trade-off solutions) and the risk of reverting to linear production models, due to the discomfort that CE tensions can generate (Rovanto and Finne, 2023; Smith and Lewis, 2011). Finally, this study also responds to Van der Byl and Slawinski (2015) call for more development of empirical studies on paradox theory in the area of sustainability, and to Dzhengiz et al.'s (2023) call to go beyond the business case assumption in the study of CE by investigating the potential tensions, trade-offs, and paradoxes involved.

2. Theoretical framework and hypotheses

2.1. Managing CE tensions with a paradoxical lens

Most studies on CE have overlooked the complexity of the transition process toward the adoption of circular models (Dzhengiz et al., 2023). Very often, research has been limited to analyzing initiatives and cases where positive environmental effects collimate with economic benefits (Kirchherr et al., 2023). Focusing only on win-win practices implies that many circular solutions, though effective, risk not being considered and adopted. As a consequence, there will be a tendency for companies to select and implement only those circular practices that simultaneously result in economic benefits. In this regard, Gusmerotti et al. (2019) showed that one of the main factors incentivizing the adoption of CE practices by "linear companies" is the economic benefits associated with them. From this perspective, the circular transition is likely to remain a utopia, since addressed according to a reductionist approach, which considers only a small and specific type of actions compared to the vast and complex array of possible circular solutions. That is, an instrumental view of CE fails to address the phenomenon in its complexity and wholeness, as the only goal that drives the implementation of circular practices is their economic return. However, CE actions do not always take the form of win-win dynamics; sometimes they can exacerbate tensions between conflicting, desirable, and interrelated goals (Gusmerotti et al., 2019). Even in the transitional phase from a linear to a circular model, companies may experience several tensions between potentially conflicting objectives.

For instance, the use of recycled materials within the production processes of manufacturing companies often implies the need to replace owned machinery with new technologies capable of recovering or processing waste or recycled materials, determining a considerable initial economic investment (Jaeger and Upadhyay, 2020). In addition, various CE practices, such as material recovery practices, in many cases require the establishment of close inter-firm relationships and greater supply chain integration (Geissdoerfer et al., 2018). Such relationships may involve knowledge sharing among the various supply chain actors directly involved in the process, hindering the need to protect their own skills and knowledge (Brown et al., 2020). Another example is the possible tensions between product's durability and revenues. A more durable product increases the value created for the societal system through longer product life and lower environmental impact along the product life cycle, but may decrease corporate sales and revenues due to a slowdown in the sales cycle (De Angelis, 2021).

These tensions tend to persist over time resurfacing under a diverse

shape. For instance, in the short run, remanufacturing practices, usually entailing a reduced price for reconditioned or regenerated products, may cannibalize sales of new products (Hopkinson et al., 2018). Once the tension is resolved, e.g. by finding a balance in the sales incentive mechanism, the efficiency of new products may reduce the cost advantages of the remanufacturing firm, bringing the tension between new and remanufactured products back into the light (Hopkinson et al., 2018).

The presence of persistent tensions allowed us to explore such dynamics in the light of Paradox Theory (Smith and Lewis, 2011; Smith and Tracey, 2016). Scholars are increasing their attention to understand how organizations face “contradictory yet interrelated elements that exist simultaneously and persist over time” (Smith and Lewis, 2011, p. 382). Recently, the managerial literature on sustainability has focused on how organizations accommodate the tensions among social, economic and environmental goals in order to reach a higher contribution to a sustainable transition (Van der Byl and Slawinski, 2015; Hahn et al., 2018). Similarly, within the framework of the CE, in order to overcome business case logics that risk achieving a fictitious circular transition, it would be advisable to understand how organizations deal with the aforementioned tensions and find creative and innovative solutions to navigate them. Companies should first be able to recognize the tensions that CE implementation may generate and then develop creative solutions to manage them over time, continuously uncovering new opportunities (Dzhengiz et al., 2023). Such an approach allows companies to address the complexity inherent in CE according to a systemic view, without opting only for instrumental solutions characterized by the preponderance of the economic sphere (Rovanto and Finne, 2023). Hopkinson et al. (2018), showed an emblematic case in which the copier and printer manufacturing company Ricoh was receiving back a large quantity of machines that had not yet reached their end of useful life. The company decided not to dispose of these stocks of products still working, but to exploit them by implementing remanufacturing practices and selling the remanufactured products at a lower price than new ones. However, this circular practice apparently undermined the company’s commercial objectives for new products because it entailed the risk of cannibalization of the relative sales, resulting in higher indirect production costs. Ricoh has successfully addressed and managed this conflicting issue by identifying new channels and market segments for the sale of remanufactured machines, where the company had little or no presence with new machines.

Another example refers to the servitization initiatives which have proven to be effective in managing the tensions that arise from the design of long-lasting products and the risk of deteriorating commercial performance. A case is represented by the Dutch medical equipment manufacturer Philips Health™, which gave the option to pay for the use of the latest medical technology while retaining ownership. By commercializing the service, sales flow remained high while designing long-lasting products, maximizing their use, and satisfying the interest of the community.

These cases illustrate how it is possible to uncover new opportunities even when the implementation of CE actions appears at odds with interrelated and equally desirable goals, such as economic ones. Nevertheless, it is important to note that there is no true and universal solution to tensions (Hair et al., 2010). They tend to resurface over time, even as an effect of initiatives previously implemented to address other ambiguities (Zink and Geyer, 2017). For this reason, it is essential to internally transform organizations to develop organizational capabilities and practices able to support the recognition and the navigation of tensions. A number of scholars have recently emphasized the role of dynamic capabilities (Marrucci et al., 2022), skills and competencies (De los Rios and Charnley, 2017), organizational design (Bocken and Geradts, 2020) and organizational factors such as leadership and culture (Chowdhury et al., 2022) in the adoption of effective circular practices, but have failed to provide a broad picture of how organizations need to transform internally to cope with the complexity of circular transition.

To fill this gap, we interpreted, through the lens of CE, the framework developed by Ivory and Brooks (2018) that describes which organizational practices and processes are able to nurture the meta-capabilities crucial for managing corporate sustainability paradoxes (Fig. 1). Focusing on organizational practices and attributes that might be critical for the development of capabilities to recognize and navigate CE paradoxes, we developed a set of research hypotheses that we presented in the following section.

2.2. Research hypotheses

Due to the systemic and multidimensional nature of CE, the implementation of circular practices requires pluralistic and ambivalent evaluations and interpretations in order to grasp the complexity and consider it into corporate strategies and operations (Burger et al., 2019; Kirchherr et al., 2023). As stated by Hahn et al. (2014), how companies deal with ambiguities is related to the cognitive frame of decision makers. In particular, cognitive homogeneity may create excessive consolidation of existing routines at the expense of broader, ambivalent interpretations of the conflicting aspects of CE (Burger et al., 2019; Hahn and Aragon-Correa, 2015). Conversely, cognitive diversity makes existing ambiguities more likely to be recognized and, hence, considered in strategic decisions (Plambeck and Weber, 2010). Companies that promote and pursue cognitive diversity equip themselves with leaders and organizational members with a variety of backgrounds, expertise, skills, and worldviews. Identifying potential tensions between the circular solutions and environmental and economic performance (Iraldo et al., 2017) requires nurturing different points of view and allowing them to emerge in order to elicit conflicting expectations (Lewis et al., 2014). When companies have such heterogeneity internally, they are more sensitive to broad issues, reduce the risk of “groupthink”, and interpret trends, dynamics and circumstances more mindfully and systemically (Ivory and Brooks, 2018). Cognitive diversity thus contributes to the emergence and recognition of the existence of different perspectives and viewpoints in the implementation of circular practices, thereby leading to recognition of CE tensions. Accordingly, we posit the following hypothesis.

H1. Cognitive diversity positively influences the recognition of CE tensions.

To properly embrace CE principles, companies must also set up an organizational design consistent with such a purpose (Bocken and Geradts, 2020). Organizational design consists of the set of structural features of the firm that define how goals are set, how decisions are made, and how roles are allocated and designed (Burton et al., 2011). As indicated by Hahn and Tampe (2021), a flexible and decentralized formulation of business strategies is more likely to incorporate the systems approach underlying regenerative practices. Since CE is regenerative by nature and rooted in a systems perspective (Desing et al., 2020), a flexible and horizontal organizational design is likely to internalize circular practices more appropriately (Tura et al., 2019). Indeed, such organizational architectures, through structural fluidity and horizontality, make business processes more participatory, facilitating plurality of interpretations and viewpoints with respect to CE (Hahn and Aragon-Correa, 2015). Recently, Bocken and Geradts (2020, p.9) stressed that “restrictive functional focus and silo thinking” hinder the development of sustainable and circular solutions. Therefore, flexible organizational design fosters a more holistic view of CE, which is likely to stimulate the recognition of its complexity and the inherent tensions.

Moreover, flexible and decentralized organizational designs encourage new ideas and creative behaviors and enhance the ability to readily reconfigure the business system and routines (Chen et al., 2010; Cheng et al., 2023), thus enabling greater dynamism and effectiveness in changing strategies and decisions on an ongoing basis (Khan et al., 2020; Ivory and Brooks, 2018). The in-depth case study by Hopkinson et al. (2018) on printer manufacturer Ricoh demonstrates how this ability is crucial for dealing with the tensions that the adoption of circular

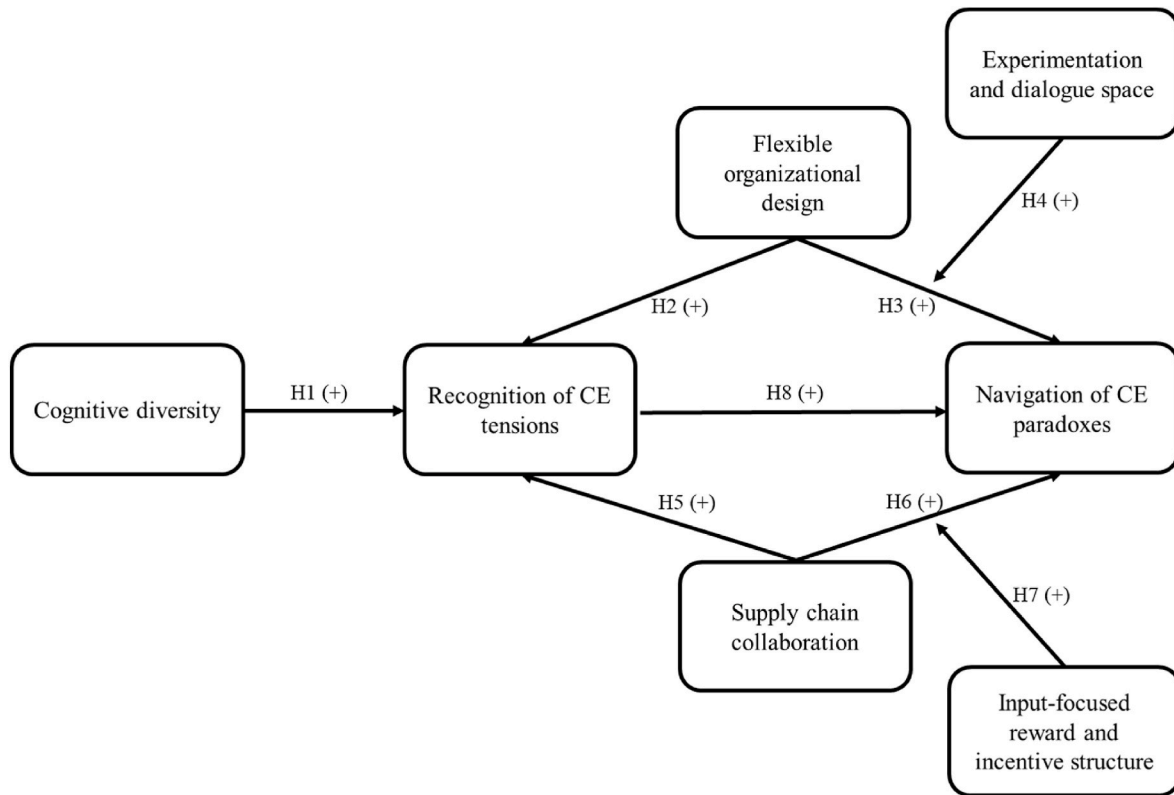


Fig. 1. Research model.

practices entails over time. As such, flexible organizational design also contributes to the navigation of CE paradoxes. We thus offer the following hypotheses.

H2. Flexible organizational design positively influences the recognition of CE tensions.

H3. Flexible organizational design positively influences the navigation of CE paradoxes.

Apart from the importance of flexible organizational design to stimulate creativity and innovativeness (Chen et al., 2010), dedicated moments where ideas and knowledge are shared in an environment of experimentation are detrimental to further triggering innovation and creativity (Donate and Guadamillas, 2011). In this vein, companies may create experimentation and dialogue spaces aimed at encouraging organizational members to openly express opinions and suggestions and to freely experiment ideas and practices (Ivory and Brooks, 2018). As noted by Lewis et al. (2014), free and open discussion among individuals within the organization triggers more creative and nimble decision-making processes. Therefore, a business context characterized by an experimentation and dialogue space based on free and open debate is likely to foster the effectiveness of a flexible organizational design in navigating CE paradoxes by stimulating new and innovative responses to CE issues. Then, we posit the following hypothesis.

H4. Experimentation and dialogue space positively moderates the relationship between flexible organizational design and navigation of CE paradoxes.

While cognitive diversity and flexible organizational design refer to the internal boundaries of an organization, in facing CE challenges companies should also gain heterogeneity of views and perspectives externally through supply chain collaboration (Cao and Zhang, 2011). Implementing CE principles in the business models necessarily requires that companies rethink their supply chains and collaborate with several actors for creating and delivering value to customers and the entire societal system (Lüdeke-Freund et al., 2019). Supply chain

collaboration, intended as the set of practices, goals, risks, and assets shared with other actors in the supply chain (Cao and Zhang, 2011), involves the development of important relational and coordinative capabilities (Genovese et al., 2017). This implies not only the acquisition of different perspectives, but also the need to consider the demands and viewpoints of other actors in the performance of corporate activities, enabling a greater propensity to evaluate them from a broader perspective (Geissdoerfer et al., 2018). Therefore, in the context of CE, characterized by a systemic nature and strong inter-company integration, supply chain collaboration favors the recognition of CE tensions.

In addition, supply chain collaboration fosters a thorough understanding of existing resources, awareness of the risks associated with the provision and use of tangible and intangible resources, and the ability to influence rapid and effective resource redistribution (Ivory and Brooks, 2018). The ability to reallocate resources in a timely and informed manner is critical for the effective execution of circular practice (Eikeleboom and de Jong, 2022), but also for identifying CE opportunities and dynamically shifting decisions and strategies accordingly (Khan et al., 2020). Therefore, supply chain collaboration also contributes to the navigation of CE paradoxes. Based on these considerations, the following hypotheses.

H5. Supply chain collaboration positively influences the recognition of CE tensions.

H6. Supply chain collaboration positively influences the navigation of CE paradoxes.

Reward and incentive mechanisms serve both to motivate individuals' behaviors and to indirectly communicate organizational priorities (Ivory and Brooks, 2018). Companies may construct these mechanisms not on the basis of outputs, such as the financial ones, but on inputs that take into account sustainability aspects, such as the procurement from sustainable or "circular" suppliers (Yu et al., 2017). First, such incentive structures help to avoid triggering linear behaviors that are solely linked to the achievement of short-term economic goals (Ivory

and Brooks, 2018). In addition, rewards and incentives focused on inputs emphasize individual perceptions of the importance of effective collaboration with supply chain actors (Yu et al., 2017). Thus, such incentive mechanisms tend to orient individuals' efforts toward a more thoughtful and mindful evaluation of the availability and quality of tangible and intangible resources along the supply chain, the associated risks and opportunities, and the company's capacity to redeploy resources effectively. Basically, an input-focused reward and incentive structure increases organizational commitment to collaborate with supply chain actors and the ability to reallocate resources in a more conscious, comprehensive, and dynamic manner. Therefore, reward and incentive structures characterized by a focus on inputs increase the effect of supply chain collaboration on the navigation of CE paradoxes. Consequently, the following hypothesis.

H7. *Input-focused reward and incentive structure positively moderates the relationship between supply chain collaboration and navigation of CE paradoxes.*

Clearly, recognizing the existence and persistence of tensions, rather than avoiding or eliminating them, implies a greater propensity to proactively confront them and to "become comfortable with the disquiet they provoke" (Miron-Spektor et al., 2018, p.11). So, companies that reach the step of recognizing tensions tend not to feel threatened by the paradoxes that inevitably arise in approaching the CE, but to explore them and continuously seek creative and effective solutions to manage them (Miron-Spektor and Beenen, 2015). For instance, in the case of the paper manufacturer illustrated by Daddi et al. (2019), recognition and acceptance of the tension between using recycled materials in the production process and poor product quality prompted the company to identify and implement an innovative solution to address the inconsistency, resulting in an opportunity. Recognition of tensions, therefore, enables the firm to accept polarities constructively, process them, and exploit them productively and dynamically (Smith and Lewis, 2011). Accordingly, the following hypothesis.

H8. *Recognition of CE tensions positively influences the navigation of CE paradoxes.*

3. Methodology

3.1. Sample and data collection

For testing the study's hypotheses, through a questionnaire-based survey, we collected data from a sample of Italian companies operating in the manufacturing and construction sector. The study's context offers a fruitful environment for testing the research hypotheses. First, manufacturing and construction are two of the most polluting and resource greedy sectors where CE practices can be more beneficial and attract the managers' attention (Kumar et al., 2019). Second, Italy has the second largest manufacturing sector in Europe and is characterized by a high polluting industries like pulp and paper, textiles, apparel and leather (Eurostat, 2022), which are one of the main targets of EU CE policy initiatives (European Commission, 2023). In addition, by limiting the scope to a well-defined geographical and sectoral context, the involved companies are presumably subject to similar field-level pressures (such as regulatory or normative factors) (Delmas and Toffel, 2010) offering a better field for exploring the role of organizational variables in recognizing and navigating tensions.

Although some scholars raised several concerns on the validity of survey-based research (Donaldson and Grant-Vallone, 2002), in designing the questionnaire, we adopted several procedural remedies to minimize bias that can affect survey-based research, such as common method bias (Podsakoff et al., 2003). First, for achieving a high content validity, we started from a deep review of the literature for obtaining acute stimuli. Second, we developed the measurement scale in close collaboration with four sectoral and CE experts from the trade association which sponsored the research, for better translating academic and

theoretical concept in an understandable jargon for the target audience (Dillman, 2007). Moreover, this approach helped us to formulate questions as simply, concisely, and specifically as possible, even with the support of examples, in order to avoid ambiguity or vagueness (Podsakoff et al., 2003).

Before sending the survey to the commercial provider we preliminarily evaluated and pre-tested the questionnaire (Collins, 2003). First, we conducted interviews with five academics, experts of circular economy management and five practitioners (both consultants and managers operating in apical positions in manufacturing organizations), where we asked to fill in the questionnaire and think aloud for checking the presence of misleading effects in the survey instrument. Second, a pretest was carried out with 12 organizations. As a result of the two pretest actions, some questions were simplified or rephrased.

Furthermore, a cover letter was included to provide detailed information and instructions and to guarantee the anonymity of the respondents, confidentiality and the independent objective of the study (Chang et al., 2010).

To avoid informant bias, the questionnaire was sent to a senior figure in the organization with a deep knowledge of organizational dynamics, able to observe the company from a 'top-down view', such as the president and vice-president, CEO, COO, CFO or general manager or their direct report with competencies on the operations.

The data were collected in June 2022. After discarding 29 incomplete questionnaires, 303 completed questionnaires were retained for analysis, representing a response rate of 55%. The sample is adequately balanced with respect to the population of Italian companies (excluding micro enterprises) in terms of geographical distribution, sectors and number of employees (Istat, 2023). Table 1 shows the composition of the sample.

3.2. Measurements

Most measures utilized in the study were developed based on already validated psychometric scales. Measurement scales were then adapted to the context of the study in close collaboration with managers, representative of Industrial Associations and academics so as to improve as much as possible consistency with the cultural and social patterns of the research setting and, thus, reduce common method bias (Chang et al., 2010). Both 5-point and 7-point agreement scales were used (Table 2).

Recognition of CE tensions –Starting from the scale "Experiencing tensions" developed by Miron-Spektor et al. (2018), by combining theoretical and practitioner knowledge, we identified the tensions that companies experience in implementing CE practices to capture the propensity of companies to recognize and accept these tensions as inescapable elements of corporate action. In detail, we relied on the conceptual systematization of the types of organizational tensions in the implementation of the CE provided by De Angelis (2021) and discussed them with managers and experts in the circular economy to select and frame the specific types of tensions that most closely resemble the business reality and to construct the items accordingly.

Navigation of CE paradoxes. Similarly to the construct "Recognition of CE tensions", we started from the scale "Types of tensions" proposed by Miron-Spektor et al. (2018), which refers on how employees can navigate tensions at work. Then, by combining the conceptual framework on CE tensions developed by De Angelis (2021) and deep discussion with managers and experts in circular economy for understanding how company can face those tensions, we adapted the scale to our study context, declining it from a corporate perspective and calibrating the paradoxes from a CE point of view, so as to value the companies' capacity to simultaneously cope with CE paradoxes over time.

Cognitive diversity – To measure cognitive diversity, we used the four-items scale validated by Van der Vegt and Janssen (2003) which is conceived to capture the heterogeneity in the mindsets, competencies, knowledge, visions and beliefs of organizational members.

Table 1
- Sample breakdown in terms of manufacturing sector, companies' geographical distribution, numbers of employees, year of company birth, role, age and gender of respondents.

Manufacturing sector	% of companies in the sample	Geographical distribution	% of companies in the sample	Number of employees	% of companies in the sample	Year of company birth	% of companies in the sample	Role of respondents	% of respondents in the sample	Age of respondents	% of respondents in the sample
Construction	19%	Northern Italy	54%	10–25	18%	1950 or before	7,90%	President	12%	<40	23%
Chemical Industry	8%	Northwest	30%	26–50	12%	1950–1959	3,00%	Vice president	5%	≥40 < 50	51%
Pharmaceutical Industry	17%	Northeast	24%	51–100	18%	1960–1969	7,60%	Chief executive officer (CEO)	8%	≥50	26%
Food Industry	12%	Central Italy	21%	101–250	18%	1970–1979	16,50%	General manager	14%	Gender of respondents	
Clothing, textile or related industry	12%	Southern Italy	25%	251–500	16%	1980–1989	15,50%	Chief operating officer (COO)	27%	Male	68%
Wood and furniture industry	9%	South	18%	>500	18%	1990–1999	17,50%	Chief Financial Officer (CFO)	6%	Female	32%
Paper and related products industry	5%	Islands	7%			2000–2005	14,20%	Manager Direct report of CEO	28%		
Other manufacturing activities	19%					2006–2010	8,60%				
						2011–2015	5,00%				
						2016–2020	4,00%				
						2021–2022	0,30%				

Supply chain collaboration – The scale was developed relying on the scales proposed by Cao and Zhang (2011). Specifically, we selected items related to decision synchronization, incentive alignment and resource sharing. These issues are suitable for providing a summary measure of collaboration with supply chain actors because they consider the sharing of decisional, strategic, and organizational aspects from a holistic perspective. Indeed, they directly or indirectly incorporate other specific aspects of collaboration, such as information sharing, convergence of goals, communication, and joint knowledge creation, thus representing a valuable proxy for the broad concept of inter-organizational collaboration (Soosay and Hyland, 2015).

Flexible Organizational design – To measure flexible organizational design, we referred to the scale developed by Perez-Valls et al. (2016), readapted in accordance with the theoretical frameworks of Ivory and Brooks (2018) and Child and McGrath (2001) to account for the various characteristics of a decentralized and flexible structure. Specifically, the measure used in this study incorporates five items related to horizontality of decision making, decentralization in goal setting, fluidity of organizational structure, and flexibility in resource deployment and role design.

Experimentation and dialogue space – The measurement was developed on the basis of the scales validated by Arnold et al. (2000) and Alegre and Chiva (2008). In particular, Arnold et al.'s (2000) measurement scale “Participative Decision-Making” was used to capture the propensity of the organizational context to give everyone the opportunity to experiment and express their ideas and opinions. On the other hand, Alegre and Chiva's (2008) scale “Dialogue” refers to an organizational environment able to stimulate free and open communication and dialogue. Therefore, we relied on both scales to obtain a broader measure aimed at capturing the encouragement of organizational members to express ideas and suggestions, to listen everyone's opinions, and to foster dialogue and reciprocal communication. We used all the items from the two validated measurement scales, except one highly generic item from the “Dialogue” scale and a very similar one for both scales, in order to avoid overlapping. Eight items were then implemented for this purpose.

Input-focused reward and incentive structure – To measure input-focused reward and incentive structure, we started from the emerging literature on procurement practices and technology use in the CE field, as inputs linked to circularity (Centobelli et al., 2021; Gusmerotti et al., 2019). Then, in close collaboration with managers and experts, we declined these practices in the form of input-focused incentive mechanisms. The measurement scale so developed incorporates four items on aspects regarding incentive structures ranging from the rewards of procurement from local and sustainable suppliers, to rewards for the use of resource-efficient technologies.

Control variables - Two company level variables are accounted as control variables in the study. Specifically, company age and company size (in terms of employees). Indeed, both size and age may potentially influence the company's ability to change decisions and strategies frequently and flexibly (Barker and Barr, 2002; Nadkarni and Narayanan, 2007), which is essential for the navigation of tensions underlying the CE. This potential influence has a twofold facet. On the one hand, larger and older companies may rely on more resources to support strategic actions in a flexible manner (Barker and Barr, 2002). On the other hand, smaller and younger companies may be characterized by a greater capacity to shift strategies dynamically, as they are less affected by structural inertia and focus on the status quo than larger and older companies (Nadkarni and Narayanan, 2007). Company size was measured by means of a multiple-choice question. Accordingly, we developed a categorical variable, dividing surveyed companies between small (i.e., less than 50 employees), medium (51–250 employees) and large firms (more than 250 employees). Similarly, company age was measured along eleven years categories (from 1950 or before to 2021–2022).

Table 2
– Questionnaire items and variables statistics.

Construct	Items	Standardized factor loading	Min	Max	Item average	Item standard deviation	Uniqueness
Recognition of CE tensions	ITEM 1: When implementing circular economy actions, we often face conflicting issues, such as the adoption of better resources from an environmental perspective and the associated increase in costs.	0.73	1	5	3.766	1.004	0.33
	ITEM 2: In our company, we often perceive strategic collaboration with our suppliers to adopt innovative circular practices at odds with maintaining a well-defined corporate identity and independence.	0.61	1	5	3.604	1.049	0.45
	ITEM 3: Often, when we ask whether the adoption of circular practices is aimed at creating and retaining value for the company or the community, the answers seem contradictory.	0.64	1	5	3.587	1.051	0.48
	ITEM 4: Achieving relevant economic performance while reducing the company's impact on the environment is a path with significant contradictions.	0.72	1	5	3.620	0.975	0.30
Navigation of CE paradoxes	ITEM 1: Our company implements circular practices while avoiding excessive costs.	0.68	1	5	3.766	0.953	0.45
	ITEM 2: Our company implements innovative circular practices while also relying on existing skills and knowledge.	0.70	1	5	3.739	0.981	0.49
	ITEM 3: Our company implements circular practices that satisfy its own individual interest while at the same time satisfying the interest of the community.	0.70	1	5	3.736	0.968	0.43
	ITEM 4: Our company maintains its individuality and autonomy in collaborative relationships with other actors in the circular supply chain.	0.71	1	5	3.828	0.958	0.35
	ITEM 5: Our company is original in the pursuit of environmental goals without undermining commercial ones.	0.68	1	5	3.733	0.965	0.43
	ITEM 6: Our company executes circular economy actions without, at the same time, compromising product quality.	0.73	1	5	3.782	0.966	0.36
Cognitive diversity	ITEM 1: The management figures in our company differ in the way they think.	0.76	1	7	4.762	1.448	0.32
	ITEM 2: The management figures in our company differ in their knowledge and skills.	0.66	1	7	5.050	1.364	0.43
	ITEM 3: The management figures in our company differ in the way they see things.	0.69	1	7	4.749	1.443	0.34
	ITEM 4: The management figures in our company differ in their beliefs about what is right and what is wrong.	0.77	1	7	4.805	1.354	0.33
Supply chain collaboration	ITEM 1: Our company and supply chain partners plan promotional events together.	0.73	1	5	3.644	1.054	0.38
	ITEM 2: Our company and supply chain partners jointly develop market forecasts.	0.75	1	5	3.700	1.029	0.37
	ITEM 3: Our company and supply chain partners jointly manage inventory.	0.79	1	5	3.525	1.187	0.36
	ITEM 4: Our company and supply chain partners jointly develop systems to evaluate and publicize each other's performance (e.g., a KPI, scorecard, and resulting incentives).	0.76	1	5	3.568	1.080	0.37
	ITEM 5: Our company and supply chain partners share costs (e.g., losses from order changes).	0.76	1	5	3.558	1.149	0.34
	ITEM 6: Our company and supply chain partners share all risks that may occur in the supply process.	0.74	1	5	3.614	1.064	0.39
	ITEM 7: Our company and supply chain partners define incentives based on shared investments and risks.	0.80	1	5	3.591	1.057	0.30
	ITEM 8: Our company and supply chain partners frequently use inter-organizational teams for process design and improvement.	0.75	1	5	3.647	1.031	0.38
	ITEM 9: Our company and supply chain partners share equipment (e.g., computers, machines etc.).	0.71	1	5	3.449	1.146	0.43
	ITEM 10: Our company and supply chain partners pool financial and non-financial resources (e.g., time, money, training).	0.76	1	5	3.475	1.165	0.34
Flexible organizational design	ITEM 1: In our company the goal-setting process is decentralized.	0.73	1	5	3.485	1.100	0.31
	ITEM 2: In our company the decision-making process takes place according to a horizontal structure.	0.75	1	5	3.528	1.091	0.36
	ITEM 3: In our company, organizational structures are fluid and not fixed.	0.75	1	5	3.597	1.044	0.39
	ITEM 4: In our company there is flexibility in the deployment and reconfiguration of resources.	0.76	1	5	3.663	0.993	0.34
	ITEM 5: In our company, roles are not rigidly specialized and defined.	0.63	1	5	3.515	1.082	0.44
Experimentation and dialogue space	ITEM 1: In our company, working group members are encouraged to express ideas and suggestions.	0.80	1	7	5.056	1.400	0.31
	ITEM 2: In our company we listen to the ideas and suggestions of the working group.	0.77	1	7	5.056	1.442	0.32
	ITEM 3: In our company, suggestions from the working group are used to make decisions concerning us.	0.80	1	7	4.967	1.451	0.31

(continued on next page)

Table 2 (continued)

Construct	Items	Standardized factor loading	Min	Max	Item average	Item standard deviation	Uniqueness
Input-focused reward and incentive structure	ITEM 4: In our company, all members of the working group are given the opportunity to express their opinions.	0.71	1	7	5.102	1.414	0.37
	ITEM 5: In our company we consider the ideas of the working group even when we disagree.	0.73	1	7	5.073	1.320	0.40
	ITEM 6: In our company, management makes decisions by considering the ideas of the working group.	0.79	1	7	5.030	1.415	0.32
	ITEM 7: In our company, managers facilitate communication within the work group.	0.80	1	7	5.221	1.335	0.30
	ITEM 8: In our company, teamwork among different business areas is a common practice.	0.73	1	7	5.191	1.311	0.38
	ITEM 1: There are incentive mechanisms in our company that reward sourcing from local suppliers.	0.71	1	5	3.330	1.149	0.37
	ITEM 2: In our company there are incentive mechanisms that reward the purchase of electricity from renewable sources.	0.63	1	5	3.208	1.215	0.34
	ITEM 3: In our company there are incentive mechanisms that reward the purchase of raw materials/semi-finished goods and services from suppliers that take into account aspects of circular economy (e.g., waste reduction, use of secondary raw materials, efficient resource management, other).	0.79	1	5	3.198	1.134	0.36
	ITEM 4: In our company there are incentive mechanisms to reward the use of technologies for more efficient use of raw materials.	0.68	1	5	3.304	1.185	0.35

3.3. Econometric model

For testing Hypotheses 1–3, 5–6 and 8, we applied the covariance-based structural equation modeling (SEM) as it allows for simultaneous testing of causal relationships between latent variables, in which hypotheses are structured based on a theoretical foundation to produce a covariance matrix between variables so that path coefficients can be estimated (Kline, 2016). In addition, the covariance-based SEM is a method considered appropriate for research that relies on explanations rather than predictions and provides a multitude of goodness of fit (GoF) indices to assess the compatibility between the conceptual model and the data (Latan et al., 2020). For testing Hypotheses 4 & 7, we used hierarchical regressions since it is recommended for testing the moderation on the relation between a predictor and a dependent variable, especially when variables are continuous (Frazier et al., 2004). Additional tests were conducted for checking the validity of our conceptual model, the presence of misspecification error (Schumacker and Lomax, 2016) and endogeneity bias (Fiorini et al., 2022). We used the Stata 17 software to execute our model and testing the hypotheses.

4. Results

4.1. Assessment of the measurement model

The evaluation of the measurement model was initially carried out by analyzing the hypothesized latent variables through factor analysis with promax rotation. Seven factors clearly emerged: two reflect the recognition and navigation of CE tensions, while the other five refer to the different organizational features investigated. We then tested the adequacy of sampling by calculating the Kaiser-Meyer-Olkin measure, which is 0.942; and we computed the Bartlett's test of sphericity index, which is highly significant ($p < 0.001$) (Kaiser, 1974).

Since we performed a SEM to test hypotheses 1–3, 5–6 and 8, using reflexive constructs as latent variables, we carried out a confirmatory factor analysis (CFA) to detect the psychometric properties of the measurement model (Hair et al., 2010). The CFA confirms the unidimensionality of the seven constructs, indicating that the measurement items load consistently on seven distinct factors, with standardized factor loadings ranging from 0.61 to 0.80 and uniqueness values less than 0.49 (Table 2). Robustness and validity checks confirm the good fit of the model: both the comparative fit index (CFI) and the Tucker-Lewis index (TLI) are 0.96 (both above the threshold of 0.90); the root-mean-square

error of approximation (RMSEA) is 0.034, well below the threshold of 0.08; the chi-square adjusted for degrees of freedom (χ^2/df) is 1.35, considerably below the threshold of 3.0; the standardized root mean squared residual (SRMR) is 0.043, lower than the recommended threshold of 0.08 (Kline, 2016). Furthermore, a post estimate test showed that multicollinearity is not a problem, as the mean variance inflation factor (VIF) amounts to 1.89 (which is considerably lower than the threshold of 4), the VIF for all variables is less than 2.5, and tolerance levels ($1/VIF$) are considerably higher than 0.25 (Kennedy, 2003).

Regarding convergent validity, all observed variables are significantly related to their latent construct ($p < 0.001$) and all regression coefficients are greater than 0.05. In addition, to assess the amount of total variance explained by each construct, we calculated the average variance extracted (AVE). All constructs show an AVE that meets the threshold of 0.5, with only two exceptions represented by recognition and navigation of CE tensions and paradoxes (0.46 and 0.49, respectively). Therefore, we calculated composite reliability (CR) for all constructs and saw that all latent variables show CR values ranging from a minimum of 0.77 to a maximum of 0.93, far above the recommended threshold of 0.6 (Bagozzi and Yi, 1988). So, since AVE is a more conservative measure than CR and given the exploratory nature of the study, the convergent validity of the latent constructs can be considered satisfactory (Fornell and Larcker, 1981).

The reliability and internal consistency of each latent construct was assessed by measuring the correlation between different items of the same construct. All Chronbach's alpha reliability coefficients are considerably greater than 0.7. Furthermore, we estimated Raykov's reliability coefficients (Raykov's ρ) for each latent variable (Raykov, 1997) and all values are above the recommended threshold of 0.7 (Hair et al., 2010), confirming the good reliability and consistency of the analyzed constructs.

Regarding discriminant validity, the squared correlations between latent variables are all below the 0.5 threshold, showing that items that do not belong to the same construct are only weakly correlated with each other. Then, following Fornell and Larcker (1981), we compared the AVEs with the squared latent variable correlations (Table 3). Since all the AVEs are greater than the respective latent variable squared correlations, the measurement model shows discriminant validity. In addition, discriminant validity was determined by evaluating Maximum Shared Variance (MSV) and Average Shared Squared Variance (ASV). Both were found to be lower than the average variance extracted (AVE) for all constructs (Hair et al., 2010). Finally, as a further confirmation of

Table 3
Squared correlations among latent variables; average variance extracted (AVE); Cronbach's alpha (CRA); Raykov's reliability coefficients (RRC); Composite reliability (CR); Maximum Shared Variance (MSV); Average Shared Squared Variance (ASV).

	Recognition of CE tensions	Navigation of CE paradoxes	Cognitive diversity	Supply chain collaboration	Flexible organizational design	Experimentation and dialogue space	Input-focused reward and incentive structure	AVE	CRA	RRC	CR	MSV	ASV
Recognition of CE tensions	1							0.456	0.77	0.77	0.77	0.44	0.30
Navigation of CE paradoxes	0.443	1						0.490	0.85	0.86	0.85	0.44	0.39
Cognitive diversity	0.388	0.297	1					0.518	0.81	0.81	0.81	0.40	0.30
Supply chain collaboration	0.323	0.381	0.195	1				0.572	0.93	0.93	0.93	0.46	0.33
Flexible organizational design	0.238	0.387	0.395	0.457	1			0.525	0.84	0.85	0.85	0.46	0.37
Experimentation and dialogue space	0.222	0.424	0.391	0.343	0.432	1		0.591	0.92	0.92	0.92	0.43	0.36
Input-focused reward and incentive structure	0.156	0.385	0.160	0.288	0.337	0.374	1	0.500	0.81	0.78	0.80	0.39	0.28

discriminant validity, we calculated the heterotrait-monotrait ratio of correlations (HTMT). None of the HTMT criteria violates the recommended threshold of 0.85 (Henseler et al., 2015). Therefore, these analyses provide no evidence of reliability and validity violations.

4.2. Common method bias

Although we minimized the risk of biases due to common method variance by introducing several procedural remedies during survey design, biases may persist since all variables were measured using the same source. Therefore, we performed two statistical post-estimation tests. First, we performed Harman's single-factor post-hoc test (Podsakoff and Organ, 1986), which is considered reliable when the reliability coefficients are not greater than 0.95 (Fuller et al., 2016). This test showed that the largest factor accounts for 36% of the variance against a threshold of 50%, and seven factors emerged with eigenvalues greater than 1.

Second, we performed the common method as suggested by Podsakoff et al. (2003). After performing a CFA inclusive of the method factor, we compared the substantive item loadings on the respective latent constructs with the item loadings on the method factor (Liang et al., 2007). All factor loadings on the analyzed latent variables are greater than loadings on the method factor. On average, the variance explained by the analyzed latent constructs was 54% greater than the variance explained by the common method factor. Based on the results of both analyses, we can affirm that common method bias is not a problem in our study.

4.3. Testing hypotheses

Testing hypotheses 1–3, 5–6 and 8

Since we used Maximum Likelihood (ML) as estimation method, three main parametric assumptions are necessary: adequate sample size, normal distribution of data, and absence of collinearity among predictors in the model. With regard to the sample number, according to Kline (2016) the minimum sample size should be 150. In this study, the sample size was 303 and meet the minimum sample size requirement. Regarding the normal distribution of the data, Kline (2016) suggested evaluating it through descriptive statistics such as skewness and kurtosis absolute values for individual variables, since Mardia's coefficient is highly sensitive to sample size and, thus, does not provide reliable information. Hair et al. (2010) stated that, when employing SEM, normal data are associated with skewness values between ±2 and kurtosis values between ±7. The skewness and kurtosis values of all our variables fall within these ranges. Therefore, the assumption of normality is satisfied. Finally, the assumption of collinearity was evaluated by calculating VIF values for each variable. All variables have VIF values less than 2.5 and the mean VIF is less than 4. So, the assumption of collinearity is also met.

The model exhibits a good fit: CFI and TLI amount to 0.97 and 0.96, respectively; RMSEA is 0.033; the χ^2/df ratio is 1.3248.

First of all, the results of the SEM indicate a statistically-significant and positive relation between cognitive diversity and recognition of CE tensions ($\beta = 0.51$, $SE = 0.079$, $p < 0.001$). Based on this result, Hypothesis 1 is supported. In contrast, we found that Hypothesis 2, related to the positive relation between flexible organizational design and recognition of CE tensions, is not statistically significant. However, Hypothesis 3, which predicted a significant positive influence of flexible organizational design on navigation of CE paradoxes is supported ($\beta = 0.30$, $SE = 0.075$, $p < 0.001$). Hypotheses 5 & 6, regarding the positive effect of supply chain collaboration on both recognition and navigation of CE tensions and paradoxes are also statistically supported (H5: $\beta = 0.43$, $SE = 0.080$, $p < 0.001$; and H6: $\beta = 0.18$, $SE = 0.078$, $p < 0.05$). Finally, results show a positive and significant influence of recognition of CE tensions on navigation of CE paradoxes ($\beta = 0.43$, $SE = 0.066$, $p < 0.001$), supporting Hypothesis 8. Table 4 displays the results of the SEM.

As far as concerns the control variables, none of them appears to

Table 4
Model paths, coefficients, Standard errors and p-values.

Paths	Coefficients	Standard errors	p-values
H1: Cognitive diversity → Recognition of CE tensions	0.51	0.079	0.000
H2: Flexible organizational design → Recognition of CE tensions	-1.22	0.105	0.240
H3: Flexible organizational design → Navigation of CE paradoxes	0.30	0.075	0.000
H5: Supply chain collaboration → Recognition of CE tensions	0.43	0.080	0.000
H6: Supply chain collaboration → Navigation of CE paradoxes	0.18	0.078	0.024
H8: Recognition of CE tensions → Navigation of CE paradoxes	0.43	0.066	0.000

have a statistically significant influence on navigation of circular economy paradoxes.

Testing hypotheses 4 and 7

Hypotheses 4 and 7, concerning the moderation roles of experimentation and dialogue space and input-focused reward and incentive structure, were tested by means of two hierarchical regressions. Following Frazier et al. (2004), two interaction terms were generated by multiplying the two predictors (i.e., flexible organizational design and supply chain collaboration) with the two moderators (i.e., experimentation and dialogue space and input-focused reward and incentive structure, respectively). So, for each pair of predictors and moderators, two distinct hierarchical regressions were structured, in which the dependent variable is represented for both by the navigation of CE paradoxes. Three models were run for both regressions: control variables were included in Model 1; in Model 2, the predictor and moderator variable were added; lastly, in Model 3, the interaction term (i.e., the product term between the predictor and the moderator) was entered.

Regarding Hypothesis 4, concerning the moderation of experimentation and dialogue space on the relation between flexible organizational design and navigation of CE paradoxes, Model 3 shows a statistically significant increase in R² ($\Delta R^2 = 0.022$, $p < 0.001$) and a significant and positive relationship between the interaction term and the navigation of CE paradoxes ($\beta = 0.146$, $SE = 0.044$, $p < 0.001$). Based on these results, Hypothesis 4 is supported.

With regard to Hypothesis 7, although in Model 3, R² increases statistically significantly ($\Delta R^2 = 0.007$, $p < 0.001$) and even the F-test is significant, the interaction term between supply chain collaboration and input-focused reward and incentive structure is not statistically significant. Accordingly, Hypothesis 7 is not supported. See Table 5.

Table 5
– Hierarchical regression results.

Dependent variable: Navigation of CE paradoxes	H4			Dependent variable: Navigation of CE paradoxes	H7		
	Model 1	Model 2	Model 3		Model 1	Model 2	Model 3
Firm age	0.010 (0.020)	-0.010 (0.015)	-0.010 (0.015)	Firm age	0.010 (0.020)	-0.003 (0.016)	-0.002 (0.015)
Firm size	0.014 (0.057)	0.010 (0.044)	-0.0001 (0.044)	Firm size	0.014 (0.057)	0.003 (0.045)	-0.006 (0.045)
Flexible organizational design		0.292** (0.054)	0.285** (0.053)	Supply chain collaboration		0.386** (0.049)	0.383** (0.049)
Experimentation and dialogue space		0.382** (0.052)	0.417** (0.053)	Input-focused reward and incentive structure		0.310** (0.048)	0.318** (0.048)
Flexible organizational design * Experimentation and dialogue space			0.146** (0.044)	Supply chain collaboration * Input-focused reward and incentive structure			0.099 (0.052)
Constant	-0.079	0.036	-0.014	Constant	-0.079	0.010	-0.030
F-test		**	**	F-test		**	**
R-squared	0.001	0.396	0.418	R-squared	0.001	0.387	0.394

Standard errors are in parenthesis. **, *statistically significant at the 1 percent and 5 percent levels, respectively.

4.4. Robustness check

To reinforce our main findings, we conducted additional checks. First, to further assess the validity of the conceptual model, three alternative models were constructed by changing paths among the latent variables. Then, goodness-of-fit statistics were compared across the four models in order to detect the most fitting model. Although all alternative models show good fit indices, the baseline model displays the best fit (see Table 6). In addition, since linearity between latent variables is another assumption of our model, we tested nonlinear effects to verify this assumption and the absence of quadratic effects. This is aimed at ensuring that there is no misspecification error in the model (Schumacker and Lomax, 2016). We used the linktest to assess this bias. The results of the linktest support the linear relationship in our model, indicating that the variable of squared prediction is never significant ($p > 0.05$) (See Table A1 in Appendix A). Finally, following Fiorini et al. (2022), we examined endogeneity bias through the Heckman test to ensure that our main empirical results are not affected by inverse causality, sample-selection bias, and omitted variables. We found no significance differences in the results with or without controlling for this bias, which confirms that our main findings were free from endogeneity bias (See Table A2 in Appendix A).

5. Discussion

The purpose of this study is to provide new insights into how organizations need to develop meta-capabilities and processes for recognizing the tensions that occur in the implementation of CE and navigating them through the adoption of new and creative solutions. In particular, we first identified the tensions that companies may experience in the implementation of circular practices (De Angelis, 2021). Then, interpreting through the lens of CE the framework of Ivory and Brooks (2018), we identified organizational factors potentially capable of stimulating a corporate paradoxical approach to the inconsistencies that circular actions involve (De Angelis, 2021).

Delving into the results, our findings show that the recognition of CE tensions is more likely for companies with internal cognitive diversity. Indeed, since CE is rooted in a systems logic it requires a plurality of interpretations to embrace its complexity from a holistic view (Desing et al., 2020). Although not specifically focused on CE, Hahn and Aragón-Correa (2015) and Hahn et al. (2014) stated that taking a more comprehensive perspective to recognize tensions in sustainability issues can be fostered internally through the endowment of organizational members with heterogeneity of skills, backgrounds and standpoints. Our result, thus, not only is in line with and validates this assumption but also extends it to the CE domain. Moreover, the literature has pointed to collaboration and interconnections with other partners as important

Table 6
Alternative models comparison.

Models	Paths	χ^2	df	χ^2/df	CFI	TLI	RMSEA
Original model	Cognitive diversity → Recognition of CE tensions	540.53	408	1.325	0.970	0.965	0.033
	Flexible organizational design → Recognition of CE tensions						
	Supply chain collaboration → Recognition of CE tensions						
	Recognition of CE tensions → Navigation of CE paradoxes						
	Supply chain collaboration → Navigation of CE paradoxes						
Alternative model 1	Flexible organizational design → Navigation of CE paradoxes	572.67	410	1.3968	0.963	0.958	0.036
	Cognitive diversity → Recognition of CE tensions						
	Recognition of CE tensions → Navigation of CE paradoxes						
	Supply chain collaboration → Navigation of CE paradoxes						
	Flexible organizational design → Navigation of CE paradoxes						
Alternative model 2	Cognitive diversity → Recognition of CE tensions	579.78	410	1.414	0.961	0.956	0.037
	Supply chain collaboration → Recognition of CE tensions						
	Flexible organizational design → Recognition of CE tensions						
	Recognition of CE tensions → Navigation of CE paradoxes						
	Recognition of CE tensions → Navigation of CE paradoxes						
Alternative model 3	Recognition of CE tensions → Cognitive diversity	652.59	415	1.5725	0.945	0.939	0.044
	Recognition of CE tensions → Flexible organizational design						
	Recognition of CE tensions → Supply chain collaboration						
	Cognitive diversity → Navigation of CE paradoxes						
	Supply chain collaboration → Navigation of CE paradoxes						
	Flexible organizational design → Navigation of CE paradoxes						

factors in adopting a systemic view with respect to CE (Genovese et al., 2017). This aspect is confirmed by the present study showing that supply chain collaboration, entailing the need to coordinate with other actors and to consider their points of view, is an organizational attribute that stimulates a broader perspective on CE issues, enabling the recognition of inherent tensions. In contrast, our results reveal that flexible organizational design does not stimulate recognition of CE tensions. One possible explanation for this unexpected result may relate to the role of organizational climate. Indeed, as stated by Chen and Huang (2007), for a flexible and decentralized organizational structure to trigger effective interactions and exchanges of perspectives, it is necessary the support of a consistent organizational climate oriented toward internal collaboration and cooperation among working groups and business units. Therefore, in order to gain a more holistic view of CE, it is not sufficient to leverage flexible and horizontal organizational design, but may also require the concomitant presence of a corporate climate that enhances its characteristics.

With regard to navigation of CE paradoxes, on the other hand, our findings acknowledge the importance of supply chain collaboration, flexible organizational design and recognition of CE tensions. First, studies have shown that collaboration with other supply chain actors enables a better management of available tangible and intangible resources, as it increases the ability to mobilize them efficiently and quickly (Eikelenboom and de Jong, 2022). In the context of CE, Khan et al. (2020) illustrated via case studies how collaboration with other actors enabled companies to develop innovative solutions to circularity issues by exploiting opportunities related to the acquisition of knowledge and recyclable materials. In this vein, our study suggests that supply chain collaboration contributes to the navigation of CE paradoxes. Second, in the literature flexible organizational designs have been found to stimulate more creative and innovative decision-making processes through horizontal and participatory setting (Chen et al., 2010), and the ability to quickly remodulate business systems through greater fluidity and adaptability (Teece, 2018). As indicated by Smith and Lewis (2011) in their seminal work, these capabilities are pivotal for dealing with tensions with a paradoxical approach, as they allow for continuous change and redefinition of business strategies to maintain the dynamic equilibrium that a paradoxical approach requires. Our results, therefore, confirm the relevance of flexible organizational design in navigating paradoxes and validate general propositions and assumptions even within the specific domain of CE. The same applies with reference to the positive influence of the recognition of CE tensions on the navigation of CE paradoxes that our findings display. Indeed, the literature has often pointed out in general terms that in order to manage tensions with a

paradoxical lens, it is necessary to first recognize and accept them, and then to find novel and effective solutions by turning challenges in opportunities (Miron-Spektor and Beenen, 2015; Smith and Lewis, 2011).

Finally, the current study reveals that the presence of an experimentation and dialogue space increases the effect of a flexible organizational design in navigating CE paradoxes. This finding is consistent with previous studies that have shown that establishing a business setting that encourages idea generation through moments of free experimentation and open sharing of opinions and knowledge is a booster for creativity and innovativeness (Donate and Guadamillas, 2011). In the specific context of CE, often hindered by the complexity of new technologies and the lack of innovations (Tura et al., 2019; Chen, 2023), experimentation has been explicitly recognized as a key factor in stimulating organizational learning, identifying opportunities and implementing innovative circular solutions (Bocken et al., 2021). Conversely, the moderation of input-focused reward and incentive structure on the relationship between supply chain collaboration and navigation of CE paradoxes is not statistically supported. Since circular solutions often require appropriate technical skills (Burger et al., 2019), increasing the effect of supply chain collaboration on the navigation of CE paradoxes may require combining an input-focused reward and incentive structure with other human resources practices, such as training programs on circularity for purchasing employees. This would increase capacity and awareness in mobilizing and acquiring resources dynamically. In this regard, Yu et al. (2017) identified the implementation of both adequate reward and incentive systems and environmental training programs as human resources practices likely to improve the effectiveness of collaboration with other supply chain actors and the related ability to manage available resources.

6. Conclusion

6.1. Theoretical contribution

The current study provides manifold contributions to CE and paradox theory literature by deepening the understanding of what organizational attributes and capabilities companies can leverage to adopt a paradoxical approach to CE that enables them to recognize and navigate the tensions inevitably arising in the implementation of circular practices. First, this study adds to the ongoing debate on the need to move beyond the dominance of the business case view within the CE (Dzhengiz et al., 2023). Indeed, some scholars have criticized the over-framing of circular initiatives within the win-win approach arguing that CE may not always lead to optimal results for the company or the

natural environment (van Loon et al., 2018). A more realistic and holistic perspective on CE should acknowledge its complexity by overcoming the focus on the business case assumption and considering the potential tensions and paradoxes. A few studies have highlighted that not all circular practices, although effective, are able to reduce costs for companies or contribute to their economic performance (Hopkinson et al., 2018; Dzhengiz et al., 2023). Often such practices can lead to tensions between conflicting economic, environmental and social objectives (Gusmerotti et al., 2019). Hence, for companies to successfully contribute to the circular transition, it is necessary to move beyond the utopian (and reductionist) view that circular initiatives are necessarily associated with win-win solutions and to address the complexity inherent in CE, with the tensions and paradoxes it entails. However, how companies can manage such complexity has remained an ambiguous and unexplored issue in the literature. In this vein, the current study advances the research on CE by investigating the organizational factors that companies can leverage to recognize and navigate over time CE tensions and paradoxes through a paradoxical lens. Such an approach is indeed critical for moving toward a “real utopia” (Gümüşay and Reincke, 2022), as it allows to adopt a broader (systemic) and dynamic view of CE, which takes into account its complexity and does not limit its boundaries to only instrumental solutions.

Second, an interesting aspect this study highlights is that in order to address CE tensions through a paradoxical lens, companies need to leverage multiple organizational levels. Indeed, we demonstrate that the development of a CE paradoxical mindset by companies necessitates organizational attributes concerning: individuals (cognitive diversity); organizational structure and setting (flexible organizational design and experimentation and dialogue space); and the supply chain (supply chain collaboration). Thus, our work contributes to the literature that investigates organizational transformation processes toward CE (Bocken and Geradts, 2020; Frishammar and Parida, 2019), shedding light on the importance for companies to holistically develop capabilities and practices concerning different organizational levels in order to embrace and address the complexity of circular transition.

Third, the study contributes to advancing research on Paradox Theory applied to sustainability issues at company level. Studies exploring the paradoxical approaches by which companies strive to manage the ambiguities arising with the integration of sustainability aspects into business dynamics have increased in recent years (Ivory and Brooks, 2018; Van Bommel, 2018; Bianchi and Testa, 2022; Slawinski and Bansal, 2015). Yet, this strand of literature has primarily focused on the study of trade-offs, tensions, and paradoxes with reference to corporate sustainability in general, analyzing them mainly from a conceptual point of view or through case studies (Van der Byl and Slawinski, 2015). Instead, the application of quantitative-deductive analyses, crucial for substantiating inductively developed patterns, has been neglected in the literature on Paradox Theory and corporate sustainability. At the same time, very little research has concentrated on the tensions and paradoxes that companies experience in the specific domain of CE and on their management (De Angelis, 2021; Daddi et al., 2019). Therefore, the current study not only advances understanding on how to stimulate corporate paradoxical approaches to inconsistencies that arise in CE implementation but is also one of the first to quantitatively investigate these issues at company level.

6.2. Managerial implications

The present research provides a number of implications for management. Overall, given the relevance of managerial action in defining structural connotations and orienting corporate perspective, the results of the study can help leaders understand the organizational factors they can leverage to address the circular transition in its complexity, and accordingly define a process of organizational transformation.

First, in order to recognize the tensions that inevitably arise in the implementation of CE practices, the study highlights the relevance for

companies to internally equip themselves with managerial figures characterized by a diversity of experiences, skills, and viewpoint. To this end, managers should orient the recruitment and selection processes of organizational members toward enhancing cognitive diversity (Burger et al., 2019).

Second, since flexible organizational design proves to be a determinant for developing new and creative solutions in response to CE challenges and dynamically shifting business processes and strategies accordingly, managers should engage in building horizontal structures and decentralized decision-making processes (Bocken and Geradts, 2020). Moreover, as shown by the present study, to nurture the effectiveness of flexible organizational design in navigating CE paradoxes managers should devote moments of experimentation and dialogue among organizational members. This could be facilitated by arranging periodic informal meetings, where everyone is encouraged to freely brainstorm ideas, opinions, and knowledge regardless of their specific role and competencies.

Third, given the importance of supply chain collaboration in both recognizing CE tensions and navigating CE paradoxes, leaders should pay attention to managing their collaborative relationships with supply chain actors (Genovese et al., 2017). In this vein, managers should take care to accommodate the demands and perspectives of the partners with whom they collaborate, not only for the sake of maintaining good inter-company relationships, but also to gain a broader view of CE challenges, which takes into account standpoints external to the company (Geissdoerfer et al., 2018). For example, practices of decision synchronization or incentive alignment could be effective for this purpose, as they presuppose the consideration in business strategies and operations of the needs and views of other actors. In addition, as illustrated, supply chain collaboration also plays a key role in navigating CE paradoxes by increasing the company's ability to reallocate and redeploy resources in an informed and dynamic manner (Cao and Zhang, 2011). In this regard, managers could implement, for instance, sharing practices of tangible and intangible resources, a coordinated inventory management, and actions to streamline information flows with other supply chain actors.

Finally, it is important to note that in contexts of global turbulence, such as the one we are currently experiencing due to exogenous events such as the Russian-Ukrainian or Israeli-Palestinian wars, tensions between conflicting objectives can be exacerbated. Indeed, such geopolitical crises have caused alterations in global markets and a huge increase in supply prices (Abou Houran and Dagestani, 2023). Therefore, companies may be more inclined to focus only on the economic sphere and neglect environmental aspects. In this regard, developing organizational capabilities that stimulate creative and dynamic responses to the challenges and conflicting elements that the external environment poses and exacerbates is a key task for managers and companies to increase organizational resilience and simultaneously pursue goals of a different nature.

6.3. Limitations and avenues for future research

The limitations of the current study help to trace directions for future research. First, our findings are based on a sample of Italian manufacturing and construction companies. Although a uniform cultural and institutional context helps to minimize biases, it may present limitations to the generalizability of our results to other types of firms and other countries characterized by different institutional and cultural contexts. Thus, additional empirical endeavors are needed to scrutinize the validity of our model across firms belonging to other industries and geographic areas.

Second, the cross-sectional approach of the present study based on key informants may bring out some potential causality issues. While we performed a wide range of controls on our model in order to rule out alternative explanations, future studies could validate the robustness of our findings through the adoption of diverse research designs, such as

longitudinal or experimental approaches, or by employing distinct data sources, such as archival data. Moreover, the cross-sectional data on which our research is based do not allow us to investigate temporal dynamics. Since tensions tend to resurface over time under a diverse shape (Hopkinson et al., 2018), future longitudinal studies could explore and substantiate how the identified organizational factors enable companies to address and manage CE tensions and paradoxes iteratively.

Third, to provide a more comprehensive picture, future research could design a strategy of inquiry based on an ethnographic or case studies approach to explore how companies can implement and develop the investigated organizational capabilities and practices as part of a process of organizational transformation toward CE.

Fourth, the current research focuses on a limited set of variables that do not necessarily take into account all the significant factors that influence the recognition and navigation of CE tensions and paradoxes. An example could be organizational slack. Indeed, since adopting new and creative responses to CE ambiguities does not necessarily coincide with the most efficient solution (Dzhengiz et al., 2023), having excess resources can help to support decisions even when they do not involve immediate returns and to change strategies more flexibly (Kennedy and Linnenluecke, 2022).

Fifth, our study does not consider the effect of exogenous shocks, such as the pandemic or the Russian-Ukrainian and Israeli-Palestinian wars we are currently witnessing. Such events, because of their detrimental repercussions on markets and society at large (Abou Houran and Dagestani, 2023), may intensify tensions between conflicting objectives and lead companies to neglect circular practices. Therefore, scholars could examine whether the organizational attributes investigated in this study are able to stimulate in companies a paradoxical approach toward CE even when the effect of disruptive shocks is taken into account.

Finally, in the present research we focused on the company-level tensions and paradoxes emerging from the uptake of circular initiatives. Thus, we see an interesting opportunity for further investigation into how the complexity inherent in CE can be interpreted and addressed even at the individual level (Burger et al., 2019; Bocken and Geradts,

2020).

In summary, this study suggests that organizational elements such as cognitive diversity, flexible organizational design, supply chain collaboration, and experimentation and dialogue space can foster a paradoxical approach to CE by companies, stimulating the recognition and/or navigation of the inherent tensions. Such an approach is crucial to embrace a holistic and systemic perspective of CE (De Angelis, 2021; Dzhengiz et al., 2023), and hence to overcome a simplistic and utopian view anchored only in win-win solutions, which risks “paralyzing” CE within a narrow and incomplete range of possibilities. Therefore, we hope that our study will fuel academic research and debate aimed at guiding and stimulating companies to be protagonists of sustainable development through the implementation of CE initiatives that consider the phenomenon in its complexity and comprehensiveness.

CRedit authorship contribution statement

Duccio Tosi: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Software, Visualization, Writing – original draft, Writing – review & editing. **Natalia Marzia Gusmerotti:** Funding acquisition, Project administration, Supervision, Validation. **Francesco Testa:** Conceptualization, Investigation, Supervision, Validation, Writing – original draft, Methodology. **Marco Frey:** Funding acquisition, Project administration, Validation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

APPENDIX A

Table A1
Linktest for the assessment of nonlinear effects

Recognition of CE tensions	Coeff.	Std. Error	p value
Variable of prediction (hat)	1.75	0.534	0.001**
Variable of squared prediction (hatsq)	-2.70	1.50	0.072
Navigation of CE paradoxes	Coeff.	Std. Error	p value
Variable of prediction (hat)	0.94	0.38	0.014*
Variable of squared prediction (hatsq)	0.23	1.03	0.823

Note: **, *statistically significant at the 1 percent and 5 percent levels, respectively.

Table A2
Assessment of endogeneity bias using the Heckman test

Structural path	Coef(β)	SD	z	Conclusion
Cognitive diversity → Recognition of CE tensions	0.197	0.072	2.73**	Not bias present
Flexible organizational structure → Recognition of CE tensions	0.056	0.075	0.75 ^{ns}	Not bias present
Supply chain collaboration → Recognition of CE tensions	0.266	0.074	3.57**	Not bias present
Recognition of CE tensions → Navigation of CE paradoxes	0.445	0.092	4.83**	Not bias present
Flexible organizational structure → Navigation of CE paradoxes	0.337	0.069	4.86**	Not bias present
Supply chain collaboration → Navigation of CE paradoxes	0.328	0.076	4.34**	Not bias present

Note: **, *statistically significant at the 1 percent and 5 percent levels, respectively; ^{ns} not significant.

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